N.E.S.T. – Network Enabled Surveillance and Tracking

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Due to the increasing public crime, industrial espionage and terrorism the need for advanced surveillance technology for prevention and criminal investigation increases more and more. Today's surveillance systems mainly focus on passive monitoring and video storage with human operators facing a large number of monitors, over a long period of time and trying to detect suspicious situations. In practice, this method is quite ineffective, because of the decreasing level of attention of humans after short time. In the research project N.E.S.T., the Fraunhofer IITB is working on advanced automated surveillance systems. The research activities focus on design and evaluation of new service-oriented system architectures able to provide expandability and upgradability for surveillance systems.

1.1 Introduction

In the research project N.E.S.T., the Fraunhofer IITB is working on a next generation automated surveillance systems. The main topics of the research activities are design and evaluation of decentralized, service-oriented system architectures, which provide expandability and upgradability for surveillance systems. Furthermore, the N.E.S.T. activities include research on intelligent services for data processing (e. g. motion detection and tracking in multi-sensor video, abandoned luggage detection) and information analysis (e.g. semantic description of complex situations).

A dynamic combination of such basic services leads to intelligent, high level and automated tasks like »Detection of Abnormal Behavior« or »Tracking of Suspicious Persons«. Thus, if supported by N.E.S.T., humans are on demand, if and only if suspicious or critical situations occur.

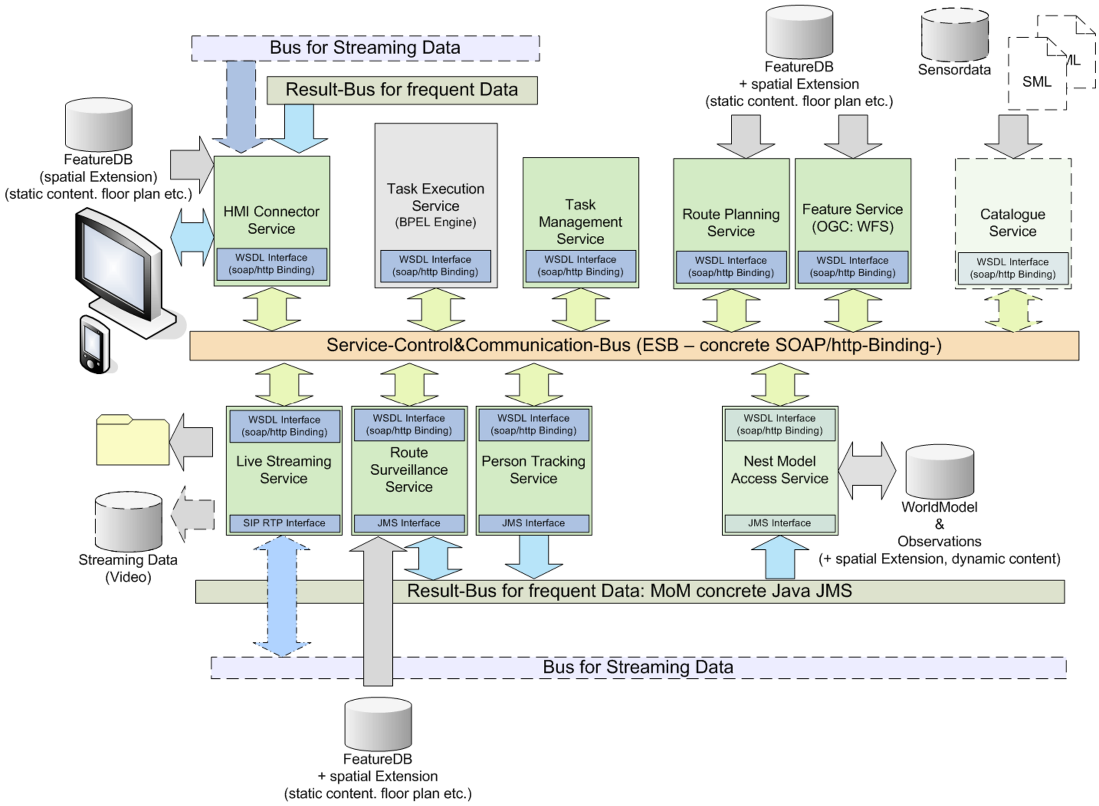

Fig. 1: N.E.S.T. System Overview.

1.2 Architecture of the N.E.S.T.-System

For fulfilling the expandability and upgradability, a service-oriented approach was chosen. This approach gives the flexibility and level of abstraction, which is necessary for an open and extendable system. One of the fundamental ideas is that different surveillance tasks can be described as automated (optionally long running) processes with a minimum of human interaction involved. Figure 1 depicts an overall view of the architecture with example services required to implement the scenario described in the next section.
Logically two "buses" were distinguished: A first bus for service-calls and service-objects to be exchanged between services (*Service-Bus*) and a second bus for very frequent data with a singular semantic e.g. alarm-events (*Result-Bus*). A third infrastructure for streaming data is planned for future (*Streaming-Bus*). The technical description of a surveillance process is modeled in BPEL and orchestrates the required service calls. The execution environment is a BPEL-engine which connects to the services through the *Service-Bus*. Data storage for static and dynamic data, which

represents the instantiation of the N.E.S.T. *World Model* is also considered and can be accessed via a dedicated *Model Access Service*. Standardized services like the *Web Feature Service* and data models from the geospatial community are deployed to provide cross-sectional functionality and a maximum support for existing tools for data acquisition and preparation.

1.3 Exemplary Scenario and N.E.S.T.-Services

1.3.1 Scenario and Workflow

The first scenario implemented on the N.E.S.T. architecture monitors the way of a visitor from the reception desk to a room (e.g. a meeting room) in the building. To accomplish this, the receptionist creates a new task of the type *Person Tracking*. The N.E.S.T. system creates a new instance of the assigned (BPEL) process and executes it. The started process first launches a face recognizer which is targeted at the area in front of the reception desk. After that, the receptionist gets presented a dialog where he sees the image stream with highlighted faces. He simply clicks on the face of the person to track and additionally selects the destination room in the building. As soon as the person is selected the *Person Tracking Service* is sending out tracking events via the *Result-Bus*.

When the dialog is confirmed by the receptionist, the tasks process continues by starting up the *Route Planning Service* to calculate all possible (and allowed) ways from the reception desk to the visitors' destination room. The calculated data is then handed over to the *Route Surveillance Service* which also subscribes to the results of the *Person Tracking Service*. The *Route Surveillance Service* sends out an alarm, if a forbidden situation (person leaves route, person enters no-go area, etc.) is recognized. The alarm is then presented to the receptionist and the position in the building on a map where the alarm occurred is displayed.

1.3.2 Route Planning Service

The *Route Planning Service* computes possible routes between a start position and a destination room. As the data of the building is organized in separated floors, this is accomplished by a hierarchical structure. A graph represents the transition possibilities between floors, e.g. stairways and elevators. Thus, several routes exist if the start floor and destination floor are connected by several options. Within the concerned floors a geometric path planner calculates the shortest path based on the according floor data for all possible routes.

1.3.3 Route Surveillance Service

The *Route Surveillance Service* automatically evaluates constraints on the person's movements, such as possible paths to the destination, restricted areas, expected time to reach the destination and the certainty about the person's location. To make a statement even in situations when the person leaves the monitored area, for example when entering an unmonitored room, the service tries to infer the person's location based on the building model. If one of the constraints mentioned above is violated, the service generates an alarm.

1.3.4 Person Tracking Service

The *Person Tracking Service* is a task-oriented multi-camera tracking approach. Its internal is designed to manage a very large number of sensors and includes multi-task capabilities for multi-object tracking. The main idea of the service is to generate a "single-target-tracking"-process for each tracking task initiated by the human operator or other N.E.S.T.-services. As input, the *Person Tracking Service* only expects an initialization parameter set (e. g. start position of the object) and once it is started, it provides high level information about the object under observation (e. g. type, position, extracted appearance and/or biometry features). Thereby, camera selection and multi-sensor data fusion is performed autonomously.

1.4 Summary and Future Work

By developing the here introduced N.E.S.T-System we made a first step towards a new generation of surveillance systems, changing today's sensor focus in surveillance to a focus on surveillance tasks. The human operator needs no longer to interact with sensors but only chooses intelligent tasks which are then performed autonomously by the corresponding combination of N.E.S.T-Services.
Our future work will be to enlarge the task list, by combing existing and creating new services. Furthermore, actuators will be incorporated, e.g. mobile robots serving as guides.