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IoT Smart Home Assistant for Physically Challenged and Elderly People

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Abstract*— Internet of Things (IoT) conceptualizes the objective of remotely connecting and keeping track of the real-world objects though the cyberspace. When it comes to home, this technology can be aptly used to forge it smarter, safer and automated. In this paper, an IoT based smart home assistant has been presented to assist the elderly and physically challenged people to be safe and active at home. Wireless communication technology and Artificial intelligence (AI) based voice recognition is used to enable them to remotely monitor, access and manage appliances, systems and surveillance of the home easily. Hypothesis is designed and tested by considering two use cases and implemented using Arduino, Raspberry-Pi.The results are analyzed and presented.

Keywords- IOT, Smart systems, Smart home, Raspberry PI, Home automation.

I. INTRODUCTION

Internet of Things (IoT) gestate the objective of remotely connecting and tracking the real-world objects through the cyberspace. When it comes to home, this technology can be aptly incorporated to make it smarter, safer and automated. Smart home technology is also often referred to as home automation which provides the homeowner's security, comfort, convenience, and energy efficiency by allowing them to control devices often through a remote, or a smart app on their smart phone or other networked devices [1].

The IoT devices perform many functions without human intervention.Humans often control them for providing operating instructions oraccessing the information [2]. The security and surveillance system captures images of intruders and emails to the user [3]. The web page GUI lets the user control electrical appliances and monitor energy consumption of individual appliances in the home with the cyberspace [4-6]. The IoT smart home system also uses voice recognition to control electrical appliances in the house [7-8]. One of the mainobjectives of IoT smart home system is to assist those with physical disabilities and elderly individuals [8-9]. However, the applications of IOT is not limited to Home automation itself.They are playing a key role in automating the power utility units like relays,Circuit breakers (CBs) using MQTT protocol [11], generation of power bills [12], infrastructuremonitoring, Transportation Sector, Road safety, IOT based activity detection [13] to help the residents. Physically challenged and elderly people can get the smart home feature by having connected with multiple implanted sensors to mobile phone and this won't be convenient for elders [14-15].

Therefore this paper aims at developing an idea of IOT based home assist for elderly and physically challenged people by including the features like voice controlling of loads, monitoring of the house remotely and live streaming to registered mail address. Section II discusses on proposed methodology, section III presents hardware and software requirements, section IV presents hardware implementation and results and section V presents the conclusion.

II. PROPOSED METHODOLOGY

The block diagram of the proposed system is shown in Fig.1. The proposed model has considered two use cases. Case (i) Surveillance system- to monitor the activities of house inmates and observe the surroundings of the house remotely. Case (ii) Convenience – To control and monitor the appliances remotely through wireless communications.

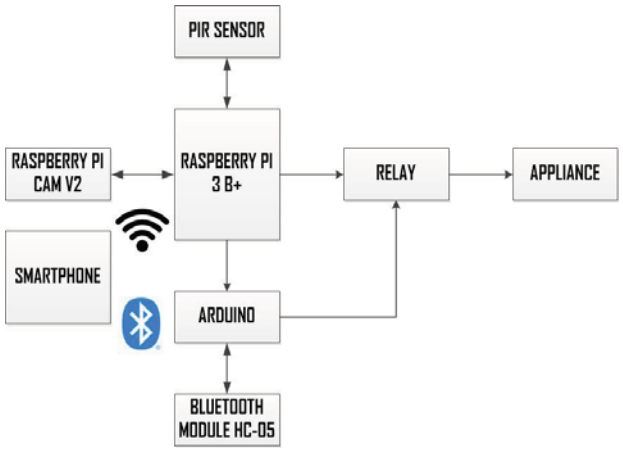


Fig.1. Block diagram of a proposed system.

III. REQUIREMENTS OF HARDWARE AND SOFTWARE

A. Hardware Requirements

- Raspberry Pi: Raspberry Pi is used as the main part of the overall system. It acts as a server using Nginx program and hosts the GUI connected to the internet. It controls the relay throughArduino enabling voice control of appliances and for surveillanceusing PIR sensor.
- Pi Camera: Raspberry Pi Camera is used as a part of live surveillance system to make sure safe keeping of the physically handicapped people and elderly.
- PIR Sensor: PIR sensor is used to detect if any movement occurs in its surveillance distance [3].
- Relay: Relay is used to control whether the appliances to be turned on or off. It is connected to the Arduino via raspberry pi and with the correct instructions, the appliances are controlled
- Arduino: Arduino is powered by Raspberry Pi and is connected to the relay. It is connected to the mobile phone via Bluetooth. When an instruction is given via Bluetooth, it is interpreted by the Arduino and sends it to relay for controlling of appliances.
- Bluetooth Module: HC-05, a Bluetooth equipped deviceis interfaced with Arduino and through the mobile phonecontrols appliances for remote control and voice control [12].
- Relay: A relay is an electromechanical switch. It is used to control the appliances through Arduino [4,12].

B. SoftwareRequirements

- PHP: PHP is used for coding the main GUI.
- Nginx: Nginx is used to collectively give a proximity sensor output. so that the GUI works with simple configuration.
- CSS:“Cascading Style Sheets” is used to help in describing how HTML elements are displayed on screens and controlthe layout of different webpages at the same time.
- HTML: “Hypertext Mark-up Language” is used to create websites ensuring proper formatting of images and texts and the cyberspace browser will exhibit as they are committed to look.
- JavaScript: “JavaScript” is used for the overall codingofthesystem.

IV. HARDWAREIMPLEMENTATION

C. Security and Surveillance System

The security and surveillance using “Internet of Things (IoT)” has been an emerging space and “Internet Protocol (IP)” surveillance cameras have been the subject of many research and studies. The working model of a surveillance system and smart switching is shown in Fig.2.

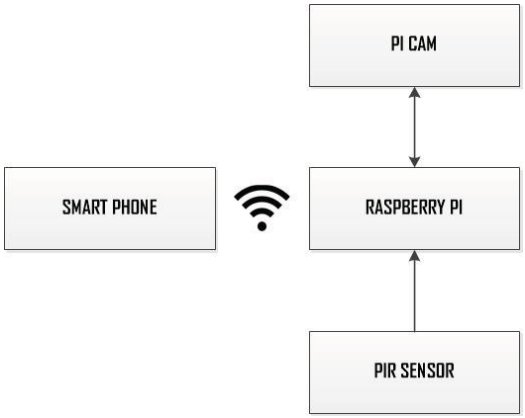
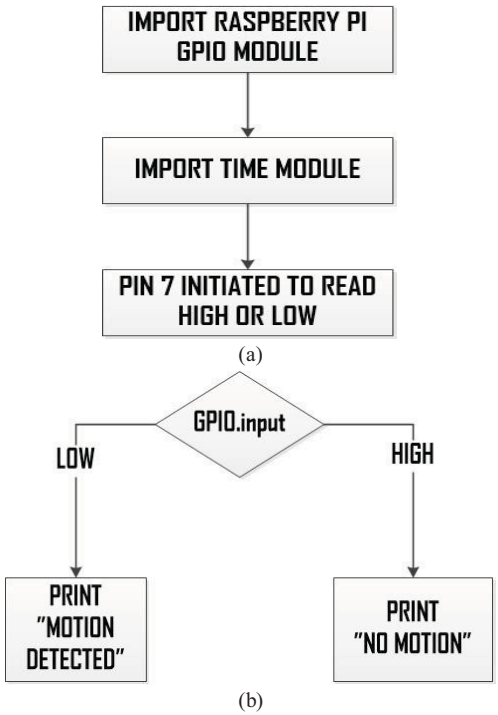
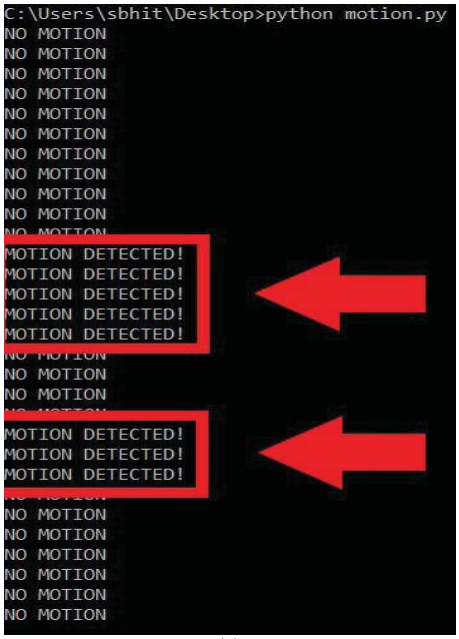


Fig.2. Working model of a surveillance system and smart switching.

In this work, PIR sensor does the job of event detection. On detection Raspberry Pi sends commands to Pi camera to click the image and save it as shown in Fig.3. Post that Raspberry Pi composes a mail and sends it to the outlined mail address with the clicked pictures. The mail contains a message & image of interloper as an attachment as shown in Fig.4.

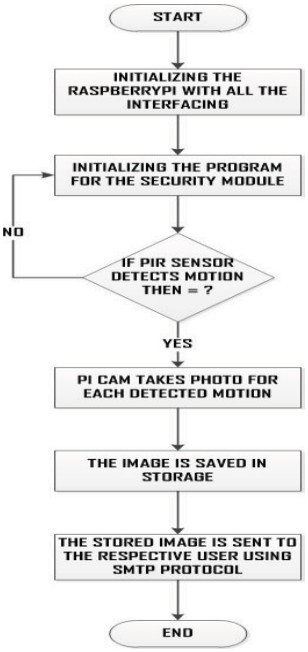
As shown below in Fig. 3(a), when the PIR sensor detects motion, Pin 7 of the Raspberry Pi is set to read HIGH or LOW. Fig 3(b) and 3(c) show that, if the GPIO input to Pin 7 is high 'Motion Detected!' printed, otherwise 'No motion' is printed.



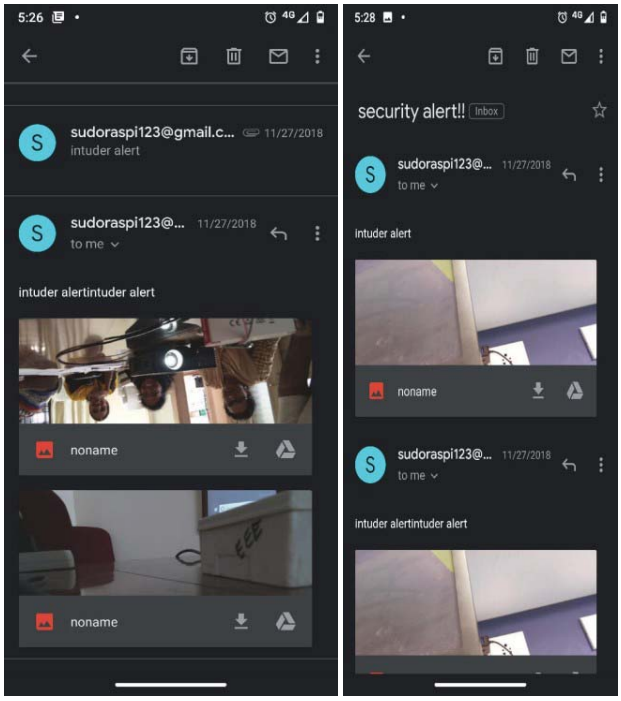


(c)

Fig.3 (a) Event sensing procedure (b) communication to the PI camera. (c) Output received



(a)



(b)

Fig.4. (a) Flowchart for surveillance system (b) security alert to registered mail address.

"smtplib" command is used to test the mail system. In order to have a reliable and clean way a Multipurpose Internet Mail Extensions (MIME) is used and libraries are imported into the Pi.

The video streaming from the Pi Camera with a Raspberry Pi can enable the residents to have real time monitoring of the house premises. The video is streamed live to a web page or an app in any device that is connected to the same network as the Raspberry Pi. To enable video streaming, the IP address of the Raspberry PI is found using the command,pi@raspberry:- ifconDiag. The IP address is entered in the app which gives access to the video streaming. A smart phone that has a browser and affiliated to the same supportsystem as the "Raspberry Pi" can be used as a surveillance monitor. The live streaming of the video is shown in Fig.5.

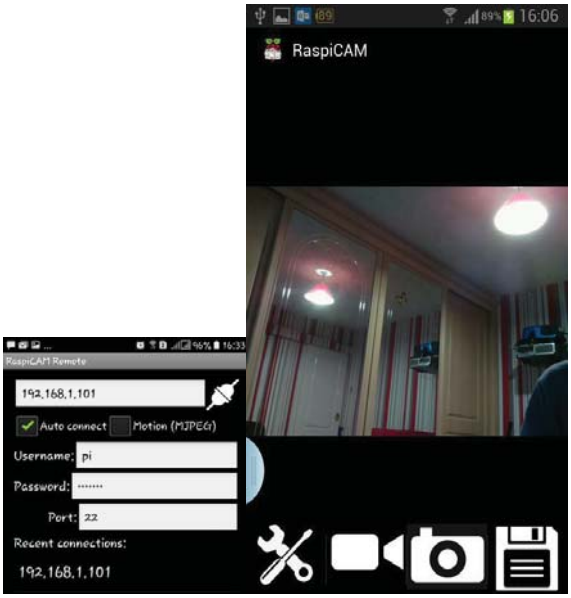


Fig.5. Real time monitoring with live streaming

D. Convenience system

The primary function of a smart home designed for an elderly or a physically challenged person is the remote control of appliances from anywhere within the house as they lack locomotive abilities. This helps the elderly and physically challenged to live in the comfort of their homes with independence. The lights and other home appliances can be controlled using a smart phone or any device with an internet connection.

The basic functioning of the scheme forremote controllinghome appliances is shown in Fig.6. The relay connects to the home appliances and to the raspberry pi. Through the GUI interface or web, raspberry PI can be reached to control the appliances

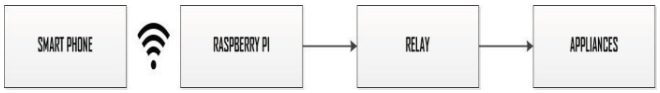
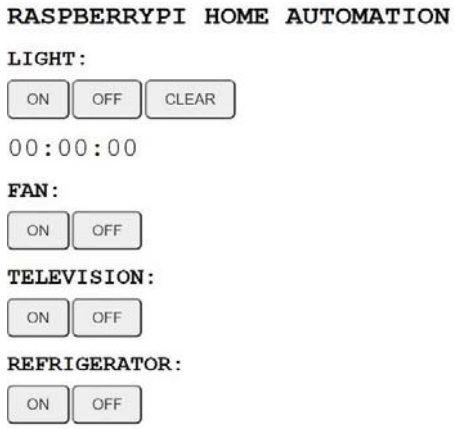


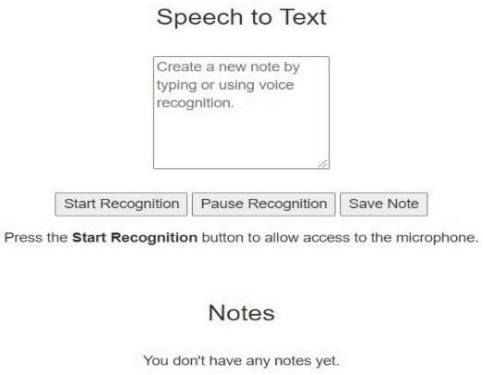
Fig: 6.Control of home appliances through smart phone

A webpage or Graphical User Interface (GUI) will be used by the residents to interact with their house, which includes controlling home appliances remotely and by voice control. The GUI also helps to monitor energy consumption of individual appliances. As it is used by elderly, the design of the GUI should be easy to use, access and the appearance should be appealing.

As shown in Fig.7(b), speech to text recognition feature is developed on the Webpage GUI. The feature can be used to send SoS messages/notes(e-sticky notes) to the concerned using voice which later converted to speech and stored in Web GUI. Manual control of electrical appliances using GUI is shown in Fig.7(a).



(a)

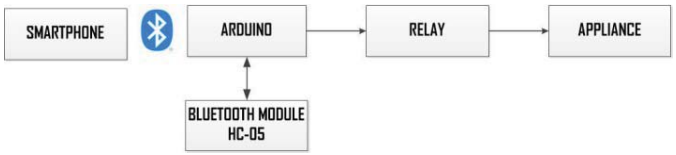


(b)

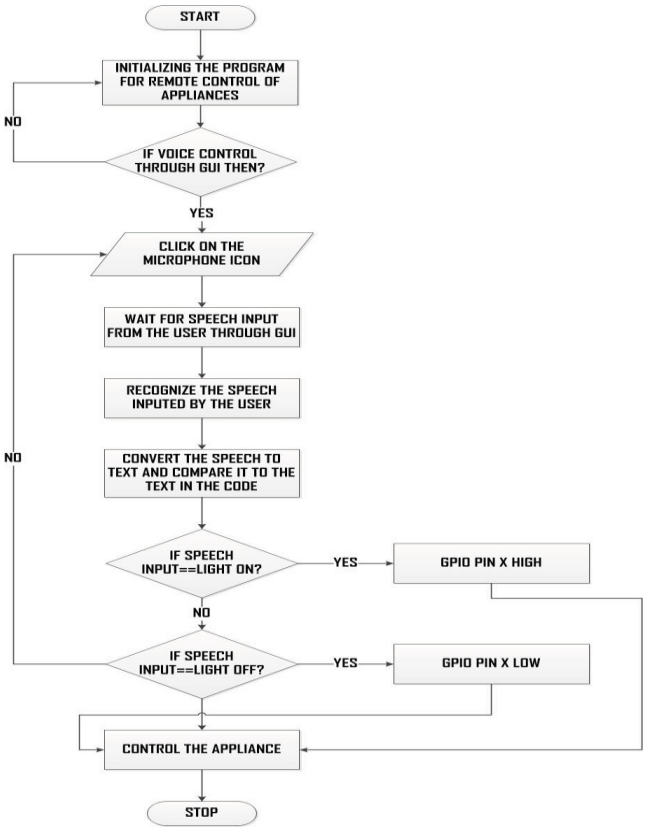
Fig. 7. (a) Webpage GUI for manual appliance control
(b) Speech to text e-sticky note

For each of the devices to be controlled a php file is created. The code in the php file links the buttons on the GUI to signals sent to relays through the GPIO pins.

In Fig.8(a),block diagram of convenience feature is illustrated. Arduino board is connected to Mobile phones via Bluetooth. Manual controls given on the mobile phones are sent to Arduino. Arduino then senses the input and outputs the information to the relay. According to relay's input, the appliances are switched on or off. Fig.8(b) depicts the flowchart for the before-explained procedure.



(a)



(b)

Fig .8 :(a) Block Diagram of control of appliances
(b) Flow chart for Voice control of Home Appliances

In Fig.8 (b), after initialising the program when the user clicks on the mic icon on the app, the program waits for the user's voice input. It then recognises the voice and converts it into string. This string then compares with the commands in the code. If the string and code string in Arduino are same, then the control of appliances are done (ON/OFF). An application called AMR_voice is installed in mobile. This app acts as an interface between mobile and Arduino. The mic icon on the app is pressed and voice command is given. Thecommand instruction is transferred from the Bluetooth module in the smartphoneto standalone HC-05 BT module. From here the command instruction reaches the relay through Arduino. The relay in turn controls the appliance. Fig.9, shows AMR GUI that enabled voice control.Voice is compared with pre-notes and as per the match respective appliance is controlled.

Fig .9.AMRVoice Control GUI

The complete hardware implementation of the module is shown in Fig.10. In the demo module one lamp load has been taken to test the use case under study, but the loads can be scaled to required number. The components are connected as per the circuit diagram. The pins Rx and Tx of the Bluetooth module are disconnected while uploading the code to Arduino.

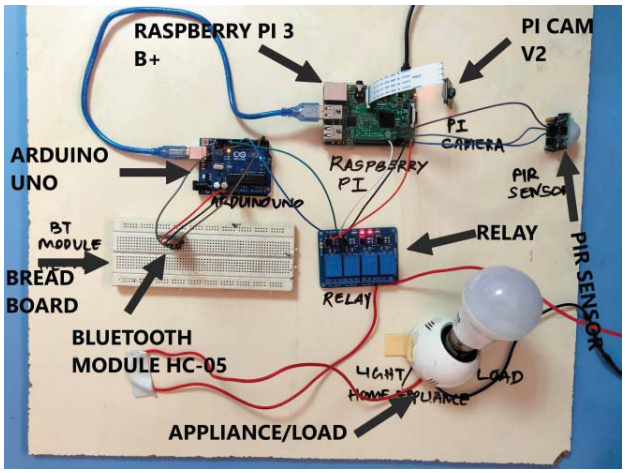


Fig .10. Hardware implementation

V. CONCLUSION

A hardware implementation of an IOT based smart home to make elderly and physically challenged safe and active participants in home is presented. This Module includes Wireless communication, Artificial intelligence (AI) based voice recognition and uses Raspberry-Pi as a Server. The detailed flow chart covering the use cases, the design of the system and test results are included. The designed module shows promising results with respect to the idea.Results for the first case – an email which includes picture of an intruder and live stream of the premises to registered email id has been sent and for second case – remote control of loads using AI based voice controlling environment is done successfully. A webpage to monitor the status of the loads remotely is presented. The proposed model is modular and scalable as per user needs.

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