

Smart Home Automation: A Literature Review

Vaishnavi S. Gunge
Walchand Institute of Technology
Solapur

Pratibha S. Yalagi
Walchand Institute of Technology
Solapur

ABSTRACT

Home automation is becoming popular due to its numerous benefits. Home automation refers to the control of home appliances and domestic features by local networking or by remote control. Artificial Intelligence provides us the framework to go real-time decision and automation for Internet of Things (IoT). The work deals with discussion about different intelligent home automation systems and technologies from a various features standpoint. The work focuses on concept of home automation where the monitoring and control operations are facilitating through smart devices installed in residential buildings. Heterogeneous home-automation systems and technologies considered in review with central controller based (Arduino or Raspberry pi), web based, email based, Bluetooth-based, mobile-based, SMS based, ZigBee based, Dual Tone Multi Frequency-based, cloud-based and the Internet with performance.

Keywords

Home-Automation, Intelligence, Microcontroller, Sensor System, User-friendly Interface

1. INTRODUCTION

Automation is a technique, method, or system of operating or controlling a process by electronic devices with reducing human involvement to a minimum. The fundamental of building an automation system for an office or home is increasing day-by-day with numerous benefits. Industrialist and researchers are working to build efficient and affordability automatic systems to monitor and control different machines like lights, fans, AC based on the requirement. Automation makes not only an efficient but also an economical use of the electricity and water and reduces much of the wastage [5].

IoT grant to people and things to be connected Any-time, anyplace, with anyone, ideally using any network and any service [10]. Automation is another important application of IoT technologies. It is the monitoring of the energy consumption and the Controlling the environment in buildings, schools, offices and museums by using different types of sensors and actuators that control lights, temperature, and humidity.

2. HOME AUTOMATION

The Smart home known as House automation, with the use of new technology, to make the domestic activities more convenient, comfortable, secure and economical. The home automation system includes main components which are:

User interface: as a monitor, computer, or Phone, for example, that can give orders to control System.

Mode of transmission: wired connections (example Ethernet) or Wireless (radio waves, infrared, Bluetooth, GSM) etc.

Central Controller: It is hardware interface that communicates with user interface by controlling domestic

services

Electronic devices, a lamp, an AC or a heater, which is compatible with the transmission mode, and connected to the Central control system.

The “Figure 1” shows projected trends in the smart home market in the coming year [10].

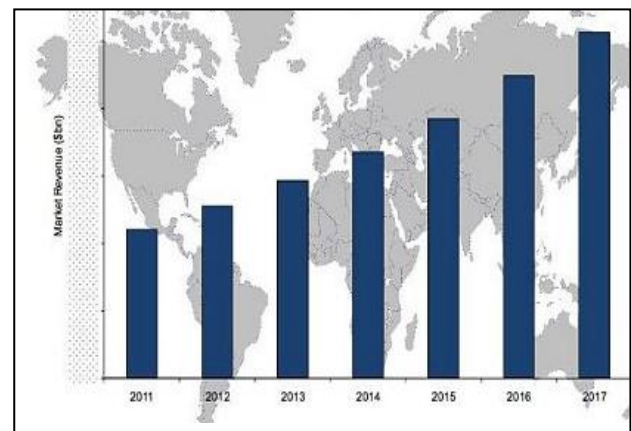


Figure 1: Popularity of Smart home in market

2.1 Features of Home Automation System

In recent years, wireless systems like Remote Control have become more popular in home networking. Also in automation systems, the use of wireless technologies provide several advantages that could not be achieved with the use of a wired network only.

2.1.1 Reduced Installation costs

Installation costs are significantly reduced since no cabling is necessary.

2.1.2 Internet Connectivity

Control devices from anywhere in the world with use mobile phones to control smart home.

2.1.3 Scalable and Expandable

With the Compare of Wireless network is especially useful when, due to New or changed requirements, an extension of the network is necessary.

2.1.4 Security

Easily add devices to create an integrated smart home security system and built-in security ensures integrity of smart home.

2.2 Challenges of Home Automation System

The work of John J. Greichen [12] discussed some of the early challenges faced by home automation systems. These include high manufacturing costs, high development costs, high installation costs, additional service and support costs, lack of home automation standards, consumer unfamiliarity with

technology, and complex user interfaces. With the advancement of time, rapid development in technology and processing power which leads to a considerable reduction in device cost and size. All of these factors have contributed to the popularity of electronic devices today, so people are no longer confused or unsure about the use of the computer, mobiles, or tablets. Moreover, a lot of home automation protocols, communication and interface standards.

3. LITERATURE REVIEW

In this section, discussed different Home Automation System with their technology with features, benefit and limitations they have. “The Figure 2” shows Basic Architecture of Remote Home Automation.

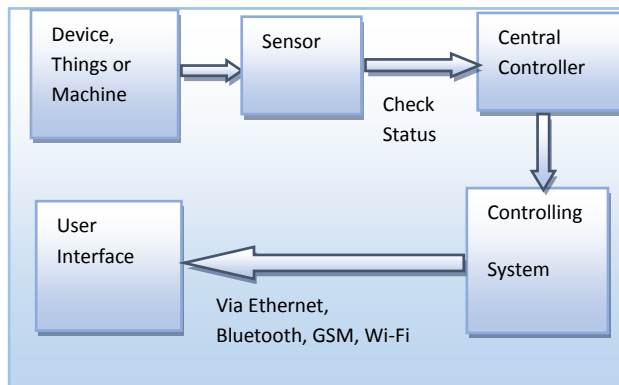


Figure 2: Basic Block Diagram of Home Automation

The Home automation system that uses Wi-Fi technology [1]. System consists of three main components; web server, which presents system core that controls, and monitors users' home and hardware interface module(Arduino PCB (ready-made), Wi-Fi shield PCB, 3 input alarms PCB, and 3 output actuators PCB.), which provides appropriate interface to sensors and actuator of home automation system. The System is better from the scalability and flexibility point of view than the commercially available home automation systems. The User may use the same technology to login to the server web based application. .If server is connected to the internet, so remote users can access server web based application through the internet using compatible web browser.

The application has been developed based on the android system [2]. An interface card has been developed to assure communication between the remote user, server, raspberry pi card and the home Appliances. The application has been installed on an android Smartphone, a web server, and a raspberry pi card to control the shutter of windows. Android application on a smartphone issue command to raspberry pi card. An interface card has been realized to update signals between the actuator sensors and the raspberry pi card.

Cloud-based home appliance monitoring and controlling System. Design and implement a home gateway to collect metadata from home appliances and send to the cloud-based data server to store on HDFS (Hadoop Distributed File System), process them using MapReduce and use to provide a monitoring function to Remote user [3].

It has been implemented with Raspberry Pi through reading the subject of E-mail and the algorithm. Raspberry Pi proves to be a powerful, economic and efficient platform for implementing the smart home automation [4].Raspberry pi based home automation is better than other home automation methods is several ways. For example, in home automation through DTMF (dual tone multi-frequency) [11], the call tariff

is a huge disadvantage, which is not the case in their proposed method. Also, in Web server based home automation, the design of web server and the memory space required is ejected by this method, because it simply uses the already existing web server service provided by G-mail. LEDs were used to indicate the switching action. System is interactive, efficient and flexible.

Shih-Pang Tseng et al. [5] proposed Smart House Monitor & Manager (SHMM), based on the ZigBee, all sensors and actuators are connected by a ZigBee wireless network. They designed a simple smart socket, which can remote control via ZigBee. PC host is used as a data collector and the motion sensing, all sensing data are transferred to the VM in the cloud. The user can use the PC or Android phone to monitor or control through the Internet to power-saving of the house.

Arduino microcontroller to receive user commands to execute through an Ethernet shield. Our house network used together both wireless ZigBee and wired X10 technologies [6]. This system followed smart task scheduling with a heuristic for the Resource-constrained-scheduling problem (RCSP). The mobile device can be either wired to the central controller through USB cable or communicates with it wirelessly, within the scope of the home. Arduino contains the web server application that communicates through the HTTP protocol with Web-based Android application. The system is highly flexible and scalable and expandable.

The home network which monitors the appliances and sensors and transmits data to the cloud-based data server which manages the information and provides services for users by transmitting data and receiving user commands from mobile application [7]. The proposed system has good modularity and configurability characteristics with very low power consumption in cost efficient way.

Application developed using the Android platform controlled and monitored from a remote location using the smart home app and an Arduino Ethernet based micro web-server [8]. The sensors and actuators/relays are directly interfaced to the main controller. Proposed design offers are the control of energy management systems such as lightings, heating, air conditioning, security, fire detection and intrusion detection with siren and email notifications.

Embedded system Raspberry Pi to serve as a communication gateway between mobile devices and Konnex-Bus (KNX) home automation systems [9]. Store the information of all actors and sensors within a Smart Home, instead of using separate profiles. Ensures energy-consumption could be reduced, compared to a standard desktop computer.

Dual tone multi frequency (DTMF) used in telephone lines [13]. There are three components in the system DTMF receiver and ring detector, IO interface unit, PC. The PC detects the ringing of the line and then authenticates the user and use the keypad tones to control the devices as required. An example of stepper motor control is taken up. This system has the advantage of being secure and allowing international standardization. This is because the DTMF tones are the same all over the world. But it suffers from the drawback that the number of appliances is limited by the number of keys in the keypad.

PIC16F887 microcontroller for home appliances controls with GSM for control of the appliances. [14]. It has high availability, coverage and security but the cost of SMS. AT commands can be sent through the GSM network to controls the home devices. The system does not does not have any

state information related to the devices and expects the user to keep track of it.

Arduino board is the controller used to control the appliances by using GSM technology. It uses certain peripheral drivers and relays to achieve this interfacing. The application on smartphone generates SMS messages based on the user commands and sends it to the GSM modem attached to the Arduino and control the home appliances [15]. The system has drawbacks of cost and reliability of SMS. An interface cannot be customized based on devices.

It has been designed Arduino board with Bluetooth board were developed for home automation [16]. Python program is used on the cell phone to provide the user interface. The Bluetooth board has I/O ports and relays are used for interfacing with the devices which are to be controlled and monitor. The Bluetooth is password protected to ensure that the system is secure from intruders. The Bluetooth has a range of 10 to 100.

3.1 Compassion of System

Discussed Comparison of Different Home Automation Systems by considering its Central Microcontroller, Communication interface, User interface, provided features and their benefits as shown in “Table 1”.

3.2 Evolution of System

3.2.1 Raspberry Pi

It is a credit-card-sized single microcontroller computer. Python as the main programming language. It is easy to learn and suitable for real world applications [4]. There are two main types of pi first one is Model A has 25 6Mb RAM, one USB port and no network connection and Model B has 5

12Mb RAM, 2 USB ports and an Ethernet port. It has a Broadcom BCM2835 system on a chip which includes an ARM1176JZF -S 700 MHz processor, Video Core IV GPU, and an SD card. The chip specifically provides HDMI and there is no VGA support. Arduino can successfully work with Raspberry Pi Computers.

3.2.2 Arduino

It is a microcontroller board, not fully computers. In this, written codes are simply executed without any obstacle. It is an 8 bit Atmel AVR Microcontroller which comprises of 32K and 512K of onboard flash memory, 2K of RAM, runs at 8-84MHz clock speeds with voltages of 2.7V-12V. programming is done using C and carries no operating system. The code is written in the computer and then sent through USB cable for execution. Its construction simply covers digital input-output pins that are between 9-54 AND 6-12 analog input pins. Its power consumption is less than 0.5 watt.

4. CONCLUSIONS

Based on surveyed study the comparison of home automation systems are presented. Microcontroller, user interface, a communication interface and their performance factor are compared. There are a number of do-it-yourself (DIY) platforms available that allow to create Home Automation system quickly and easily with low cost and high performance e.g. Raspberry pi, Arduino, other microcontrollers, etc. In this review explained different home automation system e.g. Web based, email based, Bluetooth-based, mobile-based, SMS based, ZigBee-based, Dual Tone Multi Frequency-based, cloud-based and Internet based. In future home automation will more smart and fast. It would be extended to the large-scale environment such as colleges, offices and factories etc.

Table 1. Comparison

Sr No.	System	Communication Interface	Controller	User Interface	Applications	Benefits
1.	Wi-Fi based using Arduino Microcontroller	Wireless LAN and Wi-Fi shield	Hardware interface module	web based Application.	Temperature and humidity, Motion detection, Fire detection, Door status, Light level ,Video monitoring, Controlling appliances	Low cost, Secure, Ubiquitously accessible, Auto-configurable, Remotely controlled
2.	Web service and android app Based using Raspberry pi	Web server and interface card	Raspberry pi	Android application	Controlling shutter of window	Autonomous, and Quite scalable
3.	Cloud Based Using Hadoop System	Cloud based data server uses Hadoop Technology	Home gateway and Router	Smart device	Monitoring and Controlling Home Appliances	Effectively manage Semi structured and unstructured data, Reduce computational burden of smart devices
4.	Email Based using Raspberry pi	Internet Modem	Raspberry pi	E-mail	Switching LED	Smart, Economic and Efficient

5.	Cloud Based Using Zig Bee Microcontroller	Zig bee wireless Network	Smart Socket	PC or Android Phone	entrance control management, monitoring the power consumption, temperature and humidity	Convenience, safety, and Power-saving
6.	Smart Task Scheduling Based using Arduino and Android	Wired X10 and Wireless Zig bee	Arduino	Android Application	Energy Management and task scheduling with power and cost	Energy-efficient and Highly scalable
7.	Wireless Sensors Based with mobile Technology	cloud-based data server	PCB circuits	Mobile Application	monitor the home conditions and power consumption of appliance	Low power consumption And system cost efficiency.
8.	Android based using Arduino	Micro Web Server	Arduino Mega 2560 and the Arduino Ethernet shield	Android App	Light switches, Temperature ,Humidity sensors, Intrusion detection,, Smoke/Gas sensor	Feasibility and Effectiveness
9.	Konnex-Bus based using raspberry pi	SIP Provider	Raspberry pi and Konnex Bus	Mobile App	Lights Control, Temperature Monitoring	Performance improved ,energy-consumption could be Reduced.
10.	By Using DTMF	DTMF Receiver	Logical Controller with I/O interface	Computer	Authentication of user by ringing line	Secure and allow International Standard
11.	GSM Based Using PIC Microcontroller	SMS	PIC16F887 microcontroller	Mobile phone	Control appliances	High availability, coverage and Security but costs for the SMS.
12.	GSM Based Using Arduino	SMS	Arduino	Smartphone App	Control appliances	Simplicity
13.	Bluetooth Based using Arduino	Bluetooth	Arduino	Python supported mobile	controlling	Secured and Low cost

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