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Design and Development of an Intelligent Home Automation and Security System

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Abstract - Urban households are predominated by nuclear families, often with all members working. This leaves not only the household and related property in danger, but also those members of the same who are in need of continuous care and monitoring. This creates the need to develop an integrated product that will provide easy control, monitoring and security services, along with a highly reliable remote access system which will be deliverable as a complete set, ready to be installed right away. In our research we presented a novel approach to Intelligent Home Automation technology which ensures security from breaches and includes voice-based control over appliances and operations, in-household monitoring using image processing, as well as controlling of fans and lights according to the temperature conditions and presence of a user. It is based on Android and uses the Arduino platform, both of which are free and open-source systems. In this paper, a system called Intelligent Home Automation and Security System using Remote web application that is based on GSM and Wi-Fi modules is proposed and prototyped. First the hardware design is described and then the supporting software implementation is described.

Keywords - *Mobile APP, Face-Recognition, Voice- Control, Security, GSM.*

1. Introduction

Home Automation systems have escalated the convenience, safety, comfort, and energy efficiency of increasing number of homes around the world. Earlier this was restricted to only the most elaborate homes but integrated home automation systems are now within the grasp of mainstream consumers through electronic retail outlets, do-it-yourself(DIY) stores or as a complete home security service offered by broadband, wireless or security service providers. The use of effortless, dependable, authentic and low-cost wireless networking is a key cost-enabler for bringing these systems into the main stream. The latest security and home automation systems leverage innovations in sensing, connectivity and embedded computing to eliminate the need for professionally installed systems with reams of cables and matrices of large and unsightly sensors and microcontrollers as in [1]. New IC technology has enabled smaller, more affordable, less power hungry and more easily installable security and home automation systems. Complex wiring can be replaced by authentic, low-cost wireless technology, and efficient processing can enable low-cost and small footprint sensor technology.

A huge chunk of modern day families are nuclear in nature, consisting of both spouses being full-time professionals. This leaves a large part of the property, gadgets, and appliances unattended for major portions of the day. In addition to property, nuclear families may include one or more children or elderly people who require constant attention and monitoring, in terms of security as well as health. In accordance with the changing times and needs, technology must also evolve correspondingly. This is where this integrated system comes into play.

The preface of the Global System for Mobile Communication (GSM) possesses the novelty of distance communication from various locations. This paper makes use of this ability for remote control of instruments and appliances. To better illustrate this let us consider an example: a person attending a seminar at his office suddenly remembers that he left the Air Conditioner ON, whereas it ought to be OFF. The usual scenario is having to return back home and switch it OFF. But with the Android mobile phone in hand, equipped with GHAS (GSM Home Automation System) application, one looks on how the same could be used to assert control at any point, anywhere and anytime without worrying about geographical distances.

In this paper we present a novel approach to the intelligent home automation and security system. In this field, work has been done before like implementation using Bluetooth technology like in [2], [3] and [7]**.**The primary areas of work reported in this paper are as follows:

1) Mobile APP based security system has removed the constraint of distance from our homes.
2) Voice based and App based control over the appliances in the house.
3) Controlling of regular appliances like fans and lights according to the presence of user or surrounding temperature and light intensity respectively.

The details of the work are presented in the subsequent sections.

2. Related Work

Home automation can be described as introduction of science and technology within the home environment to provide convenience, comfort and security to its users. It can also be stated as the control over the appliances either remotely or automatically. There are some factors that must be addressed when creating a blueprint of a smart home system. The system is invented to be cheaper and scalable so that new devices can be simply integrated into the system. It should also be user friendly. A variety of smart systems have been considered where the control is via Bluetooth[3], internet, android[4], short message service (SMS), smart cards, Wi-Fi etc. With the introduction and broad acceptance of the Internet of Things (IOT) in the technical community, the research and implementation of home automation has generated wider acceptance [5]. Various wireless technologies that can support some form of remote data transfer, sensing and control via devices using Bluetooth, Wi-Fi, RFID, and Cellular networks have been utilized to embed various levels of intelligence and partial control over home systems[6].

Studies have also been presented about Bluetooth controlled home automation systems that use the Android platform[7] but without Internet controllability. The devices have been physically connected to a Bluetooth sub-controller which is then accessed and supervised by the Smart phone using built-in Bluetooth connectivity. Since Bluetooth has a limited range over which it can provide optimized performance, such a system cannot be used on a large-scalebasis.

Home controlling and monitoring systems like [8] have used RESTful based Web services which consist of a micro Web-server based on Arduino Ethernet, hardware interface modules and the Android compatible Smart phone App have also been discussed upon by the research community. A smart home design application that allows homeowners to control their home related activities through the internet had also been proposed [9]. It needs a Personal Computer to direct the information through the internet. A Personal Computer is thus used as a server that increases the price and power consumption. Also web page hosting capabilities are required which amplifies the overall cost. In his paper, it is said that the use of Personal Computer can require substantial cost that can be reduced drastically by using amicro controller.

In [10]'s research the connection between the android device platform and the home devices have been established using wired connections. It has been more efficient to support various wired as well as wireless technologies such as Bluetooth, Zigbee, Wi-Fi, and the World Wide Web itself.

Home automation systems have been developed using RFID, Wireless Sensor Network (ZigBee) and GSM technologies toolike in [11]. ZigBee provides a low power wireless technology that has been used for monitoring and controlling various devices.

Design and implementation of a low cost, flexible wireless solution for home automation, especially for turning lamps or the television set on or off automatically has also been implemented as in [12]. However, this is a fundamental system without advanced features like integration of RTOS, and also does not have requisite sensors that are required to intelligently control the home appliances without human interference.

All researches which are mentioned above have inspired us to research about a device that would provide an authentic, rugged, reliable and efficient solution for controlling home automation and security with minimal human intervention.

3. Proposed System

In our proposed system we first ensured a Mobile APP based control over all household appliances: there have been provisions to control all household appliances using a dedicated mobile application. Each family will be able to download the App from their respective stores as the application is made for all popular smartphone platforms. All the appliances present in the house will then have to be linked to the app. This will enable the user to access to all devices running in the household. From ACs to pumps, to lights and fans, everything will be a click

away. Thus with this application remote switching is implemented in the household, as from anywhere in the world the appliances can be controlled. The entire household will be under control from anywhere in the globe.

One of the most unique features of this system is that it will also work even without internet connection. It will work even with a call to a specified number. A sequence of digits have to be entered, when asked for the password, it will enable the user to control appliances using DTMF based digit sequences thus ensuring voice-based control over appliances. Hence by enabling voice based control over the appliances in case of an internet failure ensures the viability and also highlights the broad spectrum of our product.

a. To provide an efficient energy friendly based system the fans and lights are made to work in such a way that their speed or brightness is modulated in accordance to the room temperature or prevalent light intensity.

b. Entry of unexpected people without permission from the insiders or the user who is out of his home, will be notified, and an alarm sounded. Sensors and camera systems at key points will detect breaches and send security notifications to the user via SMS/automated call. Sound alarms will also be triggered inside the household. If there is no response from the user, the security flags will be triggered to the local police station. Automated snapshots of the intruders will be uploaded to the server, thus ensuring security from breaches.

c. A door lock system is also implemented and can be controlled via the mobile application. In case of children returning home early or the arrival of a known relative when the user is not at home, access can be granted inside by controlling the door with the mobile application, after verifying the presence through the snapshots that will be sent to the user from time to time.

d. From cameras installed at strategic locations inside the house, movement and similar activities of children/elderly staying inside will be monitored. In case of sudden increase or cessation of physical activity, the user will be notified via SMS/automated call. Mini-microphone systems installed inside the house will be triggered by voice commands or shouts, which may initiate connection between insiders and the remote user.

e. In case of fire or earthquakes, three notifications will be made. The first one corresponds to an alarm inside the house. The second notification is presented as an automated call to the user. The third notification is optional, and can be entered by the user to any specific set of phone numbers, including fire stations and ambulances thus ensuring safety from instant fire breakout.

Wireless communication of peripheral devices, like cameras, microphones, alarms, door locks appliance controlling relay systems, etc., with the central processing and controlling unit (CPCU) will be implemented. Wi-Fi and internet is used for the purpose.Thiswillgreatlyreducethehasslesofinstallation.Fig1 shows the block diagram for our proposed system..

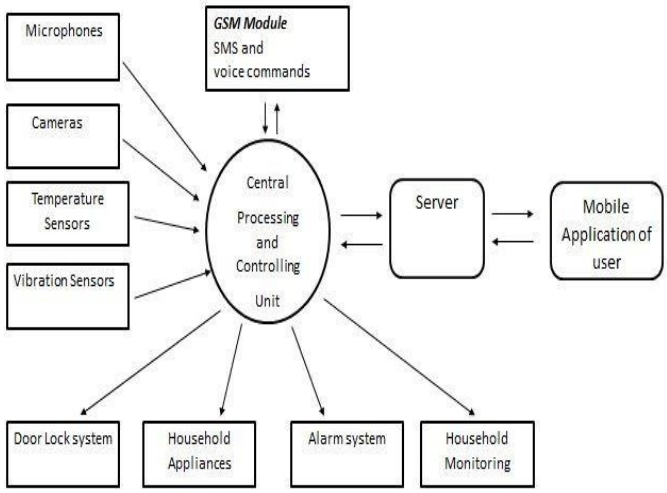

Fig.1 Block Diagram of the proposed approach

4. System Implementation

The proposed system is implemented in two stages. First the hardware part is implemented and then the software part is implemented and finally a link between the two is established.

4.1. Hardware Implementation

In the hardware system, the Central Processing Unit in the household was installed which was the point of contact between all the household appliances and the mobile application present in the smart phone of the user. The Central processing system can be any microcontroller based platform. After the Central Processing Unit was

installed, all the appliances were linked to this unit with the help of Wi-Fi modules thus ensuring control of the appliances from this unit through the mobile application. After all the appliances which were needed to be controlled remotely were linked, the automatic door lock system was implemented using servo motors and was also linked to the Central Processing Unit for control via the mobile application.

When the controlling part was over, the sensors were installed in the home at key points. Temperature sensors, light dependent resistors were installed at respective places which would help us to measure the temperature and light intensity of the surroundings from time to time and correspondingly report it to the Central Processing Unit which in turn regulates the fans and light present in the house. Vibration and gas sensors were also installed in the house and monitored such that in case of any anomaly like fire and earthquake the user will be notified.

To implement Security, monitoring cameras were then installed at various strategic points which help to continuously monitor activities inside and outside the house and notify the user in case of a threat. Lastly the Central Processing Unit with the GSM based system would generate an automated call/SMS to concerned places in case of an emergency. This GSM based system will be also used to receive a call/SMS in case of an internet failure. In this case for the user to control the home appliances, he would have to make a phone call to the concerned number present with the Central Processing Unit, which would then prompt the user to enter a password. This would thereby enable the user to control the home appliances using DTMF based digit sequences.

4.2 Software Implementation

The major part of the software implementation consists of implementing the mobile application. The mobile application was made using C# in Visual Studio with the use of Xamarin [13]. The interface of the mobile application is simple. When the App was used for the first time it prompted the user to enter the appliances which were linked to the Central Processing Unit present in the household. After the user entered all the devices in the App, they can be controlled via the application from anywhere on the globe. In the application there is a separate tab for Security from where time to time snapshots were uploaded of the household thus maintaining Security. To identify the increase of physical activity and presence of any unknown person, image processing and Face-Recognition model was used. Image processing was performed through Python where the cameras provided the feedback and accordingly the Python application which was running in the CPU processed it. In case of any threat, the central processing unit will immediately notify the user and the concerned places.

4.3 Linking the Software with the Hardware

Finally the Hardware part and the software part were linked through a central server which would serve as the adapter between the mobile application and the Central Processing Unit present in the household. The server was present along with Central Processing Unit which would enable all the communication between the mobile application and the Central Processing Unit.

5. Conclusion and Future Work

Security is always an important factor in our household as we hope to protect all our indispensable commodities securely and privately. This may include our locker rooms, personal privacy and household limitations. Now, the central control from the user phone App gives exclusive access to the services, provided the user crosses all security firewalls including password protection, face-detection algorithms and pattern locking-unlocking facility. This system redefines simplicity in innovation. In future we would like to improve our system and also expand it to offices and other commercial spaces where Security and monitoring shall be extensively focused upon. Also the system would be tested in remote industrial areas where human labor is less and a high level of automation exists.

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References

[1] B. Murali Krishna, 1V. NarasimahaNayak, 2K. Ravi Kishore Reddy, B.Rakesh, P.Manoj Kumar, N.Sandhya, “Bluetooth Based Wireless Home Automation System Using FPGA”, Journal ofTheoretical and Applied Information Technology, Vol.77, No.3, 2015.

[2] Ming Yan, Hao Shi, “Smart Living Using Bluetooth Based Android Smartphone”, International Journal of Wireless & Mobile Networks (IJWMN) Vol. 5, No. 1, 2013.

[3] Nupur K. Sonawane, PayalD.Waghchavare, KajalA.Patel. “Bluetooth Based Device Automation System Using Cellphone”, International Journal of Computer Applications & Information Technology.

Vol. 7, 2014.

[4] Sharon Panth, Mahesh Jivani, "Home Automation System Using Android for Mobile phone", International Journal of Electronics and Computer Science Engineering (IJECSE), Vol .3, No.1.

[5] Liu Y, "Study on smart home system based on Internet of things technology" ,In Informatics and Management Science IV. vol. 207, W. Du, Ed., ed: Springer London,pp.73-81, 2013.

[6] Al-Qutayri, M.A., Jeedella, and J.S.: "Integrated Wireless Technologies for Smart Homes Applications", In Smart Home Systems, M. A. Al-Qutayri, Ed., ed: InTech, 2010.

[7] Yan, M., Shi, H.: "Smart Living Using Bluetooth-Based Android Smartphone", International Journal of Wireless & Mobile Networks (IJWMN), Vol. 5, No.5, pp. 65-72, 2013.

[8] Rajeev Piyare, Seong Ro Lee, "Smart Home-Control and Monitoring System Using Smart Phone", ICCA 2013, ASTL Vol. 24, pp. 83-86,2013.

[9] S. Kumar, "Ubiquitous Smart Home System Using Android Application", International Journal of Computer Networks and Communications (IJCNC). 6, pp.33-43, 2014.

[10] D. Javale, M. Mohsin, S. Nandanwar, and M. Shingate, "Home Automation and Security System Using Android ADK", International Journal of Electronics Communication and Computer Technology (IJECCT). 3, pp.382-385, 2013.

[11] M. Patil and S.R.N. Reddy, "Comparative Analysis of RFID and Wireless Home/Office Automation.", International Journal of Soft Computing and Engineering (IJSCE) .3: pp.151-154,2013.

[12] R.Piyare, M.Tazil, "Bluetooth Based Home Automation System Using Cell Phone", IEEE 15th International Symposium on Consumer Electronics, 2011.

[13] Xamarin:https://www.xamarin.com/