Home Automation Using Face Recognition for Wireless Security

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Abstract The aim is to develop a detailed and precise face recognition-based home automation system which is based on IoT using modules and microcontroller for wireless security. This project mainly highlights and focuses on controlling certain devices such as home appliance by integrating it to Internet and making it an IoT-based system, and building an accurate and smart wireless home security system using face recognition system and Wi-Fi as communication protocol and certain network protocols. Looking at the current scenario, we find an existing system which is assimilated with home automation system. The paper is being focused more on reducing the limitation with respect to being more widespread in terms of usage. As far as the study area of this paper is considered, NodeMCU microcontroller unit along with relays module is used to control electrical appliances. Face recognition module will provide smart security wherein a captured image is sent through an E-mail/MMS to the owner using IoT-based cloud service such as Internet when a face is detected. User can be authorized to control security controllers using certain application after authenticating. Hence, resulting in being useful to people with physically challenging disabilities.

Keywords Home security · Home automation · Face recognition · NodeMCU · Microcontroller · IoT · Smart devices · Network protocols

1 Introduction

Home automation refers to microcontroller-based technology for controlling home appliances. Automation is a necessity now since it provides security, easy control and efficiency. In this, the IoT sensors transmit the status of appliances and provide updates to the user with the help of a Wi-Fi module. The user being away from home can access and modify the status of electric appliances, i.e. switching it ON/OFF.

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This paper is developed to describe the automated approach for controlling home appliances and security using the face recognition module.

We always dream about having all the work done automatically for us just at the tip of the finger. The home automation system is one of the systems that fit well in this scenario. The dual aspects of this project are wireless security and wireless home automation. The currently working prototype of the system is based on a notified system. Where the authorized person is sent alerts when a particular event occurs. The notification is sent based on a network protocol and the main mode of application being SMS using the Internet. The system is trained in a specific course of action that if any sort of unusual activity is recorded or observed, the authorized person then and then is notified using the SMS service and further circumstances can be avoided.

Various other means of events can be handled using the ideology of home automation which are counted essential. For example, electronic appliances can be turned on using voice command. Of the multiple advantages, a useful one is that even when Wi-Fi is not available, we can go over by using our mobile cellular network services. This feature is lacking in existing prototype methods. Overcoming the drawbacks of the existing systems, we have implemented this system which is designed to provide security at comfort.

Thus, the aim of this work is to reduce power consumption and also better time management. Further, there is need to provide the safety and wireless security of the various appliances at home. As we know technology is upgrading each and every minute so, it is very much necessary for us to implement the latest technology. Most of the work in the field of IoT-based automation and security is in progress and there is tremendous scope for improvements in final field implementation.

Further, this paper is organized in sections. Section 2 highlights the basics of current existing systems and their comparison. Sections 3 and 4 explain the design and implementation of our work, respectively. Finally, Sect. 5 discusses results, and 6 conclusion and further enhancements.

2 Related Work

In this section of the paper, the existing work of a wireless home automation system using IoT is described.

2.1 Bluetooth-Based IoT Home Automation System

It is a system which can be integrated with Bluetooth for the definite purpose of controlling and monitoring home automation. The system can make use of smart phones which are portable and reliable. The Bluetooth system basically works on a server-client procedure. The PC/Smart phone acts as a receiving device. It has a higher rate of communication and is available at an affordable cost. Bluetooth has

undergone several revisions in its technology. Bluetooth Class 1 operating range is up to 100 m and Class 2 range is up to 30 m. Most smart phones operate within Class 2 range. Bluetooth's disadvantage is its limited range. Outside the range, the system will not be able to control the automated home appliances. The effective range is further decreased by Wi-Fi interference.

2.2 Voice Recognition-Based IoT Home Automation

Voice recognition mode of communication can turn out to be very reliable. Since voice commands have shown consistency and accuracy since few years due to enhance development in the system, it is a prime reliable and efficient system to be implemented. The communication that takes place between the smart phone and the Arduino Uno is categorized as a wireless communication and is carried using the Bluetooth technology. This aids people who are specially challenged and want to control using their voice.

2.3 GSM-Based Home Automation System

A vital system that is utilized by the smart home automation is the global system for mobile communication, also called as GSM. In the addressed system, the GSM system communicates between the main module and appliances using the mod of text messages. One of the drawbacks of the GSM-based home automation system that can be brought to notice is that it lacks the guarantee whether the text messages will be delivered to the designated system. Hence, it is particularly not reliable under various circumstances. These automation systems were particularly developed to reduce the human efforts by managing the increasing number of home appliances like television sets, music systems, refrigerators, dish washers, water heaters, air-conditioners, etc. The existing IoT-based home automation systems use core technologies such as Wi-Fi, Zigbee, Bluetooth, Arduino Board, GSM connectivity, etc. Each and every technology has some advantages and drawbacks. There is immense scope for further research to address the technology issues and remove their potential drawbacks.

3 Proposed Work

To overcome the drawbacks, we are implementing "Home Automation using Face Recognition for Wireless Security".

3.1 Hardware Components

A. **Raspberry Pi 3 B + Board**: Raspberry Pi is a remarkable fully functional digital computer which is inexpensive and compact.
B. **Node MCU**: The IoT platform with respect to NodeMCU is an open source which is made available to everybody. The NodeMCU obviously will include a particular firmware, the firmware in return successfully runs on the ESP8266 Wi-Fi SOC.
C. **Relay Board**: A relay is used to switch-ON or switch-OFF appliances. Relay selection is based on what needs to be switched ON and OFF.
D. **MQ135 Gas Sensor/Air Quality Sensor**: This sensor ionizes the gases which come in its contact and varies the resistance of a small electro-chemical sensing material.
E. **DHT11 Temperature–Humidity Sensor**: It is a low-cost sensor for sensing temperature and humidity of the environment. It can be easily interfaced with Raspberry Pi. The sensor consists of a capacitive humidity sensing element and a thermistor for sensing temperature.
F. **Infrared (IR) Sensor**: It is an electronic device which senses some aspects of its surrounding environment by emitting and/or detecting infrared radiation.
G. **Camera Module**: The camera module is powered from a single + 3.3 V power supply. It can be used to capture the images as well as videos.
H. **LCD Touch Screen**: A liquid crystal display (LCD) touch screen has additional layers over the display element to provide touch functionality.
I. **Mobile/WEB Controller**: The Mobile/WEB controller is the control module using which the user can interact with the system from a remote location as well as send commands to the system.
J. **GSM Module**: A global system for mobile communication (GSM) module is used to establish communication between a mobile device and a GSM or GPRS system.

3.2 Software Requirements

A. **Raspbian OS**: It is a Debian GNU/Linux-based operating system for Raspberry Pi. It is now called Raspberry Pi OS.
B. **Open CV Library**: Open Source Computer Vision (OpenCV) library is an open source computer vision and machine learning software library. It has more than 2500 optimized algorithms. It focuses on real-time applications. It is written in C++ and its primary interface is also in C++. Its binding is in Python, Java and MATLAB. OpenCV runs on a variety of platform, i.e. Windows, Linux, macOS, OpenBSD in desktop and Android, IOS and Blackberry on mobile.
C. **Twilio Services**: Twilio is a cloud communications platform as a service (CPaaS) company. Developers can use Twilio Web service APIs to programmatically

make and receive phone calls. They can also send and receive text messages and perform other communication functions.

Before getting into the details of the proposed system, we must understand the importance and the necessity for this work. A robust user interface application or portal that can be used to operate the entire home automation system without any technical guidance is lacking in most of the current automation systems. The designed user interface application should be easy to use, it should be reliable and accessible from anywhere in the world. It should not limit the user to operate the system infrastructure from just a particular area or from home. The process of upgrading the system has always been a challenge for the adaptation of the system. If a person wants to install a system, there is a need of the technical person to guide throughout the process of installation, and every device needs to be integrated into the control panel. After that, if a user wishes to upgrade the system by integrating new devices /appliances, it's very difficult as the user needs to go for the whole process again as there is a need to reconfigure the system to integrate the new devices and would again need the assistance of technical guidance. Every system is expected to fail in one or the other scenario let it be a power failure, hardware failure or software failure. Moreover if all the systems are integrated at a single point, the failure of that single point would make the whole system down. Such difficulties faced by a user are addressed and this work proposes the following solutions and improvements. The Web interface of the proposed home automation system is used to operate and monitor the state of various appliances and user commands that can be easily modified to support additional hardware interface modules (Fig. 1).

The advantage of this home automation system is that it is accessible from the smart phones with Internet connectivity. Also they can be accessed from a variety of Web/mobile controller devices. The speed, security, mobility and flexibility of the overall system is enhanced.
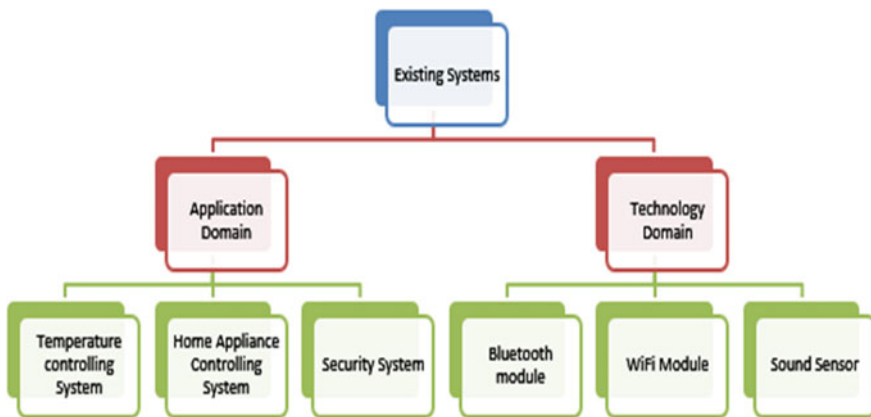

Fig. 1 Classification of application and technology

4 Implementation Details

The presented prototype can be implemented for three proposed systems (Fig. 2).

(1) **A Complete smart Home Automation and Wireless Security**

In this prototype, we will be able to control all electrical appliances from long distances through any Web/Mobile controller. In this project, we are integrating Web cam to recognize the person and if the person is authorized to enter the home premises. The automated system will trigger the door lock system, if the person is not recognized, the image of the person will be sent to the admin via Email/MMS to intimate about the arrival of unauthorized person and if the admin wants to allow the person, he can then using the Web/Mobile controller trigger the door lock system. This prototype is time and storage efficient as it will trigger the recording only when the sensors give any input, for example: imagine there is a movement detected by the IR sensor, then the microcontroller will start the recording using the Web cam, and hence, it becomes easy for the admin to check for that particular footage rather than wasting time in checking the whole footage. To make automation simpler, we can control lights and fans or any other appliance connected to a relay board through the Internet. Even though for some reason Wi-Fi is unavailable, we have the option to go to 3G or 4G services. This will help us in operating our home appliances from a distance. This will be of great convenience to the differently abled and senior people to control home appliances (Fig. 3).
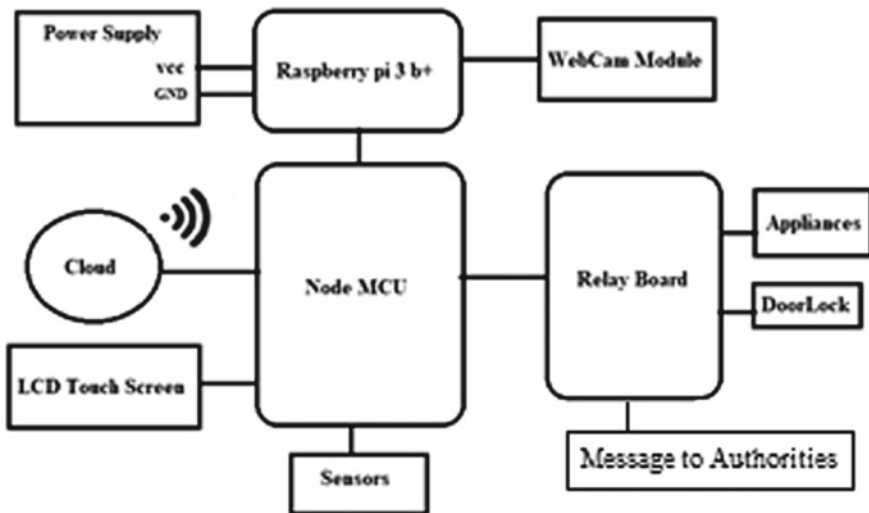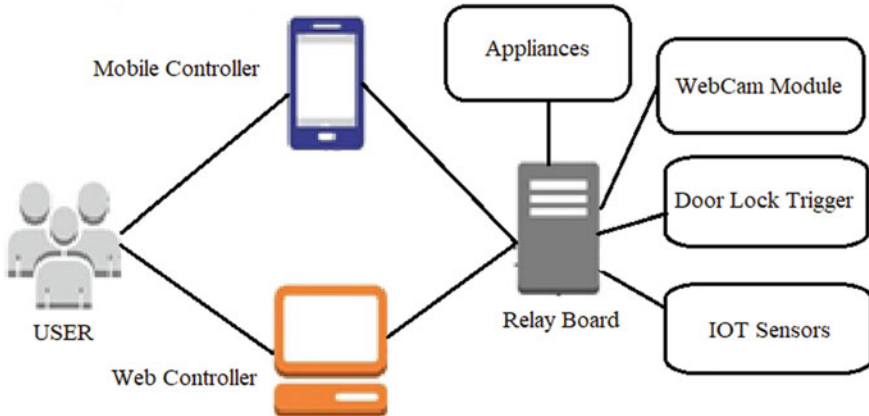

Fig. 2 Block diagram

Fig. 3 Complete smart home automation and wireless security

(2) **Face Recognition Based Security System**

In this prototype, we are integrating Web cam to recognize the person and if the person is authorized to enter the home premises. The automated system will trigger the door lock system, if the person is not recognized, the image of the person will be sent to the admin via Email/MMS to intimate about the arrival of unauthorized person and if the admin wants to allow the person, then he can then using the Web/Mobile controller trigger the door lock system. We can also integrate sensors, for example, placement of an IR sensor in the premises. This sensor detects the motion of the object/human. This detected signal will in turn become the input the microcontroller. The owner, who may/may not be present in that premises, will be instantly alerted by the message along with the captured image that is sent as an E-mail/MMS stating "There is an intruder movement in the premises". Further, to trigger the security modules, so that the unauthorized person will be warned, the owner can press 'Alert' button in the user interface of the mobile device application. If situation demands, the owner will be able to send an SMS to the concerned security person or to the police department stating the intruder situation with the captured image (Fig. 4).

(3) **Smart Home Automation**

In this prototype, we can control all the appliances connected to the module using a Web/Mobile-based controller. We can integrate various sensors to make automation efficient and smart. We can include an IR sensor so that whenever there is a movement, the lights of the staircase would turn ON automatically, we can also integrate the gas sensor and fire sensor so that the user can be intimated if there is a gas leakage or fire in the premises. We can also integrate a temperature sensor so that the user can maintain the room temperature as per his need well before entering the room. This automation will not only make the whole system efficient but also safe. This controller can be of great help to the differently abled people and senior people, as it can be used conveniently (Fig. 5).
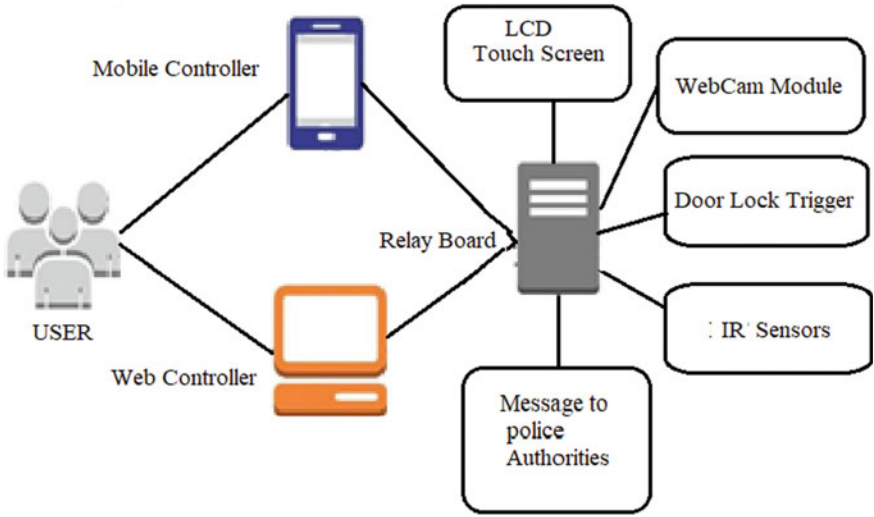
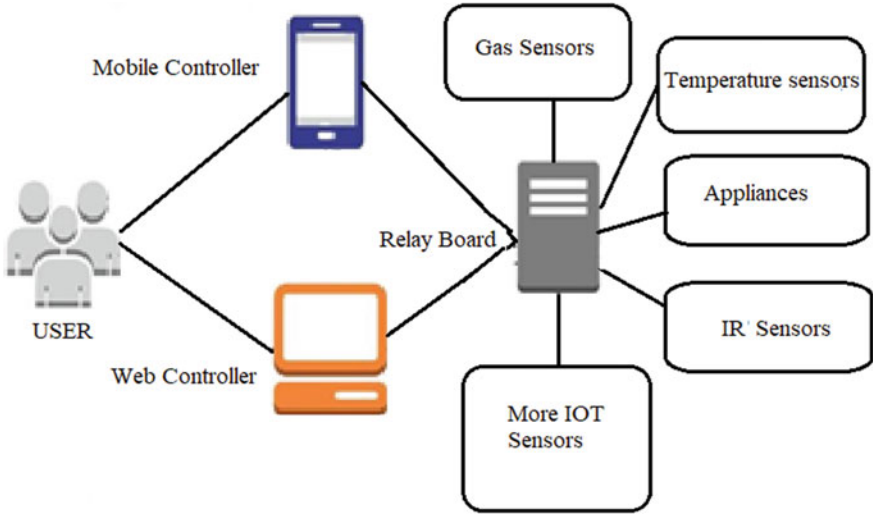**Fig. 4** Face recognition-based security system

Fig. 5 Smart home automation

5   Result

After successful implementation of the system, following are the results of the tested software and hardware prototype (Fig. 6).
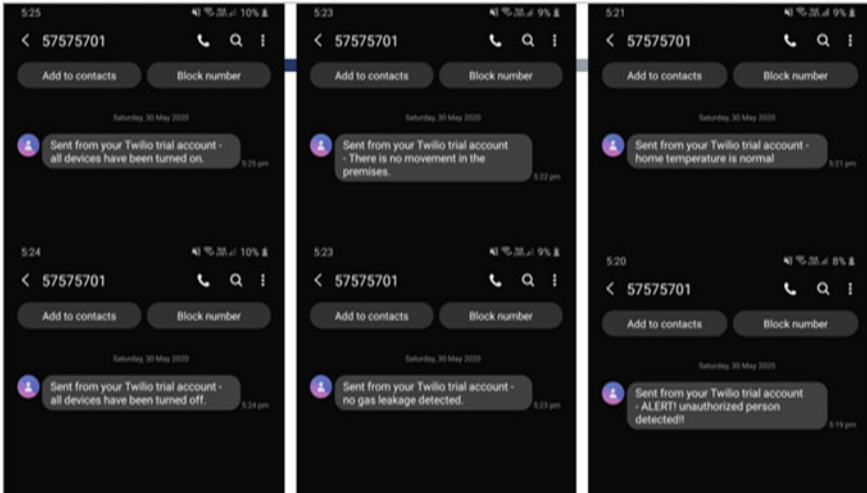
Fig. 6 Intimation of updated status to the user

Using Twilio service, user was greeted and intimated about the updated status of the premises. The images are captured using the Web cam and stored in the database and send to the user to intimate about the intruder. Users can also forward these details to the police authorities (Figs. 7, 8 and 9).

Advantages of the System

(1) Time management is the key factor considered in this system.
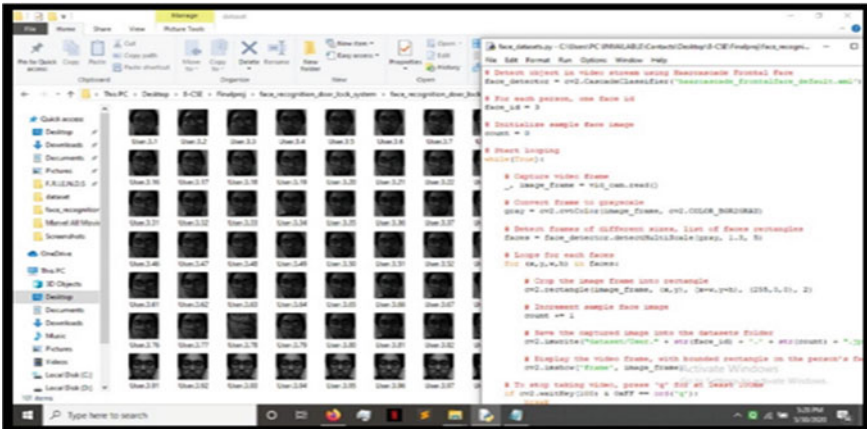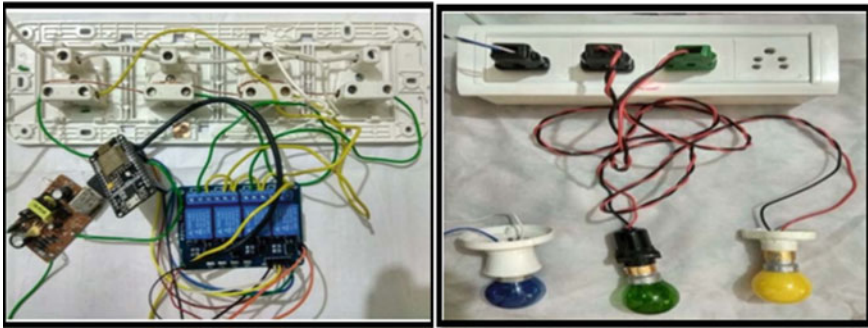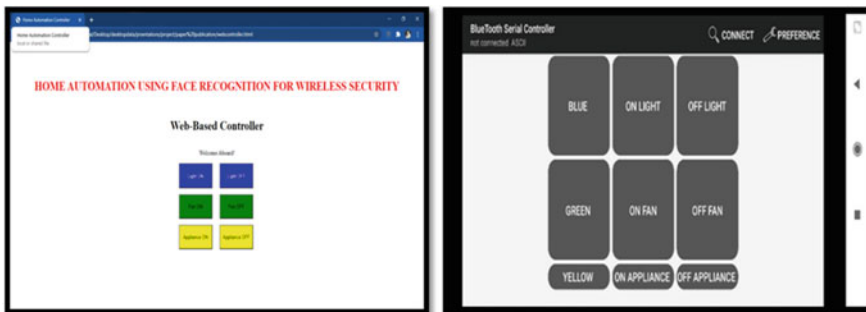(2) Specific surveillance using an IR sensor.

Fig. 7 Captured and stored images

Fig. 8 Relay board connection

Fig. 9 Web/Mobile controller module

(3) The system provides alert only in the presence of intruders using the GSM module.
(4) Face recognition for enhanced security.
(5) Memory management is concentrated.
(6) This low cost system.
(7) Great help for differently abled people.
(8) Devices can be easily controlled and managed from a remote location.
(9) Highly secured and time-saving.
(10) Remote surveillance over Web service.

6 Conclusion

In this work, a real-time implementation of home automation using face recognition is demonstrated. The system using Raspberry Pi has made the system compact. So it is more reliable than the PC-based system. It has all the advantages of open source software. Also, it sends security alerts to the authorized user. The power bank can

be used to provide the power backup to charge the Raspberry Pi so that down time due to power failure is very minimal. Also it is power-efficient and provides enough flexibility to suit the different requirements of people. Hence, the system is low-cost, fast and highly reliable. The automation makes the daily life of the humans very easy and secures as there is no need to have an overhead regarding the control of devices. The overall system is implemented keeping in mind the ease and safety of the user. All the sensors are integrated in such a way that users can have the complete automated feel of the premises.

As future possibilities, we can integrate an OTP-based system along with face recognition at the door lock system to deal with the current COVID-19 scenario where the users are wearing masks, and face recognition is challenging. Also, a log system can be integrated to keep track of the run time of the particular appliance.

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