Context as a resource for diagnostic work

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Abstract. This Position Paper provides a description of our ongoing work with the Paris fire-fighter brigade. Based on our pragmatic experience in designing and developing ubiquitous computing solutions for a domain that poses complex physical and cognitive restrictions, we believe that there is a need for a post-positivistic perspective on context aware systems. Here we came up with the design concept of building diagnosis artefacts based on the idea of providing context as a resource. In relation to this concept, our research interest lies in understanding the mechanics of emergence of the dialectic process between available information and interpretation practices.

Introduction

The motivation of the workshop relates to the fact that technology use pervades diagnostic work, and that the discussion around studies of technology facilitates diagnostic work.

Maybe the quintessential of diagnostic work is to shout fire if you see smoke. And maybe the quintessential diagnosis artefact is the stethoscope, instrument used by doctors to hear the various sounds generated inside of the body. It was invented in France in 1816 by René-Théophile-Hyacinthe Laennec as a replacement for the practice of placing one's ear directly in the patient's chest [1]. The stethoscope allowed doctors to isolate the sounds coming from inside of the

body from other sounds, and made available a host of new sounds that provided the base for new diagnosis methods and techniques. Slowly but steadily, a collection of diagnosing practices grew around the stethoscope.

The ability of constructing a diagnose around sounds heard trough a stethoscope can be understood as the result of an appropriation process, in the sense of a co-evolution as a semiosis that interweaves information with interpretation practices.

Research context

The wearIT@work project at Fraunhofer FIT is working closely with the Paris Fire Brigade in conducting a participatory design approach to bring wearable technologies to the fire-fighters working on the first line of intervention [2]. Fire fighting constitutes a highly situated activity that heavily relies on experience and training. Fire-fighters' roles change dynamically during an intervention, and decisions responds to the analysis of highly unpredictable situations that heavily resorts to the implicit knowledge constructed through experience. Information resources are scarce at different levels. On one side the available information could be incomplete due to the complexities of an intervention, and on the other side, processing time for this information could be limited, as the attention of the fire fighters must be focused on many different tasks during an intervention.

Context Awareness for Firefighters

For fire fighting, the advances of context aware and pervasive computing represent a progressive instrumentation of the reality. The availability of sensors embedded in the environment or attached to garments provides an increasingly large amount of information available for being consumed right away. We can convey temperature, position and quite a few other circumstances of the environment to the fire-fighters. However, we do not know a priori what kind of tools and practices can be built around this information. Moving from the simple availability of information to a set of useful diagnosing mechanisms will call for the emergence of an appropriation process comparable to the case of the stethoscope, which will be driven by the interactions between the evolution of the technology and the uses and practices that the different user activities will build around these technologies.

The Context Awareness Dilemma

Traditional approaches to context awareness [3, 4] understand and model context as a concrete reality lying outside the users and thus susceptible of being acquired by electronic sensors. Based on this information context aware systems

provide relevant services, adapting their behaviour to the captured reality. Context aware applications have had, however, a hard time in leaving the lab test phase. Applications that work fine in closed micro worlds, fail when facing more complex circumstances, especially when dealing with the recognition of mental or social contexts. The emphasis on objective features leaves out aspects of the user experience that are central to understand the real needs and intentions of the users.

Contrasting to the positivist approach, research developed mainly by the CSCW community has been building a notion of context that draws from Constructivist social sciences [5, 6]. Knowledge (and context) is not a fixed object; it is constructed by individuals through their own experience. Individuals are active agents that construct their environment instead of processors that passively react to external events, and thus cannot be understood outside of their embeddedness in a social system. These constructivist notions of context pose a deep contradiction to the realist approaches, since that what is being modelled and represented in the computer is not what context actually is, but just external structures upon which the context is actively constructed by the individuals in their dynamic coupling with reality. The subjectivity of this construction implies that there are many different plausible interpretations for a set of circumstances, thus making very difficult to generate automatic interpretations for situations others than very simple ones.

Bridging the gap

Building on the constructivist understanding of knowledge [7], we are researching on ways of providing contextual information as a resource that can be explored, analyzed and redefined [6]. Our interest is not primarily focused on the construction of more or less precise models of the reality inside of the computer, but on developing useful means of using contextual information to allow the users to build themselves a meaningful representation based on shared perceptions of the information.

Building diagnosis practices

To spark the process of reflection and appropriation around wearable technologies we follow a strong user centered design approach. Using field studies with the fire-fighters, we are starting to learn about the context of use for our solutions. This knowledge serves as input for a collaborative search of opportunities for mediating or facilitating the work by using technology. Most of the time, these opportunities are in the form of very simple or incomplete ideas. Nonetheless, we understand them as possible seeds to more complex diagnosis practices. Hence, exploring these ideas by bringing them to the context of use is a

central part of our design approach.

Navigation of Unknown Spaces

One of the problems in which we are focusing our efforts will help us to illustrate the work that we are conducting in Paris. Navigation in an unknown space with low-visibility conditions is a common situation for fire-fighters as they usually need to perform reconnaissance missions inside buildings without lights or filled with smoke. They are specially trained to deal with such situations using complex physical techniques and cognitive skills but they always represent a source of risk.

Accurate indoor localization has been an objective of the ubiquitous computing, but as of today remains a largely open question. There are a number of different approaches that deal with the problem with different levels of precision and required infrastructure [8]. Without the help of complex pre-installed infrastructure and complicated processes of calibration, we can only afford very imprecise, if any, location information, and no network available to transmit this information. A motivating question for us is then, how to provide this information to the fire-fighters as a useful resource, and how to deal with the problem of uncertainty of the available information and with the unreliability of the technology.

Workplace Studies

We started our work by exploring the use of location information in reconnaissance missions. In a training facility of the Paris Firefighting Brigade we ran several simulated reconnaissance missions with teams of up to eight fire fighters. The missions were run in a building specially designed for training and the fire-fighters were equipped with the complete required equipment for such missions, including protective clothes and breathing apparatuses. To simulate null visibility conditions, we placed a layer of paper in the breathing masks, thus blocking sight, but allowing a rough recognition of light sources. The mission in every case was a reconnaissance mission which consisted in walking through the building and finding bottles of water that were previously hidden by members of the team.

To obtain indoor positioning, we constructed a Wizard of Oz prototyping platform. One facilitator was assigned to each and every fire fighter in the mission. He disclosed the actual position of the fire-fighter by clicking on a map of the building shown on a piece of software specifically designed for the task. This information was transmitted using a wireless network to a central computer mounted on a command post, where visualization software allowed following the

position of the tracked fire fighter in a Large Interactive Display.

In each mission, one or more teams of fire-fighters entered the building, with the task of finding bottles of water placed inside of it in different rooms.

We defined every mission simply by setting up the initial conditions of the situation and then letting the fire-fighters act according to their common practices. The position information, provided by the facilitators was introduced in different forms for each mission.

In the first mission we provided the fire-fighters no location information at all. We tracked the position of the members of the fire-fighters team using the prototyping platform, but this information was not provided to the fire-fighters. We used this first mission as a reference for the other two missions. Following their common set of practices, the team toured the complete building systematically, going from one room to the next using their complete body to grasp their environment until they found the three hidden bottles. At the end of the reconnaissance mission, the fire fighters reported to the commander, drawing a sketch of the building based on their recalls of the path that they followed, besides any other details that could be relevant to the intervention.

In the second mission, we provided the commander of the mission with a floor plan marked with the position of the bottles to be found. The commander and the reconnaissance team communicated with each other with 2-way radio devices. Using this channel, the commander guided the team inside of the building. The team, on the other side, provided information about their environment that the commander translated to the floor plan and used to find the current position of the team. By means of this change, some very interesting effects in the praxis emerged to accommodate and take advantage of the new information. The reconnaissance mission ran no longer systematic, as they followed the directions of the commander and went directly to the places where the bottles were located. The radio communication was of very low quality, and for these reason, the team inside the building used some very basic expressions to identify and describe their position to the commander. By the identification of the disposition of the doors and walls, it was possible for the fire-fighters to collaborate with the commander in finding out the position of the fire-fighters. Even though this location was not perfectly clear for the commander, through the use of landmarks for navigation, he was able to provide a quite direct guidance.

In the third mission, the commander used the command post application to follow the fire fighters on a large interactive display using the position information provided by the Wizard of Oz platform. As in the previous mission, the commander and the team communicated through 2-way radio. This time there were no doubts about the actual position of the fire-fighters, so the guidance was

by means of directions. The Wizard of Oz platform, however, didn't provide heading information, so it was not possible for the commander to have a reference indicating the direction of the next movement. This problem was also solved after some trial and error by an emerging collaborative praxis. He started to ask the fire-fighters to move forward and then backwards to identify the direction of movement. Based on this information, he was then able to give instructions like "go forward 4 meters" or "find the next door and then left".

The change on the navigation mode of the fire-fighters from finding their own way in the first mission to being guided in the second and third mission had a direct impact on the report of the fire fighters. When guided by the commander, their ability to recall the path and the details of the building were considerably lower. This can be understood as a negative effect of the use of location information for guiding the fire-fighters, but it is also very difficult to tell if such effects can be overcame by expert training around the new available practices.

Conclusions and Future Work

A key point of interest for our research lies in understanding the mechanics of emergence of the dialectic process between available information and interpretation practices, and in using them to inform the design of pervasive computing solutions. In this direction, we want to further elaborate on the concept of building diagnosis artefacts based on the idea of providing context as a resource. We frame our work on three dialectically connected levels: a practical, a methodological and a theoretical one.

Practical Level

On the practical level, we are working with the Paris Fire Brigade to explore paths of appropriation for new information that we can make available from existing technology. One very interesting form of information that are exploring is position, but as of today, indoor positioning is very imprecise and error prone. Nonetheless, despite the high levels of uncertainty and the low quality of location information, we think that a combination of the available technologies for positioning can be used as the seed for building a collection of practices that can help the fire fighters in their work. The work in progress presented here shows results in this direction.

Our next steps will consist on providing the fire fighters with tools to annotate their environment, in order to support and enrich the process of spatial sense making that fire-fighters perform in reconnaissance missions. During such missions, fire-fighters could deploy annotations that mark the space with small units of information that are relevant to him in finding his way out, or to other

fire-fighters who further find these annotations. The annotations can be stored in deployable tags (for example RFID tags) that can be written by the fire-fighter using a non-intrusive interface and that can be read as soon as the tag enters a certain range of reach of the device. The goal for these studies will be to observe the appropriation process and to understand how simple contextual information such as space and annotations, when used by the users, can affect the practices of a community.

Methodological Level

On a methodological level, the idea of context as a resource has to deal with the co-evolution of diagnostic practices and the reliable signs required for such interpretation works. Here technology can play two different roles which are of interest for our research.

First, it can start with an existing diagnostic practice and then improve the quality of the signs used in this diagnostic practice. But as the workplace studies demonstrated, people do diagnose without being explicitly aware of this process and furthermore it is not always obvious which are the representative signs being used in the process. Motivated by these observations, we plan to study working practice and to reconstruct the semiotic process in its actual, real-time, moment-to-moment production and use.

The second role of technology is its use as a seed to innovation in the diagnostic practice. From an economical perspective it could be a disaster to wait until a new working practice is fully developed. Therefore one has to try to grasp early indicators, so that design can react to them in order to improve the emergence of co-evolution processes.

For the first role, ethnomethodological analysis of the work in the command post has demonstrated that ethnomethodology can be used to identify diagnostic work which was previously overlooked [9]. For the second role of technology, the work of Crabtree on transferring the ethnomethodological concepts of breaching experiment to study the use of new technology [10, 11] can be very interesting.

We think, therefore, that Ethnomethodology is a good starting point to study the concept of context as a resource in practice. It seems however that ethnomethodology's primary focus lie more on communications than on sign processes, and also more on situating practice than on the evolution of practices. This is a topic that we will have to further dwell on in order to study appropriation processes.

Theoretical Level

On the theoretical level we want to explore the technical interpretation of the basic structure of diagnosis. Such exploration should take into account two linked aspects that characterize this basic structure: On one side, diagnosis is the

semiotic process of recognizing (as a disease) by signs and symptoms. On the other side, diagnosis has an activity-oriented facet, perceived in the way that people needs to demonstrate themselves a diagnosis working practice. Here we want to resource to Charles Sanders Peirce, motivated by the fact that he has developed a theory of signs as well as pragmatism as an activity oriented theory of true, but that both theories are most of the times used separated from each other. In this point, recent work has started to work out the link between his semiotic concepts and his logical considerations including his concept of abductive reasoning [12, 14]. We think that his work can provide a suitable theoretical frame of reference for our work

In particular, Edmund Steiner has demonstrated on the case of the puerperal fever that Peirce provides a good framework to understand diagnostic work [14]. Oevermann has demonstrated from a social point of view, how the philosophy of Peirce can be interpreted as a theory of experience. Here, the semiotic pragmatic consideration of Peirce helps to explain how knowledge development is related to the practical activity in common life (Lebenspraxis) [13]. Hoffmann provides in his work a systematic approach that brings Peirce semiotics and pragmatics together by stressing out the importance of signs and activity for an evolutionary epistemology [12]. Hoffmann also makes a characterization of Peirce abduction, which we can use as a working definition for our idea of context as a resource:

> "In contrast to Platonic "ideas", it is important to note: first, that contexts are not "eternal" but part of a process of evolution and, second, that these general elements are not disjoined from the "facts" or particular "states of affairs" which they determine. For Peirce, there is a mutual determination between the general and the particular and a "co-evolution" of both."[15].

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