Home Automation & Security System using IoT

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Abstract—In this paper, we are presenting a system for Home Automation technique using Internet of Things (IoT). It is done by integrating temperature sensor, gas sensor, passive infrared (PIR) sensor, fan, lights and buzzer with the Arduino. The main objective of this work is to facilitate the user to control home appliances by three ways: (1) Remotely via voice command through android application, (2) Using remote control to control the appliances through webpage using IoT and (3) Face recognition for security purpose. Arduino operates and controls lights, fan, temperature sensor, gas sensor, passive infrared sensor and alarm. Arduino is connected to webpage hosted on internet through home router. Commands given on webpage are transmitted to Arduino which in turn implements those commands. For example, if gas leak or smoke is detected by gas sensor then Arduino alerts webpage and user can then take measures to contain the damage by remotely controlling home appliances.

Index Terms—Home Automation System, Internet of Things (IoT), Arduino Uno, Wi-Fi module, Face Recognition.

I. INTRODUCTION

Automation is being used in various field from manufacturing to aircraft control. Home automation using Internet of Things (IoT) [2], [7] is one of the emerging industries due to tremendous growth in internet connectivity. Typically, IoT is expected to offer advanced connectivity of devices, systems, and services that goes beyond machine-to-machine communications and covers a variety of protocols, domains, and applications. The interconnection of these devices, is expected to usher in automation in nearly all fields. This increase in connectivity has made possible the inter-networking of home appliances and different sensors. Integrating sensors and home appliances allows us to create new solutions to collect data from sensors and make intelligent decisions giving us ultimate control over our homes by automating the lighting system, dimming, fan speed, other electric appliances and audio systems. This Home Automation System integrates electrical devices in house with each other.

The electrical devices in house are directly interfaced to Arduino through relay circuit. Arduino can be controlled through either webpage or android application. Arduino is connected to an android application installed on a capable device through Bluetooth technology. User can give commands by clicking buttons on website or android application corresponding to particular devices or through voice commands [6] which are decoded by the mobile application. The method of voice control works only when the user is inside the house and within Bluetooth range from the Arduino board. User can control the Arduino through a webpage if he/she is outside the house. Arduino is connected to internet through the router which is used to communicate with webpage. The operating principle here uses the capabilities of Arduino that makes a GET request [7] to a server in order to make updates of the desired parameters. All these parameters are stored on the server from where the webpage can display this information to user. This allows user to be always informed about the status of electrical devices in the home or regarding any emergencies like gas leak or smoke generated due to fire hazards which are detected by gas sensor and communicated to webpage.

Face recognition [8], [9] has a wide range of applications such as identity authentication, access control, and surveillance. Interest and research activities in face recognition have increased significantly over the past few years. Face detection is the process of finding a 'face' within images or videos and face recognition is the process of matching the detected 'face' to one of many the faces known to the file system. Our goal was to create a portable low cost system that can recognize the face of the persons in the family and take actions accordingly like opening the door and if face doesn’t match with the database then
a buzzer rings to indicate that some unknown person is trying to enter the home.

II. ALGORITHMS

Algorithms of different methods involved in the implemented system are described below:

1. Home Automation using IoT

The IoT allows objects to be sensed and/or controlled remotely across existing network infrastructure, creating opportunities for more direct integration of the physical world into computer-based systems, and resulting in improved efficiency, accuracy and economic benefit.

Here the remote user can access the home appliances using internet of things technology. First the user will get connected to the internet. A manually assigned IP address is assigned to the server which is like 198.168.4.1. Initializing the server will make a request to the server to open a listening connection and after getting a request it will display the current state of sensors and provides manual control by sending commands to electrical appliances. There will be an interface to handle the commands of user. Then these commands are passed to the main system containing Arduino Uno which is connected to the internet through router using Wi-Fi module. The main system will decode the commands and pass it to the devices which are to be controlled.

![Figure 2.1: Algorithm for Home Automation using IoT](image)

2. Voice Command Control

This home automation system can be controlled by means of a user-friendly android app. This app simply enables user to control the appliances wirelessly from a range of 10m by connecting the system through Bluetooth.

The voice recognition based home automation system is an integrated system to facilitate the elderly and physically challenged people with an easily operated home automation system that operates fully on voice commands. User speaks the command, which is picked up by the mobile’s microphone. User can speak commands like ‘Turn ON lights’, ‘Turn ON fan’. Commands should be direct and precise to avoid any ambiguity. This app uses Google’s speech recognition engine for converting voice command to text. The text converted from voice is displayed by the android application on screen. It then compares this command with a list of commands which are programmed into it. The recognized command is then sent by app over wireless channel to Arduino Uno by using Bluetooth module (HC-05). It receives the command from mobile app through Bluetooth or Wi-Fi. Arduino decodes the command and identifies which device is to be given instruction. It then sends the instruction to identified device. The device receives the instruction and effects the changes according to the instruction.

![Figure 2.2: Algorithm for Voice Control](image)
3. **Face Recognition**

Once the user arrives at the door or gate, camera will take a picture of the visitor. The image taken will be compressed and will be sent to the database. Once the data is received, it manages to recognize face automatically and identify face by comparing image in the database. If the image matches the content present in the database i.e., if image is of one of the members, then the door latch will open automatically. If the contents do not match, then an alarm will ring giving the notification to the people in home.

In this method, Haar feature-based cascade classifier is used for face detection and Local Binary Pattern Histogram (LBPH) is used for face recognition. Face recognition is carried out in three stages: feature extraction, matching, and classification. The unique and at most useful features are extracted from the images. It is an effective object recognition method. In this, local binary pattern for person's face recognition considers both shape and texture information for evaluation. The image that is given is segregated into small parts from which Local Binary Patterns are taken and clubbed into a single vector feature. This feature vector helps in finding similarities between images by forming an efficient representation of face. Initially, the algorithm needs a lot of positive images (images of faces) and negative images (images without faces) to train the classifier. To use this algorithm, a set of training data with pictures of users' faces is created and labels are attached to each image.

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**III. SCHEMATIC DIAGRAM**

![Schematic Diagram of Home Automation System](image)

**IV. CIRCUIT DIAGRAM**

![Circuit Diagram of Home Automation System](image)

**V. SYSTEM HARDWARE**

1. **Arduino UNO and Wi-Fi Module**

This module is the heart of the Home Automation and Security system. Arduino Uno is a microcontroller board based on the ATmega328P. It contains
everything needed to support the microcontroller. The Arduino Uno can be programmed with the Arduino Software (IDE).

![Figure 5.1: Arduino Uno with Wi-Fi Module](image)

The ESP8266 Wi-Fi Module is a self-contained SOC with integrated TCP/IP protocol stack. During the initialization stage, which is the first step to connectivity, the Wi-Fi module initiates connection with internet.

2. Sensors
In this project three types of sensors are used and they are as follows:

   1. PIR sensor
   2. Temperature and Humidity sensor (DHT11)
   3. Gas sensor (MQ2).

A passive infrared (PIR) sensor is an electronic sensor that measures infrared (IR) light radiating from objects in its field of view. Usually this radiation is not visible to the human eye because it radiates at infrared wavelengths, but it can be detected by electronic devices designed for such a purpose. It activates only in the security mode to detect any unwanted motion at the entrance. If any unwanted movement is detected then it will signal the microcontroller to ring the buzzer.

The Grove - Gas Sensor (MQ2) module is useful for gas leakage detection (in home and industry). It is suitable for detecting H2, LPG, CH4, CO, Alcohol, Smoke or Propane. Due to its high sensitivity and fast response time, measurements can be taken as soon as possible. The sensitivity of the sensor can be adjusted by using the potentiometer. If the above mentioned gases are detected by this sensor, then buzzer starts ringing.

DHT11 is a composite sensor which contains a calibrated digital output of the temperature and humidity. By getting the readings from this sensor, the user can actuate other appliances through webpage. If the temperature becomes very high and it is reflected on website, then user can increase fan speed to decrease the temperature.

3. Relay Board
Relay boards are an array of relays and switches. They have input and output terminals and are designed to control the voltage supply. This provide independently programmable, real-time control for each of several onboard relay channels. The relays used in the system are 5V relay. Relay Boards are used in different applications. Some products are used to control lights, motors and other electronic devices. Others are also used to control Heater temperatures or in power switching applications.

4. Buzzer
A Piezoelectric buzzer is a loudspeaker that uses the piezoelectric effect for generating sound. It will only be activated in the security mode when some intruder is detected by the PIR motion sensor or when face of the visitor is not recognized by the face recognition system.

VI. SOFTWARE
The software implementation part of voice recognition and IoT based home automation system implemented using the Arduino Software (IDE). The main program for the home automation system is written in C++ language in Arduino IDE. Upon successful recognition of voice command the control action corresponding to that command is generated. A program for Arduino may be written in any programming language for a compiler that produces binary machine code for the target processor. This C/C++ program is used as a partial interface between humans and the microcontroller to instruct the microcontroller so as to perform a particular operation. So, the codes of accessing the sensors through webpage and through voice controlled app are implemented using C or C++ and are executed by a hex code.
MIT App Inventor Platform is used to build an Android app, for controlling the home appliances through voice commands which is connected to system through Bluetooth. This project uses: i) OpenCV computer vision library to perform face detection and recognition. ii) Viola-Jones Algorithm and Local Binary Pattern Histogram (LBPH) in OpenCV to perform face recognition. iii) Python software for building a program for face recognition.

VII. RESULTS

The system allows the user to control the appliances from anywhere using an internet connection and also through voice commands. This home automation system is practically implemented and thus the results are obtained. Results of this automation system are as follows:

Fig. 7.1 shows the android application which is used to control home appliances. Fig. 7.2 shows the website containing the status of all the home appliances and sensors. Fig. 7.3 shows the recognized images of users.

VIII. CONCLUSION AND FUTURE SCOPE

This home automation system has been proven to work satisfactorily. The designed system not only monitors the sensor data like temperature, gas leak, smoke, light and motion with the help of sensors but actuates a process according to the requirement. This will help user to analyze the status of various parameters in the home anytime from anywhere. The use of voice commands eliminates the need of other electronic devices and makes it easy for differently abled persons to interact with the system to perform automation and control electrical devices. From intruders security is obtained using face recognition method.

Using this system as framework, the work can be expanded to management of vehicles, parking control, power grids and weather stations. All the data gathered by sensors can be stored on cloud which can be further analyzed to predict future demands and
requirements, increasing efficiency and saving cost. Smart cities initiatives, enabled by the Internet of Things, is set to transform life. It can be associated with various other options like energy conservation, transportation, public safety and the environment all stand to benefit.

REFERENCES


