Using Sensor Data in Smart Surroundings

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Abstract This paper motivates the need to use sensed data in Smart Surroundings and shows a few examples of how this data is currently being effectively used. The motivation stems from the settings of the Smart Surroundings project. Key to the settings is detecting context—derived from physiological data, location, environmental data, agenda, social maps, etc.—and acting on the detected context, for example by adapting the ambience, determining access to privacy sensitive data, choosing between personal feedback or ambience feedback, etc.

Smart Surroundings

The overall mission of the Smart Surroundings project (http://www.smart surroundings.org) is to investigate, define, develop, and demonstrate core architectures and frameworks for future Ambient Systems. In this context, ambient systems are referred as networked embedded systems which support people in their everyday activities by integrating with the environment. They are aimed at creating a Smart Surrounding enabling people to increase their life standards and their productivity at work. These systems differ from traditional computing systems by being based on an unbounded set of hardware and software, which will be embedded in everyday objects or appear as new devices.

One of the objectives of Smart Surroundings is to study ubiquitous computing in concrete and complex settings to ensure that development of platforms and foundations remains firmly grounded in reality. The project target is to design and implement real world experiments that expose ubiquitous computing systems to the challenge of supporting a multitude of competing applications and user experiences.

We have decided to focus on two main settings: well-being and office. The focus on the well-being setting is stress management, while the focus on the office setting is flexible offices. As the reader may notice, both settings meet in the scenarios for stress management in the work environment. Additionally, a sub-project—Home Care SenseNet—to improve elderly care began recently. Within the consortium work is also carried out in another setting for elderly care—Smart Medication System— but this will not be discussed here because of the potential for creating a product from it in the near future.

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Settings

Stress Management

Stress is experienced by most people due to their work, sports, family responsibilities etc. People believe they can use some assistance in dealing with stress. Medically, stress is defined as a ”perturbation of the body’s homeostasis”. The common indices of stress include changes in (1) biochemical parameters (such as epinephrine and adrenal steroids), (2) physiological parameters such as increased muscle tension, heart rate and blood pressure and (3) behavioral effects such as anxiety, fear and tension. However, just as distress can cause disease, it seems plausible that there are good stresses that promote wellness. Stress is not always necessarily harmful. Increased stress at work for instance, may result in increase in motivation and awareness providing the stimulation to cope with challenging situations. However, long lasting periods of stress may result in negative stress.

Excessive, prolonged and unrelieved stress can have a harmful effect on mental and physical conditions; for instance it is associated to cardiovascular diseases, immune system diseases, asthma and diabetes. Common signs of negative stress are tiredness, concentration and memory problems and changes in sleep patterns. People need to find an optimum balance between positive and negative stress. Since there is no single level that is optimum for all people, personal stress training systems can assist in reducing elevated levels of stress. Controlling stress by means of these systems contributes to the subjects’ well-being. Stress management should be individually adapted, able to learn from ongoing experiences, private, anywhere and anytime, active and continuously interacting with the surrounding to optimize feedback. This addresses the need for a wearable or private product (clothes, jewelry etc) so the subjects can and will be trained in a variety of settings which are not physically bounded.

In the Smart Surroundings project the stress level is determined using different methods: measuring physiological data (e.g. muscle tension, heart rate), monitoring the user’s interaction with the environment (e.g. pressure exerted when using the mouse, playing with a pen or pressing a ball) letting the user provide feedback about his stress level with tangible interfaces, and taking into account the context of the user (e.g. room temperature, light level, activity performed, agenda, etc.).

The feedback will be provided to modify the ambience (e.g. lights, sounds, music) where the user is at present (e.g. office, home, car), using wearable and private products as PDA, watches, jewelry, clothes, etc. Figure 1 provides a high-level view of the stress management setting.

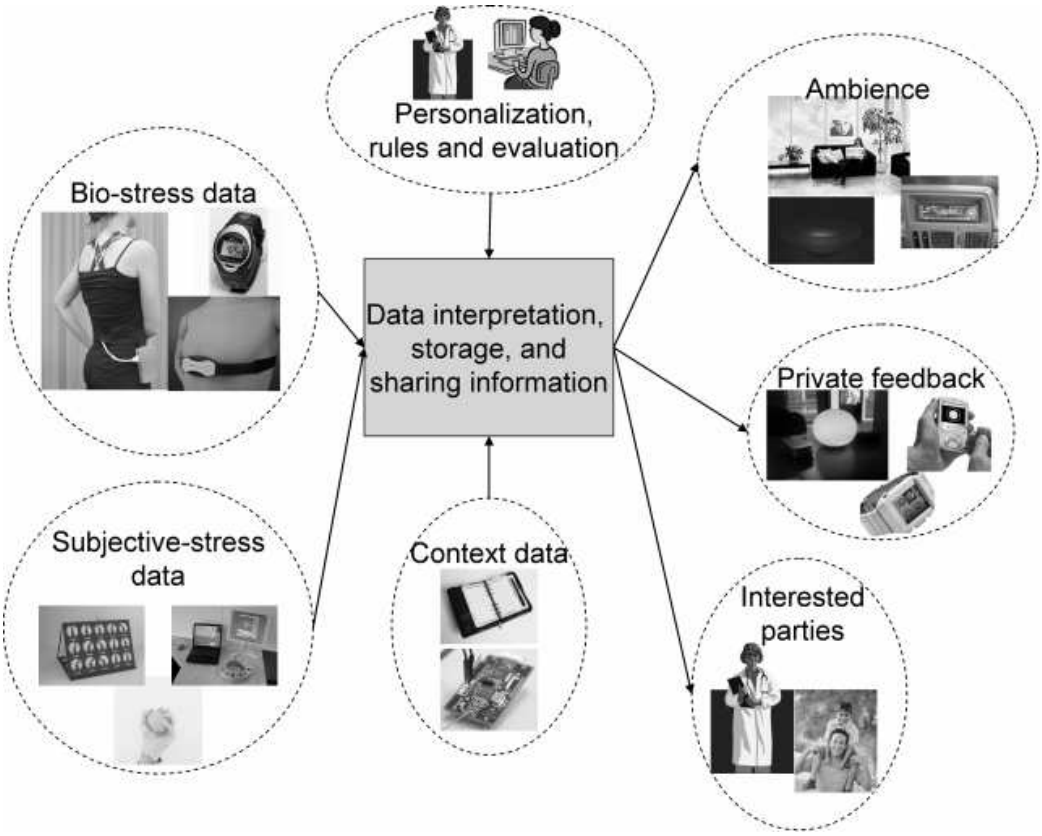

Figure 1: Abstraction of the Stress Management setting

Flexible Offices

Nowadays, the trend for people to work in a more flexible way both while travelling to various locations and countries and within their own company building is apparent. Governments and employers have already started seeing advantages of flexible office solutions. It saves expenses of building maintenance, parking costs and reduces intensity of traffic and increases effectiveness of employees. This trend will continue in the future. Such a change will be motivated by economic reasons as well as by being a way to enhance the quality of work.

Smart Surroundings envisions the future of office working as being different from what we experience today. Both the environment and the work itself will differ from today's style of working. International cooperation and global activities of business, industry and research will involve more and more people working abroad. The mobility and temporary residence of working people promotes the idea of renting offices for short and mid-term periods instead of buying or continuously renting them. In this project, we picture the situation of a flexible office being rented for some weeks to some months for people who work abroad. This setting outlines requirements and possible solutions for such flexible offices. Special attention will be on the personalization of the office space as well as practical flexibility and usefulness of furniture and electronic equipment.

People will start working in more flexible ways not only while traveling abroad but also within their own company building. A growing number of companies are switching to open work spaces and flexible working styles. An example of such a transformation is the Dutch insurance company - Interpolis. The biggest technical enabler for implementation of the flexible office concept was development and popularization of wide area networks, wireless communication and the Internet enabling remote access to the office. This change has an impact on technology as well as on the way teams work.

Smart Surroundings believe that flexible offices will be part of our future. It is clear that if this is not correctly implemented, it can result in an undesirable environment for work. Therefore, the project is involved in providing a flexible and yet friendly and efficient way of working. We picture the situation of a flexible office, where no employee has his/her own, static office space. Every person has means to work from any place within a company building as well as from another location (client, home, etc.). The project outlines requirements and possible solutions for such flexible offices. Special attention will be paid to the communication aspect as well as to enablers for ad-hoc meetings.

At present we are working on an abstraction called Mini-ME. Mini-ME is the user's doublet in the working and family life, providing and receiving information around the worlds from/to other Mine-MEs, and giving to employees data needed in order to take decisions, organize time and get in contact with other people. Mini-ME will also allow the environment to be controlled and personalized to fit the preferences of the user, and the devices in the offices and outside them (e.g. coffee machines, copiers, overhead projectors) to be controlled. Other envisioned scenarios involve supporting workers to hold informal meetings in coffee rooms or corridors, and supporting formal meetings with unknown people.

The Flex Office system offers a plethora of services to the inhabitants of the office. It can, for example, localize people and services within the office, and in this way provide appropriate information to the Mini-ME system. As nobody has a fixed place in the flexible office, it can be difficult to create a sense of personality in the office. Thus, the system can also execute personalized requests of a particular user in the office.

An example of the services offered by the flex office is Smart Signs (Lijding et al, 2006). Smart Signs are a new type of electronic door- and way-sign based on wireless sensor networks. Smart Signs present in-situ personalized guidance and messages, are ubiquitous, and easy to understand. The Smart Signs system uses context information such as a user's mobility limitations, the weather, and possible emergency situations to improve guidance and messaging.

The following usage scenario is presented in the context of a fictitious Flex Office called TheNomads.

TheNomads also offers a system of Smart Signs, which the employees can use at the doors of the office they occupy. The Smart Sign shows the name of a person working in a particular room and some information about where the employee currently is or when he is expected to be back. It can also show some personalized message addressed to a specific passer-by.

Martha is very often on the move and she often uses her Smart Sign to show a notice of 'I'll be back in a moment' whenever she goes to the toilet or to fetch coffee, or to get copies from the printer or office supplies. Whenever she is in a meeting the Smart Sign blinks frequently and shows the time the meeting is expected to finish. This is an advantage for Martha as she was never able to stay so long at her desk and her friends were complaining that she was unattainable.

As she changes her offices so frequently, Martha never knows where the closest office facilities such as a printer are. The Smart Signs can collectively show to Martha the way to go to collect her prints. These are arrows projected in the direction of the printer; alternatively she can get the route on her personal handheld device. The signs can show the route to resources or people. When using a personal device, the system can also use audio as well as visual clues to indicate the way.

Additionally the Smart Sign at the printer could show Martha when her printouts will be ready or what were the last documents it printed for Martha and when.

Home Care SenseNet

The Home Care SenseNet (HCSN) aims to improve quality of life for patients in need of care and for their care-givers. It achieves this by enabling longer independent living, and automating routine administrative task of care-givers.

The strength of the HCSN is its simple deployment in existing private flats/houses and care institutions since no expensive cabling infrastructure is necessary. Sensor nodes can be attached exactly where they are needed and can last for years without maintenance. Small ad-hoc mesh WLAN nodes, which require only a power outlet, provide the second layer infrastructure connections that extend the lifetime and reach of the network in large buildings. The whole network is largely auto-configuring and requires no or little IT knowledge for set-up and maintenance.

The wireless sensor network will monitor a part of the physical environment, physiological state, and current location of clients and, optionally, of care-givers. The health-care application uses this context data to derive significant events, notify care-givers where appropriate, and log events for long-term analysis, administration, and accounting. Examples for significant events are "change diaper of client", "client's diaper was changed by care-giver", or "client sleeping uneasily". In case of potential emergencies (e.g. "client may have fallen"), the HCSN will use the location information to alert the closest care-givers. A significant use case can be the recognition and monitoring of behavioural patterns and the detection of changes in that pattern. For example, the HCSN may monitor "normal" wake-up times, when which room is used in the house, at what times the fridge is opened or when medicine is taken.

The actual events or parameters to monitor, acceptable form-factors for the sensors, and user interfaces to the health application are established in close cooperation with care givers and other users during the project. Important scientific challenges addressed in the project are to select the optimal, least invasive sensors, provide an auto-configuring and self-healing network while

enforcing security and privacy of sensitive data, and deriving high-level client-related context using sensor fusion and inference.

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