An Advanced Internet of Thing based Security Alert System for Smart Home

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Abstract—Before inception of Internet of Things (IoT), personal computers and laptop were used to handle daily tasks of individuals like mail surfing, access to bank portal, observing current temperature, among others. Nowadays, IoT-enabled smart devices like smart mobile phones, PDAs, and tablets are being used by them for such tasks due to rapid growth in IoT. Smart homes have been widely accepted by individuals and organizations world wide due to their many advantages. Home security systems can be defined as monitoring of complete home/some portion of home from a remotely located or centralized location. It allows the user to watch all activities inside the home from a remote location that ultimately gives satisfaction to the owner of the home. Many home security systems exist, but they have some challenging issues like: delay, non-web enabled and difficult to handle during transfer of alerts to user in situation where any unusual event occurred inside the home. If any unusual event encountered inside the home, where security systems deployed, then system must be capable enough to send alert to the user without any delay by phone, text, or email. Cameras and other latest network technologies have enabled us to remotely monitor the home more effectively and efficiently from our smart phone. Hence, considering the above mentioned facts, in this paper, we have proposed an advanced Internet of Thing based Security Alert System for Smart Home in order to detect an intruder or any unusual event at home, when nobody is available there. This low-cost home security system utilizes a small pyroelectric Infrared (PIR) module and raspberry pi for minimizing the delay during process of e-mail alert. This paper also confirms the advantage of Raspberry Pi flexibility and broad probability of its usage. Preliminary analyses have shown encouraging results.

Index Terms—Home security, Internet of Things, PIR sensor, Raspberry PI.

I. INTRODUCTION

IoT emerged the idea of remotely monitoring objects through the Internet [1, 2]. When it comes to our home, security is crucial issue to the general public. Currently, the increments of wrong doing identified with the house was numerous. As to diminished that proportion this thought gets to be distinctly conceivable that expanded the security level of home. The shrewd arrangement is that make our home as advanced home in the security viewpoints. In prior days, we have one pet at our home for the security, but the situation has changed turns out to be current days. Individuals begin accepting on the innovation to attains some level of security in household. From these circumstance, we are spurred to make such system that would be prepared for society or businesses

give security [3]. On the off chance that one can not accessible at home and theft was occurred at your home that would give you a major inconvenience. This abruptly address ascend as a primary concern who illuminates you're that your home is not protected! This framework is the response to the issues as mentioned above and can advise about burglary at your home instantly with the picture of your home current movement.

For enhancing the security of home this framework is used by owner of the house. Assume you are not at home and a thief enter at your home then this framework will give a caution through the burglary action. At a point when the thief movement is beginning at your home then the PIR sensor is connected with the framework and sensed the action happened at home. After that, it offers flag to the raspberry pi. Raspberry pi is computational circuit which processes the information inside it. Therefore, with help of raspberry pi it can offer flag to another segment. Here, we utilize the camera for catching the present action of your home. Camera is catching the picture and offer back to the raspberry pi with the goal that it sends the email to the owner whose mail id was already put away inside it. The email is send through IMAP (Internet message get to convention). For that the raspberry pi is associated with the Internet through either RJ45 or the WIFI module. Assume owner is outside the state or nation, still user get the alarm for robbery in the form of email. So, he/she can educate his/her neighbor or advise the police that house is stuck in an unfortunate situation. According to the survey conducted by various agencies [4], in which technology is major concern for comforts and individuals accept new technologies and year wise up-gradation in technology, smart home market revenue and reasons for adoption of technology are described in Figure 1.

A. Motivation

Gaps in the literature motivates us for providing the more efficient security for the society, so that society can live without any fear. This work reduced the threats in the society related to home theft. Remote access to the owner so when every member of family is not at home one person can monitor the home all the time. Society need a system that can inform about theft at home to owner, who is when far away from the home. Keeping above mentioned motivations, next section highlight the research contribution of this paper.
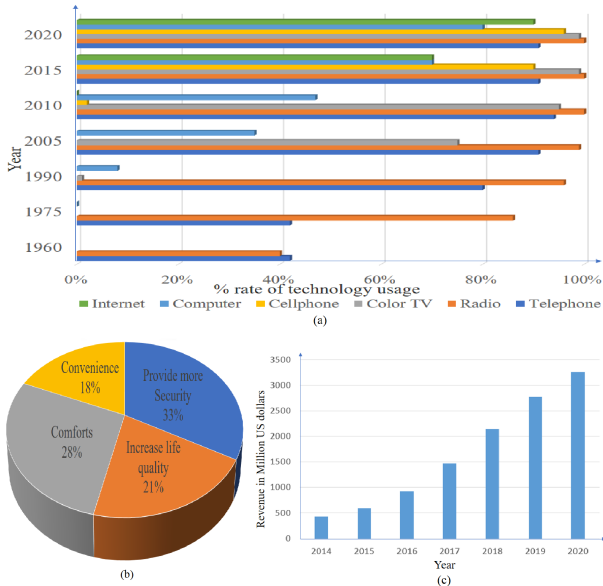
Fig. 1. (a) Evolution of Technologies, (b) Smart Home Market Revenue, (c) Home Automation Adoption Reasons

B. Research Contribution of This Paper

Research contribution of this paper are as follow

- We have presented an architecture that provide security for home and some restricted places like army area, government as well as private places etc. Also, the owner/administrator can get an email alert, contains the images of their house, regarding the theft.
- From the proposed hardware module, any immediate decision can be taken as on when required (during occurrence of theft at home).
- We have tested the performance of proposed hardware module over other existing approaches.

The rest of the paper is organized as follows: Section II highlights previous work done by researchers in this domain with pros and cons. Section III formulate the problem statement. Section IV presents the proposed hardware and its components. We have presented the performance evaluation results scenario wise in section V and finally, section VI concludes the paper with future scope.

II. RELATED WORK

In this section, we are presenting earlier home security system suggested by various researchers. Following are the contributions of various researcher done in this domain:
K. Balasubramanian *et al.* [5] proposed home automation and security system which can remotely control the home appliances and alert owner on presence of intruder and occurrence of fire at home. This include motion detection and intruder detection in sensor circuit and LDR (light dependent resistor) and RF were exchanged. Dey S. *et al.* [6] worked with web based home security system utilizing Arduino Uno micro-controller with Wi-Fi switch. Router was used to provide an IP address through an Ethernet module to the device. This

ethernet module provides a static IP address, so that all devices related with same router uses TCP/IP based communication. Arduino Uno micro-controller, where the server program for controlling is executed. Thus, it does all the control over the system.

P. Vigneswari *et al.* [7] introduced smart automated security system with surveillance. When an intruder entered the room, camera should be switched on and it captured pictures of an intruder. The user was cautioned by sending SMS (short message service) through GSM (global system for mobile) modem. Shaligram A. *et al.* [8] introduced home security system based on GSM technology. They proposed few techniques for home security framework. The first one used web-cams for security alert to the owner, when there were movements in front of the camera. Second technique sent SMS with the help of GSM and GPS Module. Main controller used in it was Atmega644p micro-controller, which captured signals from sensors, and based on signal makes its decision and sends situation over SMS. Android interface will be helpful for build easy Home security approach [9]. In this system, user will get real-time status of house weathers it is secured or not and any unwanted motion occurred in house can be detected by the PIR sensor.

Sharma R. K. *et al.* [10] introduced Android based GSM home security. An android application, which interprets message and consequently answer with SMS that turns on the buzzer. Through GSM modem, signal goes to the mobile phone as SMS alert. The android application instantly triggers a pop-up notification, informing about interruption in the house. Authors have also added a face recognition system here as an extra security features. When any intruder's face is recognizing by the system, then system sends the capture images to owner device. Home security based on face recognition also used in proposal [11]. They used wireless network such as ZigBee and image processing technique PCA. After capturing the signal, it send an email and additional SMS via GSM network. Wireless Information Units and Wireless Control Unit that exchange control information. Raspberry PI micro-controller was used for central control. Kumar M. *et al.* [12] introduced intruder detection and alert system using three processing units, a micro-controller, a raspberry pi single board computer and a PC. The micro-controller unit wirelessly sends an intruder alert to central PC in case of an intrusion, via ZigBee protocol.

Anwar S. *et al.* [13] introduced IoT based smart home security system with alert and door access control using smart phone. A PIR motion sensor and camera module were used to detect motion and capture images respectively. Features like view video stream through mobile phone were added in system. Additionally, voice alert or siren activated to alert neighbors when intruder detected. One can also use LCD monitor for setting up Raspberry web server. Kodali R. K. *et al.* [14] introduced IoT based Home Security. They sent alert to the user through Internet if there should be an occurrence of any trespass. This alert contained voice calls through Internet. If the entered person in house is not an intruder but an unexpected guest, then the owner make arrangement

to welcome his guest. Their is need to integrate the system with cloud to provide better services to the owner of the house [15]. Cloud system used a PIR and IR sensor, and ARM7 micro-controller as a central controller. This approach framework sent messages after identifying intrusion via GSM module. Each webcam installed in house having an IP address, so owner easily monitor the home. In this system captured evidences are stored over the public cloud.

A. Focus of The Paper

After gone through the literature exist on the topic, we have observed that the relevance of real-time/less delay as a potential parameter for home security. The novelty of this paper is its real-time E-mail alert system in home security and inclusion of other important parameters of home security like delay, not web enabled, and difficult to handle during transfer of alerts to user in situation where any unusual event occurred inside the home. Further, this paper focused to provide efficient home security system to the owner at low cost as the number of IoT enabled devices keeps on increasing in coming time.

III. PROBLEM FORMULATION

Security checking system requires information transmission and quick response. Clients can put gadgets unreservedly at vital areas to get beneficial information. At the end of the day, this system must be convenient and easy to use. Slow system is appeared to be direct and straightforward, with the goal that clients can make imperative quick move. The system must not be hacked by anybody, regardless of its different routes including info source control, the substance of information transmission, substance of getting information and area of security sensor gadget's primary processor is put away. The system should likewise have attributes, e.g., high temperature safe and strong, so that information transmission process and information accepting won't come up short. Security systems have some restrictions on the utilization of sensor gadgets. These issues will bring about constraints on the security systems. In any case, it is inescapable that a security system requires broad utilization of sensors for the system to work effectively and have the capacity to identify protests in each range of the house. The utilization of sensor gadgets is likewise imperative in security systems. Sensors must work on the most proper range, that is not very close and excessively far off, making it impossible to identify development and ought to accord to the human instinct. Next section described each component used in the proposed approach in brief.

IV. SYSTEM ARCHITECTURE AND COMPONENTS

In this approach we have considered two scenarios, as shown in Figure 2. The first scenario, as in figure 2 (a), shows the overall system configuration and components attachment in house with no intrusion. Second scenario, as in figure 2 (b), shows the email sending procedure after the intrusion detected in house. Over all architecture of the proposed approach with function of all modules shown in Figure 3. Specifications of the components used for monitoring the intrusion in house are
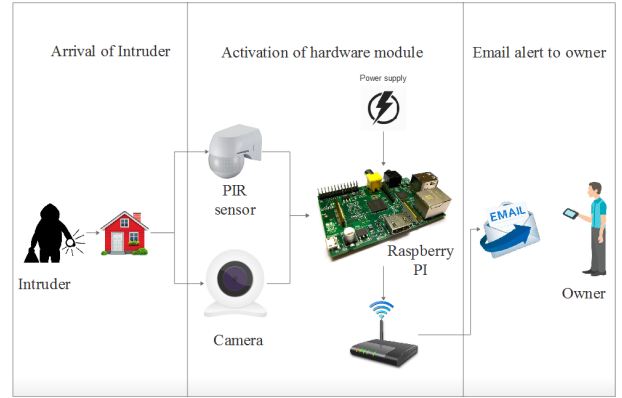

Fig. 3. Main architecture of proposed approach

TABLE I
SPECIFICATIONS OF COMPONENTS

Component Name	Description
Raspberry PI	Raspberry PI 3 Model B, ARM Cortex-A53, 1.2 GHz 64-bit quad-core ARMv8 CPU, 1 GB RAM, 802.11n wireless LAN
Web Cams	USB 2.0 security camera with night mode for external security
PIR Sensor	Hc-Sr501 Pyroelectric Infrared PIR Motion Sensor Detector module

summarized in Table I.

For hardware implementation, we utilize the Raspberry PI 3 Model B as overall system computation device. Complete working hardware module of the proposed approach is shown in Figure 4. PIR sensors and security camera are connected with Raspberry PI which automatically send signals to Raspberry PI when intrusion detected.

A. Component Description

Raspberry PI: We have used Raspberry PI in proposed approach as main computational device. It performs signal fetching and processing, and email sending processes. It fetches the signal from webcams and PIR sensors and send capture images to Home owner via email services. We require
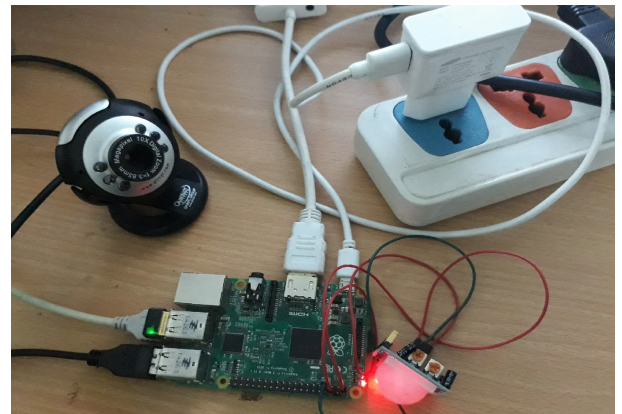

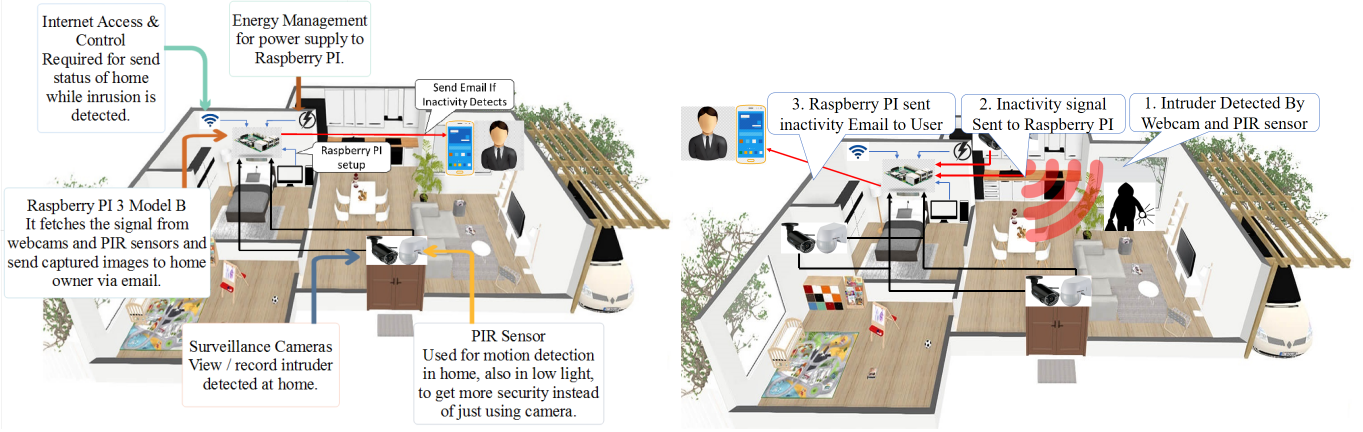Fig. 4. Hardware Module of Proposed System

Fig. 2. (a) Home Security Scenario-1, (b) Home Security Scenario-2

TABLE II
DEFINITION OF DIFFERENT VARIABLES

Abbreviations	Terms
G_u	Sender ID
G_p	Sender password
T_o	Receiver email ID
S	Subject of mail
T_{xt}	Email textual content
S_N	Input number, sensors
P_S	Sensor previous state
C_S	Sensor current state
C_{ap}	Capture image and storing in temporary space
P_N	Date & time, set as image name
M	Message / mail object
I_{NT}	Intrusion
P	PIR sensor signal status
C	Camera images
E_M	Email alert with captured images

USB ports and GPIO pins as connector.

Webcam: Webcam is used in proposed approach that captured the images of any inactivity happened in home while user is not available at home. Webcam and PIR sensor detects any inactivity in home and instantly send signals and capture images to Raspberry PI.

PIR Sensor (Passive Infrared Sensor): PIR sensor is used in proposed approach that frequently utilized as a part of movement detectors by measuring infrared lights which is transmitting from the object over sensor range. For home security, we have used it for motion detection in home. PIR sensor also work in darkness, so we get more security instead of just using camera for detection.

Different variables used throughout the paper are defined in the Table-II. Next sub section includes the systematic execution of the proposed approach with algorithm.

B. Algorithm

Based upon the above discussion systematic execution of our proposed scheme is presented in the form of algorithm 1. In algorithm, first of all signals of the PIR sensor is taken from the GPIO pin, Which are attached with the Raspberry PI. If

the previous signal(P_S) and current signal (C_S) are same then there is no interrupt means exit from algorithm. If any signal is detected so that C_S and P_S not matched than this indicate the presence of intruder inside the home. Then camera attached with the Raspberry pi start capturing the image and store it in the temporary storage available to the system. Finally, the system defined mail can be sent to the user id of owner of home with fixed subject.

Algorithm 1 Pseudo code of Proposed Approach

1: **Input:** I_{NT}, P, S
2: **Output:** E_m
3: C_s= GPIO input (S_N)
4: **if** $P_s = C_s$ **then**
5:     Return exit
6: **else**
7:     Cap picture (USB)
8:     Attach = $P_N(USB)$
9:     Send email (M, T_o, T_{xt})
10:     Alert!!
11:     Take-appropriate action(user)
12: **end if**

V. RESULTS AND DISCUSSION

We have tested proposed approach in the real environment with sensors placed in the room. We have considered three different scenarios to validate proposed approach. In scenario 1, we are monitoring the room with motion sensors and camera, as shown in Figure 5(a). In scenario 2, an intruder detected by system, as shown in Figure 5(b), and in scenario 3, system sent captured images to owner via email, as shown in Figure 6. Above experiment was performed on third generation cellular phone, however, same could be performed using fourth generation cellular phone and captured video could also be send to the owner. Depending on the quality of camera better picture or video of the intruder could be captured and transfered to the owner. In future, proposed model could be updated by including the GPS system and transferring the

Fig. 5. (a) Room monitoring with motion sensors and camera, (b) Intruder detected by system
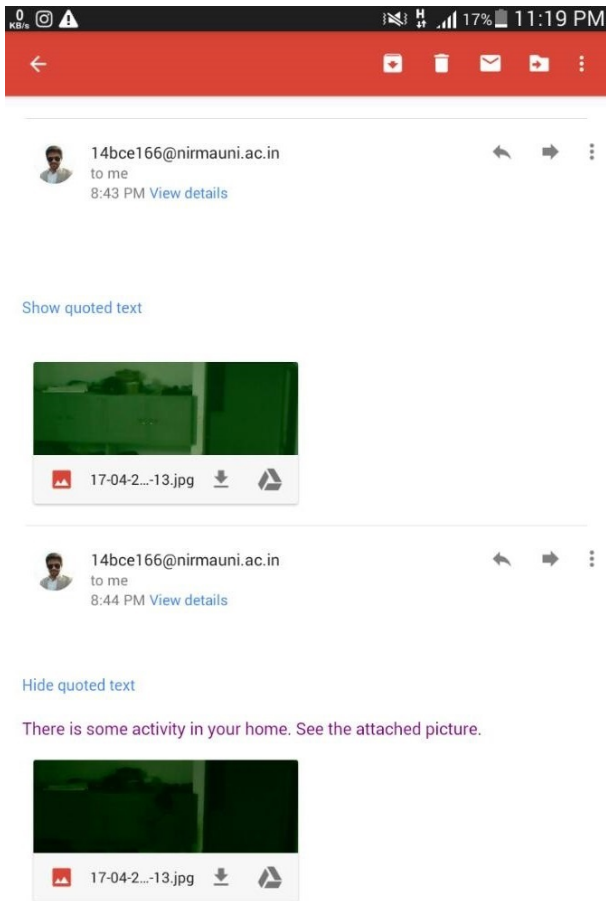

Fig. 6. Proposed approach sent captured images to owner via email

captured image or video to the nearest police station by closing all the entrances of the smart home.

VI. CONCLUSION AND FUTURE SCOPE

Suitability of IoT, in the context of the home security means integration of all devices and their monitoring, controlling and alerting in ways not possible before. In order to address the issues of flexibility, low cost home security and monitoring system using Raspberry Pi based Web services, in this paper, we have proposed An Advanced Internet of Thing based Security Alert System for Smart Home, to detect an intruder or any unusual event at home, when nobody is available there. With improving the security in smart home, the result of proposed approach has met our expectations, where attached sensors are properly working in real-time scenarios. Here system starts once without user input and further it automatically send email to owner on any intrusion detection and owner take necessity action. It can be concluded that the proposed system present the basic level of home security and remote monitoring while the required objectives of home security system have been achieved. This low-cost home security system has minimum delay during process of email alert. This paper also confirms the advantage of Raspberry Pi as the flexibility in-terms of cost and broad probability of its usage. Preliminary analyses have shown encouraging results. In future, we will apply fog computing in our proposed system in order to minimize the propagation delay and to enhance the security level of smart home.

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