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Design and Implementation of Smart Home Automation System for Elderly and Disabled People

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ABSTRACT: Home automation is presently a new invention in the field of engineering and technology. The goal of this automation is controlling the house elements lights, fans, air conditioner in order to save energy and raise the quality of living. In this project in order to make life easier some smart home applications were designed. This paper presents a design and prototype implementation of new home automation system that uses Wi-Fi technology as a network infrastructure connecting its parts. With the help of a web server and a LAN connection, the system provides a scalable and a wide range coverable device. Wireless Home Automation system is a system that uses mobile devices to control basic home functions and features automatically through internet from anywhere around the world,. It is meant to save the electric power and human energy. The home automation system differs from other system by allowing the user to operate the system from anywhere around the world through internet connection. The system is highly advanced as it uses a cheaper Wi-Fi connection and a server that can store data. Users and system administrator can remotely (internet) manages and control system code. Thus, a highly automated system is available to the user. The system is secured as the user has to enter password and that is not known to any intruders.

KEYWORDS: Smart Home Automation, Arduino platform, GSM module, Wi-Fi-network.

I. INTRODUCTION

Home automation system existed for decades but due to its high cost, it remains as a niche product for the high end consumers. Due to the rapid development in electronics technologies and their integration with traditional building industry, the concept of smart or intelligent home automation system has been adopted by researchers and lifestyle practitioners.

Home automation provides a total control of lighting, heating, ventilations, air conditioning appliances, curtains, security locks of doors and other systems by using codes on your smart phone. The primary objective of this project is to design and implement cost effective but yet flexible, adaptable and secure Home automation system for elderly and physically challenged persons. The main objective of Home Automation is to help physically challenged persons and Senior citizens to enable & control the home appliances and raise an alarm in critical emergency situations. This system support wide range of security, multimedia applications, and telecommunication device. Home automation systems are generally separated into two categories: Locally controlled systems and remotely controlled systems. Locally controlled systems comprises of an In-house controller to achieve home automation. It allows users the complete coverage of their automation system from within their home via a stationary or wireless interface. Remotely controlled systems use an Internet connection or Integration with an existing home security system to allow the user complete control of the system linked appliances from their Mobile device.

A. PROBLEM STATEMENTS

Many people are always on the move from place to place due to business demands. Some

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people can spend a couple of days away from their home leaving all their household appliances without any kind of monitoring and control. Some devices are left plugged into power sockets whereas others are supposed to be plugged into and out of power sockets at different intervals depending on the time of the day. All this requires an individual to manually attend to each of the devices independently from time to time. All such monitoring and control can be done without necessarily being around or inside the home. Some devices if not controlled properly consume a lot of energy which leads to extra expenditure on electricity. Therefore, in this paper; it presented the design an implementation of internet based home automation system which will enable one to remotely manage his/her appliances from anywhere round the globe, anytime.

II. LITERATURE REVIEW

As per the survey no system is at cheaper rates. There are various systems which are hard to install, difficult to use and maintain.

Anindya Maiti(2012) has introduced design and implementation of home automation as a service. It conveys the home automation as a service based on cloud computing, which assist in shrinking residential computing workload.

Basil Hameed (2012) designed and implemented a control and monitor system for smart house. Smart house system consists of many systems that controlled by Lab VIEW software as the main controlling system. Also, the smart house system was supported by remote control system as a sub-controlling system. The system also is connected to the internet to monitor and control the house equipment's from anywhere in the world using Lab VIEW.

Deepali et al., (2013) developed a system to assist physically challenged and old aged people. It gives basic idea of how to control various home appliances and provide a security using Android phone. The design consists of Android phone with home automation application, Arduino Mega ADK. User can interact with the android phone and send control signal to the Arduino ADK which in turn will control other embedded devices/sensors.

Basma et al., (2013) proposed a new design for the smart home using the wireless sensor network and the biometric technologies. The proposed system employs the biometric in the authentication for home entrance which enhances home security as well as easiness of home entering process. The structure of the system is described and the incorporated communications are analyzed, also an estimation for the whole system cost is given which is something lacking in a lot of other smart home designs offers. WB-SH is designed to be capable of incorporating in a building automation system and it can be applied to offices, clinics, and other places. The paper ends with an imagination for the future of the smart home when employs the biometric technology in a larger and more comprehensive form. The paper ends with an imagination for the future of the smart home when employs the biometric technology in a larger and more comprehensive form.

Panwar et al. (2017) implemented the Eyrie smart home automation system using the Raspberry Pi 3 MCU as the central hub. Their proposed architecture connected several Arduino Nano boards located around the house to various types of sensors and NRF24L trans-receivers that eliminated the need for Ethernet or Wi-Fi connectivity. Mosquito Broker, an open-source message broker used for relaying messages to the Raspberry Pi 3, operates using the Debian OS. Eclipse SmartHome framework was used to implement a web interface and a smartphone app for end-users.

In Baraka et al. (2013)a home automation system with smart task scheduling is developed making use of wireless ZigBee to connect appliances and wired X10 technology to connect light and switch modules to an Arduino microcontroller. An Ethernet shield mounted on the Arduino MCU allows communication between Arduino and a web-based Android application which is then used to remotely add and manage devices and view recommended scheduling.

ShariqSuhail et al. (2016)implemented a prototype for smart home security system that uses PIR sensors for intrusion detection, MQ2 sensors for detecting smoke and gas leaks, LM35 temperature sensors as input to an Arduino Mega 2560. A buzzer, LCD, LED strip and a Global System for Mobile communication (GSM) module are outputs to this MCU board while a Raspberry Pi 2 board is used to include a webcam that captures images upon motion detection. GSM, a wireless technology interfaces with the Arduino Mega to send SMS notifications and calls to the user's cell phone whenever potential intrusion, smoke or gas leak is detected.

Piyare et al. (2011) present a Bluetooth-based home automation system where an Android cell phone running a Python script communicates with an Arduino BT board with digital and analog input/output ports to which sensors and appliances are connected. The smartphone application has a

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toggle on and off feature for each device. However, Bluetooth connectivity between the smartphone and the Arduino BT board required a range of 50 m or less within a concrete building and mobile platforms other than Symbian do not support the Python application.

Gunputh et al. (2017) a similar architecture utilizes an Arduino Mega 2560 board with a Wi-Fi module to implement a voicecontrolled smart home system. The Elechouse V3 voice recognition module allows users to send voice commands to adjust lighting, open or close windows and control a folding bed.

Vineeth's et al. (2017)voice-controlled secure e-Home also make use of the V3 voice recognition module but use an RF module instead of Wi-Fi for wireless communication between an Arduino UNO and Raspberry Pi MCUs. The Raspberry Pi supports sensor connectivity to the Internet so all sensory data can be logged onto a Google spreadsheet. There is no implementation of a mobile or web app thus confining the controlling of this system to the location of the mic

Sunehra et al. (2016) propose two schemes for a speech-based home automation system. The first scheme uses HC-05 Bluetooth module along with Arduino Bluetooth controller mobile application to control appliances when inside the house. GSM/GPRS technology is used to remotely control appliances and receive SMS alerts for possible intrusion detections. The ARM11 Raspberry Pi board acts as the central hub for receiving voice commands though the HC-05 Bluetooth module and connects to a PIR sensor, relays, a Wi-Fi router and a webcam.

Howedi et al. (2017)proposed a low-cost smart home system built upon a similar architecture using the Arduino Uno board, PIR sensors, DHT11 temperature sensors, INA219 high side DC current sensor and servo motors that control doors and windows. The Arduino IDE is used to implement the control and monitoring module of the system while the MIT App Inventor is used to develop a simple Android application.

III. MATERIALS AND METHODOLOGY

The design involves both hardware and software. The hardware was implemented using modular design method while the software developed using embedded C language.

Hardware Requirements

The following hardware devices and sensors are used to build the proposed system:

- Arduino UNO
- Servomotor
- Stepper Motor
- Light Dependent Resister (LDR)
- Power Relay Board
- DC Motor
- Capacitor
- GSM Module

I. **Arduino UNO** is a microcontroller with Microchip ATmega328P based upon open source technology. It works as a control board and contains different set of pins for connecting other boards or devices with Arduino. Board contain 6 analog and 14 digital pins and programmed by using Arduino integrated development environment. Inbuilt WIFI facility is available on board for connecting with internet. In our system, all the sensors are integrated over Arduino that sense the data. Arduino transfer the data over ThingSpeak that offers realtime updates for user via mobile application or web interface.

Fig.1: AT Mega 328 microcontroller

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II. **Power Relay Board**: The most useful thing that can do with Arduino is to control voltage of appliances like light, fans, heaters, AC and others. Arduino operates at 5V and can't control voltage directly but can be done by using 5V relay to switch 120-240V. Some relays use electromagnet to operate automatically the switch nonetheless others use solid state relays.

III. **Stepper Motor**: Stepper motor is used to control curtain in automatic manner. It enables the automatic opening and closing of curtains according to specific times like morning or evening plus manual control is possible via mobile application. Servomotor can also be used for curtain control but it cannot move the curtains with exact torque.

IV. **Light Dependent Resister (LDR)**: LDR is often used in circuits where it's important to identify the existence of light level. In this research paper, we are using LDR to automate the light to control the switches and checking the present condition of appliances.

V. **Capacitor**: Capacitors are used in the project to blocking direct current from the GSM Module andallow alternating signal to pass into the system. It is also used for filtration and smoothing of unwanted A.C ripples in the power supply unit. A capacitor is a passive component consists of a pair of conductors separated by a dielectric (insulator). When there is a potential difference (voltage) across the conductors, a static electric field develops across the dielectric, causing positive charge to collect on one plate and negative charge on the other plate.

Fig. 2: Capacitor

VI. **GSM Shield:** The GSM shield makes the system is able to send and receive short text messages, make voice calls and connect to the Internet. Shields of this kind could stand upon the microcontroller platform, but they must be compatible. Two basics connections of this shield are TX and RX pins, which allow the microcontroller to connect with the GSM shield sending serial data. GSM operates with a SIM card. The SIM requires a subscription, with a mobile communication provider. Based on this, the user can get access to the mobile network. The UART (Universal Asynchronous Receiver Transmitter) Interface codes and decodes data between the parallel and serial formats. It takes bytes of data and transmits them in a sequence of bits. Thus, the data can be sent, in a serial mode, through TX to the microcontroller orthrough an antenna to the network.

VII. **Remote Control Unit:** Various technologies are offered by the e-home community and presented by the manufacturers starting from peculiar software installed on PC or Laptops to dedicated applications on mobile phones, android devices, and i-devices; from touch screen, keypad to apparatus supported by buttons and switches. In fact, the disabled people could find devices with touch screen control panel confusing and difficult to use. Therefore, they prefer a simpler remote control using laser-engraved backlit buttons, some switches, and equipped witha LCD screen to display necessary notifications.To each command button is associated a warning LED light that visualizes the situation status of the corresponding appliance. All operations are governed by a microcontroller where the EEPROM memory gives the opportunity to lock the remote by means of pass code stored in its memory.

VIII. **Master Control Board:** As previously mentioned, the proposed home is assumedto have pre-existing wiring which allows the user to use one master control board. Nevertheless, multiple master boards could be configured in order to group the variety of appliances according to location or types. However, the master control board is based on microcontroller interfaced with XBee transceiver module to ensure full communication between the remote control and its base. The microcontroller pins are connected to relays and sensors where the configurations of the On/Off functionality of the demanded appliances are performed according to conditions specified by input sensors.

IX. **Electronic Circuits:** The realized prototype is designed to control 8 different appliances:

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home lights, garden lights, HVAC system, entrance lock door, security system, emergency system, heater, and houseplant watering. However, the system can be extended for larger number of operations. The relays (Figure 1) are considerably adopted to let the low power control signal generated by the microcontroller operate high power devices. The diode connected in reverse bias mode aims to protect the transistor against inductive loads that can damage it due to their back electro-motive force. Moreover, relays can be replaced by Triac that can be suitably applied to control AC power elements such as motor speed control, light dimmers, and temperature control.

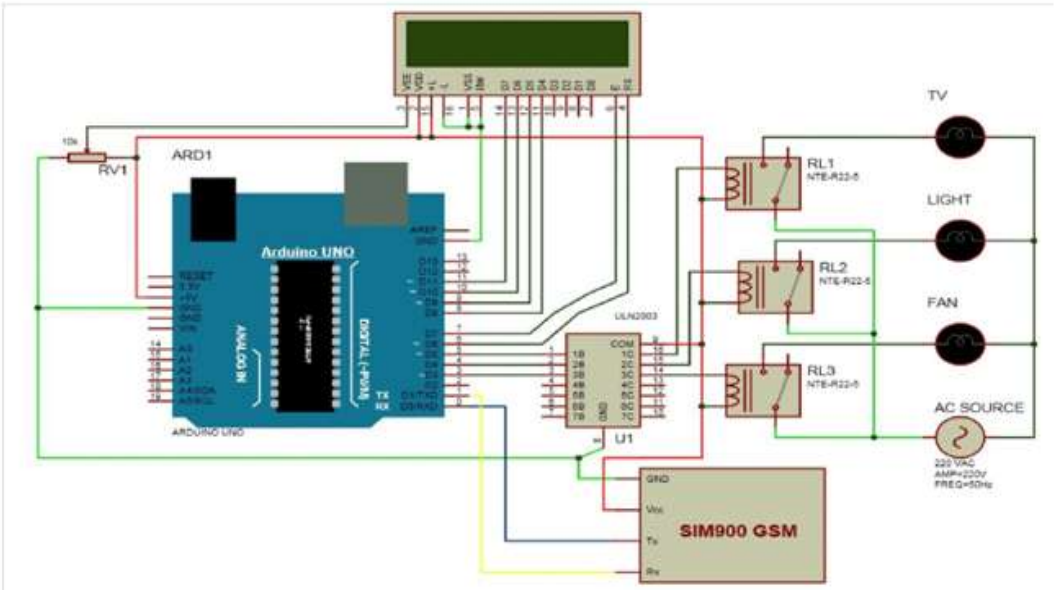

Fig. 3: Circuit Design

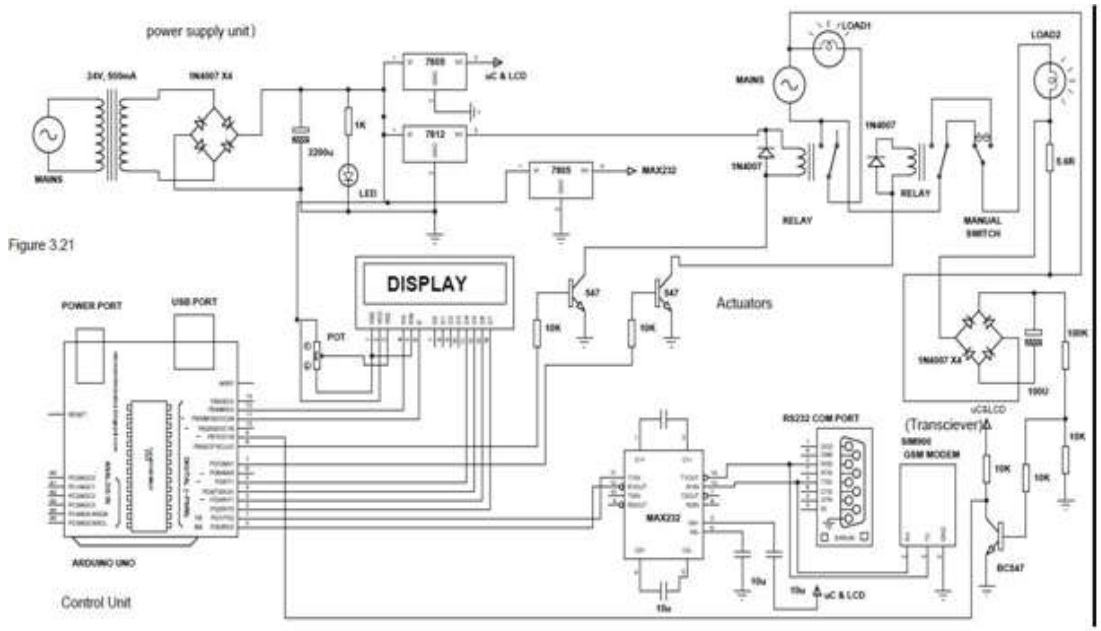

Figure 3.21

Fig. 4: System Circuit Diagram and its operations

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When the system is powered, the regulated 5V and 12V supply power to the microcontroller, MAX232 IC, relay and LCD. The, written program initialized LCD. When SMS (LL1) message is sent as a command via mobile phone to the GSM modem, the GSM modem on receiving the signal through its antenna also sends a signal to the microcontroller. The MAX232 IC that links the GSM modem with Microcontroller is used as a dual converter to convert the RS232 signal (-15V) from the modem to TTL signal (5V) that the microcontroller operates with and vice versa The microcontroller on receiving this signal interprets, process and sends a command signals via pin 7 and pin 8 to the transistor respectively which triggers the relay to switches ON any load connected to the pin. The system then sends a feedback message indicating the status of the load to the user via the GSM modem. Furthermore, when SMS (LL0) message is sent as a command via mobile phone to the GSM modem, the GSM modem on receiving the signal through its antenna also sends a signal to the microcontroller. The microcontroller on receiving this signal interprets process and sends a command signals via pin 7 and pin 8 to the transistor respectively which triggers the relay to switches OFF any load connected to the pin. The system then sends a feedback message indicating the status of the load to the user via the GSM modem. The system circuit diagram is shown in fig.9

b) Servomotor: A servomotor is designed to control the positioning of specific devices. It is integrated with sensor to direct the actuator to precisely control the linear or angular position, acceleration and velocity. It belongs to special class of motors that are used to build the closed loop control systems. It's widely used in automated systems, CNC systems and robotics. In this system, it is implemented on doors and windows to lock and control the movement through Arduino.

Fig. 5: Relay Box

X. **GSM Module:**A GSM modem is a wireless modem that works with a GSM wireless network. A wireless modem behaves like a dial-up modem. The main difference between them is that a dial-up modem sends and receives data through a fixed telephone line while a wireless modem sends and receives data through radio waves. Like a GSM mobile phone, a GSM modem requires a SIM card from a wireless carrier in order to operate.

Computers use AT commands to control modems. Both GSM modems and dial-up modems support a common set of standard AT commands. GSM modem can be used just like a dial-up modem. In addition to the standard AT commands, GSM modems support an extended set of AT commands. These extended AT commands are defined in the GSM standards. With the extended AT commands, various things can be done:

- Sending SMS messages.
- Monitoring the signal strength.
- Monitoring the charging status and charge level of the battery.
- Reading, writing and searching phone book entries.
- Reading, writing and deleting SMS messages.

Fig. 6: GSM Module

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Fig. 7: Complete Construction of the project

IV. RESULTS

The construction of this project was done on a Vero board. It is a widely-used type of electronics prototyping board characterized by a 0.1 inch (2.54 mm) regular (rectangular) grid of holes, with wide parallel strips of copper cladding running in one direction all the way across one side of the board. In using the board, breaks are made in the tracks, usually around holes, to divide the strips into multiple electrical nodes. With care, it is possible to break between holes to allow for the components that have two pin rows only one position apart such as twin row headers for ICs.

V. CONCLUSION

There has been a tremendous growth in the home automation field, and many reputed companies are utilizing their opportunity to work and deliver an elegant way to connect families to their homes. Consumers are looking to secure their home environment in today's unpredictable world, and the new Home automation system gives them the peace of mind that they need to protect their family's well-being.

This project is about wireless home automation using Android mobile helps us to implement such a fantastic system in our home at a very reasonable price using cost-effective devices. Thus, it overcomes many problems like costs, inflexibility, security etc. In addition, will provide greater advantages like it decrease our energy costs, it improves home security. In addition, it is very convenient to use and will improve the comfort of our home.

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