IOT FRAME-WORK FOR ENERGY EFFICIENT SMART BUILDING

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ABSTRACT

Internet of Things (IOT) is a vision towards Future Internet where "things" are provided with enough intelligence to communicate with each other without the human intervention. With the proliferation of Internet of Things (iot) Devices such as smart phones, sensors, cameras, and RFID etc. It is possible to collect massive amount of data for localization and tracking of people within commercial buildings. This proposed occupancy monitoring develop effective data fusion techniques for improving occupancy monitoring accuracy using a multitude of sources for the occupancy collection of data, IR sensors are used for the detection of existence of the persons and it will count the people in the buildings entering .

Keywords: IOT, Sensor, occupancy monitoring, Energy Efficiency.

1. INTRODUCTION

Buildings are known to be one of the largest consumers of electricity; the US Department of Energy estimates that buildings consume 70% of the electricity in the US. Recent efforts have focused on making buildings more energy efficient, including research that target specific areas such as lighting and managing IT energy consumption within buildings. Smart buildings are becoming a reality with the integration of Building Management Systems (BMS) [1] with an underlying monitoring and communication infrastructure that consists of smart devices such as sensors, cameras, RFIDs, meters, and actuators. These smart devices, along with the communication infrastructure, are referred to as Internet of Things (IOT). These approaches have certain drawbacks with respect to accuracy, cost, intrusiveness, and privacy. Accuracy, cost and intrusiveness are inter-related in the sense that with the increased cost, you can deploy additional devices (such as various sensors, RFIDS, cameras) and increase the accuracy of the system while at the same time increase the intrusiveness. Therefore, a wise method to reduce costs is to rely on the existing infrastructure as much as possible. This automatically addresses the intrusiveness issue since there will be no need to deploy additional devices inside the rooms, and additional applications on the users' devices. None the less, this raises the question of accuracy which may be severely affected. This paper provides an analysis of the existing approaches and help address therefore mentioned issue by promoting the use of multi-modal data fusion that will be collected from the existing IOT network. A data fusion process could improve the accuracy of occupancy detection while maintaining a low intrusiveness. By exploiting the system energy among the available data, information fusion techniques can filter noisy measurements coming from IOT devices, and make predictions and inferences about occupancy status. Specifically, we first analyze the variations of the problem and the available IOT devices and then survey the existing works with respect to these assumptions. There are a number of variations when we refer to Occupancy Monitoring problem. These are interrelated but depending on the goal of the application, in the past, various forms of the problem are studied Occupancy Detection: This problem studies whether a space is occupied or not at a given time. This is typically in the form of binary answers which does not tell how many people exist if the space is occupied. The spaces considered here are typically offices or private spaces. Occupancy detection of the public spaces (e.g., meeting rooms, aisles, cafeterias), on the other hand, is more challenging. Typically, these public spaces can either be monitored via other means (e.g., cameras) or by default considered occupied for HVAC applications.

Occupancy Counting: The goal of this problem is to determine the total number of people in a building at a given time. There are two versions of this problem: First, counting all the people in the whole building. Second, counting people based on some predefined zones.[2] [3] The zones can be defined, for example, using HVAC zones, offices, or Wi-Fi access point (AP) coverage areas. The granularity of the zones differs in most of the studies.

Occupancy Tracking: This problem can be considered as the superset of the all of the above problems. It not only detects people, but also counts, locates, and tracks them. The solutions to this problem can utilize the well-known user localization algorithms that run on the network side rather than the user devices.

Occupancy Event/Behavior Recognition: This problem is mostly related with the activities of the users once they are detected at certain locations. The activities can be individual or collective. Through occupancy event/behavior recognition, the behavior analysis of the individuals can be done and used for intelligent HVAC control. When

Investigating these problems, researchers relied on several network and IOT devices. These can also be classified into the following categories in order to assess the cost and intrusiveness of the approaches [4].

Tier-1: Approaches which rely on the existing Wi-Fi infrastructure without any addition of hardware or software.

Tier-2: Approaches which additionally require new software to be installed on APs or client devices.

Tier-3: Approaches which requires new hardware/software deployment. This category can either aggregate several IOT devices or use one of the other IOTs such as sensors or cameras.

In this paper, we survey the existing occupancy monitoring approaches based on the tiers above. Specifically, Tier-1 and Tier-2 are considered under WiFi-based occupancy monitoring. Tier-3 can be divided into several classes, where we will survey sensor-based and camera-based occupancy monitoring techniques in this paper. The approaches that fused data from several IOTs will also be reviewed under data fusion based occupancy monitoring techniques. Buildings, both residential and commercial, represent one of the highest energy consumption fields in the world. This tendency is particularly pronounced in developed countries, where between 20% and 40% of the total energy consumed is related with buildings. Reduction of the carbon footprint [5] [6] on a global scale as well as ensuring energy efficiency of buildings are key goals of high priority for multi-disciplinary researchers in the fields of building engineering and energy policy. IOT has raised interest in many fields, both from the industrial sector, for which it is seen as a new market opportunity, and from researchers and public stakeholders, where IOT is seen as a tremendous experimentation field able to deal with major technological challenges worldwide. Energy efficiency, social exclusion or urbanization processes are some fundamental challenges gaining attention in this area. In this sense, different IOT application domains have been already proposed. But the heterogeneity of resources and service attributes, and the dynamicity of mobile environments, require efficient solutions that can discover services matching them to the data and capability requirements from users and different application contexts.

2. BACKGROUND

Although much interest has been put into smart building technologies, the research area of using real-time information has not been fully exploited yet. In order to obtain an accurate simulation model, a detailed representation of the building structure and the subsystems is required, although it is the integration of all systems that requires the most significant effort. Initial solutions to energy efficiency in buildings were mainly focused on non-deterministic models based on simulations. A number of simulation tools are available with varying capabilities. With the incessant progress of ICT and sensor networks, new applications to improving energy efficiency are constantly emerging. For instance, in office spaces, timers and motion sensors provide a useful tool to detect and respond to occupants while providing them with feedback information to encourage behavioral changes. The solutions based on these approaches are aimed at providing models based on real data sensor and contextual information. Intelligent monitoring systems, such as automated lighting systems, have limitations such as, in which the time delay between the response of these automated systems and the actions performed can reduce energy savings, whilst an excessively fast response could produce inefficient actions. These monitoring systems, while contributing towards energy efficiency, require significant investment in intelligent infrastructure that combines sensors and actuators to control and modify the overall energy consumption. The cost and difficulty involved in deploying such networks often constrain their viability. Clearly, an infrastructure less system that uses existing technology would provide a cheaper alternative to building energy management. On the other hand, building energy management must face up the inaccuracy of sensors, the lack of adequate models for many processes and the non-deterministic aspects of human behavior. In this sense, there is an important research area that proposes to implement artificial intelligence techniques to process all data related with the problem, and as a way of providing intelligent building management systems solving the above drawbacks. This approach involves models based on a combination of real data and predictive patterns that represent the evolution of the parameters affecting the energy consumption of buildings. An example of such an approach is in which the authors propose an intelligent system able to manage the main comfort services provided in the context of a smart building, i.e., HVAC and lighting, while user preferences concerning comfort conditions are established according to the occupants' locations. Nevertheless, the authors only propose the inputs of temperature and lighting in order to make decisions, while many more factors are really involved in energy consumption and should be included to provide an optimal and more complete solution to the problem of energy efficiency in buildings. Furthermore, no automation platform is proposed as part of the solution. Now smart energy in buildings is an important research area of Internet of Things (IOT). Buildings as important parts of the smart grids, their energy efficiency is vital for the environment and global sustainability. In addition to hardware cost, the inconvenience of deployment and the maintenance issues make it unattractive for commercial building owners to invest on the deployment of smart technologies for energy-efficiency purposes. Therefore, there is a research trend recently towards the use of existing communication infrastructure, such as the widely available Wi-Fi AP infrastructure in buildings. Using occupancy as a driver for intelligent control of HVAC and lighting systems has been explored previously. Prior research in HVAC control systems shows that occupancy information can be used to drive a more optimized HVAC [7] schedule. However, due to the difficulty in obtaining real time accurate occupancy data, many of these techniques focus on using pre-determined schedules.

Many modern buildings use passive infrared sensors (PIR) to drive lighting; the PIR sensors are connected directly to local lighting fixtures and are rarely used for intelligent HVAC management[8]. These PIR sensors are also simple movement sensors and often cannot actually determine if the room is occupied or not. Thus most use a timeout for shutting off the lights (30 minutes is common) which can be sub-optimal. Other methods for detecting occupancy include using sonar based methods or camera based systems that bring up concerns relating to cost, deployment and privacy issues. CO2-based occupancy detection has also been examined - the main limitation of these systems is that they are very slow to detect events such as incoming people. Many modern buildings already contain a limited number of wired sensors. A major barrier to more widespread deployment of sensors, however, is installation costs due to the need for additional wiring for each sensor. The advent of low-cost wireless sensor networks has enabled wider deployment opportunities of a large number of connected sensors. The term “Internet of Things” (IOT) was first used in1999 by British technology pioneer Kevin Ashton to describe a system in which objects in the physical world could be connected to the Internet by sensors. Ashton coined the term to illustrate the power of connecting Radio-Frequency Identification (RFID)tags[9] used in corporate supply chains to the Internet in order to count and track goods without the need for human intervention. Today, the Internet of Things has become a popular term for describing scenarios in which Internet connectivity and computing capability extend to a variety of objects, devices, sensors, and everyday items. While the term “Internet of Things” is relatively new [10][11]. The concept of combining computers and networks to monitor and control devices has been around for decades.

3. INTERNET OF THINGS FOR SMART BUILDING

The IOT architecture proposed in this work is depicted in Figure 1. For the design of this architecture, as it has been already mentioned, we have especially taken into account the vision proposed by the IOT project. Following this approach, our IOT-based architecture promotes a high-level interoperability at the communication, information and service layers. Our approach is generic enough to be applicable in different smart environments such as intelligent transport systems, security, health assistance or smart buildings, among others. A smart building provides occupants with customized services thanks to the intelligence of their contained objects, be it an office, a home, an industrial plant, or a leisure environment. Since the building environment affects the quality of life and work of all citizens, buildings must be able of not only providing mechanisms to minimize their energy consumption (for instance, integrating their own energy sources to ensure their energy sustainability), but also of improving habitability and productivity. Sensor and actuator deployments in buildings need to be optimized in such a way that the associated cost is offset by the economic value of the energy saving.

A. Technologies layer: Looking at the lower part of Figure 1, input data are acquired from a plethora of sensor and network technologies such as Web, local and remote databases, wireless sensor networks or user tracking, all of them forming an IOT framework. Sensors and actuators can be self-configured and controlled remotely through the Internet, enabling a variety of monitoring and control applications. Among previous works related with automation systems for smart buildings presented in literature, we take as reference the proposal given in [12], where the authors describe an automation system for smart homes on top of a sensor network. Although the goal pretended in this work is similar to the one aimed by our reference use case here presented, the system lacks on automation flexibility, since each node of the network only offers limited I/O capabilities through digital lines, there is not a local friendly interface for users in the house, and, what is most important, the integration of energy efficiency capabilities is in fact weak. The work presented in [13] is also based on a sensor network to cope with the building automation problem, but this time the messages of the routing protocol include monitoring information of the building. We present here a real and interoperable experience on a general purpose platform for building automation, which is able to address the problem of energy efficiency and comfort, monitoring and security issues, among others, by means of a flexible sensor architecture which allows the collection of data, and is able to control a wide range of automated parts of the building. Our automation system, which is used to gather information from sensors and actuators allocated in the building, has been developed as a particular study case of our system in the University of Murcia in a test bed building6. The base system is known as Domosec, and its main components were presented in detail in [14]. Domosec has been used as the basis for an automation system able to monitor environmental parameters, gather data for tracking occupants, detect anomalies (such as fire and flooding in buildings), and take actions to deal with key efficiency requirements, such as saving power or water consumption. The main components of this architecture are the network of Home Automation Modules (HAM) [15] and the SCADA (supervisory control and data acquisition). The HAM module comprises an embedded system connected to all the appliances, sensors and actuators of the various spaces of the building. These devices centralize the intelligence of each space, controlling the configuration of the installed devices. Additionally, the SCADA offers management and monitoring facilities through a connection with HAMs. Thus, all the environmental and location data measured by the deployed sensors are first available in HAMs and then reported to the SCADA, which maintains a global view of the whole infrastructure.

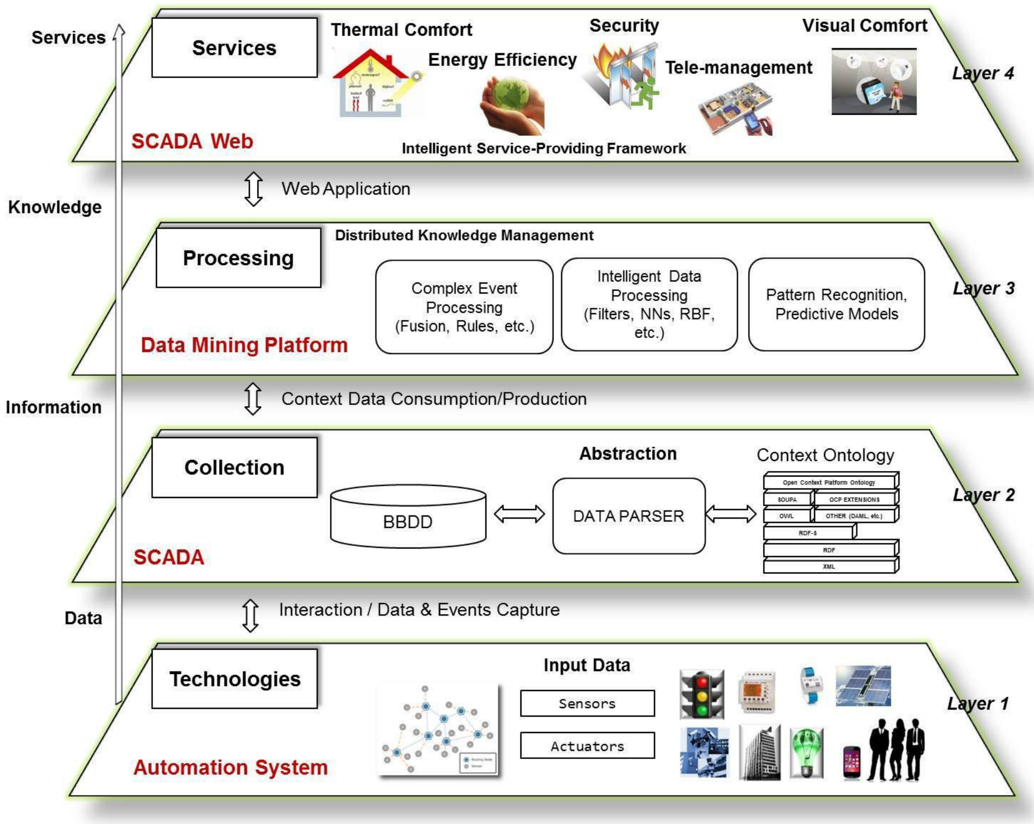

Figure1 IOT Architecture For Smart Building

B. Middleware layer: This layer is responsible for the management of the information flows provided by different sources. The different information sources could be: sensors, data bases, web pages, etc., whose data and behavior can be controlled. These data sources can be enquired through several coordination mechanisms, for instance through publisher/subscriber methods. In our IOT-based architecture, we use the OCP platform (Open Context Platform), developed by the University of Murcia and further described in [15]. OCP is a middleware to develop context-aware applications, which is based on the paradigm of producer-consumer. Hence, the producer, in our case the Domosec system collecting information from the automated devices, adds information to the OCP. Meanwhile one or more consumers interested in some specific context parameters are notified about the changes performed in this information. The context information is collected in an ontology defined according to the model that represents the knowledge of the application domain, while a service to manage this information using OCP is used by consumers and producers of the context.

C. Management layer: This layer is responsible for processing the information extracted from the middleware and for making decisions according to the final application context. Then, a set of information processing techniques are applied to fuse, extract, contextualize and represent information for the transformation of massive data into useful knowledge that is also distributed. In this layer two phases can be distinguished. The first one acts as context consumer of the middleware, and intelligent data processing techniques are implemented over the data provided by the middleware layer. The second phase acts as context producer. In this stage, complex event and decision making processes are applied to support the service layer with useful knowledge. Considering the specific application in the smart buildings context, in this layer it should be implemented the data processing techniques for covering, among others, security, teleassistance, energy efficiency, comfort and remote control. In this context, intelligent decisions are made through behavior based techniques to determine appropriate control actions, such as appliance and lights control, power energy management, air conditioning adjustment, etc.

D. Services layer: Finally, the specific features for service provisioning, which are abstracted from the final service implementations, can be found in the upper layer in Figure 1. This way our approach is to offer a framework with transparent access to the underlying functionalities to facilitate the development of different types of final applications. Besides, buildings are an important energy consumption area worldwide,[16] with a pronounced tendency in recent years. As a reference, in developed countries the electric consumption of buildings covers between 20% and 40% of the total [17].

4. PROPOSED SYSTEM

Buildings as important parts of the smart grids, their energy efficiency is vital for the environment and global sustainability. In addition to hardware cost, the inconvenience of deployment and the maintenance issues make it unattractive for commercial building owners to invest on the deployment of smart technologies for energy-efficiency purposes. Therefore, there is a research trend recently towards the use of existing communication infrastructure, such as the widely available Wi-Fi AP infrastructure in buildings. Enabled By occupancy monitoring capabilities, there are extensive Opportunities for improving the energy consumption of buildings. In this respect, the major challenges we envision are 1) to achieve occupancy monitoring in a minimally intrusive way, e.g., using the existing infrastructure in the buildings and not requiring installation of any apps in the users' smart devices, and 2) to develop effective data fusion techniques for improving occupancy monitoring accuracy using a multitude of sources. This Paper surveys the existing works on occupancy monitoring and multi-modal data fusion techniques for smart commercial buildings With the availability of IOTs in commercial buildings, building occupants and environment can be monitored in real time. In this way, we can have real-time access to occupancy counts in different zones of the building and even locate most of the users carrying a wireless device. This real-time occupancy status information can be used in a variety of applications controlled by the BMS. For example, the smart building systems of the future can adjust their energy consumption by intelligently controlling the HVAC, and respond promptly to any potential issues that can put the building off its track to carbon neutrality [5] [6]. In addition to energy issues, real time occupancy tracking may also help rescuing survivors in case of emergency response applications. The security or fire system can benefit from this information through the BMS. Finally, this information may also be used to improve building surveillance and security, and help in better deploying the wireless communication infrastructure for fulfilling ubiquitous throughput guarantees throughout the buildings. Due to such advantages of occupancy detection/monitoring, many approaches have been proposed in the literature by considering the use of different devices, assumptions, and goals. Based on most advanced sensing technologies, smart buildings must be able to monitor status parameters, analyze these data and, finally, actuate to reach some objectives, but considering at the same time transversal and essential goals such as cost and, more recently, energy efficiency [7]. The latter is obviously interrelated to cost, but, in the last years, its influence in environment preservation has gained terrain. The main goal of the scenario here presented is to reduce the energy consumption of a smart building through efficient management of resources, while occupants comfort needs are satisfied at acceptable levels, being necessary to rely on multiple network accessible devices and services. Below we formulate the problem associated to the provision of these services in the smart buildings context. Semantically, the IOT means "A world-wide network of interconnected objects, uniquely addressable, based on standard communication protocols" [18][19]..

5. APPLICATIONS

It is mainly used for Offices, colleges, school
In Industry.
The need for this device to occupancy monitoring of smart building.
It is beneficial for hospitals.
In hotels.

6. CONCLUSION

The developed system effectively monitors and controls the occupancy monitoring for energy efficient smart building. Thus, the real-time monitoring of the electrical appliances can be viewed through a website. The system can be extended for monitoring the whole intelligent building. Finally, we investigated the current efforts where IOT comes into picture with the involvement of smart phones, and Wi-Fi APs.

REFERENCES

[1]. G. Levermore, Building Energy Management System: An Application to Heating, Ventilation, Lighting and Occupant Satisfaction. Taylor & Francis, 2002.

[2]. T.-Y. Chen, C.-H. Chen, D.-J. Wang, and Y.-L. Kuo, "A people counting system based on face-detection," in Genetic and Evolutionary Computing (ICGEC), 2010 Fourth International Conference on, Dec 2010, pp. 699–702.

[3]. T. van Oosterhout, S. Bakkes, and B. J. A. Krse, "Head detection in stereo data for people counting and seg mentation." in VISAPP, L. Mestetskiy and J. Braz, Eds. SciTePress, 2011, pp. 620–625. html#OosterhoutBK11

[4]. R. Melfi, B. Rosenblum, B. Nordman, and K. Christensen, "Measuring building occupancy using existing network infrastructure," in Green Computing Conference and Workshops (IGCC), 2011 International, July 2011, pp. 1–8.

[5]. "Radio-Frequency Identification." Wikipedia, the Free Encyclopedia, September 6, 2015.https://en.wikipedia.org/wiki/Radiofrequency_identification

[6]. T. A. Nguyen and M. Aiello, "Energy intelligent buildings based on user activity: A survey," Energy and buildings, vol. 56, pp. 244–257, 2013.
[7]. L. J. Lo and A. Novoselac. Localized air-conditioning with occupancy control in an open office. Energy and Buildings, 2010.
[8]. T. Teixeira and A. Savvides. Lightweight people counting and localizing for easily deployable indoors wsns. IEEE Journal of Selected Topics in Signal Processing, 2(4):493–502, August 2008.
[9]. A. Depaola, M. Ortolani, G. Lo Re, G. Anastasi, ans S.K.Das "Intelligent management systems for energy in buildings: survey, " ACM computing Surveys, Vol. 47, no.1, May 2014
[10].Bradbury, Danny. "How Can Privacy Survive in the Era of the Internet of Things?" The Guardian, April 7, 2015, sec. Technology. Technology/2015/apr/07/how-can-privacy survive- the-internet-of-things.
[11].Other views on the converging market trends driving IOT's growth include Susan Conant's article "The IOT will be as fundamental as the Internet itself", available at internetitself.html and Intel Corporation's statement to U.S. House of Representatives hearing on IoT,
[12].D.-M. Han and J.-H. Lim, "Design and implementation of smart home energy management systems based on Consumer Electronics, IEEE Transactions on, vol. 56, no. 3, pp. 1417 –1425, august 2010.
[13].P. Oksa, M. Soini, L. Sydanheimo, and M. Kivikoski, "Kilavi platform for wireless building automation," Energy and Buildings, vol. 40, pp. 1721 – 1730, 2
[14].M. Zamora-Izquierdo, J. Santa et al., "Integral and networked home automation solution towards indoor ambient intelligence," Pervasive Computing, IEEE, no. 99, pp. 1–1, 2010.
[15].Nieto, J. Botía, and A. Gómez-Skarmeta, "Information and hybrid architecture model of the ocp contextual information management system," Journal of Universal Computer Science, vol. 12, no. 3, pp. 357–366, 2006
[16].ASHRAE handbook. Fundamentals. American Society of Heating Refrigerating and Air-Conditioning Engineers, 2001.
[17]. D. Clements-Croome and D. J. Croome, Intelligent buildings: design, management and operation. Thomas Telford, 2004, ch. 10, pp. 273–288.
[18]."Values and Principles." Principles. Internet Society, 2015. Org/who-we-are/mission/values-and-principles.
[19]. Internet of Things in 2020: Roadmap for the future, (2008), Infso D.4 networked enterprises & RFID Infso G.2 Micro and Nan systems in co-operation with the Working Group RFID of the ETP EPoSS, Version 1.1, 27 May.
[20].R. Melfi, B. Rosenblum, B. Nordman, and K. Christensen, "Measuring building occupancy using existing network infrastructure," in Green Computing Conference and Workshops (IGCC), 2011 International, July 2011, pp. 1–8.
[21]. V. L. Erickson, M. A´.Carreira-Perpin˜a´n, and A. E. Cerpa, "Occupancy modeling and prediction for building energy management," ACM Transactions on Sensor Networks (TOSN), vol. 10, no. 3, p. 42, 2014.
[22]."An indoor localization system based on artificial neural networks and particle filters applied to intelligent buildings," Neurocomputing, vol.122, pp. 116–125, 2013.
[23].V. Callaghan, G. Clarke, M. Colley, H. Hagras, J. Chin, and F. Doctor, "Inhabited intelligent environments," BT Technology Journal, vol. 22 no. 3, pp. 233–247, 2004.
[24]. EN 15251:2006. Indoor Environmental Input Parameters for Design and Assesment of Energy Performance of Buildings - Addressing Indoor Air Quality, Thermal Environment, Lighting and Acoustics, Centre Europeen de Normalisation, 2006.
[25]. G. Song, Z. Wei, W. Zhang, and A. Song, "A hybrid sensor network system for home monitoring applications," IEEE Trans. Consumer Electron., vol. 53, no. 4, pp. 1434–1439, Nov. 2007.
[26]. C. Suh and Y. B. Ko, "Design and implementation of intelligent home control systems based on active sensor networks," IEEE Trans. Consumer Electron., vol. 54, no. 3, pp. 1177–1184, Aug. 2008.
[27]. Y. Agarwal, S. Savage, and R. Gupta. SleepServer: A Software-Only Approach for Reducing the Energy Consumption of PCs within Enterprise Environments. In Proceedings of USENIX Annual Technical Symposium (USENIX ATC '10), 2010.