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The Smart Home: An instance of Ubiquitous Computing

Utkarsh Kumar & Sujeet Kumar

Final year Student, Information Technology, DCE Gurgaon, MDU Rohtak, Haryana, India.

Email: utkarsh.kumar10@gmail.com

&

Email: sujeetkumar0110@gmail.com

Abstract:

This paper pronounces the concept of building "Smart Homes" using the principle of Ubiquitous Computing. Ubiquitous computing is based on the simple notion of "Computing everywhere". With the help of Ubiquitous computing, we can access our system from anywhere, any time, and with ease. A Smart Home will be interactive, intelligent, and adaptive. It will know the requirements of the people living in it, and will adapt itself according to the mood and requirements of its residents. It will be run by a centralized computer system.

Keywords: Home, Ubiquitous Computing, context-awareness, sensors, applications

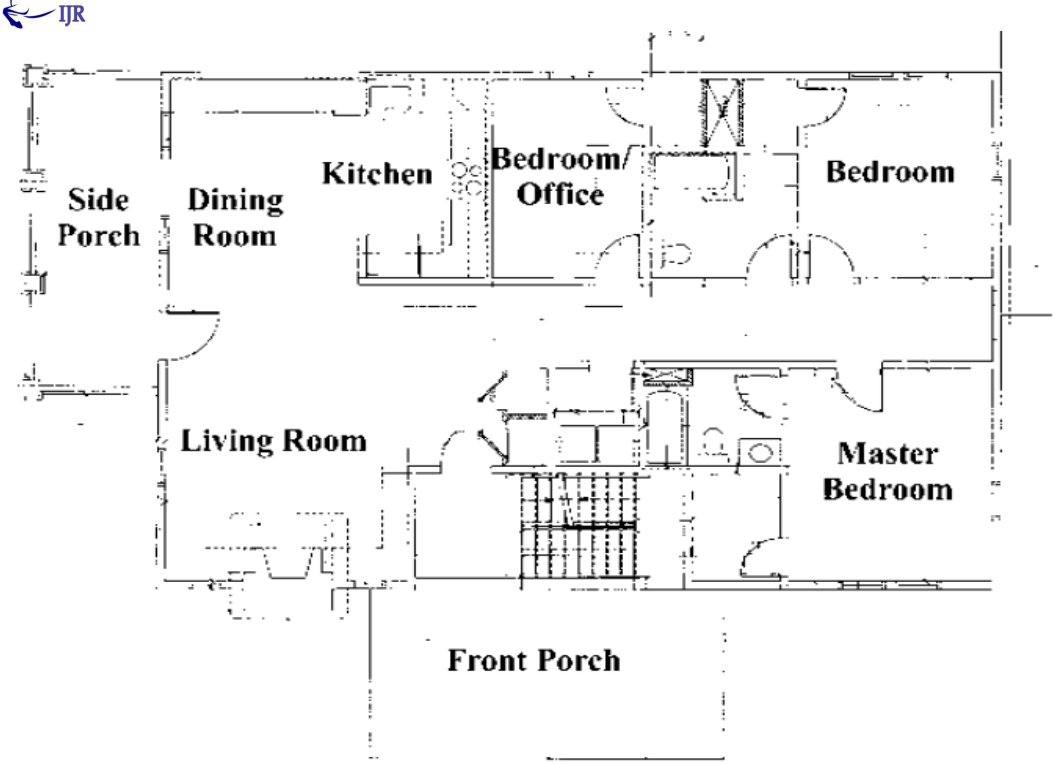
1. Introduction

In this changing world of computing, where a lot of efforts are being made for moving the computers away just from desktops and laptops, new challenges are being faced every day. There are a lot of scopes for research work to be done, for this purpose. One such trending research topic is to focus on computing needs in our everyday life. Everyday life specifically refers to that part of our lives, which is not centered on work or office. Rather, it comprises of the day-to-day lifestyle. The things that we do at our homes. And, this paper suggests a method to use technology to make our day-to-day lifestyles easier and comfortable. This paper suggests the concept of "The Smart Home". Such a home will be an intelligent home and will use ubiquitous computing to make our home lives more convenient. It will be able to produce an environment that is capable of knowing information about itself and whereabouts and activities of its inhabitants.

2. The Smart Home Architecture

The smart home will have two identical and independent living spaces, consisting of two bedrooms, two bathrooms, one office, kitchen, dining room, living room and laundry room. In addition, there will be a shared basement with a home entertainment area and control room for centralized computing services. The reasons for building two independent living spaces are to allow for controlled experiments with technology and to allow inhabitants to live on one floor while prototyping or providing demonstrations on the other floor.

The room will be constructed using standard house construction techniques to resemble the actual house as closely as possible. It is expected to implement some systems immediately in the house. These systems include human position tracking through ultrasonic sensors, RF technology and video, recognition through floor sensors and vision technology.



3. Context Awareness and Ubiquitous Sensing

Humans, in general, are quite successful at communicating complex ideas to each other, due in part to an implicit shared understanding known

as context. When humans interact with computers, there is very little shared understanding or context. However, it is becoming increasingly possible to build sensors that can help a computational environment to interpret and begin to understand the contextual cues of its occupants. In augmented environments, such as the Smart Home, the capability for computational services to take advantage of these soon-tobe ubiquitous sensing capabilities needs to be provided. For example, vision-based sensors are required to track multiple individuals in an environment and similar signal processing techniques will be used to build a smart floor interface that can identify and track people walking across a large area. There are many compelling applications for these sensing technologies throughout a home, such as support for the elderly or finding lost objects, or in specialized spaces within the home, such as the front door or the kitchen.

4. Individual Interaction with the Home

One interesting direction of this work occurs when we consider sensing on the body, as is done in wearable computing, in conjunction with sensing off the body, as is typical in an instrumented environment. In this environment, human-home symbioses becomes important as a means to provide as seamless interaction as possible with the home. Wearable computers and intelligent environments allow the delivery of convenient, personalized information and entertainment services at almost any time and in any context. However, there is very little work on how wearable computing and any computing infrastructure attached to the home environment should interact together on behalf of a user. By learning about users' habits and behavior, embedded systems in the home may perform complex, seemingly intelligent tasks automatically. Part of the technological and social challenge is determining where to put various interaction and sensor technologies for maximum benefit.

The data gathered on the wearable might then be filtered and released to the environmental infrastructure as appropriate. On the other hand, the wearable may draw on the house's data resources to cache important information for the mobile user when away from the house. Thus, an automated wireless collaboration between the platforms seems appropriate, with the user placing limits on the type and level of information transferred between his personal and environmental infrastructure.

5. The Smart Floor

In ubiquitous computing, knowing *who* is *where* and *what* they are doing is central to enabling intelligent behavior. In the Smart Floor project, the *who* and *where* aspects of this problem will be addressed: a system to identify and locate a person based solely on his or her footsteps will be created. In this system, ten strategically sized and located force-sensitive load tiles will be placed throughout the Smart Home to gather footstep data from occupants. The tiles are flush with the floor and consist of a metal plate supported by four industrial load cells; the data we gather from these tiles are known as *ground reaction force* (GRF) profiles. Sets of training data to create footstep models for each person will be gathered; and then each new GRF profile will be compared against these models and search for the best match. Two techniques will be used to create models for each user: Hidden Markov Models (HMMs), and simple feature-vector averaging.

6. Finding the lost objects

One of the applications of the tracking and sensing technologies in the Smart Home will be a system for finding Frequently Lost Objects (FLOs), such as keys, wallets, glasses, and remote controls. The system will use small audio-frequency tags attached to each object the user would like to track and a long-range indoor positioning system to track these objects. The user will interact with the system via LCD touch panels placed strategically throughout the house (for example, by the front door). The system will

guide the user to the lost object using spatialized audio cues (e.g., "Your keys are in the bedroom."). While it is expected that the FLO system will be able to keep track of objects 100% of the time, it is known that these expectations are not realistic; another person may walk off with the keys, or the batteries in the tag may fail. In these exceptions, the other tracking technologies in the house, such as the Smart Floor, can assist in locating the objects.

7. Support for the Elderly

Assisting a person to remain in familiar surroundings as they age not only improves the quality of their life but also increases the length of that life. But the increased mobility stemming from the industrial revolution has forever changed the society. People no longer live in the same community all their lives. Aging parents no longer live close to their adult children. The current practice of institutionalizing elderly people into assistive living centers is expensive and often an unsatisfactory experience for all involved.

As people get older and find it more difficult to live on their own, they are often forced to move out of their homes, though they do not require any type of constant physical assistance. This is done not only to provide peace of mind to their family members, but also to themselves. Moving out to some form of assisted living provides the security of frequent monitoring and the availability of medical assistance in the event of an emergency. If these people were able to keep that "peace of mind" while still living in their own homes, they would not be forced away from the familiarity and friends to which they are accustomed. The goal of this project is to design a system that provides a type of monitoring currently supported by an assisted living center for those individuals that do not demand frequent medical help or services that could only be provided by another person.

The Smart Home will provide social connections between elder parents and their adult children promoting peace of mind for family members. Secondly, it will also provide support to "everyday cognition" by augmenting those aspects of memory that decline with age and planning capabilities of elder residents. Thirdly, it is also planned to sense and identify potential crisis situations, so that appropriate outside services can be contacted as needed.

8. Challenges for the Future

The most important challenge for the future in the aspect of Smart Homes will be "The Qualitative understanding of Everyday Home Life". Designing the next generation of applications for homes is different from designing for offices. In offices, time and how it can be used is determined by the rhythms and culture of the organization. Movement is restricted and often monitored. Tasks and activities are circumscribed and determined by the organization. Work is generally couched in terms of productivity, efficiency and profit, emblems of Tayloristic notions of work.

But, at home, we have a lot of time. We are free to choose how space and time are structured, what activities are undertaken and who is involved. For these reasons, homes are what we call "free choice" environments. Because designing for such environments is challenging, it is critical that we develop methodologies that ensure that the latest technological advances are being funneled into useful applications.

Using qualitative techniques, one specific activity it will be attempted to understand deeply is how people lose and find objects around the home. This study will be used to support our Frequently Lost Objects project mentioned above. Ethnographic techniques will be used to study what people lose frequently, why these things become lost, how people go about finding these objects, and how other people in the household may assist in finding what has been lost. While a technical solution to the problem of finding lost objects in the Smart Home has already been outlined, it is hoped that the qualitative study of this problem can help to direct modifications or the existing system or help inform the design of

another solution altogether. It is also hoped to use the relationships with the families as a point for additional broader studies of home life.

9. Conclusions

Thus, it can be seen that, our proposal for Building "The Smart Homes", can be very useful in making the human lives much easier and comfortable. These kinds of Homes will have every facility that is not provided by any other home architecture. Our research would be very useful, if implemented in the construction of homes in a new way. Hence, we conclude that technology can be used in making our lives comfortable and much easier. And, "The Smart Homes" can be the perfect example for the same.

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