IoT Based House Intruder Detection and Alert System

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ABSTRACT

This research aims to design and implement a home security system with human detection capability. Traditional home security systems, i.e., Closed-Circuit Television (CCTV) can only capture and record videos without the ability of giving warning feedback if there is any suspicious object. Therefore, an additional object detection and warning method is required. The proposed design is implemented using Raspberry Pi 3 and Arduino, that is connected by USB cable. The PIR sensor is installed on Arduino and webcam is mounted on Raspberry Pi 3. The Raspberry Pi 3 is used to process inputs from sensors and process images for human detection. PIR sensor detects the movement around the sensor to activate the webcam to capture a picture. Then, the object recognition is performed using Histogram of Oriented Gradients (HOG) and Support Vector Machine (SVM) to detect the suspicious object.

1.INTRODUCTION

House is a residential building, an asset, as well as a place to store wealth. Therefore, security becomes one of mandatory considerations in keeping the house from undesirable events or accidents (Eseosa and Promise, 2014). The traditional solution for house security is a Closed-Circuit Television (CCTV). CCTV is a device for monitoring the situation around an office area, house and building. CCTV is also useful for monitoring the situation around a house, both when the residents are at home and when they are not at home (Bangali and Shaligram, 2013).

Despite the benefits, there are some problems related to the use of CCTV. Firstly, CCTV does not produce any notification and warning whenever it captures any suspicious object. Secondly, CCTV streams continuously to capture events that occur in the home environment even when there is no suspicious object or activity. Therefore, the streaming requires huge consumption of bandwidth and storage media due to the continuous video streaming and storing. Internet of Things (IoT) is a network of interconnected electronic devices capable of sendingdata without interference or with minimal human intervention. This technology has been widely used for smart city application, personal health monitoring, manufacturing and smart lighting. Some researchers have developed security monitoring system based on IoT concept (Charadva et al., 2014; Chitnis et al., 2016). They utilize the capability of sensors, e.g., Passive Infrared (PIR) motion sensor, door open sensor, glass break detector to monitor the occurrence of any suspicious activity. The system is also equipped with feedback mechanism which warns the house owner if there is any intruder entering the house. In general, this technology offers better protection compared to the traditional CCTV

2.PROPOSED SYSTEM

Based on the problems faced, an IoT system with an additional capability of detecting and recognizing intruders using HOG and SVM methods is proposed (Dalal and Triggs, 2005; Satpathy et al., 2014). The system is implemented on Raspberry Pi 3 (Kumar and Reddy, 2016) and Arduino (Abdullah et al., 2016; Badamasi, 2014). The Raspberry Pi 3 is used because this board can process image processing with low power from computer and laptop. Arduino is used to integrate the electronic devices in one environment. To detect the motion, the PIR sensor is utilized

The system is implemented on Raspberry Pi 3 and Arduino. The evaluation of the system includes the measurement of accuracy and delay of intruder recognition. The system is expected to recognize the intruder accurately in the shortest time. This paper is an extended version of our previous published conference proceeding (Surantha and Wicaksono, 2018). In this paper, the literature review and the explanation of HoG in detecting objects are extended. More experiments are also conducted to evaluate the performance of the system

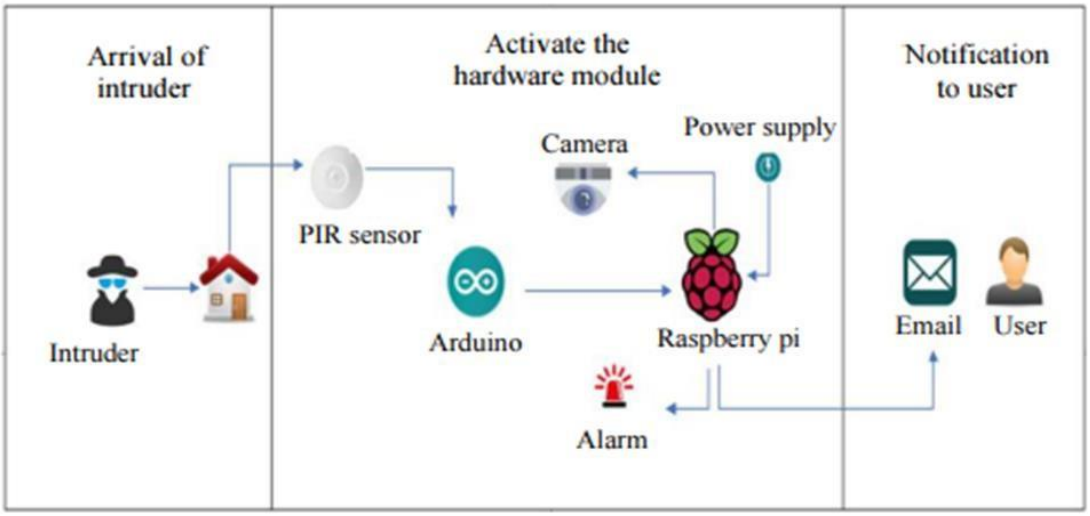

Fig1: Proposed system Architecture

3.LITERATURE SURVEY

Zaied Shouran, Ahmad A, Tri P Kuntoro, "IoT of Smart Home: Privacyand Security", in International journal of computer Applications 2019.

The progress of information and communication technology in the era of globalization is a phenomenon that presents a big challenge for thecompany to continue to grow and develop.Application of the proper security system and the availability of many security tools that are either pro or anti become a challenge for the emergence of system vulnerability.In this paper, author proposed the design of smart home by using raspberrypi and computer vision technique. Raspberry pi manages devices control,video camera recording and motion sensing while computer visiontechniques detect the presence of intruder.

Anamika Chauhan, Rajyavardhan Singh, Pratyusha Jain,"IntrusionDetection System inInternet of Things", in IOP (Institute of Physics) Publications 2020.

This paper presents a comprehensive description, from a security and accessibility perspective, of various security automation systems and technologies.For everyone who owns or rents a home, home security should be a top concern.Every individual needs a safe and secure residential space. Most of themarket's security systems; however, are either costly or unsafe.

Muaadh A. Alusoufi, Shukor Razak, "Anomaly-Based Intrusion Detection Systems in IoT using Deep Learning", in Multidisciplinary Digital Publications Institute 2021.

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4.IMPLEMENTATION

1. PIR Sensor on Arduino :

Programming for motion detection using PIR sensor is performed on Arduino IDE application. The source code is then embedded into Arduino by connecting the Arduinowith a computer using a US cable and the programs are downloaded to Arduino

2. Raspberry Pi 3:

a. Raspbian Stretching. Open CV and Python

The operating system used for Raspberry Pi 3 is Raspbian Stretch. This operating system can be downloaded on the official Raspberry site. After Raspbian Strech is installed, the applications required on Raspberry Pi 3 are Open CV and Python to run HOG and SVM. For the computer vision library, opencv 3.3.0, open cv_contrib and Python 3.0 is used in this research.

b. Camera:

The webcam camera function uses the fswebcam library. Then the .sh file is created with a program script. The resulting photo is 640×480 pixels and the FPS parameter 15. The purpose of the low-resolution setting is to perform the photo process quickly, i.e., less than 1 sec.

c. Alarm:

The Alarm function on the Raspberry Pi 3 already supports the gpiozero pin interface. Therefore, the alarm can be used immediately.

d. E-mail:

To send an email using SMTP, some configurations are conducted. In this study, two emails with the Gmail domain is utilized. The first e-mail address is rpiserverxxx@gmail.com, used as server initialization (from e-mail sender, from) and second e-mail address

rpiserveryyy@gmail.com, used as the recipient. Then, the email as the sender and recipient's email are configured. The configuration is performed on the sender and recipient's gmail account in order to allow the less secure applications, therefore email can be sent automatically without any problem.

e. Network:

For networks, WiFi is used as media for internet connection. Static IP is used for IP configuration. These settings aim to facilitate connection and remote access to Raspberry Pi 3

3. Training Dataset:

Dataset training is not performed on the system. In this study using a dataset providedby Open CV. The function is HOG Descriptor _get Default People Detector().

5.HARDWARE DESIGN

This section outlines the hardware design. The hardware design includes the selection of electronics equipment and the integration of all of components. Figure 3 shows the hardware design for our security monitoring system. Meanwhile, the specifications of every component are presented in Table 1. The number in Fig. 3 corresponds to the order of component in Table 1. For processing module, we use Raspberry Pi 3 model B. This board is equipped with wireless LAN module for communication. Arduino is used to collect the signal from PIR sensor through jumper cable. Arduino is connected to Raspberry Pi via USB cable. To capture the picture, USB webcam is mounted to the Raspberry Pi 3 via USBcable. To release warning, buzzer module is connected to Raspberry Pi 3 through GPIO port. The Raspberry Pi 3 is also connected to the internet so that the system has the abilityto send an email notification.

5.SOFTWARE DESIGN

After the hardware design, software was then designed. Firstly, we create a use casediagram as shown in Fig. 4. The user starts activating the system in Rasp-berry Pi 3.

Algorithm: Motion Detection in Arduino
Declare:

Pin, pirState, val := 0,

Algorithm:

1. **While** val <> 1 do
2. **If** pin: = HIGH
3. **If** pirState := LOW
4. val := 1
5. pirState := HIGH6 . **Else**
7. **IF** pirState := HIGH
8. val := 0
9. pirState := LOW
10. **End While**

6. RESULTS AND DISCUSSION

In this section, the accuracy of detection is described. The experiment used 2 objects, which are human (the true-event) and animal object (the false-event). The tests include checking from the start of the detection until the alarm is activated.

Figure 2 shows the result of the processing time. The x-axis indicates the index of experiment (the total experiment is 100 times), while the y-axis indicates the measured time in seconds (s). Blue line indicates time to take pictures. It means the time started from the PIR sensor detects the movement until the photo is taken. Red line indicates time for human detection

Fig 2. Human detection

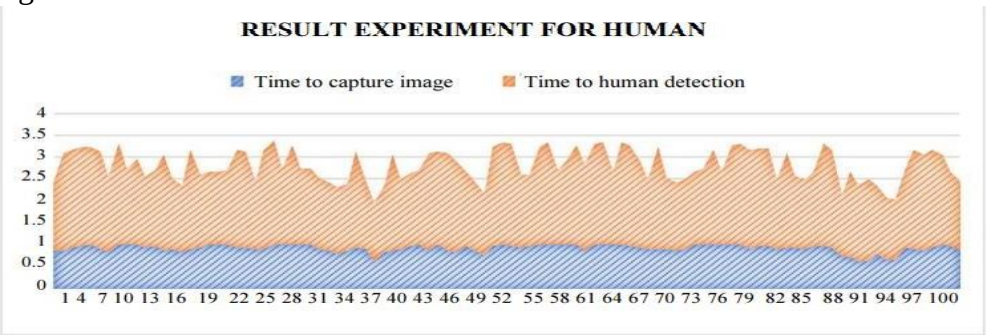

Fig 3. Animal detection

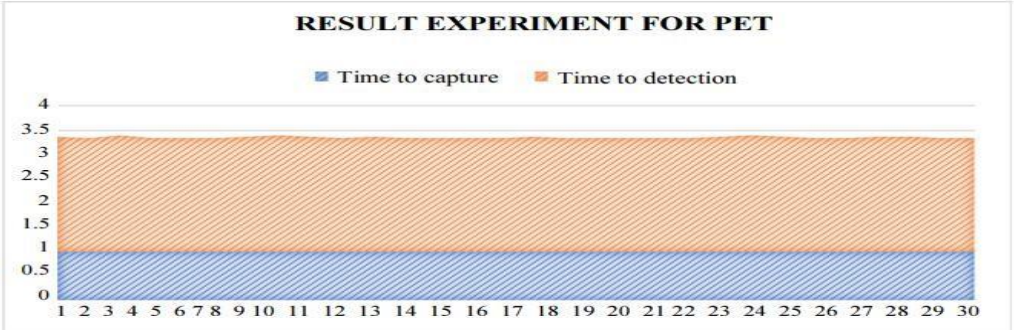

Table 2: Confusion matrix table

		Prediction	
Total sample = 130		Negative	Positive
Actual	Negative	TN = 28	FP = 2
	Positive	FN = 11	TP = 89
Accuracy: (TP+TN) / (TP+FP+FN+TN) = 0.9			

Table 3: Comparison result

No	Works	Method	Sensitivity	Time detection (second)	System accuracy
1	Patidar *et al*. (2014)	Change detection technique	-	-	86% (at 5-6 frames/second)
2	Our proposal	HOG + SVM	98%	1.9044	90%

- average time for human detection : 1.91 s
- average time for animal detection : 2.35 s

7.CONCLUSION

This paper has proposed a security monitoring system based on IoT technology. The proposed system consists of Raspberry Pi 3, Arduino, PIR sensor, webcam and buzzer. The novelty of the system is the inclusion of human detection capability by HOG and SVM method and buzzer as method to warn the house owner. The simulation results show that the system can detect an intruder within seconds with accuracy of 90% with processing time around 2 seconds. Future research will explore other feature extraction and classification method to improve the accuracy of intruder detection

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