Wi-Fi Based Home Surveillance Bot

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***Abstract*— Surveillance and monitoring have become very important for security reasons these days. Residential areas, government organizations, commercial spaces, banking, and other outdoor environments require high-end surveillance systems. In this paper, a new scheme is being proposed called Wi-fi based home surveillance bot. This system provides a real-time live streaming and monitoring system using Raspberry Pi with installed Wi-Fi connectivity. It also provides detection of gas leakage to prevent any kind of major fire hazard. In addition to this, it also has the facility to send voice messages which can be played at the desired location.**

Keywords—Raspberry Pi, Node MCU, Firebase, Twilio

I. INTRODUCTION

Nowadays home without a security system are at a higher risk of burglary. Statistics show that the chances of burglaries are more when there is no one at home. Above fact indicates the need for home surveillance and monitoring system. We always employ human beings for surveillance and monitoring, but it is not a foolproof solution. Technology has always provided an economical and user-friendly solution to all human needs. In the case of home security also Internet of Things (IoT) has provided an economical solution to all surveillance and monitoring related problems. Internet of Things is an innovative technology through which we can connect and control numerous electronic or electrical devices from any part of the world. Therefore, we can easily employ IoT in our home security solutions and try to build a foolproof solution.

Through this project, a new scheme is being proposed called wi-fi based home surveillance bot. Here bot means simply a small device which can be easily guided throughout the room remotely. In this project, a small toy car with four movable wheels is used as a bot. In this system, a camera is installed on the bot itself through which the bot can be guided to the desired place that needs to be monitored. This system provides a real-time live streaming and monitoring system using Raspberry Pi with installed wi-fi connectivity. It also provides detection of gas leakage to prevent any kind of major fire hazard. In addition to this, it also has the facility to convert our message into a voice which can be played at the desired location.

This wi-fi bot surveillance system is developed using Raspberry Pi 3 model B+, Node MCU (Microcontroller Unit), Pi camera, PIR (Passive Infrared) sensor, gas sensor and using IoT platform. This system performs various functions such as detection of intrusion and gas leakage as well as live streaming of video. Gas sensor and PIR sensor are interfaced with the Node MCU. Also, the additional facility is provided for the user to control home appliances through the Node MCU. Here Raspberry Pi is used for live video streaming, guiding the bot throughout the area to be monitored and for playing the audio file. In this system service has been taken from two online communication service provider, one is Firebase and the other is Twilio.

This system also requires an android app to be installed on the android mobile phone for controlling the movement of the bot, live video streaming and switching on/off home appliances. YouTube is used for live video streaming. This whole combination results in a real-time, energy-efficient, economical and user-friendly surveillance system.

II. LITERATURE SURVEY

In the past few years, much of the research work has been conducted in the field of security systems. Few of them are mentioned below.

Author of paper [1] mainly focusses on the design and implementation of a cost-effective and flexible application-based smart home automation system using the IoT. It is designed to detect robbery, smoke, fire, detection of suspicious activities and informs the user through text messages. It is low in cost, flexible, easy to use and it gives better results as compared with the previous systems. By this system entire home environment can be monitored and controlled.

Author of paper [2] has proposed an IoT based automated security system using Raspberry Pi, PIR sensor and Pi-camera. In this system if any intrusion is detected then the user is informed through a text message. The images of the intruder are captured and sent to the user's email account. This system uses Twilio messaging service to send text alert messages to the user and neighbour's mobile phone.

The author of paper [3] has proposed a smart home security system using Raspberry-Pi 3 board, USB camera, and DC motor and motor driver circuit L293D. The DC motor is used to control the door lock and the USB camera placed at the door is connected to the Raspberry-

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Pi 3 board. The user can control the door operation and allow or reject the entry of a visitor. A webpage is provided to the end-user for carrying out the above-mentioned operation. The user can also watch live streaming video of the vicinity of the door on this webpage.

In this paper [4] author has proposed home security and automation using Raspberry-Pi, motion sensor and Pi-camera. In this system, the camera starts recording video only when the motion is detected by the motion sensor. After receiving input from the motion sensor, the Raspberry-Pi alerts the user of the intrusion. This system also includes features of home automation i.e. controlling of all electrical home appliances e.g. home lighting, fans, air conditioners, etc., For this, the author proposes to use custom made Raspberry-Pi board at every switchboard. The appliances are controlled through the relays which are interfaced with the Raspberry-Pi board. The Raspberry-Pi boards are connected to the internet hub through a wireless connection. The internet hub is connected to the internet via LAN or Wi-Fi. The user can control home appliances through the webpage. The coding of the webpage is done such that user can have full control over the home automation.

Similar to paper [3], the author of paper [5] has also proposed a system for controlling the lock of the door through IoT. Whenever any visitor presses the doorbell. The doorbell input goes to the Raspberry-Pi, the camera captures the image of a person and transmits it to the Raspberry-Pi, which further processes it and sends it to the user. The user upon receiving this image can take a decision and control the operation of the door using twitter. In this system, the author has also placed an LCD on the door which displays the reason for rejection of entry to the visitor waiting at the door.

The Raspberry Pi Foundation is a UK-based organization that works in developing Raspberry Pi boards for educational purpose and general use. Official website of Raspberry Pi provides online training and download facility. It has made available a common learning platform for people who are interested in developing Raspberry Pi-based projects.

Twilio provides a cloud communication platform for services like messaging, voice and video in web and mobile applications. By using Twilio messaging services we can send and receive global SMS text messages from any app.

III. System Architecture

With reference to the block diagram of the proposed system given in Fig. 1., following are the components used. Node MCU and its components will be stationary with its components installed at the critical location in the room while Raspberry Pi with its components will be mounted on the bot which can be moved throughout the room. The input sensors to the system are a Gas sensor and PIR sensor which are connected as an input to the Node MCU. The output from the Node MCU is connected to the relay PCB through which switching on/off of the home appliances is possible. This switching on/off of home appliances will be done remotely by the user from the second page (refer Fig. 6) of an android app installed on the user's mobile phone. A DC 5V adaptor is used as a power supply to the Node MCU. The main requirement of this system is a wi-fi modem centrally located in the room with Raspberry Pi and Node MCU both connected to this wi-fi network. PIR sensor is installed near the main entrance of the house or at the main location in the house. It should be located such that there are higher chances of detection of any kind of human intrusion. The gas sensor is installed in the kitchen room so that it can easily detect gas or smoke in case of gas leakage or fire hazard.

The Node MCU is programmed to continuously keep on polling for the sensor inputs and the status of the Firebase. As soon as the user makes any changes on the mobile app it changes the Firebase status which gets detected by the Node MCU. The Node MCU processes the information accordingly and generates the output. The output from the Node MCU is given to the relay PCB board. The appliances are thus switched on/off through the relays.

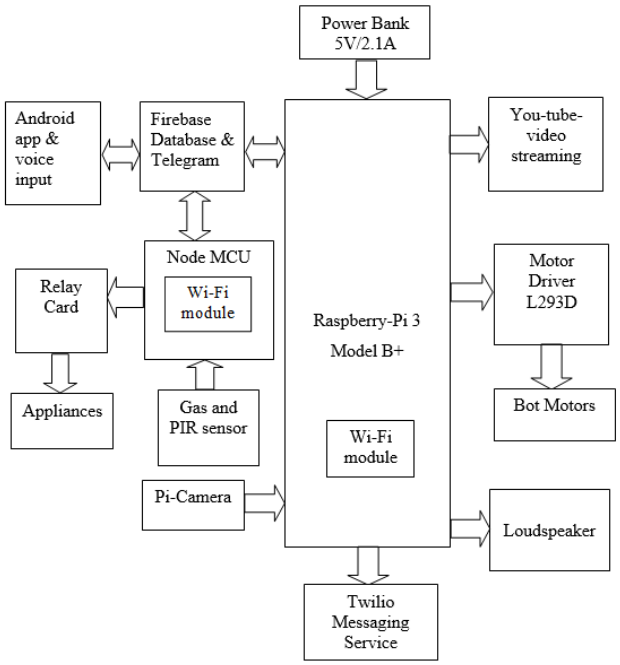

Fig.1 Block diagram of proposed system

Raspberry Pi board, loudspeaker, Motor Driver PCB, Power Bank, and Pi camera, all components are mounted on the bot. As previously mentioned, the bot is a small car driven by four motors. The Pi-Camera is connected to the CSI port as an input while the outputs from the system are motor driving signals and the audio signal given to the loudspeaker. The Pi camera act as the eyes of the bot. It carries out live streaming of the video captured which is displayed on the first page (refer Fig.5) of the mobile app. The user can watch this video and manually guide the bot at the required location by using soft keys on the mobile app (present below video window). The soft keys are triangular in shape. The soft keys when touched update the corresponding Firebase status. The Raspberry Pi is programmed to continuously keep on polling for the status of the Firebase and any input audio file received from the Telegram app. The Raspberry Pi processes this

information and generates the output. The GPIO pins of Raspberry Pi - 20,21,12 and 16 are programmed as outputs and are connected to the input of the L293D motor driver circuit. Two motors of the same side are connected in parallel. The motors get activated accordingly and forward, backward, right or left movement is achieved. The loudspeaker is connected to the audio jack output. As soon as any audio file is received by Raspberry Pi it gets processed and audible sound is heard from the loudspeaker.

The wi-fi based home surveillance bot is made up of following main components given below: -

A. Processing Unit

Processing unit consists of two main components. One is the Raspberry Pi board and the second one is Node MCU. The Raspberry Pi 3 Model B+ has been recently introduced in the Raspberry Pi 3 range. It is the heart of this surveillance system. It can be easily connected to the internet using a wireless LAN (Local Area Network). It gets input from the firebase, the pi camera connected at the CSI port and Telegram app. It is powered by a 5V/2.1A Power bank. It runs on a Raspbian Jessie Operating System. Programming of Raspberry Pi is done using python language. A python script program runs after power-on booting operation of the Pi board gets completed. The Node MCU is an open-source hardware and software platform. It is built around ESP8266 which is designed by Espressif Systems. It can be connected to the internet using its inbuilt wireless LAN. Just like any other microcontroller, it can be programmed to perform a specific task. It has been programmed using the Arduino IDE (Integrated Development Environment) using embedded C language. In this system both i.e. Raspberry Pi and Node MCU both work as a standalone system.

B. Sensors

1) Passive Infrared Sensor

PIR sensors identify alterations in the infra-red radiation, in forms of the heat emitted by several bodies that include human beings and other animals. PIR sensor detects the change in infrared radiation of warm-blooded moving object in its detection range.

2) MQ6 Gas Sensor

The MQ6 Gas Sensor module can be used to detect gas leakage at home and industry. It can detect LPG, iso-Butane, Propane gases. It is less sensitive to cigarette smoke and cooking fumes. It can detect the presence of LPG gases at concentrations ranging from 200 to 10000 ppm. MQ6 gas sensor module can be easily interfaced with Microcontrollers, Arduino Boards, Raspberry Pi, etc.

C. Pi- Camera

The Raspberry Pi camera module, a low-cost hardware module that supports still picture and video recording. It is the first official hardware add-on for the Raspberry Pi. The camera consists of a small (25mm by 20mm by 9mm) circuit board. It is connected to the Raspberry Pi through a flexible ribbon cable. The camera's image sensor has a native resolution of five megapixels. The camera has a fixed focus lens. Installation of Pi camera involves connecting the ribbon cable to the CSI connector on the Raspberry Pi board and configuring the software.

D. Motor Driver

L293D is a dual H-Bridge Motor Driver used to drive high current DC Motors like Geared DC Motors, etc. The purpose of this driver is to drive DC Motors from the low current IO Pins of microcontrollers like Arduino, 8051 and other AVR Boards. The output of Raspberry Pi will provide input to this driver board and its outputs will drive the four bot motors.

IV. WORKING OF SYSTEM

This system can be used in two modes as explained below: -

A. Security and Monitoring Mode

In this mode, we assume that there is no one in the area or room in which this system is installed and the area or room is locked. We will install the bot car at a suitable location in the room. Wi-fi network is powered on. Raspberry Pi and Node MCU both are powered on. The pi camera is ready in capturing mode. Whenever any movement is detected by the PIR sensor then intrusion detected SMS message is sent on the user's mobile phone through the Twilio messaging service by the Raspberry Pi. The user can immediately watch this video on his/her mobile phone by opening the installed app and can take appropriate action. In the other scenario if there is no intrusion and a gas leakage occur then gas sensor detects the gas leakage and gives input to the Node MCU board. The Node MCU updates the Firebase database. The Raspberry Pi detects this changed status of Firebase database and immediately sends an SMS message on the user's mobile phone through Twilio messaging service. The user upon receiving this signal can take appropriate action.

B. Monitoring/Viewing mode

In this mode, we assume that there are people in the area or room in which this system is installed, and the user wants to monitor the activities of the person or children in the room. The video capturing is on and the user directs the robot car to the required location and watches the activities of the person in the room. The user can then guide or instruct the person by sending a voice message through the telegram app installed on the mobile phone of the user. The Raspberry Pi receives this audio file and converts it into audible voice output and plays it through the loudspeaker. By this way, the user can monitor the activities of children, old people or any other kind of activity taking place in the room. Similarly (if the user permits then) by sharing the web address to other people, a greater number of people can view the live streaming of this video.

V. RESULTS

As per the above discussion a surveillance bot was built with all the components mounted on it as shown in Fig. 2. Another experimental set up of Node MCU with PIR and gas sensor, Relay PCB board interfaced with it as

shown in Fig. 3. Here a lamp has been connected as a home appliance.

The PIR and gas sensors were activated one by one and the alert SMS text messages were received on the mobile phone of the user as seen in Fig. 4. Similarly, once the PIR sensor gets activated the user opens the android app (already installed on the mobile phone of the user) and the live video streaming captured by Pi camera is ready for viewing as seen in Fig. 5. The control of switching on/off of home appliances from the mobile phone can be done from the next page of the android app as displayed in Fig. 6. Also, when a voice message is sent on a mobile phone using the android app "Telegram", the same audio message gets reproduced at the receiver end on the loudspeaker.

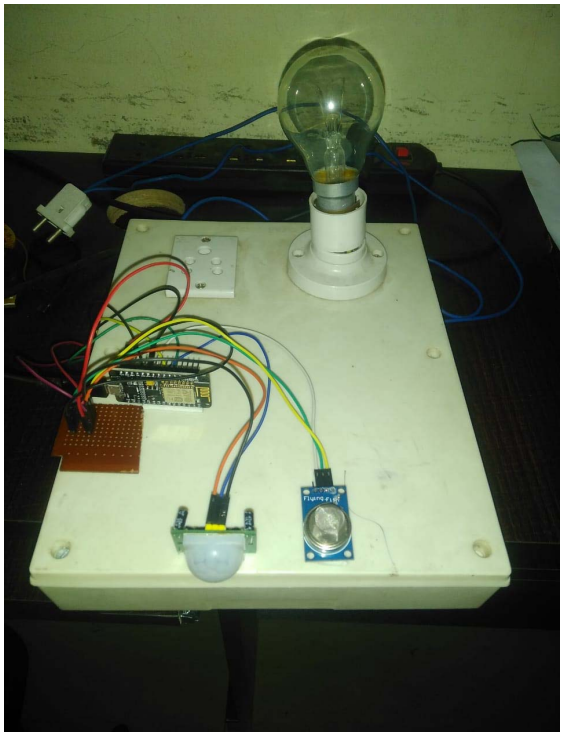

Fig. 3 Node MCU experimental setup

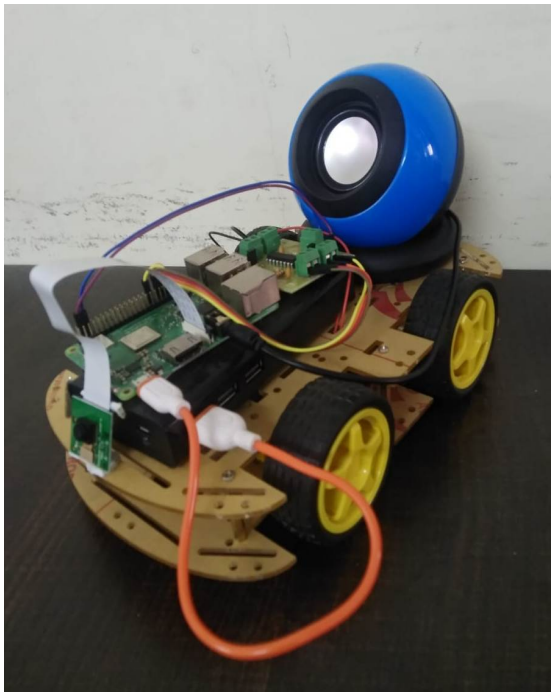

Fig.2 Wi-Fi Bot with all mounted components

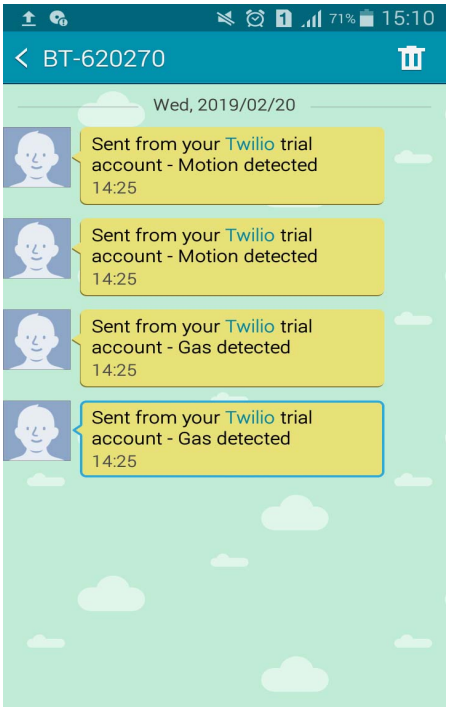

Fig.4 SMS text messages received on mobile phone

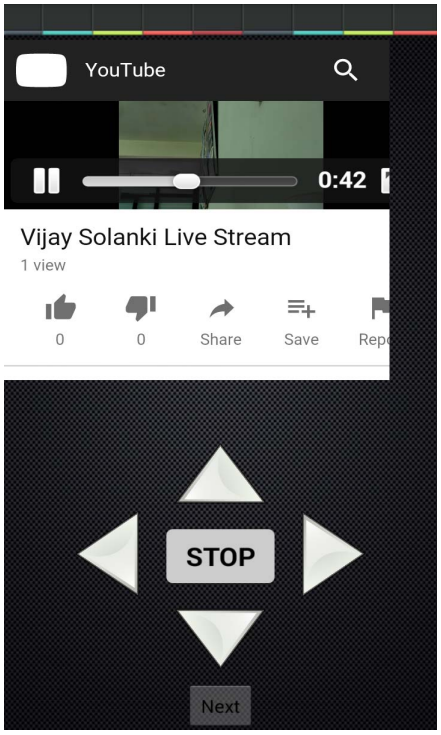

Fig. 5 Wi-Fi Bot Android App Page 1

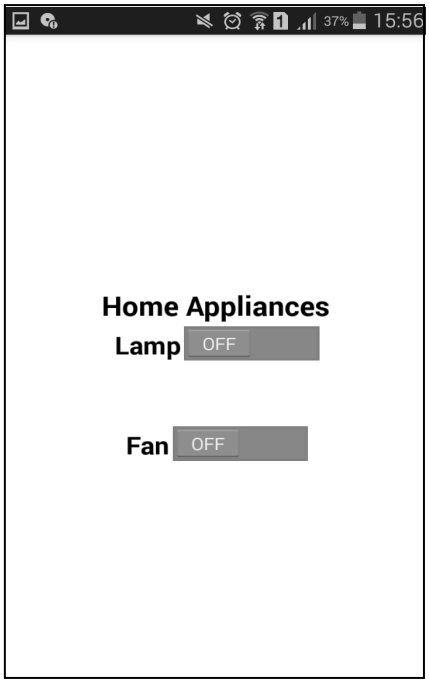

Fig. 6 Wi-Fi Bot Android App Page 2

VI. Conclusion

From the above results, it can be concluded that using this "Wi-fi based home surveillance bot" we can easily carry out monitoring and surveillance of our home. This system provides an economical, flexible and user-friendly alternative to the previously available security systems. The overall cost of this system is approximately one-third of the cost of the similar product available in the market. There is always a scope of further improvement which applies to this system also. Even though this system is at the experimental stage it performs all the desired operations and satisfies the objectives of this project.

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