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What are the key characteristics of a “smart home”?

The vision of a true smart home system extends far beyond conventional home automation systems. Smart home systems are able to dynamically adapt to the users’ needs and preferences by considering a wide range of factors, such as the users’ physical and social environments as well as health-related and psychological variables. To this end, they rely on a multitude of connected, unobtrusive sensors either embedded in the users’ physical surroundings or worn on the users’ bodies. In the ideal case, a smart home is able to learn from data how to improve the users’ comfort, health, and safety over time without demanding the users to manually adjust system parameters as their requirements change. In this way, a smart home significantly reduces the effort typically needed for system configuration and maintenance.

In which areas of our lives do you foresee smart homes having the greatest impact?

I expect smart homes to have a huge impact in the area of geriatric care. Smart home technologies will enable a larger number of senior people to age in place, i.e. remain in familiar surroundings and maintain their independence for a longer period of time than is possible today. Smart home technologies can improve elderly people’s level of comfort, for example, by automatically adjusting the accessibility of furniture on demand and also by helping mitigate age-related risks, such as falls. In addition, they contribute to a person’s safety and security, for example, by automatically switching off unused electrical appliances or securing doors and windows to prevent burglaries.

In the near future, there will be a stronger emphasis placed on the use of smart home technologies to enhance people’s general well-being. One example is the use of ambient light in people’s homes. However, while current technologies primarily rely on hard-coded rules, we will see much more flexible approaches in the future, which automatically adjust parameter settings from people’s physical and psychological reactions.

Furthermore, the trend to use smart home technologies for more efficient energy use is likely to continue with the increasing number of connected smart devices in people’s homes.

How do you foresee humanoid robots transforming our living environments?

Robots in the form of vacuum cleaners, lawn mowers, or similar household appliances have already made their way into our daily living environments. To improve the accessibility of

service robots for a wide user spectrum, attempts are being made to design them as anthropomorphic creatures with human-like behaviors including body postures, gestures, facial expressions, and speech. As a consequence, the role of domestic robots is likely to change from a pure tool to an assistant or even a companion as has already been anticipated in a number of movies like "Robot & Frank." In the future, we will be surrounded by a multitude of connected devices and robots that not only perform household chores, but also engage in demanding social work, such as acting as personal health and lifestyle advisors.

What innovative technology do you think will have the greatest impact on smart homes over the next decade? Why?

Progress in the area of smart homes will be supported by novel developments in four areas: the Internet of Things (IoT), Big Data analysis, IT security, and human-computer interaction.

First, smart devices communicating with each other via the IoT will provide the infrastructure for the aforementioned smart home services. Equipped with a plethora of sensors, they will generate vast amounts of user and context data over extended periods of time.

However, this leaves us with a big data analysis problem: assigning meaning to data. The techniques used for data analysis in smart home settings do not require a complete data set for training. They process data as it becomes available which is quite different from the data techniques for batch or offline learning, which necessitate a complete data set. It goes without saying that smart home infrastructures and data collection must be secured against unauthorized third-party access and abuse.

As with any highly adaptive system, smart homes raise a number of issues from the perspective of human-computer interaction. User interfaces have to be designed in a way that they can master the challenge of hiding the underlying complexity from the user, but still demonstrate a transparent and plausible behavior. Consequently, the success of future smart homes will greatly depend on novel techniques for monitoring and maintaining user trust.

Please describe how your research on exploring new paradigms for human-computer interaction could be applied to smart home concepts.

Up until now, most approaches analyze the users' situational context and activities as input to smart home systems. In contrast, we do not only take into account user activities, but also aim at the development of systems that empathically respond to psychological user states. This approach manifests a paradigm shift from pure activity tracking to empathic environments. I have chosen examples from two current projects that follow this paradigm.

In the CARE project, we are researching the concept of sentient stimulation. The basic idea is to improve well-being and quality of life of elderly people living alone by means of unobtrusive recommendations for activities. To this end, we have been developing techniques for synchronizing and analyzing sensor data to infer information on the user's physical and psychological state including their activity level, vitality, and emotional state, as well as information on the user's environment, such as ease and comfort.

In the GLASSISTANT project, we make use of augmented reality techniques to create an empathic environment for elderly people to help them cope with negative emotional states, such as anxiety and stress. What both projects have in common is that they strongly focus on psychological factors of well-being rather than on performance of a particular task for the user in the most efficient manner.