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IoT Based Home Security System Using Raspberry Pi-3

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Abstract— Nowadays, Internet of things (IOT) enabled smart system has entered into a golden era of rapid growing technology. The Internet of Things is a concept to make every system connected with the Internet. This concept can be used for home security in an effective way. In this paper, we developed IoT enabled system to send security alert to user/owner of the home and registered members through email whenever human intrusion detection in front of home door. IoT enable home security system consists of raspberry pi-3, pi-camera, PIR sensor, Microphone, Ultrasonic sensor, buzzer, doorbell button, LED/LCD screen and internet connection. This paper suggests two operating modes for home security. In the first mode, whenever any person motion is detected and that person presses doorbell button, then system will capture an image and decide the person is familiar or unfamiliar with the help of stored database. If the person is not familiar then system will alert through e-mail notification to the user and registered members by sending captured image, video and audio clip of that person. If the person is familiar then system will capture an image of that person and stored in the system. In the second mode, whenever any suspicious movement of person is detected in front of door by system, it will send email notification alert and also activates security warning alarm system installed at the door. The designed system provides security against intruder, using IoT platform.

Keywords—IoT, Embedded System, Python, OpenCV, YOLO

I. INTRODUCTION

Internet of things (IOT) platform based smart device/system has entered into a golden era of rapid growing technology in the field of home security. The Internet of Things is a concept to make every device/system such as Internet TV's, smart phones and sensors connected with the Internet can be controlled and monitored from anywhere and anytime. There are various existing systems that are used for home security purposes such as Microcontrollers- based wired and wireless security systems, CCTV system etc., but they are much expensive and having limitation in range and accessibility to the user. In this research work, cost effective Raspberry Pi based home security system using PIR sensor

and Pi-Camera is designed and build.[1,2,10]. In this paper, a IoT platform based home security system is developed. Whenever human intrusion is detected in front of home door then system send security alert to user/owner of the home and registered members through email on his/her smartphone . This email alert will contain image of the Intruder which is captured by Pi-camera and also video and audio clip of the Intruder. Raspberry Pi-3 is used to control the whole home security system with Python programming. This system can be installed at the main door of user home or office, then user can get the email alert on his/her smartphone from system anywhere in the world over internet..

II. RELATED WORK

In the IoT platform based home security system, the main emphasis on protecting our loved ones and our belongings at home. Today numbers of IoT based home security systems are available in market. According to the literature and market survey, the common parameters of IoT enabled home security system are 24 hours monitoring and detection of the intruder, real time, cost effective and precise notification system suggested by various researchers. Following are the contributions of various researcher done in IoT domain.

Rani et al. (2018) explains the IoT based home security using Raspberry Pi which give SMS alert to authorize person through WAY2SMS and image of the unauthorized person via g-mail. Dinakar et al. (2018) proposed IoT based automated home security system using Raspberry Pi which gives intruder detection alarm and notification to the owner. Ghodke et al. (2017) explains in their paper how the IoT network based system send the information of any person image coming close to the door for home security to the owner. Anwar et al. (2016) explains the IoT based door accessibility and voice alerting through smart phone for home security system. Tanaya and Kishore (2016) explains the up-gradation of home security system with face detection technique using haar algorithm in open CV for the detection of authorized or design and build

unauthorized person. Chowdhury et al. (2013) describes IoT based remote access control system for authorized person at door using raspberry Pi. The internet connectivity, raspberry pi, pi-camera and PIR sensor, these are common components are used in the above references system. PIR sensor is used for detection of movement at the door and pi-camera is used to capture the image according to movement in all system. Few system gives the remote access for authorized person at the door step. Comparatively very less work is done on the human face and object detection algorithm.

III. SYSTEM ARCHITECTURE

The home security system based on Internet of Things (IoT) with additional capability to detect and recognize intruder using YOLO algorithm. The system is implemented on Raspberry Pi-3, because it can process captured image with low power and high processing speed. Raspberry Pi-3 equipped with all necessary electronics components (PIR sensor, Ultrasonic sensor, Pi-Camera, Buzzer, Speaker and Microphone) required for home security.

In this section we discuss architecture of the home security system approach as shown in figure 1. In the architecture of home security, a PIR sensor is used to detect the presence of any intruder person and it also work in darkness. A Pi Camera is used to capture the image of intruder when the presence it detected [3,4,5]. It works into two mode. In the first mode, whenever any person motion is detected and that person presses doorbell button, then system will capture an image and save it into database on 16GB Micro SD-card. Raspberry Pi processes the image to find out the intruders using YOLO algorithm with help of Python and OpenCV, then it is decided that the intruder is familiar or unfamiliar with the help of stored database. If the person is not familiar then system will alert through e-mail notification to the user and registered members by sending captured image, video and audio clip of that person as attachment. If the person is familiar then system will capture an image of that person and stored in the system.

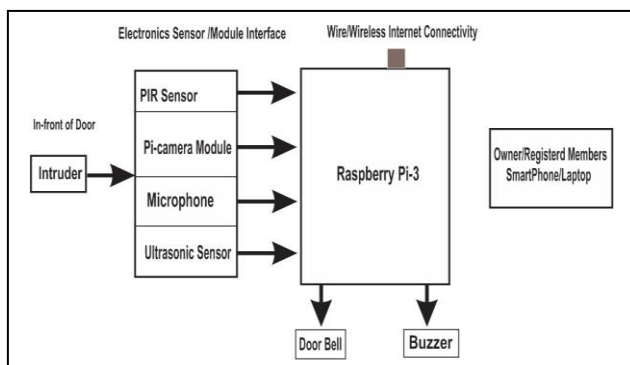


Fig. 1. System Architecture.

IV. SYSTEM COMPONENTS

In this section we discuss various electronics component used in the block diagram of home security system as shown in figure 2.

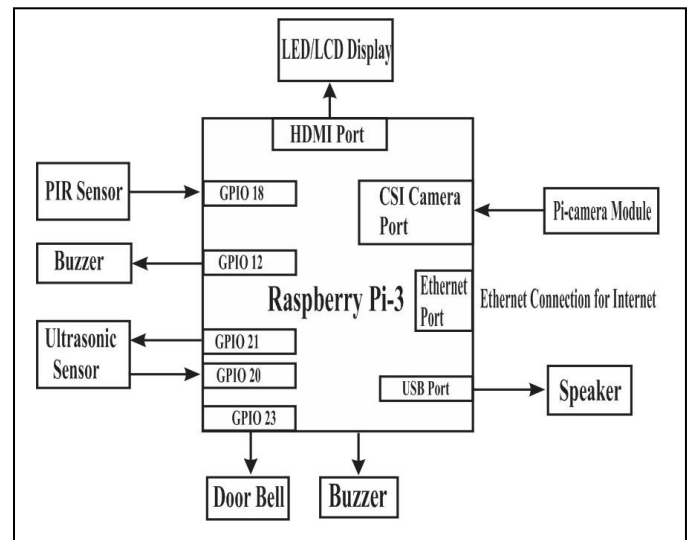


Fig. 2. Block Diagram of IoT based Home Security.

A. Raspberry Pi 3 : Model B +.

Raspberry Pi 3 Model B+ has a faster 64-bit 1.4GHz quad core processor, 1GB of RAM, faster dual-band 802.11 b/g/n/ac wireless LAN, Bluetooth 4.2, and significantly faster 300Mbit/s Ethernet. Raspberry PI-3 module is the main computational device. It performs signal fetching through sensors and processing the signal, and sending email after processing. It fetches the signal from PIR sensor, Pi-camera and Microphone and PIR sensors and send capture images to Home owner/ registered members via email services. USB ports and GPIO pins are required as connectors for connecting the sensors and devices [1,2,3,4,]. Figure 3 shows various component present on the Raspberry Pi-3 module.

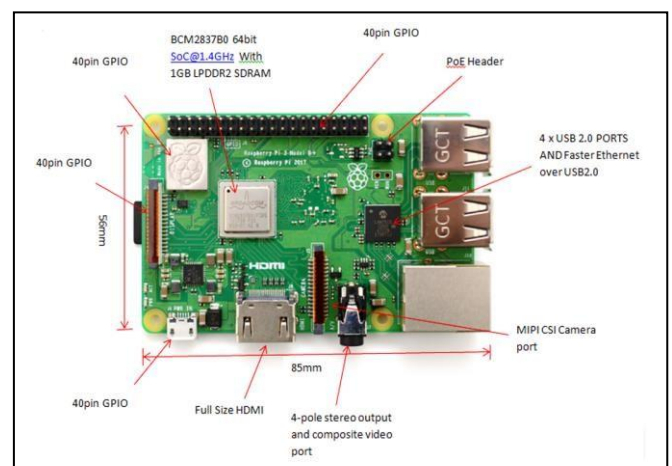


Fig. 3. Raspberry Pi-3 Model B+ Module

The main features of Raspberry pi-3 as follows:

- CPU: Quad-core 64-bit ARM Cortex A53 clocked at 1.2 GHz
- GPU: 400MHz Video Core IV multimedia
- Memory: 1GB LPDDR2-900 SDRAM (i.e. 900MHz)
- USB ports: 4
- Video outputs: HDMI, composite video (PAL and NTSC) via 3.5 mm jack
- Network: 10/100Mbps Ethernet and 802.11n Wireless LAN
- Peripherals: 17 GPIO plus specific functions, and HAT ID bus
- Bluetooth: 4.1
- Power source: 5 V via Micro USB or GPIO header

B. Pi Camera

Pi-camera is used to capture the images and videos of any intruder in-front of the home also record it into SD-card. Figure 3 shows Raspberry Pi-Camera module

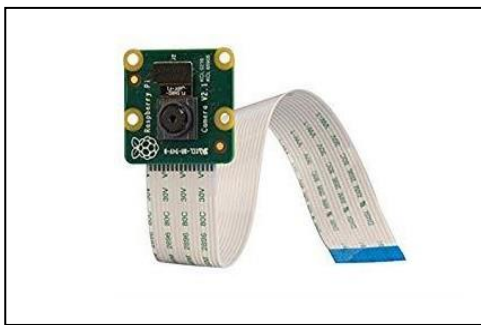


Fig. 4. Pi Camera

The Raspberry Pi Camera Board Features: [1,4]

- Fully Compatible with Both the Model A and Model B Raspberry Pi
- 5MP Omnivision 5647 Camera Module
- Still Picture Resolution: 2592 x 1944
- Video: Supports 1080p @ 30fps, 720p @ 60fps and 640x480p 60/90 Recording
- 15-pin MIPI Camera Serial Interface - Plugs Directly into the Raspberry Pi Board

C. PIR Sensor

PIR Sensor (Passive Infrared Sensor): PIR sensor is used as a part of movement detectors by measuring infrared lights which is transmitting from the object over sensor range. It also work in darkness [6,7,8]. Figure 3 shows PIR sensor module.

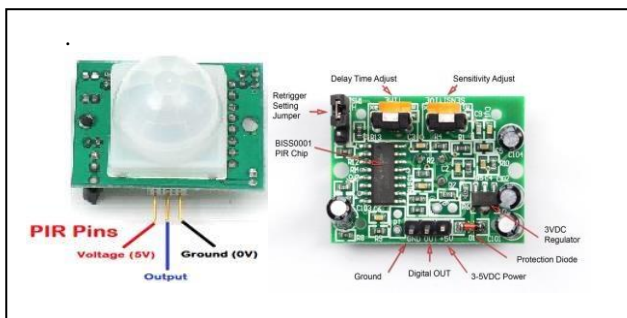


Fig. 5. PIR Sensor Module a. Front View b. Back View

In this section , we have used it for intruder detection in-front of the home. After detecting the person presence or movement in the predefined time, the camera attached to the system captures the image, video and audio and send an email to home owner/ registered members as attachment. The buzzer, Microphone, doorbell at owner home side will be ON in the predefined time. Images are stored at backend according to current time in system. Only the currently captured Audio, video will be available in the database [3,4].

V. SYSTEM WORKFLOW

The system Algorithm is as follows

1. Keep the system charged and ON for 24X7.
2. Initialization of all the peripherals attached to the system.
3. The PIR sensor will sense the intruder and Pi camera will capture the image. After that it works in two modes (The system works in two mode) Presence of user and in the absence of user at home.

TABLE I. SYSTEM WORKFLOW

MODE-A (When the user is at home)		MODE-B (When the user is not at home)
If doorbell is PRESSED by the intruder	If doorbell is NOT PRESSED by the intruder	If any suspicious movement is observed at entrance/door
The captured image will be compared with data base.	The captured image will be compared with data base.	The captured image will be compared with data base.
If captured image is as per data base.	a) If captured image is as per data base, then notification will be given to owner and registered members. b) If captured image is not as per data base i.e. new image found, then notification will be given to owner and registered members. An alert alarm will be activated	a) If captured image is as per data base, then notification will be given to owner and registered members. However, no alarm will be activated. b) If captured image is not as per data base, then notification will be given to owner and registered members. Alert alarm will be activated.
No alert alarm will be activated and door can be opened.	Door can be opened by the person available at home as per notification.	

VI. SYSTEM SOFTWARE

The home security system is implemented on a Raspberry Pi-3 development module in Linux environment-Raspbian OS, which supports SMTP (Simple Mail Transfer Protocol), TCP/IP, HTTP. YOLO (You Only Look Once) a method to do object detection. It is the algorithm used for intruder person detection with the help of OpenCV and Python coding. The system is fully functioning by sending an Email alert to registered members after the detection of intruder.

The following library module files are imported on python script.

```
import numpy as np
import argparse
import time
import cv2
import os
import picamera
import imutils
import dlib
import cv2
import matplotlib.pyplot as plt
```

VII. RESULT AND DISCUSSION

In this section, we can see the results of IoT based home security system which is implemented in prototype with all the system components as shown in figure 6. (a),(b),(c), and (d).

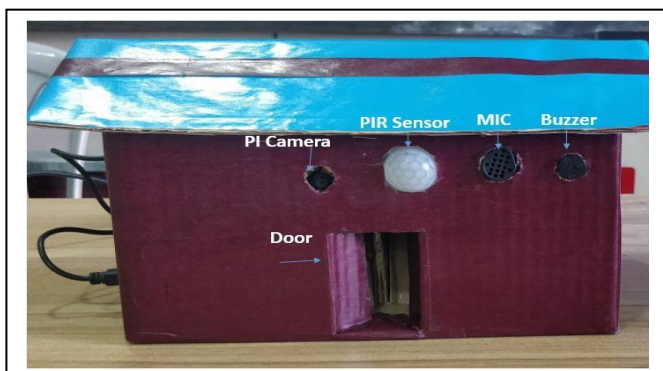


Fig. 6. (a). Prototype of home security System
The prototype of home security systems is tested as shown in figure 6. (a).



Fig.6. b. Final Home Security System

The final home security systems is tested as shown in figure 6. (b).

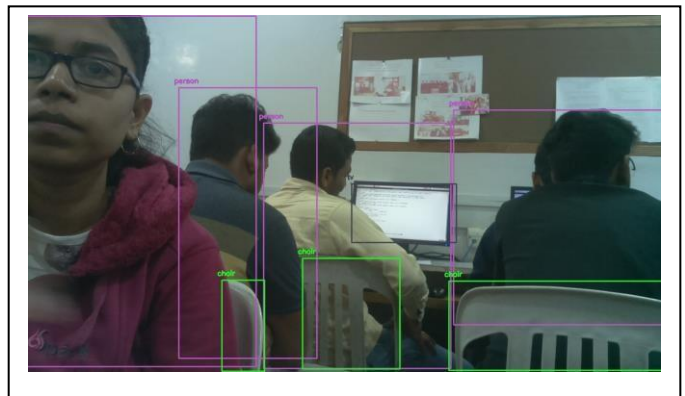


Fig. 6. (c). Object and person detection using YOLO

The final home security systems is tested as shown in figure 6. c.

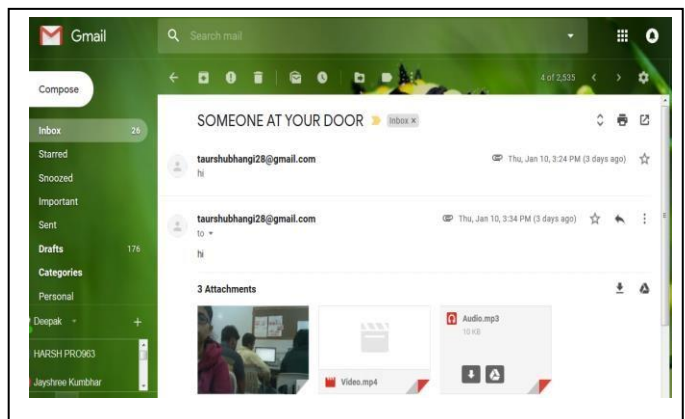


Fig 6.(d). Screenshot of E-mail alert on Internet browser

VIII. CONCLUSIONS

The IoT based home security system has been designed and developed with RaspberryPi-3, Pi-camera and PIR sensor. The user can get alerts anytime and anywhere through e-mail on smartphones or Laptop. Whenever any unknown or suspicious movement is detected, its gives loud alarm. Hence, the designed system successfully prevent access to any unknown person entering the home.

IX. FUTURE SCOPE

The further extension of this paper is real time surveillance and Artificial Intelligence. To record direct videos and send to nearest police stations and also send alert voice messages to authorized persons.

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