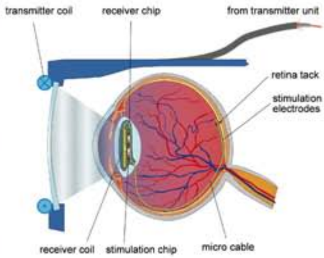
Fraunhofer Institut
Mikroelektronische
Schaltungen und Systeme

Annual Report 2007



Annual Report of the
Fraunhofer-Institut
für Mikroelektronische
Schaltungen und Systeme IMS
Duisburg
2007

Preface

Our 23rd year was characterized by a concentrated effort of our groups and departments, aimed at points of particular relevance. This gave rise to quite a number of remarkable successes and results.

The revenues from industry reached almost half of our budget. In absolute terms they grew by 23 % and thus much faster than our total budget, which grew by 7% compared to 2006. The buildup of activities was supported by a corresponding addition of eleven employees to our staff; in 2008 we plan to add another eight people. The growth of industrial demand during 2007 and the high interest of the public funding authorities in topics of innovative potential promises considerable growth in the next years.

The cooperative CMOS ramp-up, together with our industrial partner ELMOS, lead to an average 70 wafer fab outs per day. In 2008 we aim at 125 wafer fab outs daily. Several customer audits were passed successfully, the number of products released by customers is now 15. The process freeze for our new production process L035 was reached in December 2007; the first MPC runs for product designs will be launched in January 2008.

After start of full operation of our clean room extension for production lithography, our new micro system lab was partly equipped with machinery for post-processing of CMOS devices. Its main objectives are development and fabrication of IR imagers and biohybrid sytems on 8" silicon wafers. This project is supported by the European Community, German Federal Government, Northrhine-Westphalian State Government and the Fraunhofer-Gesellschaft.

In September we started the Fraunhofer Strategy Process, the first part will be finished by an external technology audit in March 2008. Nine designated industrial, commercial and scientific experts will examine our own vision, give comments on our intended future development and thus help us finding our way.

Our Wireless Sensor Networks have found further applications in agriculture, cofinanced by the INTERREG IIIA Program of the EUREGIO Rhein – Waal and the ministries of economics of the Netherlands and Northrhine-Westphalia.

During this year, we hosted the 3rd European RFID Workshop and the inHaus-Innovation-Forum in Duisburg.

In May '07 we laid down the foundation stone of "inHaus2", the commercial smart building complement to our "inHaus1" for the smart home segment. The construction made good progress, so that the topping out ceremony could be held in August. In her address Minister Thoben of the NRW Ministry of Economic Affairs and Energy pointed out the importance of these new technologies for the site of Duisburg and NRW as a whole.

Together with leading companies in pertaining business fields and eight more Fraunhofer-Institutes we will develop system solutions to reduce building and operating costs and to optimize operational processes in these commercial buildings. The different sectors of the inHaus2 facility cover offices, hotels, hospitals and senior care institutions of the next generation.

Our staff canteen has become a lively meeting point for our employees and visitors and its services are widely appreciated. The social rooms for our technology operators have been thoroughly renovated.

The affirmative cooperation with our long-term industrial partners, and the confidence of our government authorities in our ability to find adequate innovative solutions led to the unique position of IMS in the R&D landscape of the region and beyond. We thank our highly motivated and dedicated staff members, who never cease to attain their goals in today's fast moving R&D markets.

Anton Grabmaier

Contents

Contents

Profile of the Fraunhofer IMS

The Fraunhofer Institute of Microelectronic Circuits and Systems (IMS)

The Fraunhofer Institute of Microelectronic Circuits and Systems (IMS) was established in Duisburg in 1984. The Fraunhofer IMS is, through continued growth and innovative research and development, one of the leading institutes in Germany for applied research and development in microelectronic and CMOS-technology.

Fraunhofer IMS

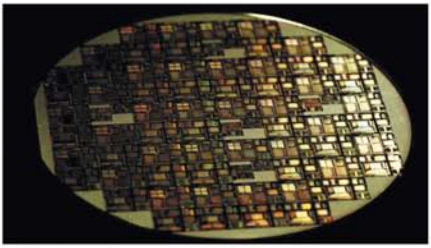
Employees	203
Budget	17 Mio. Euro
Industrial Projects	50 % of Budget
Public Projects	35 % of Budget
Fraunhofer Projects	15 % of Budget

200mm-CMOS-cleanroom

Infrastructure

The IMS offers a wide range of services and production of in silicon based devices and systems.

The fabrication takes place in class ten cleanrooms, wafertestingrooms and an assembly-line with together more than 1600 square meters.



Multi-project-wafer

Fraunhofer IMS Wafer Fab

Wafer size	200 mm (8 inches, 0.35 µm)
Cleanroom area	1300 square meters
Cleanroom class	10
Employees	app. 90 in 3 shifts 7 days a week
Capacity	> 70.000 wafer/year

CERTIFICATE

The TÜV CERT Certification Body
of TÜV Rheinland Cert GmbH
certifies in accordance with
TÜV CERT procedures that

Fraunhofer

has established and applies a quality management system for

Research, Development, Production and Distribution of
Microelectronic Circuits, Electronic Systems, Microsystems,
Sensors and Actuators, Test Equipment and Technologies
as well as Consultation in these Fields

DIN EN ISO 9001:2000

TÜVRheinland®

CERTIFICATE

The TÜV CERT Certification Body
of TÜV Rheinland Industrie Service GmbH
certifies in accordance with
TÜV CERT procedures that

ELMOS AG

ELMOS Semiconductor AG

has established and applies a quality management system for

- with product design and development -

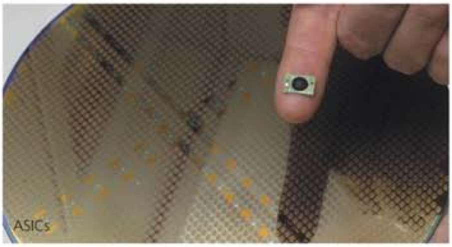
ISO/TS 16949:2002

IMS-Production and Development

The Fraunhofer IMS develops, produces and assembles smart sensors, integrated circuits and discrete elements (ICs and ASICs). It also offers the fabrication of devices on a professionally managed CMOS production line in small to medium quantities.

Our know-how has been applied in shavers for Braun, a self-ballasted lamp for Osram and many other applications for customers from every field of industry.

The ICs are assembled in the cleanroom (400 square meters) of the Fraunhofer IMS assembly facility. This facility supports the production of ICs in ceramic packages or as COB (Chip on board, COB). COB assembly is available from small quantities to several million units per year.

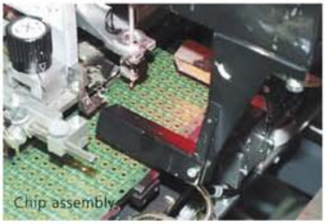

ASICs


Shaver


CMOS-camera

Self-ballasted lamp


Assembly


Chip assembly

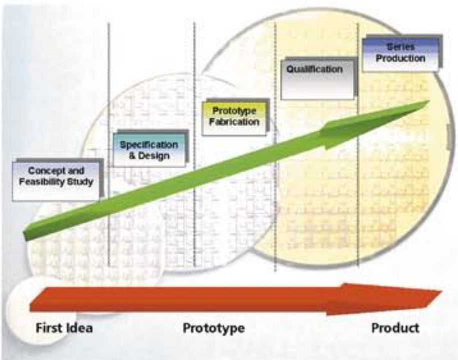
Supply and Service

The Fraunhofer IMS offers R&D services tailored to our customer needs, providing efficient solutions ranging from the initial studies to the series products.

Cooperation possibilities:

- studies and feasibility studies
- consulting and concept development
- demonstrator and prototype development
- chip production (ASIC Production)
- development of soft- and hardware

From idea to production



Fraunhofer IMS Business Fields and Core Competencies

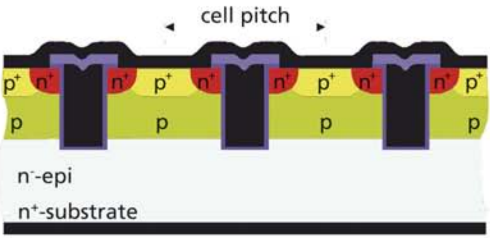
High Temperature SOI CMOS Process

The high temperature SOI CMOS process uses SOI substrates for the production of ASICs that operate at temperatures of up to 250° C.

Only fully CMOS compatible process steps are used to manufacture not only standard CMOS circuit elements, including EEPROM, but also silicon based sensors, actuators and power devices.

Power Devices

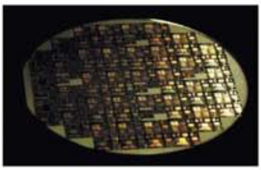
In close cooperation with industrial partners, Fraunhofer IMS provides a 600V-CMOS-process for half- and full bridge driver chips for IGBTs. Also a novel discrete power MOS transistor process based on trench technology has been developed at IMS. It features an ultra low on-resistance so that transistors with less than 1 mOhm on-resistance can be realized on a small die, while keeping the number of process steps low. Such low loss switches are used in power supply, automotive and other low voltage applications.



CMOS Fabrication

Fraunhofer IMS provides numerous semiconductor production services in its 200 mm CMOS production line. The professionally managed class 10 clean room has more than 1600 m^2 floor space. The 24 hour, 7 days a week operation ensures the uniform quality of our products.

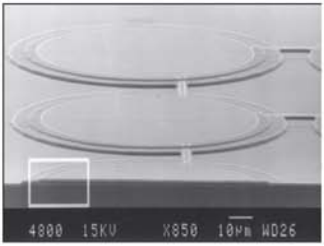
The Fraunhofer IMS production line especially caters to the production of smaller and medium quantities of ASICs. The production line operates under an ISO 9001:2000 and TS 16949 certified quality management system, assuring stability and reliability of products and production. Timely, reliable and customer-oriented production is our and our customers key to success.



2. Sensors

Pressure and Temperature Sensors

The basic element of our pressure sensors is a micromechanical sensor that is fabricated using standard CMOS processing equipment. These sensors can be realized for a wide range of pressures, sharing a single chip with all electronic devices available in a CMOS process, e.g. MOSFETs, capacitors or EEPROMs. The sensors can be configured as absolute or as differential pressure sensors, both with capacitive readout. The necessary signal conversion, linearization and amplification circuits are realized on the same chip, effectively eliminating interference on sensor wiring that is a major issue for discrete solutions. We have already created a variety of innovative products using this monolithic integration of sensors and signal processing functions like programmable amplifiers, sensor linearization, temperature compensation or wireless interfaces.



The layout of the sensor element determines its pressure range, which may be situated between 0.5 to 250 bar, as the sensor diameter controls the stiffness of the membrane: Smaller and stiffer membranes shift the pressure range to higher pressures. Thus the sensors are suitable for the measurement of pressures ranging from blood, air, and tire pressure all the way to hydraulic oil pressure. The small size of the sensor and its associated electronics enables innovative medical applications for the in vivo measurement of the pressures of blood, brain, eye or other body fluids.

CMOS Image-Sensors and Sensor System

Fraunhofer IMS image sensors are based on CMOS technology, which enables the monolithic integration of sensor and circuit elements on a single chip. This integration is used e.g. to control the sensitivity of each individual pixel to avoid blooming.

CMOS Image sensor

CMOS Camera

A wide range of CMOS image sensors has been developed for our customers and in research projects. The realized sensors include high dynamic range sensors, high speed sensors – which deliver 1000 high quality images per second – low power sensors with less than 40 mW of power consumption and high-resolution sensors with "region of interest" function for faster readout of subsections of the pixel array.

The CMOS image sensors suppress smearing and blooming effects and always deliver sharp images. Their electronic high-speed shutters enable the realization of 3D imagers.

Comparison of images taken with CCD (left) and CMOS (right) cameras

Our customers, among them BMW AG, Siemens VDO and EADS, use our know-how for concepts and designs of CMOS image sensors.

A newly established field of research and development now extends the spectral range of our imagers into the far infrared (FIR, 8–14 µm). This will be achieved with microbolometer arrays that are integrated on a CMOS chip. Packaged in an evacuated case with IR-transparent lid for thermal insulation these sensors will open up a new window to the world, providing a new solution for many applications.

3. Smart Buildings Embedded Systems Hardware and Software

InHaus1: The Innovation Workshop for Private Homes and the Housing Industry

After a successful first phase 2001 to 2006, the internationally acclaimed inHaus1 home innovation facility has now started its second operating stage. In the living laboratory and workshop area we have developed in close co-operation with users and research, service and industrial partners, networked systems solutions for private homes and the housing industry. These systems use new technologies to save energy, increase security, provide support for senior citizens and sick people, and generally improve life at home. Our spin-off inHaus GmbH has realized more than 100 smart home systems since 2004, for the housing industry and private home owners in both new home and home upgrade projects.

InHaus 1

InHaus2: The Innovation Workshop for Commercial Buildings

In March 2007 began the construction of the inHaus2 research facility. This research platform for modern commercial buildings will provide a realistic environment for the development, deployment and testing of innovative techniques and products. The main R&D objectives are operating cost reduction and workflow optimization in commercial buildings. Right from the beginning new techniques will be implemented to optimize the construction process of the inHaus2 facility itself, e.g. using RFID-tags collecting data which will give information for facility management later on.

In different sectors of the inHaus2-facility, new systems solutions for future hotels, hospitals or retirement homes will be put to the test. Another field of research is offices that adapt to the user's behavior.

The inHaus Center offers R&D and complete systems-solutions to builders, modernizers or operators of homes and commercial buildings, to implement complete electronic and ITC systems for new and added value functions. This includes the following aspects:

- Safety and security
- Multimedia
- Support for the elderly
- Energy saving
- Light management

InHaus 2

4. ASIC Design and Development

The development of analog, digital and mixed analog-digital integrated systems is a core competence of Fraunhofer IMS. Application specific integrated circuits (ASICs) enable our customers to provide cheaper and more powerful products. We offer the full spectrum from custom to IP-based ASIC solutions.

Full-Custom ASICs are designed from scratch to accommodate the specific requirements of the customer, providing a highly optimized product. The IP-based ASIC is based on proven generic components, with lower design time and cost. Using a mix and match approach both design styles can be combined to leverage the benefits of both.

The close co-operation with our in house CMOS production line provides a seamless and efficient path from concept to series production. Our long experience in the development of integrated circuits, starting from concept through design, layout, and fabrication to testing ensures a short development time and a minimized design risk.

Our fields of design expertise are:

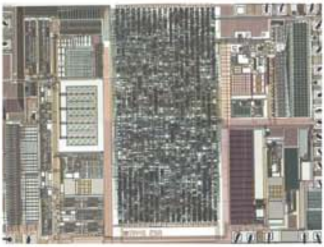
- Embedded microcontroller, IP-cores
- High-temperature ASICs
- Smart power integration
- Non-volatile memories
- Mixed-signal design
- Sensors and sensor signal processing
- RFID and transponders
- Wireless systems and radio frequency circuits
- Wireless sensor networks

Beside standard ASIC solutions for all kinds of applications, ASICs with sensors and sensor signal processing integrated on a single chip have been realized.

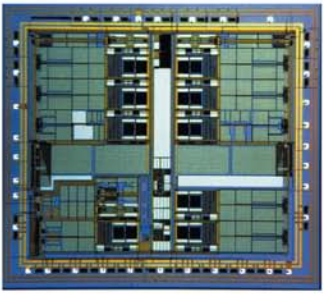
These ASICs often combine our core competences in ASIC design,

- System-on-Chip (SoC) solutions with micro system technologies,
- Mixed-signal signal processing and
- Integration of RF building blocks for wireless energy and data transfer.

These wireless and transponder based micro systems including integrated sensors are challenges for modern micro electronic and micro system technologies. Our customers benefit from our research in these areas, which provides viable solutions for their applications – applications that demand miniaturization, energy-efficiency, cost-optimization and reliability.



Fraunhofer IMS
ASIC with integrated pressure sensors



Fraunhofer IMS
CMOS ASIC

5. Wireless Systems and Transponders

A core-competence of Fraunhofer IMS is the development and realization of wireless systems. Research and development focuses, among other things, on wireless sensor networks. These networks comprise autonomous sensor modules that are distributed over a large area or volume, and measure physical, chemical and other quantities. The measured values are transferred to a central agency, making use of intermediate nodes for data transfer, or they can be used by similarly distributed actor modules for decision-making and control processes.

Development in this field includes new methods for communication (e.g. protocol stacks, localization) and the realization of cost-efficient, miniaturized components. The realization of new products in an efficient and timely manner is facilitated by the use of modular hardware and software components that allow a quick adaptation to application requirements.

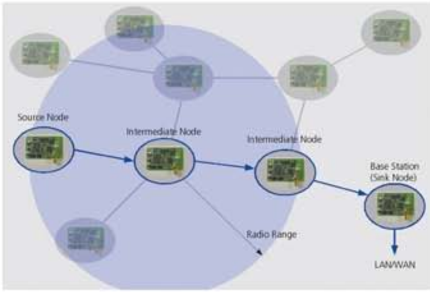
High-frequency measurement chamber at Fraunhofer IMS

The advantages of wireless sensor networks were successfully demonstrated in various projects addressing a variety of environments.

Important applications of **wireless sensor networks** are in the field of:

- Industrial automation, e.g. logistics and inventory control.
- Agriculture e.g. monitoring of air and soil parameters.
- Facility management, e.g. remote monitoring of buildings and infrastructure elements.

Sensor-network in green house



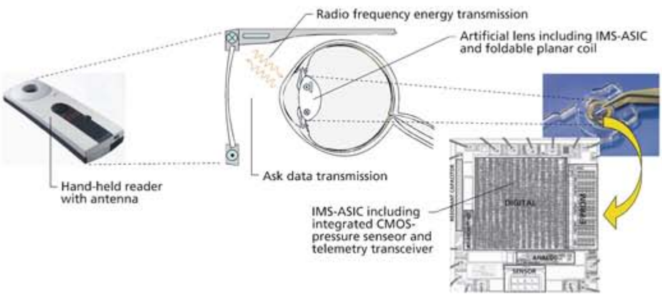
Topology of wireless Sensor-networks

Our customers face a number of challenges that are adressed by our R&D activities. One set these activities addresses tools for network development, deployment and maintenance. Others address the field of energy harvesting, the ability to extract module power from the environment and obviating the need for batteries or power cables.

The **transponder systems** unit at the Fraunhofer IMS offers system solutions for the integration of novel portable or stationary transponder read-write devices and base stations into smart network-systems.

It also provides base stations for transponder ASICs with integrated micro sensors developed at Fraunhofer IMS, thus offering complete system solutions.

These transponder systems are used in smart buildings and vehicles, industrial automation, medical devices and logistics.

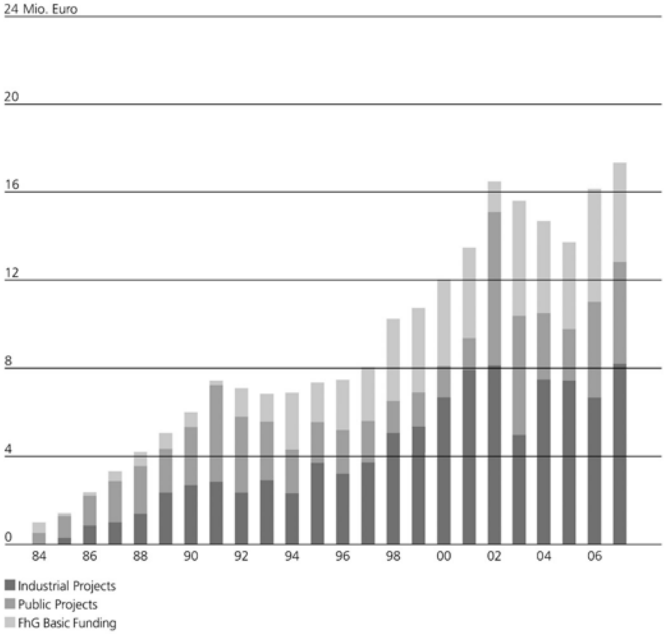


Transponder System Example: Intraocular Pressure Measuring System

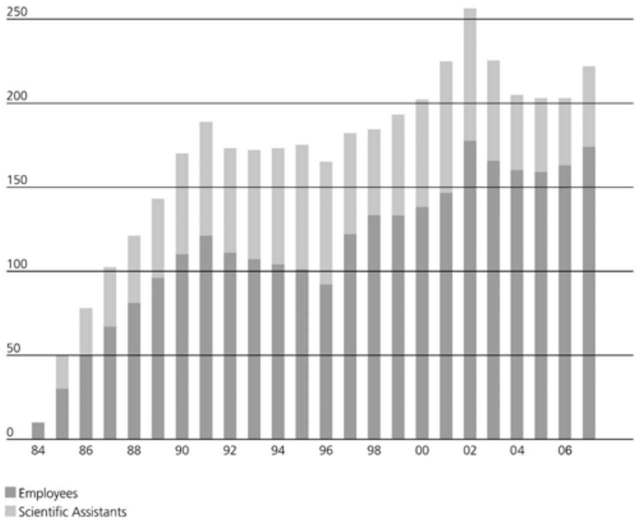
Development of the IMS

Development of the IMS

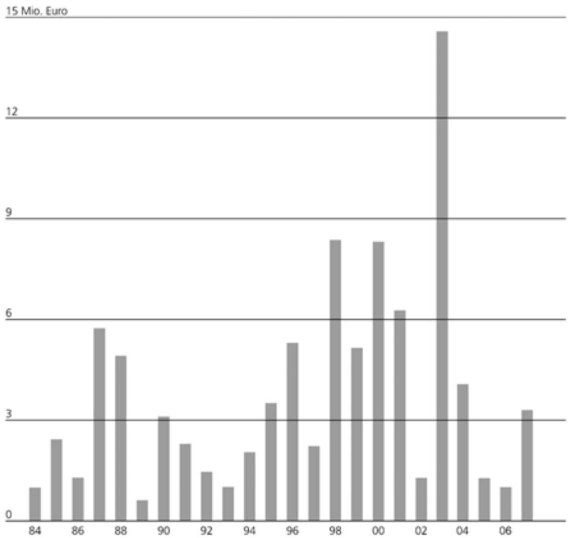
Budget IMS



Staff Members IMS



Capital Investments IMS



Selected Projects of the Year 2007

Development of a 0.35 µm Smart Power CMOS Process for Automotive Applications

Uwe Paschen

Introduction

One of the most demanding fields for Application Specific Integrated Circuits (ASICs) is in automotive applications. Increasing circuit complexity, very high requirements concerning reliability and the permanent striving for cost efficiency demand versatile smart power CMOS processes. These must combine several features: Mixed-signal (i. e. analog and digital) capability, small feature size in order to realise dense complex digital intelligence on the chip as well as robust high voltage/ high current devices for interfacing with a harsh electric environment.

In this report the main features of a new Smart Power process with 0.35 µm feature size, which was developed in close cooperation with ELMOS Semiconductor AG, is described.

Smart Power CMOS Process

The main features of the process construction are depicted in Figure 1.

The process comprises LOCOS isolation and two gate oxides. The thick gate oxide is employed for robust analog devices, the thin one for high density digital devices. Other process features are dual work function gate polysilicon, salicide (self aligned silicide), CMP for planarisation, Tungsten plugs and 4 metal layers.

The process is constructed in a modular way. Therefore, depending on the requirements of the application, several process options can be added or omitted without affecting the rest of the process. The main process options include high voltage capability, nonvolatile memory (EEPROM, Flash), a second polysilicon layer (capacitors, flash memory cells) and salicide blocking.

An SEM cross section of the full process is shown in Figure 2. Contact as well as via1 and via2 level are planarized by CMP, the respective holes are filled with Tungsten plugs. Via3 is realized with relaxed design rules so that no Tungsten fill is required here.

Figure 3 shows an SEM cross section of a transistor with silicided polysilicon and Soure/Drain regions. The silicide serves to enable low sheet and contact resistance. The silicide formation can be blocked in order to make high resistivity resistors possible.

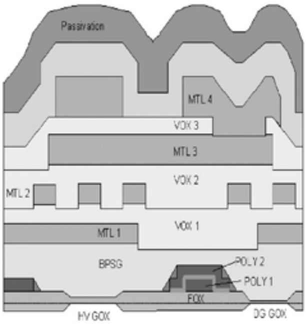


Figure 1: Schematic process cross section

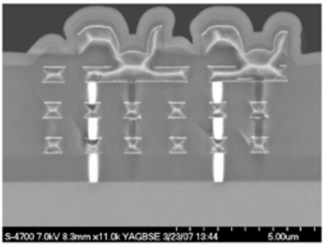


Figure 2 SEM cross section of the backend of the process

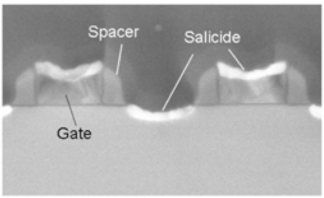


Figure 3: SEM cross section of a transistor

Devices and Design Rules

In Table 1 the main geometrical design rules of the process are summarized. The small feature sizes enable the cost efficient integration of high density logic and therefore increased "intelligence" on the chip. For mixed signal design voltage independent capacitors and high resistivity poly silicon are available.

Besides logic devices with 3.3V operation voltage which are optimized for high density design several other types of devices are available. This includes high voltage transistors like those described in Table 2. Several additional transistor types are also available. They are developed in order to ensure an optimum balance between maximum allowed voltage and area consumption. For example special transistors are employed in the nonvolatile memory arrays, because here the transistor size is critical for the area consumption of the whole array.

Summary

A versatile Smart Power process with a modular process concept was developed. The process offers a wide range of devices for different voltage classes and is thus capable to address a broad variety of applications. While one focus is on the automotive field, however, other fields that are characterized by harsh electric environment and/or require relatively high voltage or high current capability, like for example industrial electronics, are also very interesting markets for this technology.

Designrules (µm)		
	Width	Pitch
Active Area	0.48	1.2
Polysilicon	0.36	1.0
Contact	0.4	1.0
Metal1	0.48	1.0
Via1	0.4	1.0
Metal2	0.48	1.0
Via2	0.4	1.0
Metal3	0.64	1.24
Via3	1.44	3.0
Metal4	1.44	2.8

Table 1: Selection of relevant geometrical design rules

Device	max. voltage
DIMOS	40–60V
HV pmos	60V
HV pnp	60V
nmos with field oxide as gateoxide	80V

Table 2: Selection of special High Voltage devices

IP cell based SoC Design

André Lüdecke

Abstract

With the continuous increase in system-on-a-chip (SoC) complexity, the development and application of reusable sub-components (Intellectual Property components, or short: IP cells or IP cores) has become essential to meet requirements in reliability, correctness and time to market. IP cells serve as basic building blocks of a larger SoC design. The reuse of IP cells may be as simple as using standard cell libraries, meant for general ASIC (application-specific integrated circuit) designs or specifically designed for high performance or low power designs. Another field of application for IPs involves the reuse of common complex design entities like memories, ADCs, PLLs etc. This article will give a short overview of this last category of IP cells regarding the integration into the design flow of a SoC design and the development of such IPs.

Introduction

Modern SoCs often include processors or controllers, memory blocks (ROM, RAM, EEPROM or Flash), real-world interfaces such as data converters, filters or phase-locked loops and other large building blocks, which often lead to a multi-million gates design. It is impossible to design such a system from scratch within a reasonable time frame. The reuse of complex IP cells, already used and tested in previous designs, can dramatically decrease the design time while the development risk can be reduced at the same time. In best case almost the entire SoC can be realized with the functionality of the available IP cells and only a few function blocks must be developed. This leads to a so-called structured ASIC design (also referred as platform ASIC design).

Generally IP cells can be classified into soft, firm and hard IP [1]. The difference is in the degree of flexibility of the cell:

- Soft-IPs are in the form of synthesizable HDL descriptions (e.g. VHDL or Verilog RTL models), which can be parameterized and synthesized by the user. They offer the largest flexibility.

- Hard-IPs are provided as fully routed layout (e.g. in GDS II format) that could be printed directly onto an ASICs mask. They are targeted to specific applications and intended for use in the specific technology associated with them. Therefore, Hard-IPs are not reusable in a more general sense. But, by the nature of their low-level representation, they offer better predictability in terms of timing-performance and area.

- Firm-IPs are somewhere in between: they are usually presented as netlists, which are optimized for a specific technology, but the cells can be migrated from one process to another. The netlist of the IP comes together with detailed information about the behavior, the layout and simple analytic models that capture the performance characteristics of the cell. Therefore the user has to "harden" the IP cell for the target process.

Design methodology and IP integration

In digital design the development of CAD tools that automate parts of the design process has helped to establish a top-down design methodology which starts with a HDL description of the system. This description is partitioned and refined in the following design steps, so system simulations on different levels of abstraction can be performed. The major advantages of such a design approach are the validation of the system specification in an early design stage and the verification of all following design steps through simulations. Logic synthesis, placement and routing than maps the HDL description to gates, and the gates to the final layout. Figure 1 shows the digital top-down design flow at IMS.

Virtually all digital IPs start out as Soft-IP cells, where the IP consists of a HDL description that can be synthesized for the target process. Thus digital Soft-IPs can be easily integrated in the shown digital design flow. Therefore only the IPs HDL description has to be included in the (partitioned) model of the entire design.

When comparing digital and analog CAD tools and the resulting automation and efficiency of the design process, it is unrealistic to expect a similar design flow for analog and mixed-signal designs as for digital designs. The main problems derive from the fact that most parts of an analog or mixed-signal design must be developed manually in a bottom-up design flow, because of the lack of available CAD tools which support higher levels of abstraction, leading to automatic synthesis. On the other hand analog hardware description languages (AHDLs, e.g. VHDL-AMS or Verilog-A) have been established, which provide modeling capability at system level, enabling the co-simulation of mixed-signal designs. With a library of analog IP cells and their associated behavioral models, it is possible to implement a top-down design methodology for mixed-signal designs, based on modeling and simulations within a reasonable time frame. The models of the IP cells can be integrated in the partitioned system model.

However, due to the specific features of analog design, almost all analog IP cells will need modifications. These modifi-

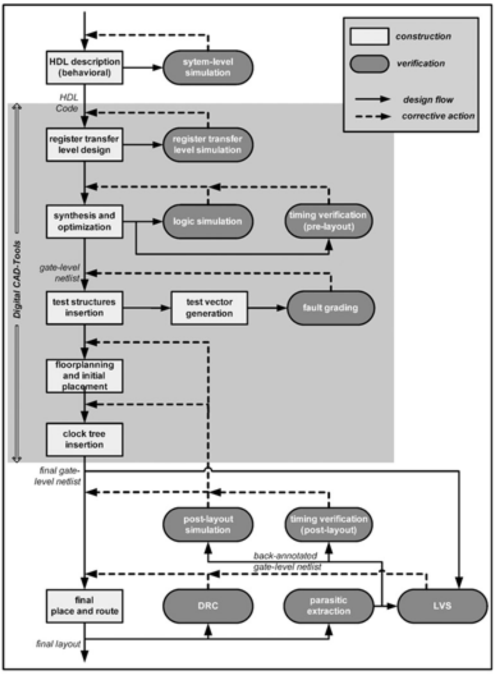


Figure 1: Digital design flow at IMS

cations are realized in the following bottom-up design flow, where each design step can be validated through the corresponding simulation model. The resulting design methodology is shown in figure 2. To realize such an design flow, the analog IPs must be available in at least the firm IP category with the following components [2]:

– Analytical View (computational models)
– Behavioral View (VHDL-AMS or Verilog-A)
– Schematic View (transistor level)
– Physical View (layout)
– Test Benches

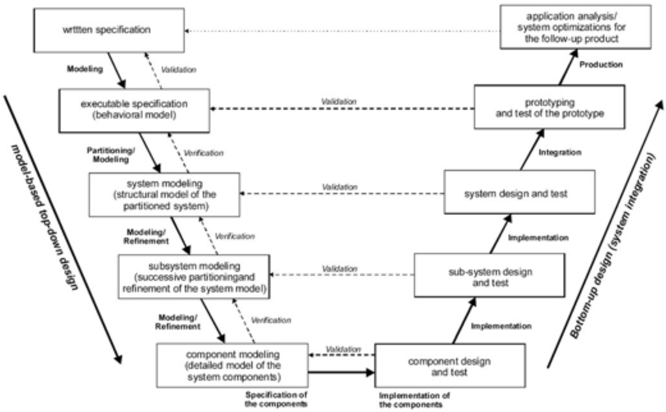


Figure 2: Mixed-signal design flow

IP development

To derive benefit from the reuse of IP cells it is necessary that the function of the IP is specified, verified and documented accurately. For this reason one of the main tasks in IP development is the qualification of the IP cells [3][4]. This qualification covers code quality, design quality and physical validation. Code quality affects the reusability, maintainability and portability of IP cells. The design quality is determined by the measurement of area, power and timing. These values can be compared to the design requirements. A reference implementation and dedicated measurements act as physical validation. Anyway, the extra cost of reusability should not exceed the added value.

To support the broadest range of applications and provide the highest reuse benefits, IPs should have the following features [1]:

– Configurable to meet the requirements of many different designs

– Standard interfaces

– Compliance with defensive design practices to facilitate timing closure and functional correctness

– Complete set of deliverables to facilitate integration into a chip design

Summary

The use of IP cells is necessary during the design of complex SoCs to meet the demands on time to market and to achieve a high level of design confidence. It helps to minimize "re-inventing the wheel" in the design process and thus decreases the design time. Moreover, the integration of tested IPs allows to improve the design flow for analog and mixed-signal designs, so the development risk can be reduced. At the IMS a wide range of IP cells like microcontroller cores, analog/digital converters or analog front-ends with different functionality are available. Custom specific IPs can be developed on request for use in IMS process as well as for use in a customer process.

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First human study of a fully implantable retina implant

M. Görtz, I. Krisch, H. K. Trieu

Background

Electrical stimulation of the retina has been considered as a possible treatment in cases of blindness associated with retinitis pigmentosa (RP) or other progressive degenerations of the retina.

Research groups worldwide are working on implantable devices for stimulation of the retina, the optic nerve or the visual cortex. Several groups have demonstrated that phosphenes can be elicited by electrical stimulation in blind subjects suffering from RP. One of the major issues of the devices currently under investigation is the sufficient transfer of data and energy from a device outside the body to the stimulator implanted in the eye or in the visual cortex. In most cases, this transfer is achieved by a cable.

The EPIRET system

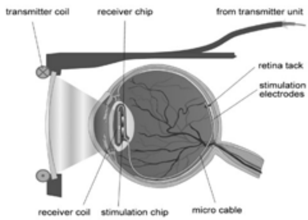

Figure 1: The EPIRET system

The epiretinal implant system, see Figure 1, provides visual sensation by applying electro-stimulation to the ganglion cells. Like the cochlea implant, it consists of an implant and an external part with a sensor element and a signal processing module. An image sensor generates pictures of the scenery, before passing them to the retina encoder. This adaptive encoder computes the receptive field function. Its output signal is transmitted wireless to the implant via an inductive link also responsible for power transmission.

Figure 2: Extraocular part of EPIRET system

The EPI-RET3 retinal prosthesis is designed and fabricated as a remotely controlled wireless implant which is placed completely within the eye. No cable connections crossing the wall of the eye are used to provide energy and data for the implant. Instead, energy and data are provided via an inductive link placed in front of the eye.

Hardware

The hardware used in the clinical trial [1] consists of an extraocular and an intraocular part. The extraocular part (Fig. 2) includes a conventional computer system, a transmitter unit and a transmitter coil attached to a special holder similar to an eyeglass frame. The software on the computer generates temporally and spatially resolved patterns, and it transforms these patterns into interpretable stimulation pulse sequences for the stimulation electrodes. The stimulation data and control signals are sent to the transmitter unit. Basically, the transmitter module contains a Programmable Gate Array, a bitstream generator, a class-E output amplifier, and an externally connected antenna. The output amplifier generates the RF signal to feed the externally connected well-adapted transmitter coil. The implant employs the wireless RF link both for power transmission and for transmission of data by modulating the carrier frequency. This telemetry link is able to bridge a gap of 25 mm in order to power the intraocular part.

The intraocular part (Fig. 3) is a remotely controlled fully intraocular wireless retinal prosthesis consisting of a receiver and a stimulator module. The micro machined implant consists of a flexible substrate with integrated receiver coil, metal wirings and 3D-stimulation electrodes. This foil serves also as a substrate for the necessary electronic components like CMOS-chips and SMD components.

The receiver coil acquires the electromagnetic signals from outside the eye and passes them onto the microchip which operates as a receiver. The receiver chip carries out all tasks necessary for power and data recovery. These extracted signals are forwarded to the stimulator chip. The stimulator generates pulses with the programmed width and height and activates the selected electrodes. It can drive up to 25 stimulation electrodes with bipolar current pulses. The surface of the 25 stimulation electrodes is covered with an iridium oxide thin film with a very high charge-delivery-capacity (up to 95 mC/cm2). The implant was encapsulated with biocompatible silicone and sterilized by ethylene oxide. (Fig. 4)

Clinical study

At two German ophthalmic centers, legally blind patients suffering from Retinitis pigmentosa (RP) should be enrolled in a prospective exploratory clinical trial to evaluate the safety and the efficacy of the EPI-RET3 implant. The primary goal is the observation of visual sensations as reported by the patients. Secondary objectives are number and severity of adverse reactions, changes in the visual function of the eye under study, changes in quality of life, and stability of the implant.

The EPI-RET3 device was implanted in the study eye after removal of the lens and the vitreous. The stimulator was placed slightly inferior to the fovea and two retinal tacks were used for fixation. The electrodes were directly placed onto the retinal surface.

No implants related adverse events were seen and four weeks later the implant was removed. The open design of the haptical part of the stimulator allows an atraumatic removal of the stimulator leaving the inert titanium tacks inside the eye.

The surgery could be carried out without complications.

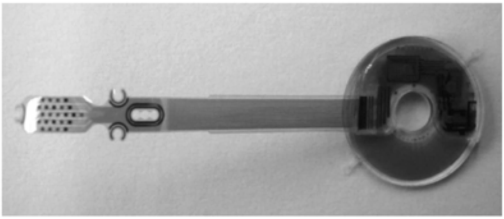

Figure 3: Intraocular wireless retinal prosthesis

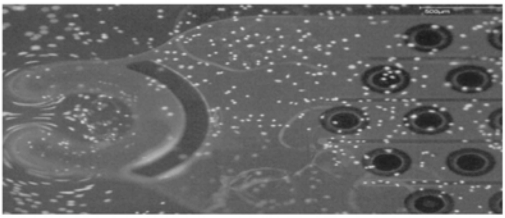

Figure 4: Test of biocompatibility

Stimulation procedure

Three stimulation sessions were performed for about an hour in each patient. During the sessions, patients sat comfortably on a chair in a dimly lit room with the fellow eye patched and DTL electrodes placed in the fornix to continuously record stimulus artefacts confirming functioning of the implant. (Fig. 5)

After the external transmitter coil had been placed approximately 2 cm in front of the eye, the implant could be controlled immediately, and after sending stimulation commands the patient reported seeing phosphenes.

Different spatio-temporal stimulation patterns elicited distinctly different percepts. Depending on stimulation, the patient reported seeing dots, lines, arcs, or circles. The phosphenes were reported to have different colors, such as yellow, red, green, blue, white or black, indicating that stimulation was fairly specific with respect to the neurons being stimulated. Visual sensations were reliably elicited with currents as low as 3μA and charge densities of 2,2 $\mu C/cm^2$. The thresholds on average were 8.1 $\mu C/cm^2$.

Such low intensities are the prerequisite to prevent electrochemical damage in the tissue and in the electrodes. The low thresholds are ensured by the 3D design of the electrodes, the material itself and the fixation technique.

Results:

Implantation of the wireless EPI-RET 3 device is safe, and the system is suitable to elicit visual sensations in blind RP patients. The system is the first functioning retinal prosthesis which avoids any cable connections crossing the eye's wall. Major problems in the design and fabrication of a prosthesis for artificial vision could be solved in this approach.

Visual sensations were reported by the patients in a four week postoperative period. No unusual adverse events related to the surgical procedures or to the implant were recorded.

The results obtained in all of the first three consecutive patients were extraordinary positive in terms of safety and efficacy.

The goal is now to begin with the design and development of a next generation wireless implant system with a considerable higher number of electrodes and more signal processing power to provide useful artificial vision for blind people based on the experiences obtained with the first implant.

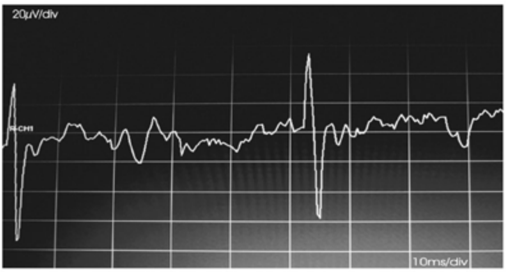

Figure 5: Record of a stimulus artefact

Acknowledgments

This work was supported by a financial grant provided by the Ministry of Education and Research (BMBF).

IMS was responsible for the transmitter module, the design of the implant and design an production of the integrated circuits. IMS has also tested the implants during the production process and has activated the Prostheses at the Stimulation procedure. Additional works contributed to the successful study were achieved by the other partners of the EPIRET consortium (RWTH Aachen University, Department of Ophthalmology; University Marburg - Department of Neurophysics; RWTH Aachen University - Department of Materials in Electrical Engineering; RWTH Aachen University - Department of Neuropathology; University Essen-Duisburg - Department of Ophthalmology; Dr. Schmidt Intraokularlinsen; Thomas Recording GmbH; bytec GmbH)

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Assembly of ASICs for high temperature applications – Material characterization and reliability testing

Robert Klieber, Hoc Khiem Trieu

Introduction

Fast decrease of device dimensions, rapid growth of the number of elements per integrated circuit device (IC) and the increasing amount of interconnections between the chip and the substrate lead to a more complex design and production of the ICs and to higher demands towards packaging technology as well. The rise in power density due to the increasing miniaturization of the device size and the interest of industry for ICs working in high temperature environments lead to high operation temperature of the integrated circuit devices and the encapsulation. Within automotive, aerospace, space, geothermal wells and nuclear power applications high temperature devices operate between 150° C to 600° C. These integrated circuits have to be protected from mechanical damage, moisture and radiation, which could negatively affect the device performance, reliability or lifetime. The proper choice of the encapsulant therefore enhances the reliability of the IC devices and improves their mechanical and physical properties for these high temperatures. While adhesives and encapsulants are a common technique for die-bonding and encapsulation of ICs for applications up to 150° C, these materials fail in high temperature applications for temperatures higher than 150° C. The achieved results for packaging of high temperature ICs for temperatures up to 250° C represent a novelty, acknowledged by the high temperature community as shown during this year at the HITEN conference in Oxford.

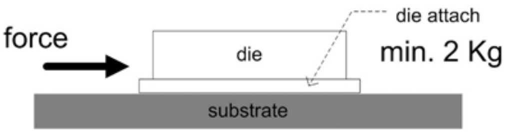


Figure 1: Schematic drawing of the shear force measurement for the die attachment test

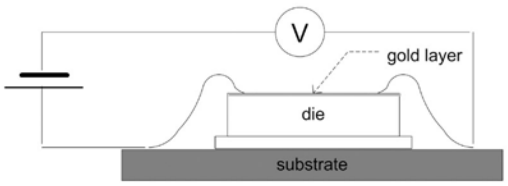


Figure 2: Schematic drawing of the conduction measurement for the encapsulation test

Experimental Setup

To monitor the performance of the die attach and the encapsulant materials, samples have been prepared and tested in a 250° C ambient and in thermal cycling experiments, – cycling the samples between room temperature (25° C) and 250° C. At designated time stamps and cycle amounts tests have been performed at room temperature.

To evaluate the performance of the die adhesives chips of the size 3 mm^2 were bonded into standard DIL24 ceramic housings with a gold surface and onto ceramic plates. The thickness of the adhesives layers was between 20 and 40 µm after curing. The die shear strength of the adhesives was measured in accordance with MIL-STD-883 Method 2019 by applying a force parallel to the surface of the substrate as shown in Figure 1.

In order to evaluate the performance of the various encapsulants a die of the size 2x1.5x1 mm^3 was bonded with the best die adhesive material into a DIL24 ceramic housing. 25 µm thick aluminium bond wires have been used to create electrical connections between each DIL24 housing pad and the surface of the die having a gold layer on the top surface. The electrical connection between the pads of the housing and the die were tested by a measurement of the resistance between two contacts of the DIL24 housing as shown in Figure 2 after the encapsulation. Also visual inspections of the encapsulants have been made to reveal defects like flaws and fractures.

Die Attachment

To attach integrated circuits to a substrate die adhesives are used in packaging technology. Several products were chosen from a worldwide survey of potential candidates for die attach, which mainly differ in their coefficient of thermal expansion (CTE) and their hardness. Table 1 summarizes the CTEs of important materials. A CTE mismatch between the die attach material and the die can cause shear loading and lead to high mechanical stress in the silicon chip, which can result in a breakage of large dies at high temperatures. This can be partly compensated by a high flexibility, – a low hardness of the die attach material. Besides common used products like epoxies, polyimides (medial hardness, medial CTE mismatch) also glasses (high hardness, low CTE mismatch) have been tested.

Figure 3 shows the results of the storage test at 250° C for different time stamps. The shear strength decreases for the polyimides and the epoxy and after three hundred hours the shear strength of all die attach materials besides the glasses was below two kilograms, which is the minimum for this chip size according to the MIL standard. After 1000 hours the shear strength of the polyimide and the epoxy nearly vanishes. The glasses showed no detectable loss of their shear strength up to 3000 hours.

The cycling tests show similar results (Figure 4). The shear strength of the epoxy decreases fast and nearly vanishes after 500 cycles. The polyimides are below MIL standard after 1500 h. Whereas the glasses show no detectable decrease of their shear strength up to 2500 cycles indicating that die attach material with a CTE in the range of the substrate and a high shore hardness can be used for die attachment. Therefore these glasses will be used for high temperature die attachment for the encapsulant tests.

Material	**CTE [ppm/K]**
Silicon	2–4
Al_20_3 (Substrate)	6.50
Glass	4.5–6.5
Epoxy	19–65
Polyimide	20–120
Silicone	200–300

Table 1: Coefficient of thermal Expansion

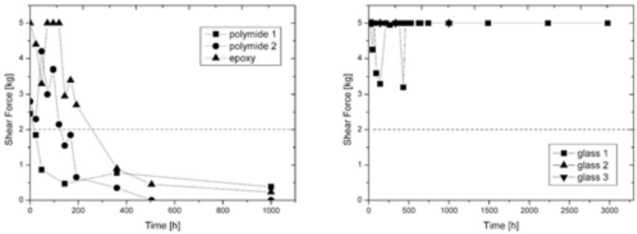


Figure 3: Maximum shear strength of the adhesives in dependence of the storage time at 250° C for polyimides and a epoxy (left figure) and glasses (right figure). The dashed line indicates the minimum allowed shear force for a 3 mm² die.

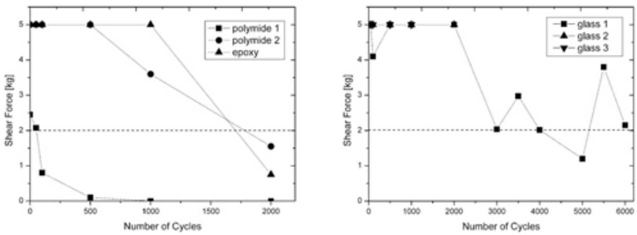


Figure 4: Maximum shear strength of the adhesives in dependence of the number of cycles between 25° C and 250° C for polyimides and a epoxy (left figure) and glasses (right figure). The dashed line indicates the minimum allowed shear force for a 3 mm² die.

Encapsulation/Glob-Top

After die attach and wire bonding the integrated circuits have to be protected from mechanical damage, moisture and radiation by an encapsulant. Thirteen different encapsulants haven been tested. Besides epoxies and polyimides, silicones and glasses have been tested. The materials were selected according to the following considerations:

– The low hardness of the silicones can compensate different thermal expansion coefficients between the substrate, the die and the bond wires (low hardness, high CTE mismatch to the die).

– As the thermal expansion coefficient of the polyimides and the epoxies is in the range of the bond wires, the expansion of the encapsulant should not tear up the bond wires (medial hardness, medial CTE mismatch to the die).

– As glasses are very hard and their thermal expansion coefficient is lower than the CTE of the bond wire, glasses will force the bond wire to their expansion (high hardness, low CTE mismatch to the die).

Figure 5 shows the results of the storage test at 250° C for different time stamps. Most of the encapsulated chips show a steady increasing amount of defect wire bonds for increasing storage time. All encapsulants made of silicone, epoxy or polyimide show first wire bond breakage after 25 to 50 storage hours. In contrast to the epoxy encapsulants, which destroyed all bond wires after 1000 h, not all bond wires have been destroyed in systems encapsulated with polyimide or silicone. Due to their elastic behaviour silicones sometimes reconnect broken bond wires. The surface of the silicones do not show any change, whereas flaws and fractures can be found on the surface of the polyimide and epoxy encapsulants. Only the glasses show no wire bond breakage for up to 2000 h.

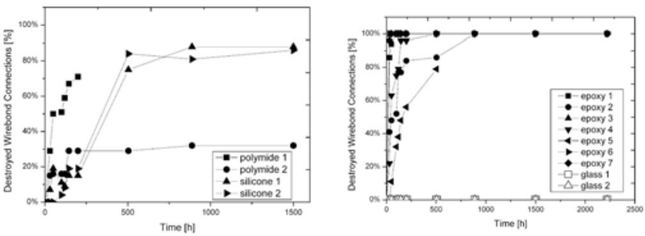


Figure 5: Percentage of wire bond breakage in dependence of the storage time at 250° C for the polyimides, silicones (left figure) and the epoxies, glasses (right figure).

Figure 6 demonstrates the results of the cycle test between room-temperature and 250° C. Most of the encapsulants destroy all bond wire connections after 50 cycles. After 500 temperature cycles all bond wires encapsulated with silicone or epoxy and also one polyimide have been destroyed completely. The second polyimide encapsulant shows a low amount of destroyed bond wires (< 30 %) after 500 cycles, but reveals in contrast to the silicones fractures down to the bottom of the housing.

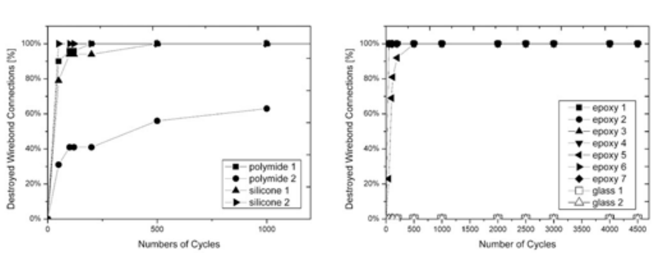


Figure 6: Percentage of wire bond breakage in dependence of the number of cycles between 25° C and 250° C for the polyimides, silicones (left figure) and the epoxies, glasses (right figure).

Only the glass encapsulants show no breakage of the electrical connections after more than 4500 temperature cycles and 2000 hours of storage.

Conclusion

The reliability and performance of different die attach materials and encapsulants have been examined in storage and cycling experiments. Well known encapsulants and die-bonding materials like silicones, epoxies and polyimides fail in these tests.

Glass as die attach and encapsulation material showed the best performance of the tested materials. With this novel approach standard aluminium wire bonding techniques can be used with glass as die attach and packaging material for high temperature electronic assembly of integrated circuits.

Reliability Issues of Modern Memory Devices

N. Kordas

Todays' electronic systems often use semiconductor memories for program and data storage. Even small portable products such as mp3-players, cellular phones or navigation systems require large memories. Through the continuing miniaturisation process in semiconductor research, it is possible to supply the electronic industry with integrated memory of so far unknown densities. However, the technological process also leads to new problems and failure mechanisms which arise from the small dimensions of the devices.

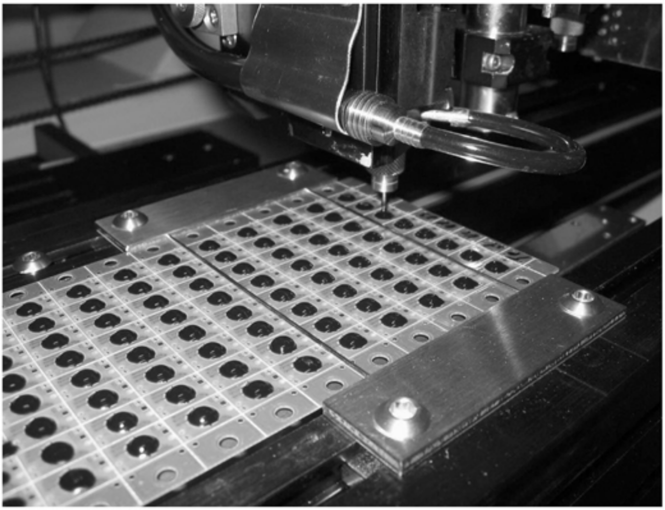
In the development of new products the designer has the choice among lots of different memory technologies. They differ not only in their performance (memory size, speed, power consumption etc.) but due to the various technological principles also in the application field. Reliability and lifetime have become important issues in the design of memory based electronic systems. However, the memory market has become somehow intransparent for the electronic designer because new technologies have reached the market in the recent years. On the other hand, the rapid technological development introduces a number of so far unknown problems and failure mechanisms.

One of the problems arising from technological progress is the downsizing of integrated electronic components. Due to the small size of the structures, physical effects come to the fore which could simply be neglected in the past. For example, hot carrier degradation is a phenomemum that is often difficult to detect but can lead to high failure rates in the end product. This effect becomes more important since the structures in integrated circuits today are in the deep submicron area with high electric field strenths occuring in single transistors. Hot carrier degradation accumulates over the lifetime of a product and is accelerated not only by physical parameters such as (low) temperature, voltage level and device size, but also by the profile of usage. Therefor a lot of knowledge is necessary in the fields of microelectronic technologies, circuit desgin and reliability analysis in order to detect and predict hot carrier related failures.

The Fraunhofer Institute of Microelectronic Circuits and Systems (IMS) in Duisburg develops and fabricates application specific integrated circuits, sensors and microsystems mainly for industrial customers. The institute has its own cleanroom with an industrial CMOS-fabrication line. ASICs can be produced in small and medium volumes following industrial standards. IMS is certified according to ISO9001:2000. The institute has a portfolio of several types of memory which can be used in their ASIC-products as embedded memories. RAM-, ROM- OTP- (one-time-programmable) and EEPROM-Cells are available in standard CMOS as well as in special value added technologies: the first is a CMOS-compatible pressure sensor technology with surface micromachined capacitive pressure sensors and the second is a high temperature technology based on a SIMOX-process which is capable of operation up to 250° C and more. Further CMOS-based technologies with additional functions are being developed.

Due to its long experience in memory development, IMS has built up a widespread knowledge around the various memory technologies, their applications and failure mechanisms. Be it for the proper selection of memories for a certain application or in failure analysis for any kind of commercial memory, IMS offers consulting in all questions of memory choice and analysis. In its laboratories, the institute has measurement and qualification equipment available such as climatic chambers, thermo shock chambers, temperature adjustable wafer probers and standard lab appliances. On the technological side, IMS offers analysis on chip level by high resolution SEM microscopy, FIB (focussed ion beam), EDX (electron dispersive xray analysis) and defect etching.

This unique combination of competences makes IMS an outstanding partner for all questions concerning design, choice, usage and analysis of semiconductor memories.



Picture: Assembly of an IMS-ASIC with embedded memory

Highly Sensitive CMOS Line Sensor

Erol Özkan, Werner Brockherde, Daniel Durini

I Introduction

Advanced image analysis applications like spectroscopy, microscopy, photon counting or fluorescent imaging demand high-resolution optical line sensors exhibiting a high dynamic range at low noise and high sensitivity. More mass market-oriented linear image sensors are addressing commercial and industrial applications like range sensors, bar code readers, line cameras, scanners, copiers, and facsimile machines. The classical approach to the realization of such arrays is based on using one-dimensional CCD arrays. Today's submicron CMOS processes have matured in the way that they can compete with many of the CCDs advantages in performance while offering a set of very useful (in terms of system cost) additional features, due to their capability of integrating the whole sensor system on a single chip. Chip cointegration of complex electronic circuitry becomes more and more important, due to the high bandwidths that are required by end-user applications.

Apart from the on-chip design flexibility, the wide temperature range, random pixel access, anti-blooming measures, and the possibility of on-chip dark current compensation make CMOS line sensors a real alternative compared with CCDs.

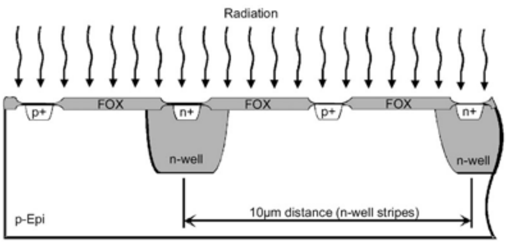


Figure 1: Cross-section of an *n*-well-over-*p*-Epi structure based photodiode fabricated in 0.5 µm CMOS process

II Photodiode in Standard CMOS Process

At the Fraunhofer IMS is currently running a 0.5 µm and a 0.35 µm standard CMOS process suitable for in-house fabrication of CMOS image sensors. In this contribution, photodetector structures (using reverse-biased p-n junctions) fabricated in the 0.5 µm standard CMOS process are described. This process uses twin-well technology, and employes a single polysilicon and three metal layers. The standard readout technique is based on integration of the photocurrent generated by the diode. Figure 1 shows a cross-section of an n-well over p-substrate stripe-like photodiode. The photoactive area of the stripes is in this case (10 x 1000) μm^2, whilst the entire photoactive area of all pixels is (10 x 3530) μm^2.

The principle figures of merit used to describe a photodiode are the dark current ($I_{PD,DC}$), the capacitance (C_{PD}), the optical sensitivity (S_λ), defined as the amount of photocurrent delivered by the device per each watt of impinging radiant flux (in A/W), and finally, the quantum efficiency, defined as the number of electron-hole pairs photogenerated by each photon of impinging radiation.

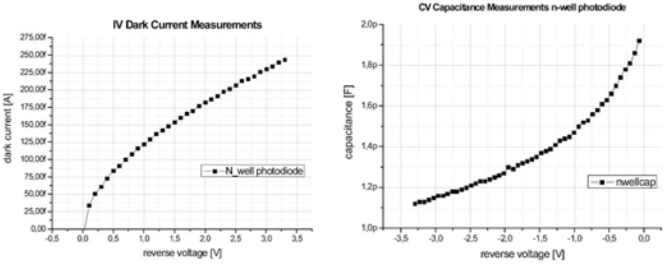
The dark current is defined as the flux of thermally generated carriers within the photodetector operating in darkness. It introduces shot noise that cannot be corrected by any noise-reduction technique except averaging. The reduction of dark current reduces the amount of shot noise and improves the dynamic range. Figure 2 (a) shows the dark current measurement performed at n-well stripe-like photodiodes.

Lower photodiode capacitance enables use of amplifiers exhibiting lower bandwidths for realization of the integrator.

On the other hand, since the integrator input capacitance (i.e. photodiode capacitance added to the amplifier input capacitance) affects the noise-power transfer function, reduction of the photodiode capacitance lowers the input equivalent noise charge (ENC) contribution of the integrator. Figure 2 (b) shows the photodiode capacitance measurement of the n-well stripe photodiode, whilst in Figures 3 (a) and (b) the wavelength dependent optical sensitivity and the quantum efficiency of the photodiode structure, respectively can be observed.

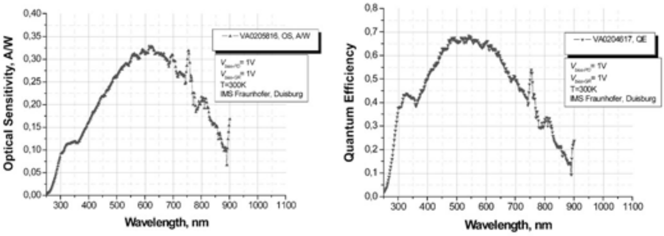
III Readout Circuit

The main goals pursued in CMOS imager design are high dynamic range of each pixel, low noise, and high linearity the last one is important for non-video applications. In Figure 4 (a) a simplified schematic of the in-pixel integrator stage is shown. These three capacitors in the feedback loop provide three different gain factors. These enable three different operational modes with different total responsivites for the detector. The responsivity values are determined by the three feedback capacitors present in the integrator block of the readout circuit, observed in Fig. 4 (a) $Cint_{1,2,3}$ = 4fF (realized as a T-capacitor divider), $Cint_1$ = 50fF, and $Cint_{1,4}$ = 850fF. The Table 1 shows the switch states for each feedback capacitor. With the help of the two binning switches, Switch_L and Switch_R shown in Figure 4 (a), we can use two photodiode areas instead of a single one, so that the total responsivity turns factor two higher than in case of using one photodiode only. For blooming compensation, i.e. the effect of single pixel photogenerated charge exceeding its saturation level and penetrating the adjacent pixels, an extra anti-blooming transistor has also been implemented in each pixel.



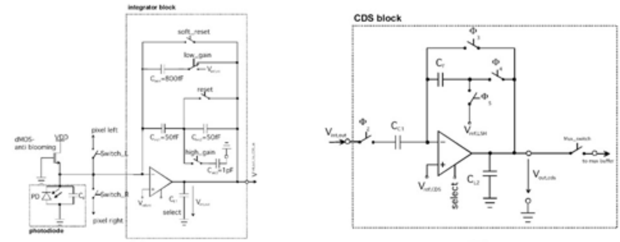
(a) (b)

Figure 2: (a) Specific dark current in A, obtained for the *n*-well-over-*p*-Epi (fabricated in the 0.5 µm standard CMOS technology at the Fraunhofer IMS); (b) the capacitance in F, obtained for the same structures.



(a) (b)

Figure 3: (a) Wavelength dependent *optical sensitivity* curves, in A/W, obtained for the *n*-well-over-*p*-Epi, fabricated in the 0.5 µm standard CMOS technology at the Fraunhofer IMS; (b) wavelength dependent *quantum efficiency* curves obtained for the same structures.



(a) (b)

Figure 4: (a) Schematic of the integrator block; (b) schematic of the CDS block

Operqation mode	low_gain-switch	high_gain-switch	reset-switch
$Cint_4$ = 850fF	High	Low	High
$Cint_1$ = 50fF	Low	Low	High
$Cint_{1,2,3}$ = 4fF	Low	High	Low

Table 1: Switch states for the integration capacitance

During a soft_reset cycle all capacitors are discharged to the bias voltage plus the OTA offset. After that, only one of the three feedback capacitors is connected, while the other capacitors remain in the reset condition. At the end of the simultaneous integration of the photocurrent of 3584 photodiodes, using the selected feedback capacitor, the charge accumulated at the selected capacitor is directly readout as voltage $V_{int,out}$ and stored at the load capacitor C_{L1}.

Offset and low-frequency noise caused by each pixel structure can be reduced by correlated double sampling (CDS). Here, each pixel output is readout twice, once right after reset and a second time at the end of the integration. The sample after reset is then subtracted from the one made after integration. The CDS circuit hold the sample readout voltage obtained from each pixel throughout the soft_reset phase, to enable the time multiplexing operation of the output signals of the entire imager. This CDS block can be seen in Figure 4 (b).

IV The IMS LS-3580 Line Sensor

The integrator and CDS blocks enable two different acquisition modes: RAI (readout after integration) and MNRDI (multiple non-destructive readout during integration). In RAI mode, the pixel signals are simultaneously stored at the corresponding feedback capacitor of the integrator and readout after the integration sequence. In MNRDI mode, non-destructive multiple readout of the pixel data is performed during the integration process. The multiple global shutter signal can either be applied externally or generated by the internal sensor electronics. The sensor also features programmable responsivity using three gain settings, as described above. The low, medium, and high gain settings yield a responsivity of 92, 1452, and 5500 V/W/m², respectively, for 625 nm wavelength and integration time of 10 ms.

The user interface is implemented as a 3 wire 16 bit serial control interface. This port enables the sensor operation exhibiting high degree of flexibility. Different integration times, speeds or region-of-interest readout are programmed via the 16 bit serial configuration interface pin. Figure 5 shows the block diagram of the LS-3580 line sensor.

The Table 2 summarizes measured parameters of the LS-3580 line sensor. The integration time can be varied independently of the clock frequency. An additional on-chip dark signal channel and temperature compensation are also implemented. The 120fA dark current per pixel is without dark current compensation. With activated dark cur-

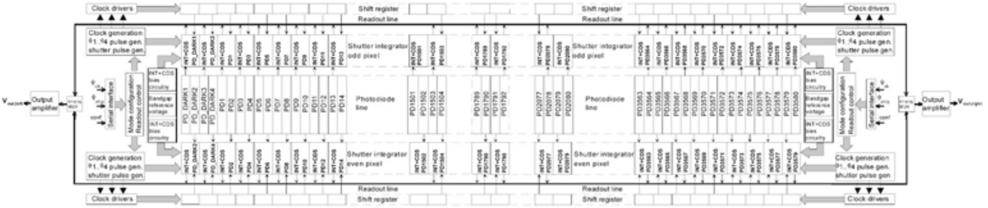


Figure 5: Block diagram of the LS-3580 line sensor

rent suppression, the effective dark current is reduced to below 1fA. The main focus of this chip design is to provide a suitable alternative for a large variety of CCD line sensors. The sensor uses a single 3.3V power supply voltage, an external clock (up to 12 MHz) signal, and a configuration pin for readout mode setting.

V Conclusion

The IMS LS-3580 is a linear CMOS image sensor featuring high responsivity, low dark current, low noise, and high sensitivity. The complete readout control, the analog biasing, and signal conditioning are implemented on the chip fabricated in 0.5 µm standard CMOS technology. In the Figure 6 (a) the LS-3580 line sensor chip with area (45.6 x 7) mm^2 is shown and in Figure 6 (b) an LS-3580 line sensor chip in ceramic package can be seen.

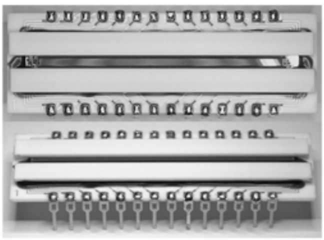
In addition to this device, we have already prototyped other CMOS line sensors. These include a velocity sensor for contactless speed measurement and a triangulation sensor. The high speed measurement feature is of great importance for high performance quality monitoring in production processes. The general family of CMOS line sensors available at Fraunhofer IMS grows due to the aim of IMS to provide a highly suitable replacement alternative for CCD sensors that exist on the market or will be discontinued in short time.

To summarize, the integration of optical line sensors in standard CMOS technology offers an enormous potential for improvement of sensor performance and addition of on-chip signal processing which will lead to new applications and products in the near future.

Parameter	Value
Resolution (active pixels)	1 x 3580
Pixel size (µm x µm)	10 x 1000
Spectral range (nm)	250 – 1000
On-chip shutter	Synchronous
Reset	Synchronous
Max. clock rate (MHz)	12
Dynamic range (dB)	54
Fill factor (%)	98
Dark current per pixel (fA)	120
FPN (%)	2.4
Responsivity ($V/W/m^2$)	1452
Noise eq. power ($\mu W/m^2$)	2.75
Noise eq. exposure (pJ/cm^2)	2.75
Image lag (%)	< 1
Saturation irradiance (mW/m^2)	1.45
Total transfer efficiency (%)	100
Output swing (V)	2.1
Power consumption (mW)	580
Supply voltage (V)	3.3

Table 2: The specify of the measured parameter of the LS-3580 line sensor (conditions: T_A = 25° C, wavelength 625 nm, T_{int} = 10 ms, medium gain setting)

(a)



(b)

Figure 6: (a) LS-3580 line sensor Chip ; (b) 2 LS-3580 line sensor chips in ceramic package

Time-of-Flight 3-D Imaging in Standard CMOS

W. Ulfig, W. Brockherde

1. Introduction

A variety of challenging tasks in automotive and automation related applications demand for real-time distance or even 3-D information about the objects involved. Typical scenarios contain moving objects and human beings under different and changing illumination, contrast, and reflectivity conditions. Current **examples** are:

- **automotive:** obstacle detection, pre-crash sensing, vulnerable road user (VRU) protection, blind spot surveillance
- **industrial automation:** safety & surveillance of plants, sites, and machines, logistics
- **building automation:** occupancy and presence sensors, object detection, security, access control
- **traffic and transportation systems:** detection, classification, and counting of vehicles
- **mobile robotics:** environment sensing, obstacle recognition and collision avoidance

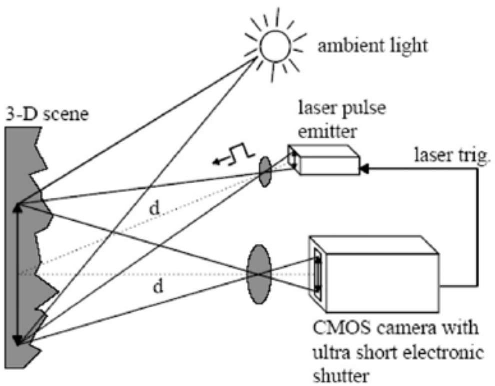


Figure 1: ToF measurement principle.

A dedicated 3-D imaging system for these application areas should be fast, robust with respect to the environmental and lighting conditions, and preferably low-cost and small size.

At present there are mainly the following **methods** used in optical 3-D imaging systems:
- triangulation
- interferometry
- time-of-flight (ToF) measurement

For the application examples named above the ToF method is advantageous compared to triangulation and interferometry because it is able to perform the task at comparatively low instrumental, mechanical, and computational effort – and thus low system costs.

The ToF method is currently implemented either using pulse delay measurement [1], [2] or continuous wave (CW) modulation [3], [4] – whereas the pulse based 3-D imagers developed and fabricated by Fraunhofer IMS are superior due to

- **high frame rates**
- **high dynamic range**
- **non-ambiguous distance measurement principle**
- **inherent background light suppression**
- **low cost: fabricated in standard CMOS process**

The measurement principle is sketched in Figure 1. The method relies on the measurement of the time that elapses between an emission of a light pulse and the reception of its reflection from a distant target. The emitted light pulse is widespread in order to cover 3-D objects, so that no mechanical scanning is required. The receiver contains a light-sensitive area sensor which evaluates the pulse travel time.

2. Current Results and Applications

Fraunhofer IMS contributes to the integrated Project PReVENT, an European automotive industry activity co-funded by the European Commission (www.prevent-ip.org).

Fraunhofer IMS particularly is active in the IP PReVENT subproject UseRCams (see Figure 2) in development, design, fabrication and characterization of an affordable active 3D sensor [4] (Figure 3), which is vital in providing improved obstacle detection and classification at short range. The sensor is especially suitable for urban collision avoidance and mitigation by localization of objects and vulnerable road users, as for pre-crash and blind area surveillance. The low-noise 3-D ToF sensor has non-destructive readout capability which enables in-situ distance range adaptation, thus facilitating reliable and predictable real-time 3-D position and velocity estimation for traffic objects. Table 1 states the main specification data of the sensor.

The following figures show some results obtained within the UseRCams project.

Figure 3 depicts a photomicrograph of the CMOS sensor IC with the light sensitive area in the center of the chip. The sensor electronics surrounding the 64 x 8 pixel area is shielded by the metal3 layer of the process.

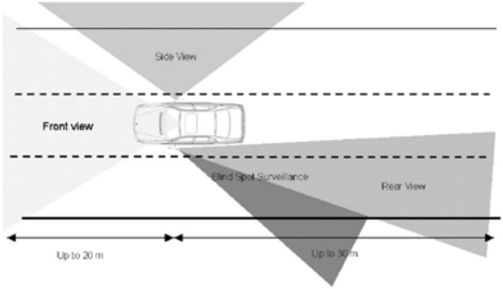


Figure 2: Objectives of the IP PReVENT subproject UseRCams.

Distance range	2 m – 25 m
Relative distance error	< 3%
Reflectivity range	5% – 100% lambertian
Dynamic range	75 dB (distance & reflectance range)
Image acquisition	50…200 fps (1 … 128 pulses/frame) non-destructive readout
Minimum shutter time	30 ns
NEP (i. e. smallest detectable signal)	2.3 W/m²
Background light suppression	> 40 dB
Operating wavelength	850 … 910 nm

Table 1: UseRCams demonstrator key specification data.

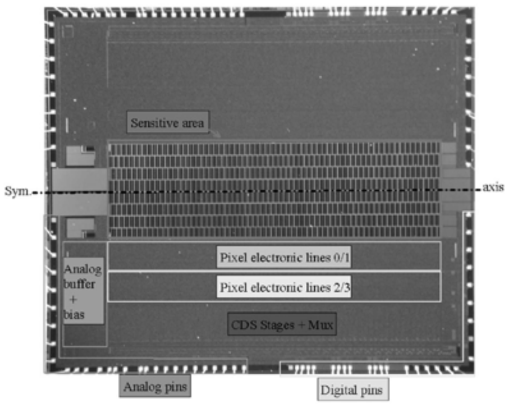


Figure 3: UseRCams 64 x 8 pixel 3-D ToF sensor by Fraunhofer IMS.

Figure 4: UseRCams demonstrator camera system.

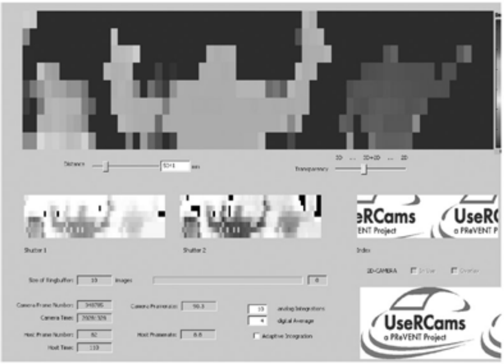


Figure 5: pseudocolor coded distance image acquired by UseRCams demonstrator camera, showing 3 persons at different distances.

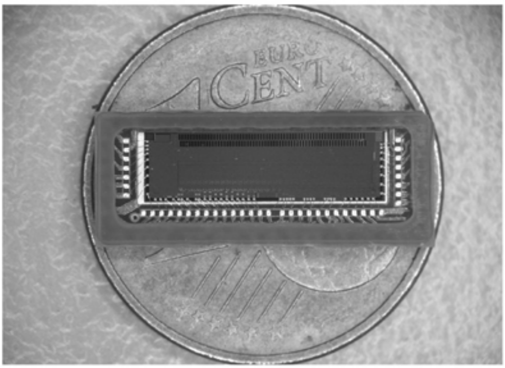


Figure 6: Fraunhofer IMS 64x2 3-D ToF sensor in a COB package.

The UseRCams demonstrator camera is shown in Figure 4. The camera is operated at 12V supply voltage and communicates with the host PC via LAN interface.

Figure 5 shows the computer control panel for the camera operation. The user can modify different settings of the camera and the range image is presented as pseudocolor image.

Additionally to ToF CMOS sensor development, Fraunhofer IMS provides technical consulting service for the application of its 3-D imagers, e. g. development of ToF sensor boards, image acquisition firmware, signal conditioning and customer specific packages for 3-D CMOS imagers. An example for a miniaturized chip-on-board (COB) package is shown in Figure 6; the soldering contacts are built of a landgrid array on the backside of the package.

3. Outlook

In order to advance its expertise in CMOS 3-D imaging, Fraunhofer IMS takes several steps ahead. Some of those are:

– **A new 0.35 µm n-well 2P 4M standard CMOS process, tailored to automotive applications and enhanced for optoelectronic devices, including color filter option,** allowing smaller feature sizes, increased fill factors, better SNR, and increased spatial resolution

– **Novel photodetection structures** [5], enabling higher responsivity and lower NEP of the 3-D imagers (see Figure 7)

– **New pixel and sensor architectures,** facilitating even faster image acquisition, and a higher level of system integration

– **Improved image processing algorithms,** e. g. increase of signal-to-noise-ratio (SNR) by the use of optimized sampling

– **A CMOS 3-D ToF Sensor for 2-D/3-D micro-system integration and sensor data fusion** at pixel level (to be developed within the project MIDIAS, funded by the German Federal Ministry of Education and Research)

An example of a new optical device development is sketched in Figure 7. The two polysilicon layers and 5 different substrate concentrations present in the 0.35 µm standard CMOS process available at the Fraunhofer IMS enable optimum charge transfer efficiency (CTE) in photogate active pixel sensors (APS), from the photoactive area to the n^+ floating diffusion, shown in Figure 7, (A), (C).

On the other hand, the use of the 15 µm deep epitaxial layer without extra implantation steps ($N_A = 3 \times 10^{14}$ cm^{-3}) enables the fabrication of buried photodiode APS, as it can be observed in Figure 7, (B) and (D).

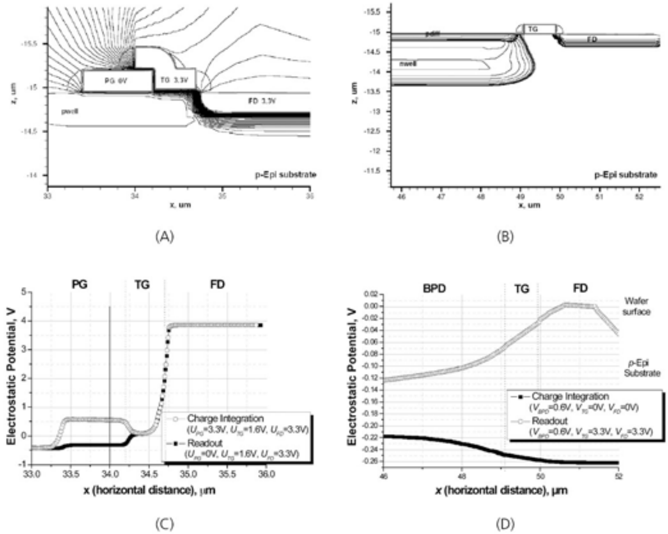


Figure 7: Photogate in 0.35 µm CMOS Process, TCAD simulations.

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A Fully Integrated Passive UHF RFID Transponder with Temperature Sensor

T. Feldengut

Introduction

Future concepts of *ambient intelligence* and *ubiquitous computing* pose new challenges to microelectronic technology and circuit design. Large wireless networks of tiny, self-organizing sensor nodes are expected to monitor environmental conditions such as pressure or temperature. To further reduce the size and the cost of these sensor nodes, wireless power transmission can be used to create an energy supply without the need for a battery. This approach is already becoming widespread in passive RFID (Radio Frequency IDentification) transponders, which can be extended to sensor nodes via the on-chip integration of microelectronic sensors and the required readout circuitry. These RFID sensor transponders are being produced by the Fraunhofer IMS and are successfully used in medical and automotive applications.

The sensor transponders that are available today operate in the magnetic near field via inductive coupling between two coils at low frequencies (LF, up to 13.56 MHz). This approach offers a sufficient amount of energy in close distance to the base station, but the range is typically limited to a few decimeters. The operation in the electromagnetic far field makes larger distances possible, but the power that is available to the transponder is critically low. To demonstrate the feasibility of a sensor transponder that operates in the far field at UHF frequency (868 MHz), a fully integrated UHF tag with a temperature sensor is currently in development. This transponder will be compatible to the ISO 18000-6 standard and will operate at distances of more than 2 m.

Architecture and System Considerations

According to the *Friis relation,* the power that is available at the tag antenna is

$$P_r = P_{EIRP}\, G_r \, \frac{\lambda_{RF}^2}{(4\pi d)^2}\,, \qquad (1)$$

where P_{EIRP} is the effective isotropically radiated power from the base station, G_r is the antenna gain, λ_{RF} is the carrier wavelength, and d is the distance between the tag and the base station. P_{EIRP} is usually limited by local radio regulations, so that P_r is typically less than 30 µW at 868 MHz and a distance $d = 3$ m. A very low power consumption of all circuits is therefore crucial to the design of the UHF transponder.

The architecture of this transponder chip is shown in figure 1. All functional blocks except for the antenna are integrated on a single CMOS IC. The top-level functional blocks are the UHF front-end, the digital part with EEPROM storage, and the sensor with the readout circuits. The digital part contains a finite state machine for the protocol handling as well as a decoder block. It implements an ISO 18000-6 standard compatible protocol and it is optimized for very low power consumption.

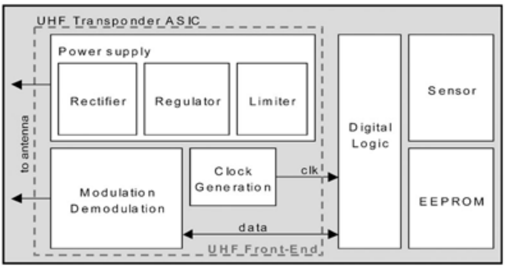

Figure 1: Transponder architecture

The temperature sensor consists of a low voltage, low power bandgap reference and an analog/digital converter. The bandgap circuit also serves as a voltage reference for other circuits in the analog front-end.

The analog front-end consists of a power supply generator, a clock oscillator, and a simple modem. Tag to reader communication is achieved by "backscattering" the signal from the base station. When the backward link from the tag to the base station is active, the base station transmits an unmodulated carrier with a constant envelope. The tag switches its input impedance between two different states, thus modulating its own radar cross-section.

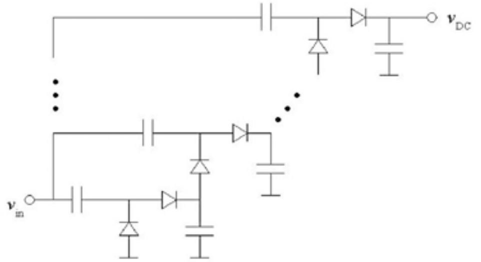

Figure 2: N-stage rectifying voltage multiplier

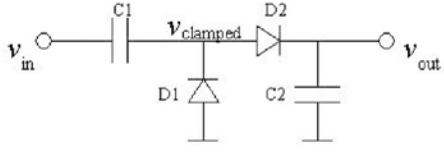

Figure 3: Rectifying stage

Analog Front-End

The analog front-end acts as the interface between the antenna and the digital part of the chip. The performance of the Front-End largely determines the maximum operating range of the transponder system, because the front-end usually has the highest power consumption on the chip. Three of the most important analog circuits are the power supply generator, the clock generator and the demodulator. The power supply generator has a low efficiency because the amplitude of the RF signal is very low. The clock generator and the demodulator need to be designed for very low power consumption, but their correct operation has to be guaranteed for a reliable data transfer. These three circuit blocks will therefore be presented in the following.

A) Power supply generator

The operating range of the tag-reader system is strongly affected by the efficiency of the power supply generator in the analog front-end. It consists of a rectifying voltage multiplier, a voltage regulator, a supply capacitor, and an over-voltage protection circuit. The most critical circuit block of the supply generator is the rectifying voltage multiplier, because the power conversion efficiency is usually below 10 % when the input signal has a low amplitude. A typical circuit implementation of an N-stage voltage multiplier is shown in figure 3. A sinusoidal input signal leads to a DC output voltage, which serves as a power supply for all other circuits.

The basic operating principle is shown in figure 3. Diode D1 and capacitor C1 create a voltage clamping circuit. Diode D1 prevents the voltage at the output from ever going negative. A positive charge is trapped at the output, which raises the amplitude of the signal from $V_{in}(t) = \hat{v}_{in}\, sin(\omega t)$ to $v_{Clamped}(t) = v_{in}(t) + \hat{v}_{in}$. The rectifying circuit consists of diode D2 and capacitor C2. If no load current is drawn from the output, the voltage is never reduced and remains at $V_{out}(t) = \hat{v}_{clamped} = 2\hat{v}_{in}$. The cascaded structure of this voltage-doubler circuit leads to the rectifying voltage multiplier shown in figure 2.

This simplified analysis does not consider the non-idealities of real world devices. The threshold voltage, the parasitic capacitance, and the reverse current of the diodes as well as the capacitor leakage influence the actual performance of the circuit. Due to their low threshold voltage, Shottky diodes are used in the presented design.

When a large current is drawn from the output of the multiplier, its input impedance drops so that the input voltage will consequently be lowered. When the total current consumption of the tag is too high, the voltage from the power supply generator will drop below the critical level of 1.5 V, causing the chip to be reset. When a sensor and a readout circuit is integrated on the tag, it has to be considered that the total current consumption is time varying, depending on whether or not the sensor readout is active. Short periods of high power consumption can be tolerated, because a large supply capacitor is used as a short-term energy storage.

B) Clock Oscillator

The digital part of the chip requires a constant system clock. In low frequency transponder systems, this clock is usually obtained from the carrier frequency. In the presented 868 MHz-UHF system, this frequency is too high and a frequency divider leads to a large current consumption. A low power IC-oscillator is used to generate a 1 MHz periodic signal. This oscillator has a large frequency variation due to process and temperature variations. A digital PLL is therefore used to synchronize the local clock signal with the incoming data.

The IC-oscillator circuit is shown in figure 4. Whenever the flip-flop is set, capacitor C2 is charged by a constant current while capacitor C1 is quickly discharged through transistor M1. The voltage at the input of comparator 2 rises linearly until it reaches V_{ref}. The flip-flop is reset, capacitor C2 is discharged through transistor M2 and capaci-

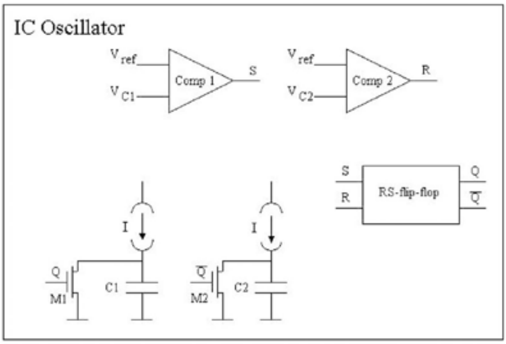

Figure 4: IC Oscillator

tor C1 is charged. The advantage of this structure compared to a single capacitor design is that no hysteresis comparator is required and the discharge time has no influence on the output frequency. The total current consumption of the oscillator is only 400 nA at a frequency of 1 MHz.

C) Demodulator

According to the ISO 18000-6 standard, a simple ASK (Amplitude Shift Keying) Modulation is used in the forward link from the base station to the transponder. The demodulator consists of an envelope detector, an average detector and a hysteresis comparator as shown in figure 5. The envelope detector consists of a Shottky diode voltage multiplier that is similar to the rectifier in the power supply. Because this envelope detector does not drive a large output current, the schottky diodes and the capacitors can be significantly smaller than those in the power supply generator. The output capacitor of the envelope detector is slowly discharged through the output resistor when the envelope of the input signal falls to the "0"-state. The size of the output capacitor and the resistor pose a tradeoff between the ripple in the output signal and the maximum data-rate.

Conclusion

A fully integrated passive UHF sensor tag for the 868 MHz ISM band was presented. The transponder chip contains an analog UHF front-end, a digital part, EEPROM storage and a temperature sensor. The design of the analog front-end is especially important to achieve a large operating range of more than 2 m for the reader-tag system. Three main circuit blocks are the rectifier, the clock oscillator and the demodulator. The design of these three circuits was presented for a 0.35 µm CMOS technology with Shottky diodes and EEPROM.

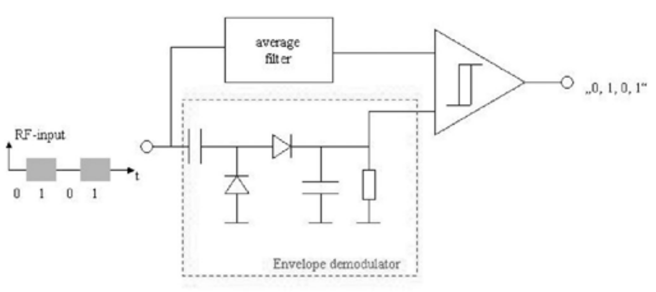

Figure 5: ASK Demodulator

Application Specific Wireless Sensor Networks

M. Marx, A. Coers

Introduction

At the exhibition "Sensor 2007" in Nuremberg, a new development kit for wireless sensor networks, (WSN's) composed by modular hardware components and a modular software framework, has been presented by the Fraunhofer IMS. The modular system approach allows versatile and flexible developments of wireless sensor networks for diversity specific applications in the areas of measurement and control. Examples come from building automating, agriculture, plant automating or health care, just to mention a few areas of application.

Modularity and Flexibility

The basic sensor μNode module (Figure 1) represents the heart of the kit hardware. It uses an Atmega 128 microcontroller (μC) for realization of protocol software stacks. Additional, further application dependent software functions like sensor data pre-processing can be implemented on the μC. The physical wireless interface is provided by an IEEE 802.15.4 compliant transceiver chip, designed for low power low voltage applications, working in the 2.4 GHz ISM band. As antenna, either the PCB antenna can be used or alternatively, an external antenna can be connected.

Further application dependent hardware extensions can be connected by an expansion port. For evaluation purposes, the development kit contains also a development board (Figure 2) that carries the μNodes in piggy back manner. The development board provides several general purpose IO-ports (GPIO), buttons and LED's for quick evaluation purposes, standardized serial interfaces like RS232 and USB as well as 32 kByte SRAM Memory.

Besides the hardware modularity the kit consists of a software framework, providing a unified interface to the application, regardless of the underlying hardware. This is achieved by introducing a hardware abstraction layer (HAL) that encapsulates the different hardware interfaces into configurable software parts and hence providing a fixed set of hardware independent programming interfaces.

The modularity of both components, hardware and software, allows flexible adaptation of an existing implementation, if requirements of the application may have changed over time. The modular system approach limits the adaptation task to just an adaptation of the HAL-drivers.

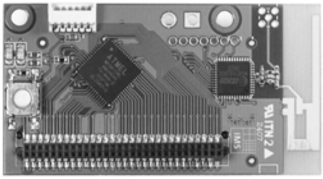

Figure 1: μNode

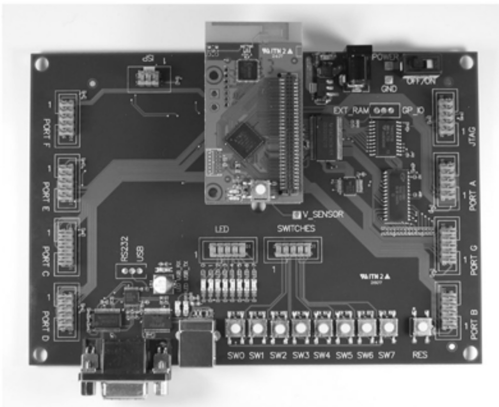

Figure 2: Developmentboard with μNode attached

Energy Harvesting

An issue frequently neglected in cost-benefit calculation, beside the costs for setting up WSN systems, is the contribution in afford for battery change procedures to running system costs. With a large WSN system, even annual replacement intervals can increase these costs considerable. Hence, IMS provides also WSN's with application specific, seamless integrated energy harvesting approaches.

Diversity

There exists a large diversity of applications for wireless sensor networks. As reference for the versatility of the µNode development kit, the following applications shall be mentioned, recently realized by Fraunhofer IMS, using the µNodes.

One project aimed on an energy analysis in greenhouses. For this purpose, several µNodes, equipped with temperature and humidity sensors, where spatial distributed in greenhouses. By gathering there data over time, a weak point analysis in time and spacial domain could be accomplished [1]. The avoidance of wires in the installation simplified the entire system setup and saved significantly time. Figure 3 shows one of the several measurement stations, where a solar energy based approach for harvesting energy has been used to power the µNodes.

Figure 3: Solar powered Sensornode

An other µNode WSN was used in an agriculture environment, where temperature, soil and air humidity was measured [2]. Again the wireless approach accelerated the whole system setup. Long distances between sensor nodes could easy bridged by interjacent nodes within the network.

Last, the "BallonMagie" events shall be mentioned that took place 2006 [3] and 2007 in Magdeburg. Here the µNode systems were used for realising remote controlled light shows in an arrangement of more then 30 hot-air balloons. The magic Night Glow event in 2007 was part of the 15th European Hot Air Balloon Championship [4] that was followed by more than 20,000 spectators.

Summary

The benefit of deploying wireless sensor networks becomes particularly obvious in applications, where the functionality of transporting gathered sensor data to the user constitutes a considerable portion of the whole system costs. The µNode development kit provides a highly flexible hardware- and software platform, that enables efficient implementation of application specific solutions and thus lowering total system costs. Further, the modularity minimizes costs for optionally later adoptions of hardware or software to application specific change requests.

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Position Localization for Object Management with the Aid of Passive RFID tags

Frederic Meyer, Gerd vom Bögel, John Harrod, Harald Wölferschneider,
Dietmar Brendle, Thomas Ledermann, Dennis Fritsch

Abstract

In this paper, a radio frequency localisation system for HF System and UHF System is described. The HF System consists of a HF-Reader, at least four receiving antennas with receive and calibrate modules, three phase detectors, a control module and a PC. The UHF system is optional expandable. In this case, the HF antenna is exchanged though the UHF antenna and the UHF receive and calibrate module. The radio frequency control module steers the identification and localisation process. It collects different values for the positioning calculation as example, the automatic gain control values and the values from the phase detector. The different values are bundled and send to a PC which calculates the 3 D position and steers the robot.

Key Concepts

- The determination of the position and orientation of a passive RFID tag or an object labeled with an RFID tag.
- The determination of the position and orientation of a passive RFID tag by measuring the run time difference of a transponder with at least three receivers.
- The determination of the run time difference by comparing the phase differences of a localization signal at the localization receivers.
- The detection and compensation of multi-path reception by measuring at different localization frequencies.
- The potential for self calibration by means of calculation with measured phase differences of an antenna at a known position.

1 Introduction

1.1 Areas of Application

Automatic handling system tasks rely heavily on knowing the position and orientation of the objects to be handled. Presently, with today's technology, the requirements for these systems to localize objects are not fulfilled. Current technology does not contain the correct combination of economics, robustness, processing time, and object independency to support systems consisting of a complex series of handling system processes. These processes can range from manufacturing a product with an industrial robot to the grasping of a household item with a service robot. Therefore, there exists a demand for effective techniques for object localization.

In all possible areas of application, RFID technology is increasingly required for object identification. As yet, RFID is not able to pinpoint the position of an object within the precision of a few millimeters. Market analysts forecast that RFID transponders will replace barcode systems, and as a result, a rapid increase in the use of RFID technology will be seen. The advancement of the technology in the ability to localize objects will make way for several new applications in the area of automatic handling systems. One of these new applications will be presented here – Radio Frequency Object Localization (RFOL).

The localization can be used either for the collection of an unknown position and orientation or as check of a desired value. For the three main scenarios are regarded:
- promoting
- camps
- handling

Handling also can be divided into three indexing steps, withdrawal by the stock location, transport to a delivery place an delivery to a destination. By inclusion the order condition and number of objects which are put down or made available, the scenario tree expand itself.

One concrete application is in the area of automated manufacturing. In this scenario, objects are sorted and made available on palettes. In order for a robot to grab these objects, it must be able to recognize the exact location and orientation of the objects. Another application would be the so called "grab in the box". In this situation the object lay unsorted in a box and they must be grabbed by a robot arm in order to be mounted on another object in the next step. In the area of service robots, the localization could be applied by house robots to grasp household items.

In all the previously mentioned examples, the objects must be localized before they can be grasped. Localization is possible without the use of image processing methods and objects can be "blindly" grasped.

1.2 The present state of technology

Current localization processes are mostly based on 2D or 3D optical sensors and an analysis system. These systems however have their limits. These limits can include implementation costs, maintenance costs, the sensitivity of the system to elements in the environment (for example dust and unstable lighting conditions), and the effort required to adjust the localization algorithm for the objects that are to be localized (the system has to be taught).

When using RFID transponders in localization system, it is important to distinguish between the identification process and the localization process. During the identification process the presence of an RFID transponder is established. The accuracy of the process is directly related to the read range of the RFID reader. This form of localization is suitable for tracking products in a supply chain management system. For handling system processes, this level of precision of localization is not enough. Up until now, battery driven (active) transponders have been used in systems where the exact location of RFID transponder needs to be determined. For reasons of cost and transponder size, these systems have only been imple-mented isolated cases. Furthermore, these systems are suitable only for large ranges and do not achieve the level of precision required for handling systems.

2 System Bases for 3 D localization

For 3 D localization there is a reference localiza-tion signal, and three different localization signals needed. The receiving antennas must stretch a 3 D coordinate System. As example, antenna 1, see figure 1, is mounted in the coordinate origin, antenna 2 is mounted in x direction, antenna 3 is mounted in y direction and antenna 4 is mounted in z direction from the origin, so the antennas stretch a 3 D coordinate System. In figure 2 a schematic shows the RFOL demonstrator, which is later explained in more detail.

2.1 System description

To realize the set goals, the subsequent method of resolution will be followed. The measurement area is defined by a set of $A_1 - A_n$ antennas with the RFID transponder located within the range

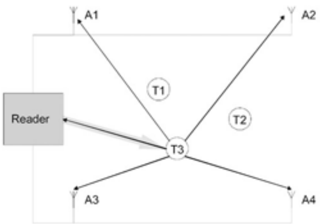

Figure 1: RFOL Component View

of the antennas. A RFID reader activates and identifies the RFID transponders $T_1 - T_m$, and then orders that only the transponder T_3 start sending a localization signal. This localization signal is either produced by the to-be-localized transponder T_3 or the transponder reflects a carrier signal (generated by the RFID reader) modulated (with backscattering or last modulation) with the localization signal. It is important to note that the localization signal is periodic.

The localization antenna $A_1 - A_n$ whose positions are known, receive the radio signal from the transponder and forward it to the localization receiver that then processes and regenerates the localization signal. At this point the runtime, runtime difference, intensity and, if applicable, the direction of the localization signal will be resolved. Next, a computer uses these values to calculate the location of transponder T_3. The key measurements used to determine the position of T_3 are the runtime differences between the signals received by antenna $A_1 - A_n$. The intensity and direction measurement can be used for testing the plausibility of the calculated position.

For determining the relative runtime difference, one of the received localization signals will be used as a reference. To discern the localization signal from the carrier signal, it is necessary to distinguish it in the time or frequency domain. The following methods are supported

1. The RFID reader periodically suspends its carrier frequency. During these pauses, the transponder sends its localization signal. This signal has no modulation (PM, FM, AM or any variants) and no demodulation is performed during the signal processing stage at localization receivers. Directly after filtering and amplification, the signal is analyzed and the phase positions are determined.

2. A varying sideband is generated in the frequency using single-sideband modulation or with an oscillator. This signal will be isolated in the receiver, and the object's position will be calculated using the phase positions of the received sideband.

3. The localization signal generated by the trans-ponder is harmonic (square or sinus wave) and is modulated onto the carrier frequency. During the signal processing stage at the receiver, the localization signal is filtered, amplified and demodulated. The object's location is calculated using the phase position of the modulation signal.

4. The localization signal is a Pseudo Random Bit Sequence Signal (PRBS) that is modulated onto the carrier frequency. Through cross correlation of the PRBS signals at the receivers, the runtime differences and therefore the location of the RFID transponder can be calculated.

The period duration of the localization signal among other things is dependent on the measurement area. Normally, the distance between antennas $A_1 - A_n$ will not be greater than 10 meters. The runtime of a signal over a distance of 10 meters in free space is 33ns. Because of the convolution principle of correlated receivers, the signals for an undisturbed analysis should not overrun half of the (runtime jamming two pulses in one convolution). Thus period durations of under 16.67 ns should be selected (this corresponds to frequencies over 6MHz).

Furthermore the required accuracy of the location localization is influenced by the selection of the period duration. In order to obtain a measurement that is

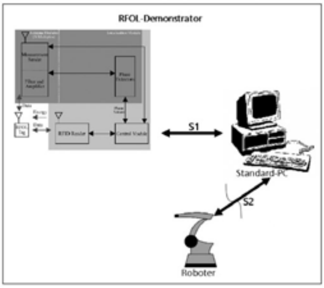

Figure 2: Block Diagram RFOL Demonstrator

accurate within 1 cm, the system has to be able to measure time differences of at least 33 picoseconds (1ps = 10^{-12}s). Typical values from a phase analyzer have 10 bit resolution (1024 stages). Accordingly, the period duration of the localization signal should be a maximum of 33ps * 1024/2 = 16.67 ns.

The increase in measurement range and position resolution can be performed with additional localization frequencies.

To recognize and compensate for multiple reflections, there exists the possibility to change the frequency of the localization signal (either automatically or with a switch).

The system has the ability to self calibrate. During this process one localization antenna acts as a sender and the other antennas act as receivers. The receiving localization antennas use the calibration signal and the known positions of the other localization antennas to calibrate. This process repeats until all antennas have acted as sender.

Through the use of many tags or through the inclusion of previous knowledge and with the aid of RFOL technology, the location and position of any object in a room can be determined

In this research project are the HF and the UHF fre-quencies examined and the Systems are illustrated in figure 3 and figure 4.

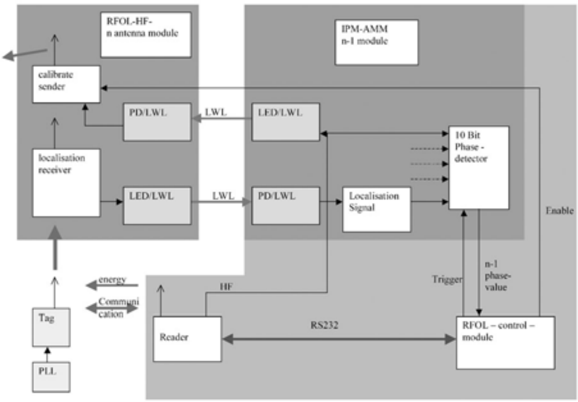

Figure 3: Block Diagram of the HF System

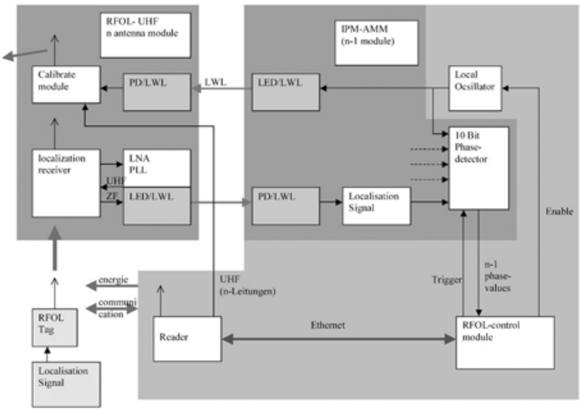

Figure 4: Block Diagram of the UHF System

2.1.1 HF Tag

The HF Tag consists of a standard vicinity tag with additional phase looked loop for frequency synchronization. After the identification, the tag gets the command for localization, means, the phased looked loop is synchronized. The reader, controlled by the control unit, suspends it's carrier frequency and the HF Tag creates and sends a synchronous 13.56 MHz localization signal back.

2.1.2 HF receive and calibrate module

The HF Receive and calibrate Module consists of a amplifier circuit with variable gain control and a sender, which transmits the calibrate signal for system calibration. It is connected to the control module about a similarly protocol to I2C. After the amplification to a constant output level, the localization signal is made available over a optic fiber for the phase detector.

2.1.3 UHF Tag

The UHF tag consists of a standard EPC 1 Gen2 Tag with the optional possibility for modulate a localization signal on the UHF carrier. See 2.1 comment 3

2.1.4 UHF receive and calibrate module

This system consists of SAW filter's, directional coupler, low noise amplifier, down converting mixer and a phase looked loop for carrier synchronization. For the phase detector it is important to get a frequency error as small as possible.

2.1.5 RFOL control module/PC/robot

The RFOL control module steers the identification and localization process. It is realized with a ARM9 micro controller included in a portux board. The control unit starts the identification process, collects the ID´s and send them to the PC. The module selects an ID for the localization process and send the command for localization to the reader, the antenna modules and the phase detector modules. After this process, the module picks the value for the automatic gain control from the antenna module and the phase detector values. The information's are bundled with the ID and send to the PC. From the Phase detector values the PC calculates the position in the 3 D coordinate system. The automatic gain control values can be used for possibility checks or for calculate a more exact position.

2.2 Realization and results

2.2.1 HF System

In the HF - measurement system the HF tag is simulated trough an active sender, including a 13.56 MHz quartz oscillator. In the measurements are local dissolutions of approximated 30 cm realized.

2.2.2 UHF System

In the first UHF measurement prototype, the passive UHF Tag modulates a 13.56 MHz localization signal on the UHF carrier. The receiver unit consists of the elements, low noise amplifier, down converting mixer and a firmly adjusted voltage controlled oscillator. This system becomes momentarily tested. In this System are problems with the frequency synchronization expected so the next iteration of the UHF system is extended with a phase looked loop for frequency synthesis.

3 Conclusion

In this paper is a concept for the localization with RFID technology presented. Test systems for the HF – and UHF – frequencies are in development. Subsequently to the comparative measurements, the emphasis is put on the more promising technology.

4 Acknowledgement

This work is supported througth a MEF by the Fraunhofer Gesellschaft.

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New transblood imaging technique to visualize the interior of the human heart

I. Krisch, M. Kurzschenkel, B. Hosticka

Introduction

To date, no diagnostic tool is on the market enabling the direct vision through blood with sufficiently high resolution. The idea of "displaying the inside of blood vessels and the endocard", more precisely the internal wall, within the cardio-vascular system has been considered utopian.

At the moment, the progress in interventional/minimally invasive surgery is slowed down due to a missing imaging device. With the following novel technical concept, our team outlines a strategy to attain this goal of an angioscopic system enabling to guide minimally invasive cardiac operations such as mitral valve repair, closure of septal defects, endovascular stenting of the severely diseased thoracic aorta, as well as several interventional procedures in cardiology. For the first time in history, a direct visualization of vascular wall structures will enable detection, classification and description of lesions within the blood stream. Due to sufficient miniaturization, many parts of the vascular system see Figure 1, become examinable.

This challenging technique holds on an enormous economic potential so that Fraunhofer supports starting a new business in this area.

Method

Standard methods, like the modern video-endoscopy and the classical fiber-endoscopy, fail at seeing through blood due to light scattering at the erythrocytes and the absorption from haemoglobin respectively water, if the endoscope is inserted into blood vessels. Similarly, sight is restricted in a foggy environment subject to droplet density and droplet size. In both cases, one can find remedy by using an infrared camera. The wavelength results from a comparison of both mentioned effects. After balancing the absorption rising up in the IR region and the scattering disappearing in this wavelength region, two windows have been identified, see also Figure 2. Blood becomes sufficiently transparent in the near infrared region around 1.7 µm as well as around 2.2 µm [1], so that an IR camera can exactly visualize the desired areas.

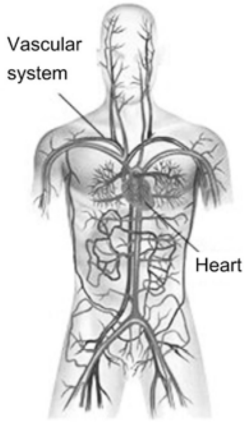

Figure 1: Schematic of the vascular system

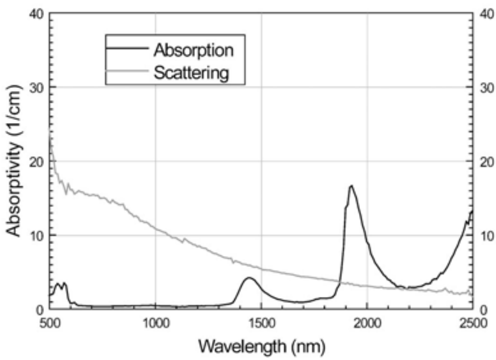

Figure 2: The effect of scattering and absorption. Red blood cells are responsible for scattering and the haemoglobin causes the absorption. In the IR region, the absorption of haemoglobin and water are equal [2].

Concept

The centrepiece of the proposed device is based upon a miniature encapsulated videoendoscope head consisting of an IR Focal Plane array, an optical system, an illumination and CMOS chip containing electronics, i.e. driver, readout, pre-processing, interface circuitry, [3]. The area of application is visualized in Figure 3. The image data are processed externally before displaying them on a monitor. The catheter which is inserted into the arteries or veins to bring the videoendoscope head to the point of interest is encapsulated sterilely in order to prevent infection.

This angioscope assists the heart surgeon with preoperative, intra-operative and postoperative treatment of patients. All components have to be miniaturized to a diameter which matches with the dimensions of the vascular system without disturbing the blood flow. Since the catheter with all components inside should be reusable for economic reasons, the assembly must tolerate several sterilization transits.

Figure 3: Schematic showing the architecture of the angioscope

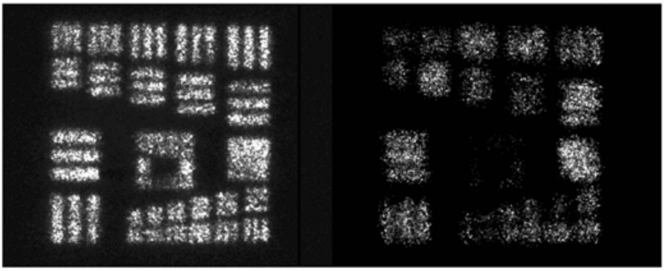

Figure 4: These photo visualize an USAF target hidden under a layer of blood visualized by an IR-camera. The first photo corresponds to a blood layer of 2 mm, the second one to a layer of 4 mm.

First Tests

As a first approach, a demonstrator was built up to receive a proof of principle and a proof of method. This demonstrator consists of a conventional IR camera, an adapted optical system, a radiation source with control unit and some fibres. The experiment focused on measurements through blood simulated by an artificial scenery [4]. Different samples and an USAF target were positioned into a volume of blood before observing them with the camera system. These pictures in Figure 4 emphasize clearly which image quality can be attained without image processing by means of a simple set-up. In a further test, the transmission capability of blood was verified in both wavelength regions.

Conclusion

Summing up all effects like absorption and scattering and taking into account the availability of all technical components the wavelength region between 1.6 and 1.7 µm is the most advantageous. The other wavelength region is considered as an add-on tool for diagnostics. If the inner wall of a vein is covered by plaques, the additional wavelength supports determining the composition of the material [5]. Our previous tests confirm that the range of visibility amounts to almost 8 mm. This distance is sufficient for application in modern heart surgery.

As a result, the cardiovascular angioscope can stimulate new techniques of visualization aiming at real four-dimensional image processing. This technical concept outlined above enables to guide minimally invasive cardiac operations. The novel diagnostic tool facilitates a simple morphologic imaging of the cardio-vascular system with a huge field of application in various medical disciplines. In contrast to standard imaging methods, which are applied to visualize the cardiovascular system, this smart system provides higher resolution without using ionising radiation.

For the moment, research is completed, but the development is continued to bring this concept as a product to the market. Having answered further questions concerning packaging and miniaturization we can now start prototyping.

Other applications concern technical domains and deal with sight through turbid media. They are currently evaluated.

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Distributed Test System for FlexRay Interoperability Tests

Holger Kappert

Introduction

Fraunhofer IMS has started their activities in the FlexRay™ business in 2005 with focus on dedicated test system hardware. TÜV Nord IFM and Fraunhofer IMS have developed the FlexRay Data Link Layer Conformance Test System whereas IMS has implemented the specific test system hardware which allows stimulation and observation of the FlexRay Communication Controller devices. Besides the FlexRay Protocol Conformance Test provided by TÜV Nord, C&S Group and TZM provide the FlexRay Physical Layer Conformance Test. However, conformance test only verify that the device itself behaves as specified, without checking for interoperability. Thus it cannot guarantee that the FlexRay devices cooperate inside a complex network topology consisting of various Bus Drivers, Communication Controllers and Hosts from different vendors. Therefore OEMs demand the institution of Interoperability Tests addressing this issue. TÜV Nord IFM has written a FlexRay Interoperability Test Specification in collaboration with the two OEMs Audi and BMW considering typical OEM requirements and concerns. As a continuation TÜV Nord IFM has developed a flexible test system based on a dedicated test system hardware planned and developed by Fraunhofer IMS. This next generation test hardware, following a scaleable and modular platform approach, provides various control and observation mechanisms as well as dedicated noise and disturbance injection to guarantee for a comprehensive interoperability test. The test system supports various network topologies with different kinds of nodes. In the first integration phase, vendor specific evaluation boards are used inside the network topologies, carrying the node specific Bus Drivers, Communication Controller (CC) and Host. In a later phase also OEM specific ECUs (Electronic Control Units) can be integrated into the network under test.

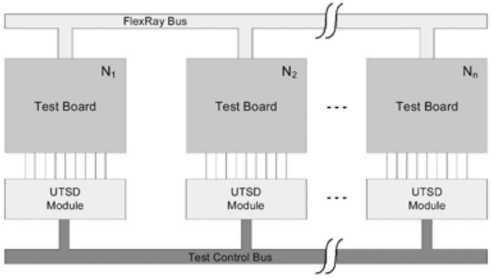

Figure 1: Simplified network topology

Test system hardware architecture

The basic approach of the test system is to provide a platform enabling FlexRay Interoperability Tests for different OEM specific network topologies. Therefore a modular and scaleable test system architecture has been chosen. Figure 1 shows a simplified network topology. Each test board represents one node of the overall cluster. For control and observation purposes as well as for the emulation of various disturbances, a dedicated tester module (UTSD Modul) is attached to each of these test boards. Each UTSD Module locally fulfills different functions like:

- communication with the Host
- observation of FlexRay communication for synchronization purposes
- trigger of host or CC related actions
- synchronization with Host application
- injection of noise
- injection of communication delays
- emulation of clock drift

All UTSD Modules are linked together via the Test Control Bus and form a scaleable distributed test system. The Test

Control Bus supports synchronization mechanisms between the different UTSD Modules. All clocks of the test system are derived from a central clock which is distributed via the Test Control Bus. Locally, the UTSD Modules provides a derived clock to the test boards. This way it is possible to operate the whole FlexRay Clustrer synchronously and to apply local clock drifts to the different nodes relative to the remaining cluster.

The whole test system is configured via a PC based Test Controller connected to the different UTSD Modules via Ethernet.

Test execution

The execution of the different test cases of the FlexRay Interoperability Test requires the configuration of the test system and of the network. All test cases are typically executed in three steps. In a first step the whole test system, distributed to several UTSD Modules, is initialized with test sequences and dedicated test patterns for each node. In addition all Hosts of the FlexRay cluster are configured with a dedicated test application or sequence, respectively. In a second step, the test is executed autonomously. In a third step, results are read out from the different UTSD Modules and Hosts for evaluation. Therefore TÜV Nord IFM has developed a powerful tool set, which allows to configure the different components and to evaluate the results dynamically based on a generic test specification and an OEM specific network topology description.

UTSD Module

Figure 2 shows a block diagram of the UTSD Module. The UTSD Module is a complex Embedded System. Its central part is an FPGA including most of the depicted modules which form a separate System on Chip (SoC). The configuration of the FPGA as well as the initialization and read out of the memories of the SoC is handled by a dedicated System Controller, which is implemented based on a commercially available DIL/NetPC. In addition the System Controller handles the communication between the Test Controller and the UTSD and provides a serial communication link to the test board's Host.

The SoC implemented inside the FPGA forms the real test hardware. The central element of the SoC is a powerful dedicated test sequencer which is implemented in two instances to allow concurrent execution of two processes during test execution. In addition the SoC is equipped with dedicated peripherals which provide synchronization mechanisms, test scheduling and injection of disturbances like signal distortion or clock drift. It also includes peripherals which provide FlexRay specific mechanisms like Macrotick generation (MTG), Media Access (MAC) or frame

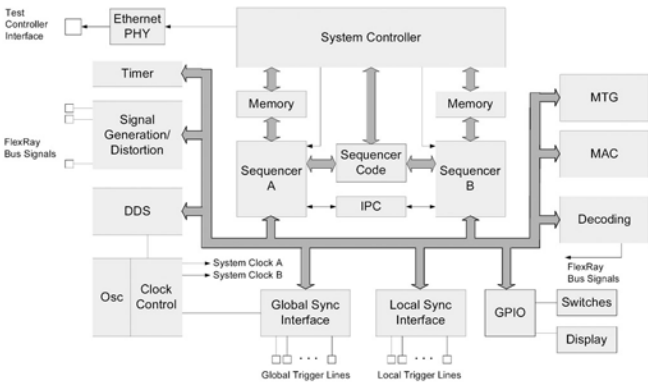

Figure 2: UTSD Block Diagram

processing and decoding. Outside the FPGA mainly driver circuitry is located like FlexRay Bus Driver or IO structures. As mentioned above, all system clocks are derived from a central clock. Locally on each UTSD Module, a subclock can be derived from this central clock, using Direct Digital Synthesis (DDS), which is provided to the CC. This provides the capability of clock drift emulation.

A photo of a single UTSD Module is shown in figure 3.

Conclusion

The described Distributed Test System allows comprehensive and user friendly FlexRay Interoperability Tests. Fraunhofer IMS has developed the next generation test system hardware which is actually focused but not limited to FlexRay specific test applications. In addition the UTSD Module provides a platform for FlexRay specific developments. The originated hardware combines different competence fields of the IMS like Embedded Hardware, Software and System on Chip design at their best.

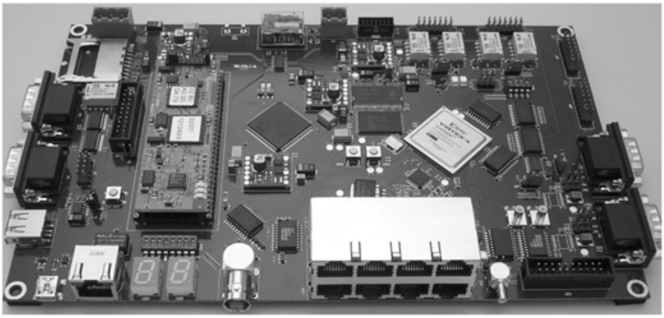

Figure 3: UTSD Module

Ambient Intelligence to Support People at Home

Edwin Naroska, Klaus Scherer, Christian Ressel, Todor Dimitrov

Abstract

In future, smart buildings will provide users with numerous functions and will thus serve many purposes. However, due to the demographic change in many countries one major focus will be put on functions that support elderly or handicapped people at home to manage their daily living activities. Of course, a major requirement is to maintain the safety and privacy of the inhabitants. Unfortunately, there is no single scenario that matches all typical care situations, which can occur at a specific home. Instead, appropriate systems must deal with dynamic changes in the environment as well as varying configurations, setups, and demands. Manually tailoring each installed system towards the specific requirements is not a feasible option in the real world. Instead, solutions are needed that automatically deal with changes in the setup as well as within the environment. A promising approach to address this issue is to use semantic technology to build a system that integrates information about sensors, applications, and the environment into a single holistic knowledge base. Using this approach, the system is be able to automatically reason about its components, the information that is available in the network, and how the system interacts with the user. This will enable it to configure itself, monitor its behavior, and take actions in a context-aware fashion.

The application of semantic technology in fact influences all components of an ambient assistance system. Sensors and actuators must be able to describe their functions and properties semantically. The middleware uses this information to discover appropriate devices and services such that an integrated network is built. Further, semantic information is used to create dynamic user interfaces that adapt themselves to the specific environment and to the needs and preferences of the users. The advent of this orchestrated, context-aware interaction between devices and services brings AmI (Ambient Intelligence) to life.

The driving force behind the AmI vision is the user's benefit. Discovering and analyzing this benefit is hence another major issue to be tackled when designing and developing such systems. To this end, appropriate tools and test environments are needed that will allow testing of solutions in a real world setting.

1 Introduction

Advanced technology tools and gadgets have become an integral part of our lives. In the past, only few of the activities of daily living had been addressed by appropriate technology. Nowadays, however, more and more functions and activities are being supported by technical devices [1]. An illustration for this trend are cars. Apart from developing new technologies that improve the mobility, more and more secondary functions are being integrated into modern cars in order to abridge the gap to other domains, e.g. communication, entertainment.

A similar change can be seen in the evolution of home environments. In the past, few basic functions (e.g. heating, lighting, etc.) had been taken into consideration. Today, many applications from different domains are being integrated in order to provide valueadded services to the home inhabitants [2].

Among all applications, those that support elderly or handicapped people in the daily living activities play a special role. Due to the demographic change, health care systems are forced to lower the costs. A promising approach towards this goal is to let elderly and handicapped people live independently at home for as long as possible before they are moved to a nursery home. To preserve the health and safety of people, modern ambient intelligence technology is employed such that people can receive adequate support during their daily living activities. Another application of AmI it to detect changes in the health status of the inhabitants (patients). This includes the discovery of gradually deteriorating health parameters as well as the detection of emergency cases.

2 Assistive functions of mod-ern buildings

The functions that are covered by modern buildings are very diverse. Useful functions range from simple solutions to control lighting, air conditioning and security up to solutions that address entertainment and communication [2].

Due to the demographic changes in the societies of many countries functions that support elderly or handicapped people in their daily living activities at home are attracting more and more attention. Of special interest are functions that go beyond the actual apartment borders. Promising solutions combine modern technology with external services in order to allow elderly people to live independently at home. Of course, this must be achieved without putting the safety and security of people at risk [4,5]. At the core of such home care scenarios are the following functions:

- **Preserve and protect.** A major task of a home system is to protect life and preserve health of the inhabitants. This includes detection of emergency cases as well as discovering gradual changes in the behavior of people that may indicate a health problem.

- **Support health personnel during their paperwork.** A significant amount of the care effort is constituted by paperwork. In order to partly free up this time for actual care tasks, appropriate approaches are needed. This does not only reduce costs but also allows care people to focus on their actual task: helping people.

- Support **care logistics.** Within the care process numerous logistic tasks are involved (e.g. distributing medicine, food). An appropriate technology can help make these processes more efficient.

To provide a comprehensive list with all available options is beyond the scope of this paper. Instead, we elaborate on the "preserve and protect" functions in the following.

2.1 Preserve and Protect

The "preserve and protect" functions have been di-vided in the following categories:

- **Fall detection:** an important function is the automatic fall detection within the apartment accompanied by an emergency notification. Fall detection shall work independent of the actual place where the incident takes place. To this end, appropriate sensors are attached to the body of the monitored person. The gained information is combined with the data of sensors embedded within the environment. This combination is especially promising to keep the system costs low and the detection reliability high.

- **Prevention oriented motion analysis:** while fall detection is an important feature, preventing falls from happening is an even more interesting goal. To achieve this, appropriate sensor data is analyzed in order to detect changes in the movement pattern that may indicate problems with the gait of the inhabitant.

- **Wandering detection:** another interesting function that can be used to discover physiological or mental problems at an early stage is detecting whether people are wandering around at night. Additionally, it may also help prevent falls. In particular, wandering should be detected even in the case the inhabitant does not leave his or her bedroom.

- **Detection of agitated sleep:** using integrated sensors in the bed, it is possible to detect agitated sleep.

- **Measuring of vital parameters:** by exploiting sensors attached to the body as well as equipment embedded in the environment, vital parameters can be measured, recorded and processed. Further, environmental sensors can be used to enrich vital parameter measurements with context information.

- **Extraction of behavior patterns:** from the sensor data the system shall extract typical behavior patterns of the inhabitant. Further, it shall detect deviations from these patterns in order to collect indications that point towards physiological or mental problems. As the behavior patterns are typically dependent on the individual user preferences, approaches are needed to learn the behavior during a startup phase and then use this data as a reference. As a result, the system will be able to adopt to the individual preferences and properties of the specific patient.

- **Helping to maintain social networks:** a rather important aspect of everybody's living is to stay connected with friends and relatives. To this end, easy to use communication tools as well as group communication facilities like portals can be used. Apart from helping people to maintain their social network, changes within this network may also be of interest to the care personnel in order to gather early information about degradation of the health status.

- **Medication:** reminding people to take their medicine is an important task especially if they live alone at home. Several solutions can be implemented. They range from systems that just detect whether the medicine box has been opened up to automatic dispensers that deliver the appropriate amount and type of medicine depending on the patient's context. The last solution is of special of interest to flat-sharing communities.

- **Detection of toilet use:** here, the focus is on frequency and distribution of usage over time. For example, a low frequency may indicate an ongoing dehydration process which is quite common in elderly care. High frequent usage may be caused by infects of the urinary passage.

- **Monitoring of devices:** in many cases it is important to monitor usage of devices that may potentially endangers safety. Especially devices like ovens or water taps are often of interest here. Depending of the state of the inhabitant, solutions come into play that monitor the state of "dangerous devices and automatically take action if a specific device is going to be used beyond safety bounds.

- **Fire and water:** of course, an ambient assistance system shall also take over the classical tasks known from domotic systems. Among these tasks, the detection of fire and flooding plays an important role in order to preserve safety and integrity of the environment.

3 Basic building blocks of modern ambient systems

The functions and solutions that have been described in the previous section are based on a large number of different sensors and components. Future assistance system will hence deal with numerous type of sensor data streams that must be collected and processed. Based on the acquired information, appropriate actions will be taken. Another challenge is to implement an efficient and easy-to-use communication channel between the user and the system in order to keep the user in control of the environment.

Moreover, all these functions and features must be realized taking into account the frequent dynamic changes within the environment. For example, new sensors or devices will enter the network and must be hence integrated without hampering performance or uptime of the overall system [1,6].

To summirize, a modern ambient assistance system must match the following profile:

- The system must be capable of integrating numerous components of different types into a single network. Integration must be achieved at different layers: it must be done at the physical, at the protocol as well as at the semantic levels. Especially, integration at the semantic level is important in order to implement collaboration between components that origin from different domains (e.g., the multimedia and the domotic domains) [1,3].

- The system must be able to dynamically integrate and remove devices. Note that dynamic changes in the configuration may be caused by new de-vices that are brought into the home as well as components that must be removed due to a component failure or just because they ran out of battery power.

- The system must be able to efficiently handle components that were not known or available at design time. This does not only cover the mechanisms, which are used to physically and logically connect such devices to the network. Especially challenging is the task of making the system "understand" how a new kind of device can be used and what kind of information is provided by it. The goal is to develop a system that automatically interprets the data provided by a new sensor.

- Future ambient systems must have appropriate user interfaces. In the past each device brought along its own user interface accompanied with appropriate menu structures and user philosophies. Given the expectation that hundreds or even thousands of devices must be integrated in future homes, this approach is not feasible anymore. Instead approaches are needed that automatically build integrated homogeneous user interfaces where the actual bounds of the devices become fuzzy or are even dissolved.

- Ambient applications will also face new challenges. They must be capable of discovering and using all information sources available within a network. Moreover, they must be capable of exploiting services and sensors that were unknown at the application's design time.

From all these requirements, in turn, special requirements for the sensors and actuators, the home automation middleware and the user interfaces can be derived.

3.1 Sensors/actuators

In order to integrate new sensors and actuators that were unknown at the system's design time, new devices must be able to provide information about their functions and properties. Moreover, this information must be provided in a machine-interpretable format such that the inherent semantics can be automatically integrated in the holistic knowledge base. As a result, the system will be able not just to read or interpret plain parameters but also to "understand" the meaning of the information.

The overall goal is to create a system that can put the information about sensors and services into an overall context [1,3]. This kind of "understanding" is needed in order to allow the system to deal with dynamic changes in the environment, i.e. changes in the system or changes with respect to tasks and goals that have to be accomplished by the system.

Fortunately, these demands typically do not effect the sensors and actuators hardware. One major requirement is that the components must be able to communicate over a network. However, there is no need to really process or provide all kinds of semantic information onsite by the components. Instead, it is often sufficient to provide some kind of ID which is then used to retrieve the required semantic information from the internet. Furthermore, resource-intensive processing can be outsourced to an appropriate gateway making this gateway act as a representative of the actual sensor or actuator.

3.2 Middleware

The numerous hardware and software components of a future ambient system will be typically contributed by many different vendors. Hence, a major task of the middleware is to integrate all these elements into a single homogenous network that provides a transparent interface to all these elements [1].

Integration must be achieved at different levels: at the lowest level the devices must be physically connected to each other so that they become capable of exchanging messages. At the next level, appropriate protocol converters may be required to translate messages so that the devices that comply to different protocols are capable of exchanging information. Finally, at a higher level, some "meaning" must be associated with the information that is exchanged.

The integration of mobile devices is another challenge for the underlying technology due to the dynamic effects that may be caused by adding or removing components.

Compatibility at the lower physical and protocol level can be achieved by using appropriate standards that are available for various application domains. For example, for wire-based industry applications the CAN communication protocol is widely used. In the domotic area, EIB or LON are quite popular and when it comes to wireless communication, Bluetooth and ZigBee are often employed. As in a complex system numerous components are deployed that typically also comply to different standards, appropriate cou-plers between the different protocol domains are needed. Ethernet based TCP/IP plays a special role here as it is often used to build a backbone network. That is, in many complex systems gate-ways intercon-nect specialized communication networks (e.g., EIB, LON) via Ethernet. This not only provides a high level of interconnectivity but also allows applications executed on PC's or other computing devices to access all components attached to the specialized buses.

More challenging than connecting devices and components at the physical and protocol levels is to enable them to reason about the information that is exchanged within the network. Currently, domotic systems are configured manually. .Unfortunately, this approach is not feasible anymore given the amount of devices and the dynamic effects that must be handled in the future. As a result, solutions are needed that will automatically perform complex configuration tasks without user interaction. Despite of this automatism, however, the full functionality of the attached components must be made visible and available within the network.

Hence, interpreting sensor data in a smart way is one of the biggest challenges for ambient systems. Applications must be capable of using sensor information that is not known at application's design time. Further, the system must be capable of extracting information from the sensors that is sometimes not directly provided by the sensor. This is needed as a sensor vendor cannot foresee all kinds of applications and usages of a specific sensor.

A promising approach to reach this goal is to use semantic based ontology technology in order to describe the behavior of the components, the behavior of the user as well as the physical interaction of components and user within the environment. These descriptions can then be combined with corresponding tools to perform reasoning in order to derive further knowledge about the system. As a result, the systems is able to interpret sensor data (to some extend) and to provide the extracted knowledge to applications. A simple example for this is a light switch. By using the semantic description of a light switch and combining it with semantic descriptions of human behavior and physical effects, the system can automatically derive knowledge from pressing a light switch: the system "knows" that (a) whenever a switch has been pressed the user must be alive and (b) the user is close to the switch's location. That is, the system can derive information that goes beyond of the actual purpose of the switch (the basic purpose is to inform the domotic system about the user's intention to activate or deactivate a specific device). Of course, this kind of reasoning could be done offline beforehand and converted into appropriate static rules by a designer. However, this static approach is not feasible in a dynamic environment where new applications and devices are to be integrated into the network, i.e. new applications may require new pieces of information that were not foreseen by the developers.

1.3 Adaptive user interfaces synthesis

Future homes will be equipped with numerous domotic devices that cover a wide range of functionalities. The availability of large PCs or computer screens will provide powerful platforms to implement attractive user interfaces. Unfortunately, today each device typically uses its own user interface along with appropriate menu structures. As a result, different devices from different vendors are typically equipped with diverse menu structures and layouts even if they actually have similar functionalities. Thus, the user is confronted with inhomogeneous menu structures forcing one to learn the logic behind each structure first.

In order to combat this situation, new approaches for synthesizing user interfaces are needed. A promising approach has been developed within the EU-IST funded research project Amigo. Functionalities of different devices and software components are integrated into one operation concept to give the user the feeling of interacting with one solid system and not with a loosely coupled set of single devices. Therefore, the binding between device and functionality has been removed and device independent menu structures have been introduced. To this end, appliances only offer and describe their functionalities. The menu structure of the user interface is automatically generated during run-time taking the personal structure preferences of the actual user into account.

In literature, numerous researches on model-based GUI generation can be found. Early approaches like the Genius project [9] or the Penguin system [10] target at rapid prototyping techniques. Other approaches build user interface during run-time. However, these approaches are appliance-based, which means that a user interface for a specific appliance is used or generated. Therefore, the generated structures are similar to fixed programmed interfaces for specific appliances. Thus, a superordinated navigation is missing. The binding between functionalities and devices is also fixed and cannot be reorganized to allow efficient operations and navigations in networked-environments. As a result, a device-independent view (e.g. a view of the functionalities that control the home related security settings of all devices) is not possible with these systems. Finally, previous ap-proaches do not offer methods to personalize the logic of the menu structures in order to help users operate more intuitively in unknown environments.

In general, three main questions have to be answered by the user interface synthesis system. These questions are addressed by exploiting different kinds of models that store the appropriate knowledge:

– Which information has to be presented to the user and which values can be changed by the user? This information is given by the environment model. The environment model contains all knowledge about the environment.

– Which information should be grouped and presented in the same view? A home environment could contain more than hundred of different devices and each device could have many parameters, which could be observed and changed by the user. To offer an efficient user interface, the existing information has to be thematically grouped. The rules for this grouping are given by the navigation model. Notice that each user can have its own navigation model and that therefore a personalized structure can be created.

– How does the presentation look like? The navigation model defines the information, which has to be presented, but layout and presentation are still missing. These are defined and given by the presentation model.

From these models a menu structure can be automatically synthesized that integrates all available devices and functions into an unified interface. Moreover, the menu structure can be also adopted to the user's needs and preferences. This feature makes the approach especially interesting for elderly care applications. It allows ambient systems to individually adapt the user interfaces in order to meet the needs of elderly people. As a result, menu patterns that are familiar with the user can be applied throughout the whole system.

Figure 1 inHaus1 innovation center

Figure 2 inHaus2 innovation center (computer simulation)

This is especially important for people that suffer from Dementia.

4 Development and testing

A major part of the actual development efforts to build ambient systems is devoted to testing. Testing does not only proof that the desired functionality is achieved by the design under test (DUT) but it also provides valuable feedback for the designer in terms of usability. This feedback may guide further revisions of the design and will be typically taken into consideration for future products. To this end, appropriate facilities are needed that allow testing to take place in a real world scenario. Note that due to the interdependencies of ambient components, a separated test of the DUT is not sufficient. Instead, this test must be accompanied by integration tests where the focus is on how the DUT performs in collaboration with the other components of the system. Here, the term performance does not only address the pure functionality of the DUT but also the usability aspects. To test usability aspects a testing environment is required that provides delivers a look and feel which is close to a real scenario. Examples for such development and testing environments are the in-Haus1 and inHaus2 [7] which belong to the Fraunhofer Reasearch Community:

- The inHaus1 is a perfect development and test environment for home care scenarios and components. The inHaus1 is a two-family house that has been built to foster research, development and test of ambient environments. It provides extensive technical support. Moreover, it also includes testing rooms that are fully equipped with all components of a real home environment (furniture, lighting, heating system, etc.).
- The inHaus2 (construction started march 2007) is a research, development and testing facility targeting at premises buildings. The building provides about 3,500m² of floor space. About one half of the building is devoted to offices, which are going to be used by the different research and development teams. The other part will be used to build test environments. One such test environment will be devoted to fields of health and senior care such that new care solutions can be implemented and tested in a real world setting.

Finally, inHaus1 as well as inHaus2 also serve as showrooms for the solutions and components that have been developed. As a result, the combination of inHaus1 and inHaus2 provides an excellent opportunity to do research and develop solutions that cover the entire care range (from home care to hospitals).

5 Conclusions

In future, smart buildings will provide their inhabitants with a wide range of functions and features. The pressure caused by the demographic change will move the focus of interest onto functions that enable elderly or handicapped people to live longer in their homes. This of course must be achieved without putting health or safety of the habitants at risk.

Due to the wide range of needed solutions and functions, appropriate ambient systems must be able to adapt their functionality towards the specific needs. Depending on the changes in the actual situation, the installation of new hardware devices may be required. However, re-configuration of the network must be done automatically. Manual configuration is not feasible given the high level of dynamics that is expected for future ambient networks.

Moreover, future ambient systems must be able to integrate new types of devices and applications that are unknown during design time of the system. In order to achieve this goal, semantic approaches are exploited that use/create a knowledge base in order to reason about the information that is available within the network.

This approach greatly affects all components of an ambient system. The sensors and actuatory must be able to describe their functions and properties semantically. The middleware must be able to use this information in order to support lookup, integration and composition of services/devices. User interface services will apply semantic information to build integrated, homogenous, holistic, and adaptive user interfaces. Finally, the applications themselves will also use semantic information to extract new kinds of information from the network of devices and services. The orchestrated interplay of modern technology with embedded sensors/ actuators is one large step towards the realization of ambient intelligence.

However, the design of smart ambient system is not driven by the available technology. Instead, the actual benefit for the user is the driving force. Discovering, analyzing and rating this benefit is hence an important step in the design cycle of an ambient system. To this end, appropriate development and testing facilities are needed, which not only provide the technical backbone for the developments, but also serve as a "real world" test platform. This platform works as a testing environment to validate the functionality of new developments. Apart from testing the usability of new solutions, it also helps to identify how well new products and applications integrate into an ambient environment. The look and feel of the integrated system is a very important aspect that must be carefully ob-erved and analyzed in order to foster the wide acceptance of ambient care systems.

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List of Projects
IMS Duisburg

List of Projects IMS Duisburg

Project Title	Partner	Project Period
Pulse Generator	Industry	07/1996–07/2010
Production High Voltage SOI-CMOS	Industry	01/2003–09/2008
Foundry IVTMX	Industry	04/2004–12/2008
Delivery CMOS Imager	Industry	05/2004–03/2008
Delivery REOS	Industry	10/2004–12/2007
ASIC Production	Industry	01/2005–12/2014
Development of technology robust IP cores	Industry	05/2005–04/2008
Quartz Wafer	Industry	05/2005–12/2007
Development for High Temperature Electronic	Industry	02/2005–10/2007
CMOS Technology R&D	Industry	01/2005–12/2014
CMOS Production	Industry	01/2005–12/2014
Spectroscopy CMOS Sensors	Industry	08/2005–02/2007
ASIC Development Pressure Sensor	Industry	03/2006–08/2008
Controller Update for Heating Systems	Industry	10/2005–04/2007
Delivery of Memory Tag III	Industry	10/2005–12/2006
Delivery OA32	Industry	09/2005–12/2007
Study Acceleration Sensor	Industry	04/2006–02/2007
3D Imaging Sensors 128x2 Pixel	Industry	03/2006–06/2007
MILDS Sensor	Industry	08/2007–12/2008
Study Inhouse Communication (EIB)	Industry	05/2006–05/2007
Service FlexRay-Testsystem	Industry	01/2006–12/2007
RF ASIC for long Range	Industry	06/2006–05/2007
IP Exchange	Industry	07/2006–06/2008
Study High Frame Rate Imager	Industry	08/2006–01/2007
LON Interface for Heating Systems	Industry	08/2006–04/2007

Consulting for Heating Systems	Industry	09/2006–12/2008
Service for Heating Systems	Industry	09/2006–09/2007
LPC Board	Industry	09/2006–06/2007
Foundry IODS P2	Industry	09/2006–01/2008
FC Sensor	Industry	11/2006–11/2007
Study SRAM II	Industry	11/2006–06/2007
Foundry Service	Industry	12/2007–12/2008
Study Energy Consumption Measurement	Industry	12/2006–10/2007
Study Energy Consumption Measurement II	Industry	04/2006–10/2007
NIOX Implementation	Industry	01/2006–04/2007
TADS	Industry	02/2007–12/2008
MIMOS II	Industry	02/2007–03/2008
Sensor Transponder	Industry	03/2007–03/2008
UTSD Modul	Industry	03/2007–01/2008
200mm Wafer Processing	Industry	01/2007–12/2007
SOI-CMOS Process	Industry	04/2007–12/2007
SOI-CMOS Process Hot Run	Industry	05/2007–12/2007
LON Interface Boards	Industry	05/2007–06/2007
Concept High Frame Rate Imager	Industry	05/2007–02/2008
High Temperature Transponder	Industry	05/2007–08/2007
Development RFID Reader	Industry	05/2007–01/2008
Concept for Heating Systems	Industry	06/2007–12/2007
Development Smart Home Controller	Industry	11/2007–03/2008
Development Smart Meter	Industry	07/2007–11/2007
Concept Master For Heating Systems	Industry	07/2007–09/2007
Simulation Portal For Heatig Systems	Industry	07/2007–09/2007

Reader for Pressure Sensor Tag	Industry	07/2007–05/2008
Demonstrator RF	Industry	07/2007–10/2007
ADC Self Test	Industry	08/2007–04/2008
EEPROM Qualification	Industry	12/2006–06/2007
EEPROM Technology Development	Industry	09/2007–11/2009
Infrastructure inHaus 2	Industry	03/2007–07/2008
Development Power Line Interface	Industry	09/2007–11/2007
Verfication RF ASIC For Longer Range	Industry	09/2007–12/2007
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Process Documentation inHaus	Industry	08/2007–12/2007
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Innovative Function of Buildings	Funding Authority Local Government NRW	12/2006–06/2007

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Smart Forest	Funding Authority BLE	11/2007–10/2010
EMSIS	Funding Authority BMBF	09/2007–12/2008
Minpro	FhG defined Project	01/2004–12/2008
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Chronicle 2007

Twice-awarded, the "cardiovascular angioscope"

The future IMS spin-off whose mission is to develop and market the "cardiovascular angioscope" (see article I. Krisch, M. Kurzschenkel) has won the 1st prize of the second announcement "Businessplan Wettbewerb Medizinwirtschaft".

This international business plan contest was supported by the European Union, the federal state of North Rhine Westphalia and arranged by the "Startbahn MedEcon Ruhr GmbH". Its goal is to support new business concepts in life science. After evaluation of all competitive business plans, the contest's jury selects innovative start-ups. The IMS team "Angiocam", which consisted of Dr. Ingo Krisch, Michael Kurzschenkel and Prof. Heinz Jakob from the West German Heart Centre Essen, succeeded in leaving all 75 competitors behind and earned 30.000 € "Although the prize money seems to be like a drop in a bucket compared to the amount deserved to operate such a venture, it is much worth especially at the very beginning" says team leader Ingo Krisch. "In addition to the money, we managed to attract investors' attention in different ways. Furthermore, we received offers for settling from several technology parks in the Ruhr region." added Michael Kurzschenkel.

The spin-off procedure was supported by the FhG programm "Fraunhofer fördert Existenzgründer". The formation of the company is planned to be in December 2007. Dr. Ingo Krisch is designated to be CEO. Michael Kurzschenkel will be responsible for product management.

Michael Kurzschenkel received the 3rd "Hugo-Geiger-Preis" 2007 for his feasibility study related to the cardiovascular angioscope.

In his master thesis, he investigated to what extent it is possible to image structures in the cardiovascular system – particularly the heart – endoscopically through the blood. This novel imaging system could enable the blood-filled, beating heart to be observed from within. Such systems have not been available until now, as blood is opaque in the visible spectrum. With this device, new minimally invasive surgery methods shall be made feasible while existing methods shall be improved. "My thesis forms a part of a project that aims at developing a diagnostic element of this type," says Kurzschenkel. The special feature of this device, which is inserted in the same way as a cardiac catheter, is based upon using infrared light instead of visible light to look into the beating heart. "I was able to demonstrate that it is possible, even through blood, to achieve images with an adequate resolution at a good penetration depth," adds Kurzschenkel summarizing his results.

The prize was handed over by the president of the Fraunhofer-Gesellschaft Prof. Hans-Jörg Bullinger in World Congress Centre in Bonn at the annual conference.

The Laying of the Foundation Stone for inHaus2

No less a person than the NRW Minister of Scientific Affairs, Prof. Pinkwart, opened the festive event on May 21st. In impressive speeches the importance of this unique project for Duisburg and North Rheine Westfalia was pointed out. Around 170 delegates from business, academia and politics attended at the ceremony.

The Project – Facts and Figures

In order to extend the inHaus innovation center with the inHaus2 research facility for commercial properties, nine Fraunhofer Institutes are working closely together. In this project, which the Fraunhofer Institute for Microelectronic Circuits and Systems in Duisburg is in charge of, the institutes develop and test new technological systems solutions for the area of commercial properties in cooperation with commercial partners such as, for instance, Hochtief, T-Systems, Berker or Lindner-Hotels. The beneficial application of these new technology solutions is also a very important aspect in this joint project. The construction of the inHaus2 research facility began on March 23rd, 2007 and will be finished in June, 2008. It is being built on a site which measures 8,000 sqm and which is in the direct vicinity of the inHaus1 research facility. In the latter, new solutions for residential properties have been being developed and tested in many innovation projects since 2001. Measuring 5,200 sqm, the inHaus2 facility will be considerably larger than the inHaus1 facility (250 sqm effective area).

New Applications for Commercial Properties

In the inHaus2 research facility intelligent room and building systems, for instance, for novel nursing homes, hospitals, offices or hotels, are going to be developed, which is aided by the Ministry of Innovation and Science, Research and Technology of North Rhine-Westphalia, by the European Union, by the Federal Ministry of Education and Research and the Fraunhofer headquarters. Thus, the inHaus innovation center is going to be a unique place Europe-wide for application-oriented research in the area of intelligent room and building systems.

The reduction of the current running costs and the optimization of application processes are among the objectives of the new innovation center. Already during the phase of construction novel procedures are coming into operation, which optimize the construction process. RFID-tags, for example, collect data which make an extensive IT-based control of the material flows and activities possible. Furthermore, novel building materials are used, for instance, self compacting concrete.

The inHaus2 topping-out ceremony

On August 27th the inHaus2-partners celebrated the topping-out ceremony. On this dignified day, Mrs. Christa Thoben the NRW Minister for Economic Affairs opend the event in a press conference. inHaus-partners and specialized journalists dealt with questions around commercial properties e.g. How can buildings of the next generation be designed and constructed in such a way that they are economical, comfortable, secure and flexible.

Intelligent Construction Site

Visitors had the opportunity to see the construction site and many demonstrations of inHaus2 innovation projects.

Some examples of innovative projects are:

Person tracking

Via the use of RFID transponders both the access control of the staff of the construction site and the people's movement at the construction site are to be monitored. People can be identified on a monitor by the construction site management or by security.

Management of material flow

By means of marking the building materials with RFID transponders, a continuous documentation of the material flow at the construction site is to be achieved. Apart from goods received, the management of stacking grounds, the documentation of installation and quality assurance are to be controlled and supervised.

Electronic delivery note for ready-mixed concrete

The delivery of ready-mixed concrete shall be documented by an electronic data exchange between the ready-mixed concrete plant and the construction site. Thus, a paper delivery note, which has been the usual method up to now, will not be used. By means of this IT solution, which is suitable concerning the construction site, the receipt acknowledgement and the analyses at the building material laboratory for quality assurance are to be recorded.

Networked sensores

Pressure sensors which are integrated in concrete record the data concerning temperature and pressure, which can be read out in order to serve different purposes e.g. quality control. For this, only an internet access and an internet-enabled end device are required.

The inHaus-Innovation Forum 2007

An efficient construction with more quality, the saving of energy and new living spaces in hotels and nursing homes: those were the main aspects of the inHaus innovation forum on August 28th, 2007, in the Mercatorhalle Duisburg. Consisting of lectures and an exposition the forum dealt with new trends and innovations concerning construction and the use of real estate. Designed as a market platform it promoted an exchange of information among the visitors such as IT specialists, electrical engineers, construction engineers, producers, architects, journalists and others.

The first sessions put emphasis on know-how for modern planning, construction and operation of modern buildings exemplarily at inHaus2 . Questions around an innovative construction site, e.g. 'How can the management of material flow be improved' as well as on environmentally friendly energy systems were discussed. The answers were given by the inHaus economic partners and by specialized Fraunhofer employees.

In the afternoon the questions of how modern buildings will meet the requirements of the user were discussed. Modern offices need to have a communication-friendly interior design as well as a highly flexible IT-infrastructure in order to promote creativity. Hotel rooms of the next generation need to offer the guests luxurious wellness oases and highly flexible IT-structures.

New impulses were given for technology assistance in the living spaces of an increased independence of senior citizens. Ambient assisted living aims at promoting the implementation and adoption of technical devices into the households of handicapped and elderly people in order to supervise them in their own flats.

The congress was accompanied by an exhibition in which the current status and future trends of innovative buildings were pointed out. All in all the event was a big success for all participants.

The KNX Scientific Conference 2007

This year's international KNX-Conference took place in the Fraunhofer IMS in Duisburg on November, 15th and 16th. More than 70 delegates throughout Europe participated in this conference and exchanged the latest results concerning developments of the KNX standard.

The objectives of the Conference were oriented towards the development and promotion of an international communication standard for Home and Building Electronic Systems by developing a single stable and affordable system technology with the goal to improve overall market acceptance and expand the today's market (mostly in commercial buildings) into the residential market.

Members of the inHaus-Center presented results regarding new configuration modes and application specifications. Thus novel simulation and visualization systems were presented as well as adaptable user-interfaces for home environments.

The achievements which have been made in two running projects were also presented. The first project 'Smart living NRW, a KNX-campus solution and second Amigo – Ambient intelligence for the networked environment.

The conference was terminated by a visit to the inHaus-Centre. Here, new technology and application solutions for private residential properties of all kinds and for different real estate of property developers and owners, are created.

Press Review

Neue Ruhr Zeitung / 22.05.2007

Wo die Zukunft ihr Zuhause hat

WISSENSCHAFT. Für elf Millionen Euro entsteht auf dem Uni-Gelände in Neudorf die „intelligente Nutzimmobilie der Zukunft" - gestern legte NRW-Innovationsminister Pinkwart dazu den Grundstein.

STEFAN ENDELL

Das ist ja da Spannende an diesen modernen „Häusern der Zukunft": Draußen wird eben gerade - von Ministerhand - der Grundstein gelegt, während drinnen im High-Tech-Bau-Container ein digitaler 4D-Film bereits bewegte Bilder vom Lebenszyklus einer längst in Betrieb genommenen nagelneuen „Forschungsplattform" zu sehen sind. So geschehen gestern Mittag in Neudorf auf dem Uni-Gelände, dort wo einst die Tennisplätze des verlagerten Club Raffelbergs anzutreffen waren.

Hier hat längst die Zukunft ihr Zuhause: In direkter Nachbarschaft zu dem kleineren inHaus1-Projekt („Das Wohnhaus der Zukunft") hat gestern NRW-Innovationsmninister Andreas Pinkwart zusammen mit zahlreichen Partnern aus der Wissenschaft und der Wirtschaft den Grundstein für das Fortsetzungsprojekt der federführenden Fraunhofer-Gesellschaft gelegt: Das „inHaus2".

Von außen herkömmlich, innen zukunftsweisend

Ein ebenso vielschichtiges wie ehrgeiziges Forschungslabor für die wissenschaftliche und anwendungorientierte Erkundung der Bedürfnisse von zum Beispiel einem Hotel, einer Altenpflegestation oder einer Büro-Immobilie der Zukunft. Rund elf Millionen Euro werden in den kommenden zwölf Monaten (Richtfest im August 07, Fertigstellung Mai 2008) in das ehemalige Raffelberg-Gelände verbaut.

Von Außen betrachtet entsteht hier eine dreigeschossige Hightech-Immobilie aus Beton, Stahl und Glas, in der nach Worten von Klaus Scherer, dem inHaus-Leiter der Fraunhofer Gesellschaft, „nicht irgendwelche neuen Einzelprodukte rund um die Nutzimmobilie erforscht und entwickelt werden, sondern die ganze Kette von Neuerungen und Anwendung." Geeint im Wunsch das Gesamtsystem „Hotel", oder „Pflegeheim" oder „Büro" vom Bau, über die Planung bis hin zum Betrieb zu optimieren, unter anderem mit Hilfe der Informations- und Kommunikations-Techiken, soll am Ende für die Anwender weniger Energieverbrauch, mehr Sicherheit sowie eine höhere Qualität der Dienstleistung „Arbeit" zustande kommen.

Schon die Baustelle ist intelligent

Beispielhaft soll dies bereits beim Bau des „inHaus2" vorgeführt werden: Mit der „intelligenten Baustelle", die die anliefernden Lkw elektronisch erfasst, die Transporte elektronisch steuert, Staus und Lager soll es keine mehr geben; dafür aber das elektronische Etikett, das berührungsfrei der Baustellenleitung berichtet, was der Lkw so alles geladen hat. Und: Gut verteilt im selbstverdichtenden Beton vermelden Mikrochips, ob denn die Wand auch nach Jahren noch in gutem Zustand ist.

Grundsteinlegung: (v.l.) Prof. Grabmeier, Prof. Sedlbauer (beide Fraunhofer IMS), Minister Andreas Pinkwart, Sigrid van Kempen, Klaus Scherer (beide inHaus-Projekt) und Andreas Höch (Fraunhofer IMS). (Foto: far/ Umbach)

DIE PROJEKT-PARTNER

Gefördert vom Land NRW und der EU wird das inHaus2-Projekt vom Duisburger Fraunhofer Institut für Mikroelektronische Schaltungen und Systeme geführt, begleitet aber von acht weiteren thematisch spezialisierten Fraunhofer-Instituten. Bauträger und Forschungspartner ist Hochtief (Essen). Weitere Partner u.a.: T-Systems, Lindner-Hotels, Henkel, BASF, Saint-Gobain Xella, St. Georg Sozialwerk, Stadtwerke Duisburg.

RP 23.01.07

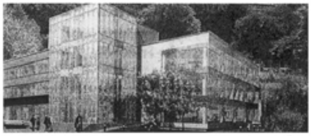
Nie mehr falscher Alarm

(RP) Im März soll mit dem Bau des zweiten „inHauses" der Fraunhofer Gesellschaft an der Uni begonnen werden. Diesen Termin nannte gestern das Ministerium für Innovation, Wissenschaft, Forschung und Technologie in Düsseldorf. Das Land unterstützt das Projekt mit 6,5 Millionen Euro. Weitere 2,2 Millionen Euro bringt der Träger auf, die Fraunhofer Gesellschaft.

Im „inHaus2" sollen in den kommenden vier Jahren Forschungsprojekte mit einem Volumen von rund 27 Millionen Euro durchgeführt werden. Wie berichtet wird das intelligente Haus neben dem Campus an der Lotharstraße gebaut. In dem 3500 Quadratmeter großen Gebäude sollen intelligente Raum- und Gebäudesysteme erforscht werden, an denen zum Beispiel Pflegeheime, Krankenhäuser ebenso aber auch Hotels oder Bürobetreiber Interesse haben könnten.

Für „InHaus2" haben sich neun Fraunhofer-Institute unter Leitung des Duisburger Fraunhofer-Institutes für Mikroelektronische Schaltungen und Systeme zusammengeschlossen, die in Kooperation mit Forschungspartnern wie der Uni Duisburg-Essen und die Firmen Hochtief und T-Systems technische Systemlösungen entwickeln und deren nutzbringende Anwendung testen.

Baumaterialien, Fassade, Heizung, Beleuchtung, Belüftung, Elektronik und Computersysteme werden so aufeinander abgestimmt und vernetzt, dass im Gebäude bis zu 30 Prozent Energie gespart, die Sicherheit erhöht und die neue Technik für Anwender leicht zu bedienen ist. Zum Beispiel werden unterschiedlich vernetzte Sensoren Notfälle im Pflegeheim automatisch erkennen und melden oder falsche Brandalarme im Bürogebäude vermeiden.



Im Modell steht das „InHaus2" bereits. Tatsächlich beginnen die Bauarbeiten aber erst im März. RP-FOTO: ARCHIV

Süddeutsche Zeitung, Immobilien 27.04.07

Meldung an den Gasmann

Internet und Telefon bieten sich als Hilfsmittel an, wenn es um die Steuerung und Abfrage wichtiger Haus-Funktionen geht

Die „intelligente" Wohnung ist Realität. Als Wegbereiter haben sich Forscher der Fraunhofer-Gesellschaft in Duisburg mit ihrem „inHaus-Innovationszentrum" betätigt, das die Integration von Haushaltsgeräten und Haustechnik vorangetrieben hat.

SZ: *Ihr Wohngebäude-Projekt geht 2007 in die zweite Phase. Welche Produkte und Komponenten aus der ersten Phase sind mittlerweile auf dem Markt?*

Scherer: Ein Beispiel: Wir haben ein sogenanntes Service Gateway entwickelt. Dieses Gerät funktioniert wie ein Computerserver und ist in eine Schalttafel eingebaut. Damit lässt sich mittels Telefon und Internet auf die Domotik, also die Haustechnik, zugreifen. Die Bewohner können per Telefon oder Internet abfragen, ob die Heizung läuft und die Fenster geschlossen sind. Oder sie bekommen eine SMS, wenn ein Fenster offen steht. Wenn ein Gasleck auftritt, dann wird automatisch ein Servicefachmann alarmiert. Der erste Typ des Gerätes wurde rund 1200 Mal eingebaut. Ein Service Gateway der zweiten Generation ist zurzeit im Einsatz.

Klaus Scherer

Foto: privat

SZ: *Das „inHaus2" wird ein Nutzgebäude. Wo liegen wichtige Unterschiede zum Wohnhaus?*

Scherer: Das Prinzip bleibt gleich: die System-Integration über eine Middleware, also eine Ebene zwischen Hard- und Software. Im Wohnbereich kommt es jedoch auf einfachste Bedienung, höchste Stabilität und niedrige Kosten an. Ein Nutzgebäude dagegen wird professionell gemanagt. Um seine Ausrüstung kümmern sich Ingenieure, nicht alleine Handwerker.

SZ: *Was gibt es in Ihrem Wohnhaus-Projekt nun noch zu tun?*

Scherer: Wir wollen es weiter vorantreiben in Richtung Wohnungswirtschaft und Seniorenwohnen. So sollen Assistenzfunktionen stabilisiert und standardisiert werden. Ein Beispiel ist der fest eingebaute Hausnotruf, bei dem mehrere Sensoren vernetzt sind: Personenerkennung, Anwesenheitskontrolle und Fallsensoren. Das System erkennt einen Notfall und alarmiert die Angehörigen oder einen Hilfsdienst. Es funktioniert auch, wenn ein Mensch ohnmächtig ist und keinen roten Notfall-Knopf mehr drücken kann. Ein weiteres Beispiel ist die Branderkennung. Dabei werden verschiedene Parameter verglichen. Wenn der Rauchmelder auslöst und die Raumtemperatur 40 Grad beträgt, dann lässt sich ein Fehlalarm ziemlich sicher ausschließen.

Interview: Roswitha Loibl

Bewährtes inHaus 1: Facility Managment kommt dazu

Zweites inHaus im Bau

OPTIMALE PLATTFORM

Das »inHaus-Innovationszentrum« des Fraunhofer-Instituts IMS in Duisburg ist international anerkannt. Nach dem Wohnhaus wird nun ein dreistöckiger Gewerbekomplex auf 3500 qm hochgezogen. Für das »inHaus2« liefert Projektpartner T-Systems eine RFID-Lösung, die alle Arbeitsgeräte und Baukomponenten lokalisieren kann. »Das ist eine optimale Plattform, Innovationen des täglichen Lebens zu zeigen und die Vernetzung von Informations- und Kommunikationstechnik in Gewerbeimmobilien voranzutreiben«, sagt Ulrich Kemp, T-Systems Bereichschef Groß- und Mittelstandskunden. Auf der CeBIT 2007 präsentieren die IMS-Projektleiter Dr. Viktor Grinewitschus und Klaus Scherer das Gesamtkonzept (16. März: Fraunhofer-Forum, Halle 9 und 20. März, 12:30 Uhr: CCM, Saal 17).
www.inhaus-zentrum.de

Digital Living / 15.03.2007

VERLAGSSONDERVERÖFFENTLICHUNG Samstag, 9. Juni 2007

Haus mit Zukunft

Intelligentes Gebäude entsteht in Uni-Nähe

NRW-Forschungsminister Pinkwart schaut sich mit Sigrid van Kempen auf der Baustelle am Forsthausweg um. Hier ist schon der Bau Teil des Forschungsprozesses.

Gestresste Häuslebauer haben meist nur ein Ziel: möglichst schnell fertig werden. Das ist auf der Baustelle am Forsthausweg neben der Uni ein bisschen anders: Dort ist schon der Bau des zweiten innovativen Hauses - „In-Haus" genannt - Teil des Forschungsprozesses. Mit 6,25 Mio. Euro fördern Land und EU das Projekt. Gemeinsam mit anderen Partnern aus der Wirtschaft, darunter Hochtief und T-Systems, werden elf Millionen Euro investiert. Bauherr ist das Fraunhofer Institut. Das Forschungsvolumen beläuft sich auf rund 27 Mio. Euro. Während beim Vorläufer InHaus I vor allem die privaten Nutzer im Mittelpunkt standen, wird nun ganz auf die Bedürfnisse und Anregungen aus der Wirtschaft eingegangen.

In verschiedenen Gebäudetrakten sollen Hotelzimmer der Zukunft entstehen oder neue Lösungen für Krankenzimmer und Seniorenpflege gefunden werden. In einem so genannten „Iroom" entsteht ein Konferenzraum der Zukunft. „Eine Hotelkette hat uns den Auftrag gegeben, zu testen, ob man mit Hilfe einer neuen Technologie Gäste individuell begrüßen kann", entwirft Frank Opfer von T-Systemst ein Zukunftsszenario. Sollte also ein japanischer Gast sein Zimmer betreten, könnte sich automatisch das Radio einschalten und einen japanischen Sender spielen.

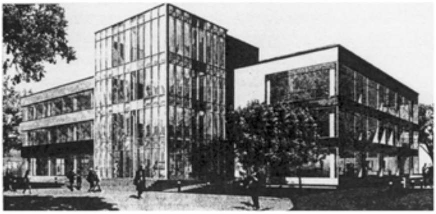
Innovative Wege wollen die Forscher auch bei der Nachhaltigkeit und der Energieeffizienz beschreiten. Wenn ein Mitarbeiter in seinem elektronischen Kalender vermerkt, dass er in der kommenden Woche Urlaub hat, soll sich die Klimaanlage von alleine ausschalten. Anhand eines Wohlfühlfaktors in den Räumen soll untersucht werden, ob ein „behagliches" Büro langfristig zu einer Produktivitätssteigerung bei den Arbeitnehmern im Betrieb führt.

„Unsere Forschung ist angebunden an die Wirtschaft. Es geht nicht nur um die Platzierung von Produkten", betont Klaus Scherer, Leiter des InHauses bei der Fraunhofer Gesellschaft. Die Ideen und Entwicklungen könnten nach der Forschungsphase tatsächlich Anwendung finden.

Um den Arbeitsablauf auf der Baustelle zu erleichtern, wird ein RFID-System installiert. Mit Hilfe von "Radio Frequency Identity Chips" (RFID) können Waren und Baumaterialien registriert werden. Und die Mitarbeiter ebenfalls. „In anderen Ländern ist es üblich, so etwas zu installieren. Es bietet Vorteile bei Unfällen auf der Baustelle", betont Hochtief-Bauleiter Ralf Mayer.

Diese Technologie sei jedoch mit dem Betriebsrat abgestimmt worden. Angenehmer Nebeneffekt für die Personalchefs ist nämlich auch: Sie wissen, wann die Mitarbeiter Pause machen.

Süddeutsche Zeitung, Immobilien 27.04.07



Innovationen am Bau

Grau ist bekanntlich alle Theorie. Deshalb soll für das Vorhaben „inHaus2" in Duisburg der geballte Sachverstand von Wissenschaftlern und Praktikern genutzt werden, um in der Praxis haarklein festzuhalten, was denn nun ein innovatives und intelligentes Nutzgebäude ausmacht. Große Hoffnungen setzen die Beteiligten deshalb in dieses Projekt. Bezug soll Mitte 2008 sein.

Foto: Fraunhofer-Gesellschaft

Spielwiese für Forscher

Duisburger Projekt „inHaus2" soll Zusammenspiel von Bautechnik und Gebäudebetrieb verbessern helfen

Von Roswitha Loibl

Auf diesen Tennisplätzen hat schon lange niemand mehr gespielt. Die Netze sind verschwunden, Gräser und magere Blümchen wurzeln im roten Sand. Die Natur hat das Terrain neben der Duisburger Universität erobert, doch nun muss sie weichen. Bagger sind angerückt, um die Grube für ein Gewerbegebäude auszuheben, das als Labor für innovatives Bauen konzipiert ist.

Das drei Etagen hohe „inHaus2" wird eine Art Spielwiese für Forscher mit 3500 Quadratmetern Fläche. Vom ersten Spatenstich an können sie alles testen, was ein innovatives und intelligentes Nutzgebäude ausmacht. Quer durch die Disziplinen arbeiten die Wissenschaftler hier zusammen. Neun Fraunhofer-Institute und die Universität Duisburg-Essen sind am Konsortium beteiligt, dazu Dutzende von Firmen wie Hochtief, T-Systems, die Lindner Hotelgruppe und das Sozialwerk St. Georg. Etwa 38 Millionen Euro fallen für den Bau und die zahlreichen Forschungsprojekte an, die bis Ende 2011 laufen. „In der Immobilienbranche gibt es einen immensen Nachholbedarf für Innovationen", kommentiert Dirk-Meints Polter, Vorstand Personal und Recht der Fraunhofer-Gesellschaft, die Kooperation. Als Vergleich zieht er die Automobilindustrie heran: „Wenn man bedenkt, was dort in Sachen Sicherheit, Komfort oder Zuverlässigkeit in den letzten Jahren entwickelt wurde, dann ist der Immobiliensektor noch auf dem Stand von etwa 1970." Für einen kräftigen Innovationsschub engagiert sich die Fraunhofer-Gesellschaft schon seit Jahren. 2001 begannen die Forschungsarbeiten in einem äußerlich unscheinbaren Zweifamilienhaus, das mit allen Schikanen der modernen Mikroelektronik ausgestattet ist: dem Duisburger „inHaus-Innovationszentrum".

Großes Sparpotential

Nach den Wohngebäuden knöpfen sich die Wissenschaftler mit dem „inHaus2" nun die Gewerbebauten vor. Ihr Ziel ist es, Büros, Hotels und Gesundheitsimmobilien von der Planung bis zum Betrieb effizienter zu gestalten. Dafür befassen sie sich mit Bauphysik ebenso wie mit Elektronik und Informatik. Das Sparpotential ist groß, denn „der Betrieb eines Gewerbeobjekts kann schon nach zehn Jahren dieselben Kosten verursachen wie sein Bau", schildert Torsten Stevens vom Fraunhofer Institut für Mikroelektronische Schaltungen und Systeme. Sparsam baut, wer den Überblick behält zwischen Baggern und Beton. Auf der Duisburger Baustelle hilft dabei eine Logistik, die sich auf Mikrochips stützt. Jedes Bauteil bekommt sein Funketikett und wird bei der Lieferung von einer elektronischen Schleuse an der Baustellenzufahrt erkannt. So ist beispielsweise klar, wie viele wärmedämmende Vakuum-Paneele ankamen und wo sie lagern. Die Handwerker können eine Einbau-Anleitung auf ihren Handcomputer laden. Kameras überwachen den Bau und geben per GPS Vermessungsdaten weiter, um sicherzugehen, „dass tatsächlich das gebaut wird, was geplant wurde", sagt Klaus Scherer vom Duisburger Fraunhofer-Institut, der das Gesamtprojekt leitet. Zukunftsmusik ist der nächste Schritt. Wenn das Haus fertig ist, könnten die Funklabels weiter ihren Dienst tun und Klimadaten oder Wartungsaufforderungen melden. Projektpartner Hochtief möchte herausfinden, „ob die fachlichen oder technischen Anforderungen sich auf einen Chiptyp bündeln lassen", teilt das Unternehmen mit.

Wie ein mächtiger Schubladenschrank aus Glas funktioniert künftig der größte Trakt des „inHaus2". Die

„inHaus2": Baubeginn im März

WAZ 23/01/07

Im März beginnt der Bau des zweiten „intelligenten Hauses", des „inHaus2" in der Nachbarschaft der Uni in Neudorf. Das Land fördert den Bau des Innovationszentrums mit 6,5 Mio Euro. Träger ist die Fraunhofer-Gesellschaft, die 2,2 Mio Euro zu den Forschungs- und Baukosten von 8,7 Mio Euro beiträgt. In den kommenden vier Jahren wollen Fraunhofer-Gesellschaft und Wirtschaft im „inHaus2" Forschungsprojekte für 27 Mio Euro durchführen. In dem 3500-Quadratmeter-Gebäude sollen intelligente Raum- und Gebäudesysteme beispielsweise für Pflegeheime, Krankenhäuser, Büros oder Hotels erforscht werden.

Innovationsminister Prof. Andreas Pinkwart: „Senioren oder Patienten werden von intelligenten Räumen profitieren, weil sie ihre Sicherheit und Lebensqualität erhöhen. Duisburg und damit NRW wird mit ‚inHaus2' zu einem europaweit einzigartigen Standort für die anwendungsorientierte Forschung im Bereich intelligente Raum- und Gebäudesysteme." Im „inHaus1" wurden in rund 70 Innovationsprojekten Lösungen für Wohngebäude entwickelt.

Recklinghäuser Zeitung / 23.01.2007

Häuser der Zukunft

Neues Forschungsprojekt in Duisburg

DUISBURG. (ddp) Mit 6,5 Millionen Euro unterstützt die NRW-Landesregierung ein Forschungsprojekt zur Entwicklung „intelligenter Gebäude".

Im Duisburger „inHaus2-Innovationszentrum" sollen intelligente Raum- und Gebäudesysteme beispielsweise für neuartige Pflegeheime, Krankenhäuser, Büros oder Hotels erforscht werden, teilte das Wissenschaftsministerium mit. Baubeginn für das von der Fraunhofer-Gesellschaft getragene Projekt „inHaus2" ist im März.

In den kommenden vier Jahren soll in dem Haus für 27 Millionen Euro geforscht werden. „InHaus2 entwickelt das Gebäude der Zukunft. Die Forscher untersuchen, wie neue Technologien die Umwelt schützen und den Menschen im Alltag helfen können", so Minister Andreas Pinkwart.

Drei Männer mit Herz

Mediziner, Naturwissenschaftler und Ingenieur arbeiten gemeinsam an verbesserter Technik für Herzoperationen. Erster Erfolg: Sieg beim Wettbewerb „Startbahn Ruhr"

Dr. Ingo Krisch und Michael Kurzschenkel stellen sich am Fraunhofer-Institut in Neudorf täglich neuen Herausforderungen. Als der Herzchirurg Prof. Dr. Heinz Jakob die Kollegen um Hilfe für sein Projekt bat und die beiden begeistert zusagten, wussten sie noch nicht, dass sie beim Business Plan-Wettbewerb Medizinwirtschaft „Startbahn Ruhr" wenige Monate später den ersten Platz belegen würden.

Drei Männer, drei Berufe, ein Ziel: Noch kann keine Herzoperation ohne Herz-Lungen-Maschine durchgeführt werden, die das Herz im blutleeren Zustand hält und gleichzeitig den Menschen künstlich beatmet. Doch nun wollen die drei erfolgreichen Duisburger, die sich im Zuge des Wettbewerbs zu „angiocam" zusammengeschlossen haben, mit einer speziellen Kameratechnologie ermöglichen, dass man durch Blut sehen und so ohne die Apparatur operieren kann.

Die Gewinner des Businessplan Wettbewerbs: (v. l.) Prof. Dr. Heinz Jakob, Dr. Ingo Krisch und Michael Kurzschenkel.

„Der Mediziner weiß, was er braucht. Der Naturwissenschaftler weiß, was möglich ist Und der Ingenieur kann es bauen", stellt Kurzschenkel die Verteilung im Team „angiocam" vor.

Christian Kolb von „Startbahn Ruhr": „Die Idee des Duisburger Teams und deren Umsetzung kann unser aller Leben besser machen. Eine Jury aus medizinischen und wirtschaftlichen Experten sowie erfolgreichen Unternehmern hat sofort das unglaubliche Potenzial gesehen, das hinter der Entwicklung eines sogenannten kardiovaskulären Endoskops steckt."

Durch Verkleinerung und Optimierung der Gefäßkamera, des Videoendoskops, werden Patienten mit Herzleiden weniger belastend operiert. Noch ist das Bild bei den ersten Versuchen schwarz-weiß. Doch Jakob ist zuversichtlich: „Ich träume von Farbe." Außerdem sei die Kamera mit vier bis fünf Millimeter noch zu groß: „Wir streben zwei Millimeter an."

Das Preisgeld beträgt 30 000 Euro. Informationen zum Wettbewerb unter www.startbahn-ruhr.de. **Jenny Miosga**

Rheinische Post / 15.01.2007

Uni-Colleg am Mittwoch: Ein Chip – viele Funktionen

(RP) Um die Entwicklung der mikroelektronischen Systeme geht es beim nächsten Uni-Colleg-Termin am Mittwoch, 17. Januar. Den Vortrag hält Anton Grabmaier, Professor an der UDE und gleichzeitig Leiter des Fraunhofer Instituts IMS in Duisburg. Beginn ist um 19.30 Uhr, im Hörsaal MD 162, Mülheimer Straße/Lotharstraße. Integrierte Schaltungen, die so genannten ASICs, begegnen dem Verbraucher täglich. Ein ASIC (Application Specific Integrated Circuit) ist ein integrierter Schaltkreis, der für eine spezielle Anwendung entwickelt wurde. Die elektronische Armbanduhr ist ein Beispiel, das von der geringen Baugröße, dem Kostenvorteil und der hohen Funktionalität profitiert. Dass die mikroelektronischen Systeme künftig nicht nur die Medizin, sondern auch andere Bereichen unseres Lebens beeinflussen werden, will Grabmaier ebenfalls zeigen.

Rheinische Post / 18.10.2007

Hirnströme kabellos überwachen

Hirnströme kabellos überwachen

(RP) Einen Prototyp zur mobilen EEG-Hirnstromüberwachung haben Forscher der Universität Duisburg-Essen entwickelt. Das kleine, leichte Gerät kann auf dem Rücken getragen werden und ermöglicht die kabellose Hirnstromüberwachung aus der Ferne. Bei dem Gerät handelt es sich um eine Gemeinschaftsarbeit zwischen dem Team um Dr. Reinhard Viga aus dem Fachgebiet Elektronische Bauelemente und Schaltungen und dem Neurologen Dr. Erich Koletzki am Malteser St. Anna-Krankenhaus.

Bei EEG-Untersuchungen werden elektrisch leitende Kontakte (Elektroden) am Kopf des Patienten angebracht, die elektrische Spannungen als Ergebnis von Hirnaktivitäten messen. Durch das gewählte Funktionskonzept der UDE-Wissenschaftler können alle dafür notwendigen Komponenten, wie der Anschluss der Elektroden oder das Aufbereiten und Speichern der Nervenaktivitäts-Signale, an und im Gerätegehäuse vereint werden. Durch die drahtlose Datenübertragung kann der Arzt den Signalverlauf dann am Computermonitor beobachten.

Das neue Konzept ermöglicht so EEG-Messungen bei Patienten in verschiedenen Körperpositionen, sogar bei schwimmenden Personen, da das Gerät wasserdicht und tauchfest ist. Von Interesse könnten diese Eigenschaften zum Beispiel bei Therapien im Wasser, wie bei der Delphintherapie, sein. Hier sind die Wirkzusammenhänge zwischen Therapie und der Veränderung zum Positiven im Patienten weitgehend unbekannt. Daher könnten entsprechende Forschungsarbeiten mit dem neuen EEG-System mögliche aus der Therapie resultierende Veränderungen in den hirnelektrischen Aktivitäten erstmals nachweisen.

In ersten klinischen Anwendungen konnte der neue EEG-Prototyp mit seiner robusten, für den drahtlosen, mobilen Einsatz konzipierten Gerätefunktion im direkten Vergleich zu üblichen stationären EEG-Geräten auch hinsichtlich der Signalqualität überzeugen.

In Kooperation mit dem Fraunhofer-Institut für Mikroelektronische Schaltungen und Systeme (IMS) planen die UDE-Forscher bereits die Weiterentwicklung ihres neuen EEG-Systems, das zukünftig ganz auf ein zentrales Gerät verzichten soll. Dabei sollen winzige intelligente Ein-Elektroden-Module am Kopf des Patienten befestigt werden und sich selbstständig drahtlos zu einem EEG-System verknüpfen. Solche Systeme sind dort interessant, wo es auf schnelle und fehlerfreie Ableitung hirnelektrischer Aktivitäten bei größtmöglicher Mobilität und mit hohen Bewegungsfreiräumen ankommt, zum Beispiel im Notarztwagen, im Operationssaal oder auf der Intensivstation.

Vorgestellt wird das neue Gerät erstmals auf der Medizin-Messe MEDICA in Düsseldorf vom 14. bis 17. November.

WAZ, Essen 27.04.07

Medizin-Ideen von Gründern aus Essen gefördert

Wettbewerb befindet sich in der 2. Runde

162 Teilnehmer in 78 Teams beteiligten sich an der zweiten Runde des Ideen-Wettbewerbs für Medizinwirtschaft im Ruhrgebiet. Der Businessplan zeichnete erfolgreiche Gründer mit 5000 Euro aus. Zwei der zehn besten Geschäftsideen in der Phase 1 des Wettbewerbs stammen von Unternehmen aus Essen. 30 Gutachter hatten die Pläne intensiv geprüft.

Operationen am durchbluteten Herzen ermöglicht das Videoendoskop für das Herz- und Gefäßsystem, das Dr. Ingo Krisch, Prof. Dr. Heinz Jakob und Michael Kurzschenkel vom Team Angiocam aus Essen und Duisburg entwickeln. Damit werden Herzoperationen in Zukunft weniger aufwändig und belastend für den Patienten. Die Besonderheit des Verfahrens liegt darin, dass für den Kardiologen nun erstmals der Blick durch das fließende Blut möglich wird.

Mit einem Such- und Informationsportal für alternative Medizin überzeugte Claus Kleinstoll aus Essen die Gutachter. Der Essener hilft Patienten, Ärzten und Therapeuten so, sich besser zu informieren, einem breiten Patientenstamm zu präsentieren und aktuelles Wissen über Behandlungstechnik zu erwerben.

Der Businessplan Wettbewerb für Medizintechnik wird von der Startbahn Med-Econ Ruhr GmbH in Essen durchgeführt. Gesellschafter ist u.a. der Verein pro Ruhrgebiet. **Ko.**

Photonik / 11.12.2007

Pfiffige 3D-Überwachung

Durch reflektierte Lichtblitze und eine schnelle Blendensteuerung lassen sich Tiefeninformationen gewinnen.

Die am Duisburger Fraunhofer-Institut für Mikroelektronische Schaltungen und Systeme IMS entwickelte 3D-Überwachungskamera sendet Laserblitze in kurzer Folge aus und ermittelt aus den reflektierten Lichtsignalen die Entfernung von Objekten sowie deren dreidimensionale Gestalt. Dazu werden die in unterschiedlicher Entfernung reflektierten Lichtsignale mittels einer Feinsteuerung der Kamerablende getrennt und danach zu einem 3D-Bild verrechnet. Durch Öffnung der Blende für eine Millionstel Sekunde wird das natürliche Umgebungslicht gemessen. Mittels spezieller Algorithmen kann störendes Hintergrundlicht dann weggerechnet werden. Auf diese Weise sind helle und dunkle Bilder auswertbar. Bei der Entwicklung wurde Wert auf den Einsatz von Standardbauteilen und -prozessen gelegt. Mögliche Anwendungsfelder sind die Fahrerunterstützung im Auto, Roboterarbeitsplätze oder auch die Zugangskontrolle von Gebäuden.

www.ims.fraunhofer.de

Financial Times Deutschland / 25.05.2007

Rein in die Kartoffeln

Das Fraunhofer Institut erprobt derzeit auf dem Acker, wie mithilfe von drahtlosen Sensoren Pflanzenschutzmittel gespart und die Knollen optimal versorgt werden können

Für manche ist es schlimmer als die Benzinpreiserhöhung: Pommes frites und Chips werden teurer. Schuld ist der Klimawandel. Extreme Trockenheit im Frühjahr und sintflutartige Regenfälle im Sommer beflügeln Kartoffelkäfer und Pilzbefall und setzen der Deutschen liebsten Beilage heftig zu.

Um der Blatt-, Kraut- und Knollenfäule zuvorzukommen, versprühen die Bauern Pflanzenschutz- und Insektenvernichtungsmittel. Das ist teuer und verseucht Acker und Grundwasser. Umweltschonender und zielgerichteter ist das vom Fraunhofer Institut für Mikroelektronische Schaltungen und Systeme (Fraunhofer IMS) entwickelte System, das derzeit in Emmerich-Elten an der holländischen Grenze erprobt wird.

Drahtlose Sensortechnik hebt schnöden Kartoffelanbau in neue Dimensionen. Sie misst, ob die Bewässerung ausreicht, und meldet sofort Schädlingsbefall. Künftig, so versprechen die Entwickler, muss der Bauer nicht mehr hinaus aufs Feld, um sich über den Zustand seiner Kartoffeln zu informieren – die Daten soll er bequem von seinem Rechner aus abrufen können. In ferner Zukunft sollen unter anderem intelligente Bewässerungssysteme angeschlossen werden.

Drahtlos operierende Netzwerke, deren Funktionseinheiten eines fernen Tages nicht größer als ein Staubkorn sein sollen, beschäftigen die Wissenschaftler auf der ganzen Welt. In der Automobilindustrie und im Maschinenbau werden sie bereits zuverlässig eingesetzt. In der Landwirtschaft ist die Technik noch weitestgehend unbekannt.

„Das Neue an unserem Projekt ist im Wesentlichen die Anwendung selbst", sagt Hans-Christian Müller, der das Projekt am Fraunhofer Institut seit knapp zwei Jahren leitet. „Zur Messung spezifischer Parameter wie Boden-, Blatt- und Luftfeuchte kommt in der Landwirtschaft nur eine drahtlose Datenübertragung infrage, sonst kann die Bewirtschaftung der Fläche nicht fortgesetzt werden", sagt Müller. Bereits im vergangenen Sommer hat er mit seinem achtköpfigen Forscherteam zwei Bodenfeuchte-Sensoren entwickelt und in den Kartoffelacker in Emmerich-Elten eingesetzt.

> **„Unsere Kartoffelbauern sind extrem innovativ"**
> Hans Hausladen, TU Weihenstephan

Die 33 mal 55 Millimeter großen Sensorknoten bilden über Funk ein vollständiges Netzwerk aus und sind zudem in der Lage, Ausfälle zu erkennen und fehlende Verbindungen automatisch anzupassen – sie verfügen über eine „kollektive Intelligenz". Die Daten werden an eine Basisstation übermittelt, die ihrerseits an ein lokales Netzwerk beziehungsweise ein Weitbereichsnetz angebunden ist. Jeder „Multihop" genannte Knoten erfüllt im Verbund mehrere Funktionen: Er kann eigene Daten akquirieren, verknüpfen und vorverarbeiten und schließlich an andere Funktionseinheiten weiterleiten.

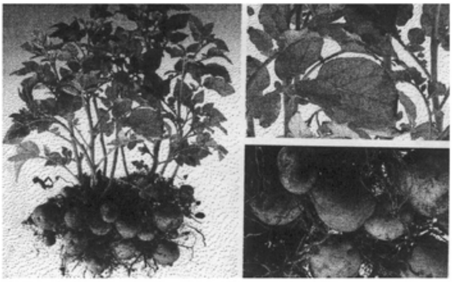
„Wenn die Technik erst reibungslos funktioniert, kann mithilfe der Sensortechnik eine effizientere Bodenbewirtschaftung realisiert werden", sagt Franz Sloot im besten Technikjargon. Der Landwirt hat seinen 15 Hektar großen Acker für das Forschungsvorhaben zur Verfügung gestellt. „Wenn wir dafür in Zukunft Pflanzenschutzmittel einsparen können, hat sich der Aufwand für uns gelohnt", fügt er ganz pragmatisch an.

Das Projekt findet im Rahmen der deutsch-niederländischen Kooperation „Technologische Innovation & New Business-Entwicklung" des Technologienetzwerks Rhein-Waal statt. Finanziert wird es zur Hälfte durch EU-Gelder, weitere 30 Prozent der Kosten tragen die Wirtschaftsministerien der Niederlande und Nordrhein-Westfalens. Darüber hinaus beteiligen sich 15 Partner an der Versuchsreihe. „Unser Part besteht im Anschluss an das erfolgreiche Pilotprojekt darin, Privatunternehmen für die Technologie zu gewinnen", sagt Wolf-Eberhard Reiff von der Industrie- und Handelskammer Duisburg. Vorzugsweise sollen Firmen aus der Region Rhein-Waal gefördert und Arbeitsplätze geschaffen werden.

An der Technischen Universität in Weihenstephan wird ebenfalls über Verfahren zur Feuchtigkeitskontrolle im Ackerbau geforscht. Ziel ist auch hier die Bekämpfung der bekannten, durch anhaltende Bodenfeuchte verursachten Kartoffelpilze. Die Idee, drahtlose Sensornetze in der Landwirtschaft einzusetzen, hält Agrarexperte Hans Hausladen für zukunftsweisend: „Wir Bayern stehen im Verdacht, konservativ an neue Technologien heranzugehen, dabei sind unsere Kartoffelbauern extrem innovativ."

Damit ist der alte Spruch bald überholt: Nicht die dümmsten, sondern die modernsten Bauern ernten die dicksten Kartoffeln.

VON CLAUDIA SCHARZ



Sensoren im Acker

Drahtlose Sensortechnik Das vom Fraunhofer Institut für Mikroelektronische Schaltungen und Systeme entwickelte Konzept in Nordrhein-Westfalen besteht aus 33 mal 55 Millimeter großen Sensorknoten, die Daten über Boden-, Blatt- und Luftfeuchte an eine Basisstation übermitteln. Das Projekt wird mit 300 000 € gefördert, nicht eingerechnet die in Handarbeit gefertigten Sensoren.

Weitere Anwendungen Auch um Lawinenopfer aufzuspüren oder Erdbebengebiete zu überwachen, bieten sich drahtlose Sensorennetze an. In der Medizin könnten sie helfen, Herzinfarkte früh zu erkennen.

Knolle en detail Die Kartoffel gehört zu den Nachtschattengewächsen. Sie enthält 17 Milligramm Vitamin C auf 100 Gramm, außerdem Vitamin A und B. In Deutschland werden pro Kopf jährlich 68,4 Kilogramm konsumiert. Problematisch sind Unkraut, Pilzkrankheiten wie Fäule, Schorf und Krebs, Insekten und Würmer. Dagegen werden Pflanzenschutzmittel eingesetzt.

INTERVIEW: DER ERFINDER DES INHAUS

Prof. Klaus Scheren: Leiter des inHaus-Zentrums

Familien können das InHaus testen. Wie sind die Reaktionen?
Nach anfänglicher Skepsis freunden sich die meisten schnell damit an. Sie fühlen sich sicherer, weil sie wissen, dass sie das Haus erinnern würde, wenn sie etwa den Herd angelassen haben.

Das InHaus weiß, wer sich wann in welchem Raum aufhält und trifft selbst Entscheidungen. Big Brother ist watching you?
Das Haus sieht ja nicht wirklich und es liegt im Ermessen der Kunden, welche Funktionen sie der Hausintelligenz überlassen. Es geht nicht um Überwachung oder Entmündigung, sondern um Unterstützung und Assistenz.

Den Heizungsinstallateur müssen die Bewohner nicht mehr selbst anrufen, geschweige denn ihm begegnen. Isoliert vernetztes Wohnen?
Definitiv nicht. Das Haus nimmt seinen Bewohnern lästige Aufgaben ab, so bleibt mehr Zeit für wichtigere Dinge im Leben – zum Beispiel die Familie.

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iwi 137 4 wi 394 dpa-afxi 137 1350
Hugin/Deutschland/Computer/
Hugin-News: ELMOS Semiconductor AG =
ELMOS mit erstem Entwicklungsauftrag für neue Produktion Corporate news-Mitteilung verarbeitet und übermittelt durch Hugin. Für den Inhalt der Mitteilung ist der Emittent verantwortlich.

- ———— Exklusiv für 8-Zoll-Fertigung in neuem 0,35µm Prozess Dortmund: Die ELMOS Semiconductor AG hat den ersten Entwicklungsauftrag für ein neues hochvolumiges Produkt gewonnen, welches direkt in der Duisburger 8-Zoll-Fertigung produziert werden soll. Bislang wurden nur bestehende Produkte von der Dortmunder 6-Zoll- auf die neue 8-Zoll-Fertigungsstätte in Duisburg transferiert. Das Produkt wird im neuen 0,35µm Hochvolt-CMOS-Prozess entwickelt. Bei dem neuen Schaltkreis handelt es sich um ein kundenspezifisches IC zur Signalauswertung von Drehwinkelsensoren, die an mehreren Stellen im Fahrzeug eingesetzt werden. Neben der klassischen Applikation Lenkwinkelmessung gewinnen diese Sensoren auch als präzise und zuverlässige Pedalwertgeber in Fahrzeugen immer mehr an Bedeutung. Die Serienproduktion soll Ende 2008 beginnen. Der Kunde ist ein deutscher Automobilzulieferer. 'Wir haben kurz nach Start der 8-Zoll-Serienproduktion diesen neuen Entwicklungsauftrag gewonnen. Dies zeigt, dass unsere Kunden Vertrauen in die neue Fertigung und Technologie in Duisburg haben und diese auch explizit nutzen wollen', sagt Dr. Frank Rottmann, Vorstand für Vertrieb und Entwicklung der ELMOS Semiconductor AG. Durch den neuen 0,35µm HVCMOS-Prozess lassen sich die verwendeten analogen und digitalen Strukturen verkleinern und damit mehr Komplexität auf gleicher Fläche im Vergleich zu den bisher verwendeten Prozesstechnologien realisieren. Die Produktion in Duisburg hat im Juli 2006 erste Produkte an Kunden geliefert. Die neue Fertigung wird in Kooperation mit dem Fraunhofer-Institut für Mikroelektronische Schaltungen und Systeme (IMS) in Duisburg betrieben. Die Kooperation umfasst neben der gemeinsamen Nutzung der 8-Zoll-Wafer Produktionslinie auch vereinte Aktivitäten in Forschung und Entwicklung. Die ELMOS Semiconductor AG ist Entwickler und Hersteller von Systemlösungen auf Halbleiterbasis. Seit über 20 Jahren werden rund 90% des Umsatzes mit Chips für die Automobilelektronik erzielt. ELMOS Semiconductor AG Mathias Kukla Heinrich-Hertz-Str. 1 44227 Dortmund Telefon 02 31-75 49-0 Direkt -199 Fax 02 31-75 49-548 info@elmos.de www.elmos.de — Ende der Mitteilung — WKN: 567710 ISIN: DE0005677108 Index: Prime All Share, CDAX, HDAX, MIDCAP, TECH All Share, GEX Notiert: Prime Standard in Frankfurter Wertpapierbörse, Freiverkehr in Börse Düsseldorf, Freiverkehr in Börse Berlin Bremen, Freiverkehr in Hanseatische Wertpapierbörse zu Hamburg, Freiverkehr in Niedersächsische Börse zu Hannover, Freiverkehr in Börse Stuttgart, Geregelter Markt in Frankfurter Wertpapierbörse, Freiverkehr in Bayerische Börse München http://hugin.info/130978/R/1102764/197510.pdf http://www.elmos.de

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