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HOME AUTOMATION USING ARDUINO

Sable Shivam Sudhir¹, Pawase Sudershan Gorakshnath², Dhomase Akash Bhausaheb³, Gaikwad R.S⁴

Student, ETC department, Amrutvahini Polytechnic Sangamner, Sangamner, India¹

Student, ETC department, Amrutvahini Polytechnic Sangamner, Sangamner, India²

Student, ETC department, Amrutvahini Polytechnic Sangamner, Sangamner, India³

Assistant Professor, ETC department, Amrutvahini Polytechnic Sangamner, India⁴

sableshivamg@gmail.com ¹, sudarshanpawase499@gmail.com ², akashdhome123@gmail.com ³

Abstract: In today's world Automatic systems are being preferred over manual systems. The rapid increase in the number of users of internet over the past decade has made Internet a part and parcel of lives. The Internet of Things (IoT) is the inter-networking of physical devices, vehicles, buildings, and other items that is embedded with electronics, software, sensors, actuators, and network connectivity that enable the devices to collect and exchange data. IoT is the latest and emerging internet technology and is a growing network of everyday object from industrial machine to consumer goods that can share information and complete tasks from a remote location. Wireless Home Automation system (WHAS) using IoT is a system that uses computers or mobile devices to monitor basic home functions and these functions can be controlled through the internet from anywhere around the world. An automated home is called as a smart home. It is meant to save the electric power and human energy.

Keywords: Internet of things (IoT), Wireless Home Automation system(WHAS) Cloud networking ,Wi-Fi, Arduino mega 2560, Transceiver ESP8266,Relay and Sensors.

I INTRODUCTION

An automated home called as the smart home is designed to control various electrical appliances from a remote location. Many existing well-established home automation systems are based on wired communication. This does not pose a problem until the system is planned well in advance and installed during the physical construction of the building. But for already existing buildings the implementation cost goes very high. In contrast wireless systems can be of great help for automation systems.

In this paper a Home Automation system using Intel Galileo is proposed that integrates cloud computing and wireless communication to provide the user with remote control of various lights, fans, and appliances within their home and storing the data in the cloud. The system will automatically change on the basis of data from the sensors. This system is designed to be low cost and expandable allowing a variety of devices to be controlled. The system is implemented with Arduino mega 2560, Wi-Fi transceiver ESP8266, relay and sensors. The transceiver is used for communication between the base station and cloud storage.

In some of the other home automation systems as mentioned in paper [1] systems are designed, implemented, controlled and monitored for a smart home. It consists of many systems that are controlled by LabVIEW software as the main controlling system. Also the smart house systems are supported by remote control system as a sub controlling system.

In paper [2] a Home Automation system that employs the integration of multi-touch mobile devices, cloud networking, wireless communication, and power-line communication is proposed to provide the user with remote control of various lights and appliances within their home. This system uses a consolidation of a mobile phone application, handheld wireless remote, and PC based program to provide a means of user interface to the consumer.

The prime objective of paper [3] is to assist handicapped/old aged people. It gives basic idea of how to control various home appliances and provide a security using Android phone/tab. The design consists of Android phone with home automation application, Arduino Mega ADK. The user can interact with the android phone and send control signal to the Arduino ADK which in turn will control other embedded devices/sensors.

The paper [4] proposes a new design for the smart home using the wireless sensor network and biometric technologies. The proposed system employs the biometric 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 estimation for the whole system cost is given which lacks in a lot of other smart home designs offers. The paper is concluded with an imagination for the future of the smart home which employs the biometric technology in a larger and more comprehensive form.

The proposed system is a distributed home automation system that consists of sensors, server controls and it monitors the various sensors. It can be easily configured to handle more hardware interface module (sensors). The Arduino mega development board has a built in Wi-Fi card port to which the card is inserted and it acts as webserver. Automation system can be accessed from the web browser of any local PC in the same LAN using server IP, or remotely from any PC or mobile handheld device connected to the internet with appropriate web browser through server real IP. Wi-Fi technology is selected to be the network infrastructure that connects server and the sensors. Wi-Fi 33 is chosen to improve system security (by using secure Wi-Fi connection) and to increase system mobility and scalability.

The paper is organized as follows: The system connectivity is shown in section II. In section III and IV the hardware and software description is provided. The implementation is presented in section V. The results are presented in section VI and the conclusion is summarized in section VII.

II SYSTEM CONNECTIVITY

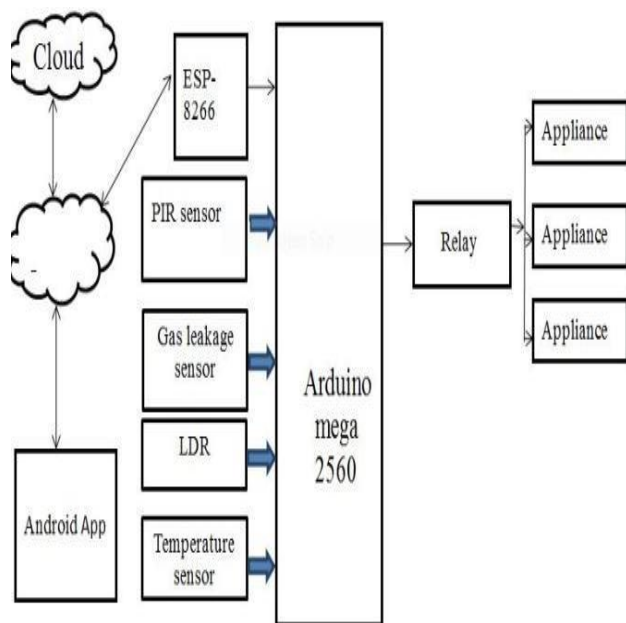


Figure 1 System Connectivity

The Fig.1 gives a brief idea about how the mobile application is connected to the base station and the cloud storage system and the details of the connectivity. It also gives a brief description of how the overall communication happens between the application and the base station system. The system is implemented with Arduino mega 2560, transceiver ESP8266, temperature sensor, gas leakage sensor, Pyro Infrared sensor (PIR), LDR and relays. When the connection is established the Arduino mega reads the parameters of the sensors. The threshold levels for the required sensors are set and the sensor data are sent to the web server and stored in the cloud. The data can be analyzed from anywhere at anytime. If the sensor parameters are greater than the threshold level then the respective alarms will be raised and the required actuation is done for the controlling of the parameters.

The Arduino Mega is a microcontroller board based on the ATmega1280. PIR sensors are used to sense motion and are used to detect whether a human has moved in or out of the sensor range. They are often referred as PIR, “Passive Infrared”, “Pyro electric” or “IR motion” sensors.

The ESP8266 Wi-Fi Module is self-contained Silicon on Chip (SOC) with integrated TCP/IP protocol stack that gives the microcontroller access to the Wi-Fi_33 network. A photoresistor or light-dependent resistor LDR, or photoconductive cell is a light-controlled variable resistor. The resistance of a photo resistor decreases with increasing incident light intensity.

The LM35 series are precision integrated circuit temperature sensing device with an output voltage linearly proportional to the centigrade temperature. The analog smoke/LPG/CO gas sensor MQ2 module utilizes an MQ2 as the sensitive component and has a protection resistor and an adjustable resistor on board.

III HARDWARE SPECIFICATION

A) ARDUINO Mega:

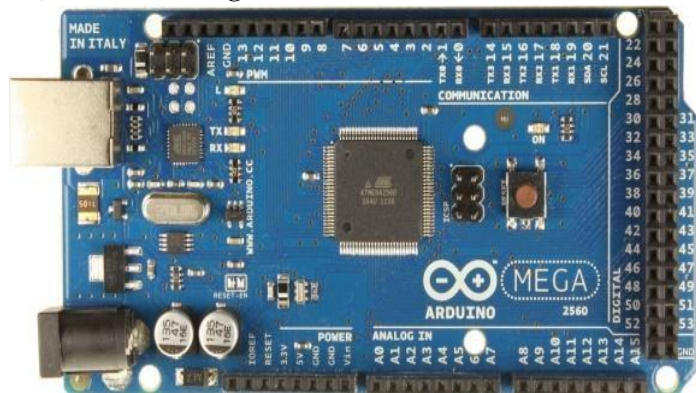


Figure 2 Arduino Mega 2560 board

The Arduino Mega is a microcontroller board based on the ATmega1280. The Mega 2560 board as shown in Fig 2 can be programmed with the Arduino Software (IDE). It has

54 digital input/output pins of which 14 can be used as PWM outputs, 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller. The Arduino Mega can be powered via the USB connection or with an external power supply.

B) ESP8266:

The ESP8266 is capable of either hosting an application or offloading all Wi-Fi networking functions from another application processor. Each ESP8266 module comes with a pre-programmed AT command set firmware and can hook this up to the Arduino device and get about as much WiFi-ability as a WiFi Shield offers. The ESP8266 module shown in Fig 3 is an extremely cost effective board with a huge ever growing community. This module has a powerful on-board processing and storage capability that allows it to be integrated with the sensors and other application specific devices through its GPIOs with minimal development up-front and minimal loading during runtime. Its high degree of on-chip integration allows for minimal external circuitry, including the front-end module, is designed to occupy minimal PCB area. The ESP8266 supports APSD for VoIP applications and Bluetooth co-existence interfaces; it contains a self-calibrated RF allowing it to work under all operating conditions, and requires no external RF parts.



Figure 3 ESP8266 Wi-Fi module

Some of the features of ESP8266 are:

- Wi-Fi Direct (P2P), soft-AP
- Integrated TCP/IP protocol stack
- Integrated TR switch, balun, LNA, power amplifier and matching network
- Integrated PLLs, regulators, DCXO and power management units
- +19.5dBm output power in 802.11b mode
- Power down leakage current of <10uA
- 1MB Flash Memory
- Integrated low power 32-bit CPU could be used as application processor
- SDIO 1.1 / 2.0, SPI, UART
- STBC, 1x1 MIMO, 2x1 MIMO

- A-MPDU & A-MSDU aggregation & 0.4ms guard interval
- Wake up and transmit packets in < 2ms
- Standby power consumption of < 1.0mW (DTIM3)

C) PIR SENSOR:



Figure 4 PIR Sensor

PIR sensors are used to sense motion and detects whether a human has moved in or out of the sensor range. They are small, inexpensive, low power, easy to use device. Some of its features are:

- Sensitivity range: Upto 20 feet (6 meters) 110° x 70° detection range
- Output: Digital pulse high (3V) when triggered (motion detected) digital low when idle (no motion detected). Pulse lengths are determined by resistors and capacitors on the PCB and differ from sensor to sensor.
- Power supply: 5V-12V input voltage

C) LDR SENSOR:

A light-dependent resistor (LDR) is a light- controlled variable resistor. The resistance of a photoresistor decreases with increasing incident light intensity; in other words, it exhibits photoconductivity.

D) TEMPERATURE SENSOR

The LM35 series are precision integrated circuit temperature device with an output voltage linearly proportional to the centigrade temperature and it is suitable for remote location. The LM35 device has an advantage over linear temperature sensors calibrated in kelvin, as the user is not required to subtract a large constant voltage from the output to obtain convenient centigrade scaling. The LM35 device does not require external calibration or trimming to provide typical accuracies of +/- 1/4 degree celsius at room temperature and +/- 3/4 degree celsius over a full -55 degree celsius to 150 degree celsius temperature range.

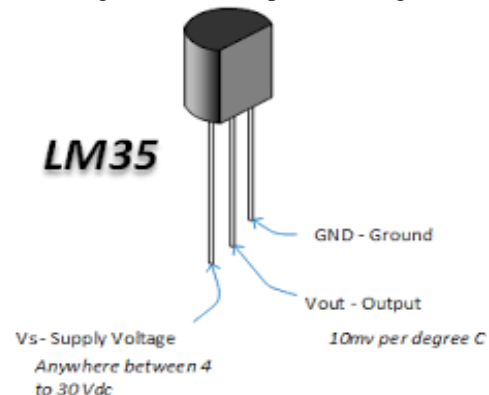


Figure 5 LM35 Integrated Circuit

E) GAS LEAKAGE SENSOR:



Figure 6 MQ-2 Gas Sensor

In current technology scenario monitoring of emission of gases produced is very important. From home appliances such as air conditioners to electric chimneys and safety systems in industries, monitoring of emission of gases are very crucial. The analog smoke/LPG/CO gas sensor-MQ2 module shown in Fig. 6 utilizes an MQ2 as the sensitive component and has a protection resistor and an adjustable resistor on board. It has higher sensitivity and gives a faster response. The sensor output voltage is proportional to the concentration of smoke/gas.

In other words, the relationship between voltage and gas concentration is as follows:

- The greater the gas concentration, the greater the output voltage
- The lower the gas concentration, the lower the output voltage

IV SOFTWARE SPECIFICATION

A) MIT APP CREATOR

MIT App Inventor is an innovative beginner's introduction to programming and app creation that transforms the complex language of text-based coding into visual drag-and-drop building blocks. The simple graphical interface grants even an inexperienced novice the ability to create a basic, fully functional app within an hour or less.



Figure 7 Building the app (Front end design)

The Fig. 7 and Fig.8 represent the front end design and back end design of the application building interface.

This helps to design applications without usage of any coding language and it helps to design applications with the help of drag and drop blocks. These blocks are predefined with certain instructions and by using these blocks the application can be performed quicker.

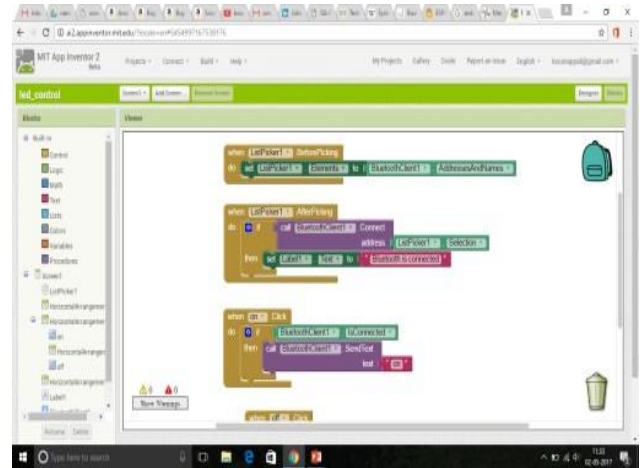


Figure 8 Building the app (Back end design)

B) THINGSPEAK AND ARDUINO SOFTWARE:

ThingSpeak is an Internet of Things (IoT) platform that collects and stores sensor data in the cloud and develop IoT applications. The ThingSpeak IoT platform provides apps that can be used to analyze and visualize the data in MATLAB and then act on the data. Sensor data can be sent to ThingSpeak from Arduino, Raspberry Pi, BeagleBone Black, and other hardware.

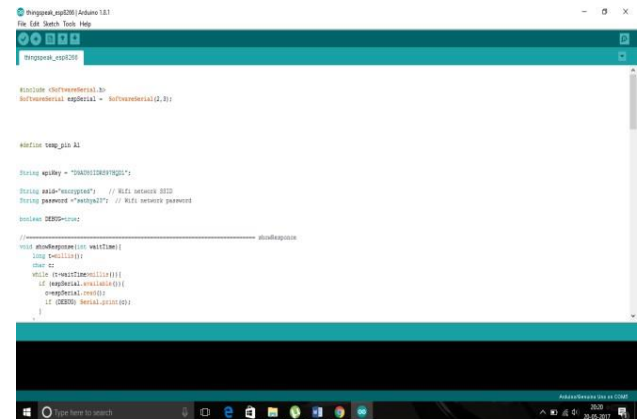


Figure 9 Thingspeak Platform

So this is used to store the data in the channel uploaded by the application and Arduino.

V IMPLEMENTATION

A model house is built for the home automation system and is as shown in the Fig. 1. At the door of the house a motion sensor is fixed to detect any movement near the door. Light 1 will turn on automatically when light sensor detects the darkness. A cooler/Fan will turn on when the room temperature exceeds the set threshold and in turn reduces the room temperature. The gas sensor MQ-2 is placed

in the kitchen to detect any gas leakage, if any leakage is detected the alarm in the hall is raised. Relay is used to switch the electrical appliances like light, fan etc. The Arduino mega 2560 is placed in store room or garage. The Arduino mega 2560 is connected with WiFi card and with the antennas for the connectivity with internet.

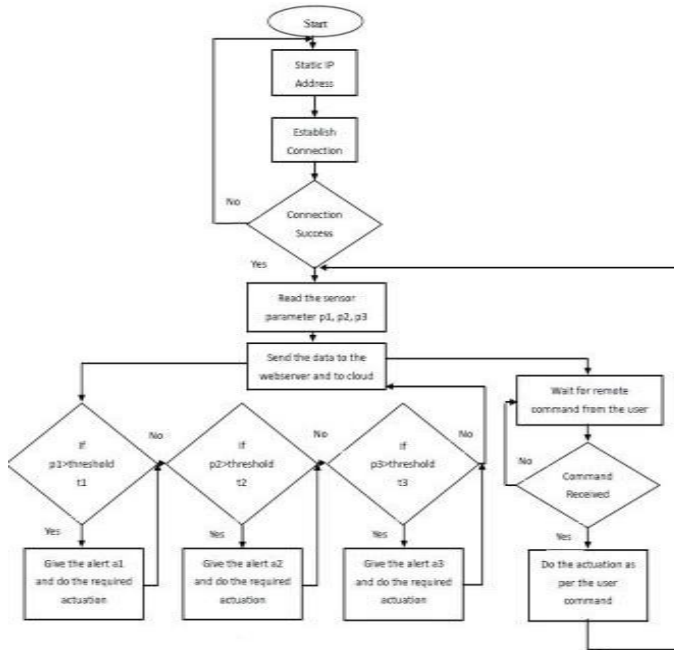


Figure 10 Data flow diagram

Fig. 10 illustrates the sequence of activities in the wireless home automation system. When the connection is established, the microcontroller will start reading the parameters of sensors like p1, p2, p3 etc. The threshold levels for the required sensors are set as t1, t2, t3. The sensor data are sent to the web server and stored in the cloud. The data can be analyzed anywhere any time. If the sensor parameters are greater than the threshold level then the respective alarm a1, a2 and a3 will be raised and the required actuation is done for the controlling of the parameters.

VI RESULTS

After securing the connection to the server, the data from the sensor is sent to the web server for monitoring of the system. The web server page will monitor and control the system. By entering the assigned IP address in the web browser the web server page will appear. The web server gives the information about the temperature in different places of the house and the state of motion in the house. It also gives the status of the various electrical appliances like light, fan etc. which can be controlled remotely.

VII CONCLUSION

The home automation using Internet of Things has been experimentally proven to work satisfactorily by

connecting simple appliances to it and the appliances are successfully controlled remotely through the internet. The designed system not only monitors the sensor data, like temperature, gas, light, motion sensors, but also actuates a process according to the requirement, for example switching on the light when it gets dark. It also stores the sensor parameters in the cloud (gmail) in a timely manner. This will help the user to analyse the condition of various parameters in the home at anytime from anywhere. The system can be expanded for energy monitoring, environmental monitoring and weather stations. This kind of a system with respective changes can be implemented in the hospitals for aiding the disabled or in industries where human invasion is impossible or dangerous.

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