

HOME AUTOMATION SYSTEMS: A BRIEF REVIEW

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ABSTRACT:

Home automation system can be implemented using wireless techniques like Bluetooth, internet, SMS, android cell-phone, etc. They aim to provide results that are better in flexibility, reliability, ease of use, cost, efficiency and security. Various household appliances could be remotely controlled and monitored and improvise the home automation systems. Different hardware as well as software aspects are considered in system development and implementation. This paper attempts to discuss few recent research papers on home automation system, along with their pros and cons. They also describe experimental results for home automation models based on Bluetooth, internet, android, etc. and explain their usefulness and limitations.

KEYWORDS: Home automation, Bluetooth, Android

1. INTRODUCTION

Every research that is carried out across the world directly or indirectly aims at simplifying human life, enhancing the way we live and communicate. Modernization and industrialization resulted in production processes that need high level of automation. In the household scenario too, automation is playing a major part for improving the network and the environment. Major contribution came from the time wireless networks were started to be considered implementable. As number of electronic devices used in homes increased, the research for their non-manual control increased rapidly. Home automation systems aims in this direction, meaning controlling household electronic gadgets wirelessly, automatically, with minimum human intervention. This paper attempts to review few of the recent researches and trends that further simplify or improvise home automation systems bringing latest advancements on board. Heterogeneous home-automation systems and various technologies are considered in review with centralized microcontroller based (Raspberry pi or Arduino), ZigBee based, web based, email based, Bluetooth-based, SMS based, Dual Tone Multi Frequency-based, etc.

2. LITERATURE SURVEY

Various experimental methods are tackled from time to time for researches based on the recent trends and advancements. This also applies for the fields of communication, embedded systems, computers, etc. Generally for navigation and tracking, three different techniques are broadly used, namely-Bluetooth, RFID and Wi-Fi. Their general specifications and availability are given below. Apart from these, other important techniques and concepts that form the basis of majority of home automation systems are also discussed in brief.

RFID TAGS

Electromagnetic fields are used for object identification in **Radio-frequency identification (RFID)**. Electronically stored information is present in the tags. Unlike the barcode, a tag is not necessarily needed to be in the line of sight range of the reader, therefore it may be embedded in the tracked object. RFID is one method for Automatic Identification and Data Capture (AIDC). There are two types of RFID tags available in the market. The first one is active and the second one is passive. Energy from a nearby RFID reader's interrogating radio waves is collected by passive tags. Active tag is the one which has its own power supply and also provides information when comes in the vicinity of the RFID reader. There is no need to swipe the card. The RS485/RS232 RFID reader detects and decodes RF transmitter signals from compatible wave trend tags. This active RFID tag can be configured remotely and connected to the host PC, edge server or intelligent hardware controller via RS232, RS485 or TTL. The detected tag data is sent by the reader to authorized computer systems.

BLUETOOTH MODULE

A Bluetooth device is used to detect other devices using enquiry protocol. Devices within its range that are set to the 'discoverable' mode are detected by the

Bluetooth module. This is a rather slow procedure. Most systems rely on the inquiry protocol. Hay and Harley propose an alternative in which they explore connection-based tracking. Some devices use low-level asynchronous connectionless link (ACL) connection [1]. The different Bluetooth modules available in the market are classified into different classes. There are mainly three classes-class 1, class 2 and class 3, of the ranges 100m, 10m and 5m respectively. The HC-05 is widely used for various applications. Bluetooth module receives the data serially in RS232 format from controller and sends it to wireless network [1]. For interfacing it with the microcontroller we have to build the circuit because the Bluetooth module can follow data in RS232 standard and controller understands data in the TTL format. Hence it is essential to design circuit to make these two compatible with each other.

Wi-Fi

Wi-Fi is a technology that allows multiple electronic devices or gadgets to connect to a wireless LAN (WLAN), mainly using the 2.4 gigahertz (12 cm) UHF and 5 gigahertz (6 cm) SHF ISM radio bands. Usually password protected, but may be open, a WLAN allows any device within its range to access the resources of the WLAN network. The Wi-Fi Alliance defines Wi-Fi as any "wireless local area network" appliance or device that is based on the Institute of Electrical and Electronics Engineers' (IEEE) 802.11 standards. "Wi-Fi" is a trademark of the Wi-Fi Alliance. The "Wi-Fi Certified" trademark can only be used by successfully completing the Wi-Fi Alliance interoperability certification testing. Various devices that can use Wi-Fi technology include personal computers, digital audio players, video-game consoles, smartphones, tablet computers, digital cameras and modern printers. Devices compatible to Wi-Fi can connect to the Internet via a WLAN network and a wireless access point. Wi-Fi is said to have less security than wired connections, such as Ethernet, because an unwanted person or intruder does not need a physical connection. Web pages that use TLS are secure, but generally, unencrypted web access can easily be detected by any intruder. Due to this, Wi-Fi has adopted various encryption technologies.

INFRARED CIRCUIT

Infrared (IR) is an invisible radiant energy, electromagnetic radiation, extending from the nominal red edge of the visible spectrum at 700 nm (frequency 430 THz) to 1000000 nm (300 GHz), reportedly having longer wavelengths than visible light. Infrared radiation is used in industrial, scientific, and medical applications. IR wireless is the application of wireless technology in devices or systems that communicate or convey data through infrared (IR) radiation. IR wireless is used for short-as well as medium-range communications. line-of-sight mode is used for operations of some systems; this means that there must be a visually unobstructed straight line through space between the transmitter (source) and receiver (destination). Unlike radio-frequency (RF) wireless links, IR wireless hardly pass through hard large obstacles, like walls. Therefore, IR Communications or control is generally not possible between two areas in a house separated by walls like the rooms, or between different houses in a neighborhood (unless they have facing windows). This feature may be often thought as a disadvantage but IR wireless is more private than RF wireless. Some IR wireless network applications offer a level of security comparable to that of hard-wired systems.

ARDUINO BOARD.

Arduino is a tool for making computers sense and control more of the real world than a computer. It's an open-source computing platform based on an easy to use, simple microcontroller board, and a development environment for writing software programs for the board. Various interactive objects can be developed with the help of arduino, taking inputs from a variety of switches or sensors, and having control on a variety of lights, motors, and other physical outputs. Projects based on Arduino can be stand-alone, or communicate with software running on your computer. There are numerous microcontroller platforms available for physical computing. Arduino also simplifies the process of working with microcontrollers, offering some benefits for academic purposes, for teachers, students, and interested amateurs over other systems. Arduino UNO is a microcontroller board that has 14 digital input/output pins (of which 6 can be used as PWM outputs), an ICSP header, a 16 MHz ceramic resonator, a USB connection, a power jack, and a reset button. It contains everything sufficient to aid the microcontroller; just connect it to a computer with a USB cable easily or power it with an AC-to-DC adapter or battery to get started.

ANDROID

A Smart phone is a cellular phone based on a mobile operating system, with very advanced computational capability and connectivity as compared to a feature phone. Android is a software stack for mobile devices that

includes an operating system, a middle-ware and variety of key applications. Android, by simple definition, is an operating system for many mobile phones [4]. Android gives us vital tools for creating applications that look very useful and extract the hardware capabilities available on every device to the fullest. Main base of Android is the Linux operating system which uses java- like languages for running applications. An important purpose of implementing android is to communicate control signals from smart phone through Bluetooth.

3. HISTORY

In this section, discussed different Home Automation Systems with their technology with features, benefit and limitations they have. The authors in [1] present a sensor network based on Bluetooth. Main objective is to implement a low-cost wireless sensor network for home or industrial application that also has internet access. Supplying correct power is the main problem to be solved here. The low-cost rPIC12C509 microcontroller is used to establish point-to-point wireless link between sensors and data logging devices. This research emphasizes that there are certain limitations and cons of wireless networks over wired ones in terms of transfer rate, cost, maintenance, battery power, but gives practical solutions for improvement. The working prototype consists of a master-slave piconet topology composed of three wireless sensor, each one equipped with LM35-temperature sensor and a digital output. At the sensor end, Bluetooth wireless standard is used. The master and gateway is connected to the internet via LAN, equipping the master station with web-server capability. Power consumption at the sensor side results as a function of the transmission rate. Operation range appears to be 14 metres in open and 12 metres in closed environment. These experimental results justify choice of Bluetooth as it gives low-cost network scalability comparable to Zigbee or similar approaches. Furthermore, using Bluetooth is a versatile way, offering performance comparable to fieldbuses, having cycle time for three slave network smaller than 20ms, and better timing characteristics. It focuses on the combined use of Bluetooth and Wi-fi, extracting advantages of both. Also, it depicts a combination of wireless and wired approach i.e. mixed system. Performance can be improved by employing more powerful microcontroller and faster serial links.

The work of Authors discussed in [2] is a home automation system based on ARM, including IR circuit, Android and GSM. Main objective is to develop a security interface model with android mobile and household appliances. Advantages such as short range system, easy accessibility, sufficient range and security are achieved through the use of Bluetooth incorporated in mobile devices. The system is capable to actuate a pin to lock or unlock a door from a short distance away with just a push of a button on the mobile device. Status of the door can also be checked and if the system fails to act accordingly, a backup plan is also ready, that includes a physical key. Thus, failure of the system will not lock or unlock the door permanently. The infrared is used to detect presence of a human. If the infrared sensor detects a person then the keypad will be activated to enter the pass code. An SMS will be sent to the owner for authentication. Depending on the owner's reply, the door will open. If the person enters wrong password, an intimation message will be sent to the owner and a buzzer will be activated after some time. Android operating system enabled phone is used to control appliances. Embedded C language is used to write the firmware. SMS will also be useful for remote switching and control activities. Experiments conducted gave positive results. Various issues related to hardware model like delays, power, resistors, motors, etc. were resolved. In this system, unavailability of efficient battery backup system may be an issue, need to be addressed. Future improvement can aim at incorporating this system with the existing one and using it for multiple doors or windows.

Al-Ali and Al Rousan [3] designed, implemented and tested a web based home automation system. The system uses an off the shelf standalone embedded system board that can monitor and control home appliances locally without the need for Internet connectivity. This paper presents design and implementation of Java based automation system that can monitor and control home appliances via the World Wide Web too. The home appliances are connected to the input/output ports of the embedded system board and their status are passed to the server. The monitoring and controlling software engine is based on the combination of Java server pages, Java beans and interactive C. The system is scalable and allows multivendor appliances to be added with no major changes to its core. Password protection is used to block unauthorised users from accessing the appliances at home. If the embedded system board still can control and operate the appliances locally, even over large distances the user can control his/her home gate, oven, refrigerator or water the garden without human intervention. Unlike previous research, this work presents an automation system via the Internet considering software as well as hardware aspects. Additional home appliances can be integrated into the system with little modifications. System also provides portability and flexibility to run on any platform. There are various Java components i.e. System java beans and JSPs that are assigned various functions which are in turn used to carry out different actions like to enable user authentication, dynamic status preview, immediate status preview, etc. These components are a part of the Java-based control and management (JCAM) engine. Accordingly, three different home appliances are used and interfaced. They are oven, fan and a light. Experimental results are also provided that shows successful control and monitoring. Despite these attractions and benefits, this HAS system

has not yet received broad acceptance and attention. This is mainly due to high cost, high complexity and less security.

Authors in this paper [4] presented the design and implementation of a home automation system where communication technologies GSM, Internet and speech recognition have been used. All these technologies are successfully merged into a single wireless home automation system. This system offers a complete, low cost, powerful and user friendly way of real time monitoring and remote control of the house. The author realized that previously developed HAS lacked alternative control mechanisms. Hence, in this model, three remote controlling mechanisms were proposed using GSM network, Internet and speech recognition respectively. The first two of these methods are designed for the users when they would like to remotely access the devices in the house whereas the third one is designed for the users while they are inside the house. Main objective for using GSM network for the communication between home and the user is its wide spread coverage which makes the whole system online for almost all the time. Another advantage of using GSM network is its high security infrastructure which provides maximum reliability so that the information sent or received cannot be monitored by any eavesdropper. Despite these benefits there are some disadvantages like high complexity, high costs and time consuming tasks. RF protocol is used for communication between home appliances. Unlike a system using wired communication methods such as X10, an RF system has the advantage of installation and maintenance. Moreover, it has a lower cost when compared to other wireless communication methods such as Bluetooth. To use Internet as a mode of communication, a web server is built to take requests from remote clients. A web page is constructed as an interactive interface where commands can be submitted by the client to change and also monitor the status of the devices. The user can also give commands to interact with the system. This way greatly simplifies the interaction with the appliances when the user is at home. A speech recognition program is written to control the house by means of human voice using the dynamic time warping (DTW) algorithm. To use DTW in speech recognition, first, the input data has to be converted into a template. Then, this template is compared with the speech templates stored in the database by the use of DTW. If a match is found, the recognised command is sent to the server. The main control program running on the server takes status information via the transceiver nodes every second. Synchronization and preamble bytes are used to decrease error probability and increase efficiency. The whole system is secured through a login password based authentication. The design is completely wireless and integrated with the software to form a low cost, robust and easily operable system. RF communication simplifies the installation of the system. The multi-value adjustment feature is another strong point in the system enabling the devices to have distinct states rather than just on and off. In addition, the nodes in the system can easily be expanded to incorporate other devices.

4. CONCLUSION

This paper provides a brief perspective of recent research work done in the field of automation, aimed at household level. Few wireless techniques like the Bluetooth, Infrared, etc are used to develop various home automation systems. Every method has its own pros and cons, but they all prove useful in controlling and switching different home appliances. Home automation models are easy to use, low-cost and most of the times portable. Use of wireless techniques make it more flexible, mobile and user-friendly. Improvements relating power, security, cost, wide range of operability, etc could be aimed in near future.

5. REFERENCES

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