Secure Internet of Things Based Human Detection in Computer Vision

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Abstract

Billions of the objects around us are transformed to the IoT device by connecting them with the internet and control in that way of collecting and sharing data. Privacy is required to keep the data save from the security attacks in internet of things. Computer vision is used for monitoring the people. Computer vision algorithms, application and tools are primarily used in IOT for human movement's analysis. Traditional system and algorithms are unable to detect the human in a perfect manner. Use of the thermal camera is degraded the movements of human detection. In this paper we propose a new IoT system that is combined with the latest feature of computer vision to detect the position using computer vision. It is a useful technology that helps to keep an eye on your house and office. It will alert you if anybody enters your home or office and do any harm at your place. For that purpose, the credit card size Raspberry PI card will be used. Histogram of oriented gradient (HOG) algorithm is used to detect the person in the image.

Keywords:

Computer vision, Internet of Things, Raspberry PI, Histogram of oriented gradient

1. Introduction

With evaluation of time, internet of things (IoT) plays an effective role in our lives ranging from a small toy to the large industries. It is a fast-growing technology that is used to interconnect the entire world by using the embedded sensors to enable them to exchange and share the information (Lakshmi Boppana, 2016). The things that are connected to the internet in IoT are not only the physical objects but also can be the data of a virtual world that make the IoT applications.

IoT is a source for interaction between digital and virtual and physical and real worlds. The physical part represents the counterparts like devices and equipment, mean the touchable things and the virtual part presents information, data, knowledge, they can interact with them. In different software application, with the help of decision making intelligent algorithms data can be collected by physical entities and respond in seconds. These basics facilities provide a new concept of IoT as like smart environments (smart buildings, smart homes), smart transportation, energy consumption, agriculture and defence.

So people live in the era of information and in this era, the security constituents are considered as one of the most important section for our lives. The smartest feature of system security is the home automation that widely helps you to make your life much easier. Lots of smart objects are running in the effective way to perform various tasks and provided with the internet of things (IoT) [12].

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1.1 Computer Vision and IoT

In IoT platform, an interesting application is used with the ability of monitoring the people called Computer vision [11]. Computer vision is linked with the artificial intelligence that enables a computer or a machine to see, identify and process the image to provide an appropriate output based on the

Observation. As the IoT devices are widely using all around the world to generate the huge amount of data via the internet and used as a security system. In order to enhance the security system in IoT platforms these devices are combined with computer vision for the detection and monitoring features for the security purposes [11].

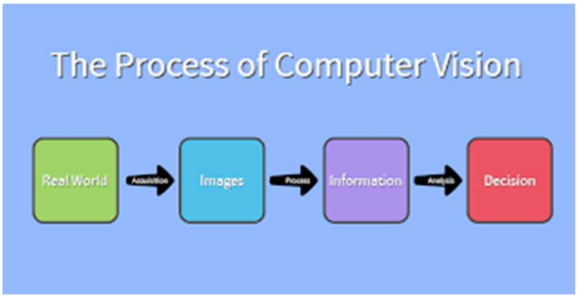


Figure 1: Computer vision process [9]

1.2 Role of Computer Vision in IoT

Computer vision cannot working well alone it will do batter with IoT, many application of IoT is used for detection of human accurately. The IoT provide the greatest security platform to computer vision such as smart home intelligence devices. In this way IoT provide security capacity since they have done recognition of a man either it is authentic or not and it is not harmful for environment [3]. IoT fulfil our security need. Interconnected sensors are used to get the information as well as a unique system to perform an automated task in any place. Sensors are of various types that play a vital role in the field of the security system that are noise detector, Passive Infrared Sensor (PIR), ultrasonic sensor, microwave sensor, and photo-electric sensor etc. A monitoring device used the PIR sensors in order to detect and recognize the person [2]. Passive infrared sensors (PIR) are mounted in the device that helps to monitor and detect the motion or movement of the person. It is a useful technology that helps to keep an eye on your house and office.

This research paper investigates a new proposed system that is based on IoT and combined with the feature of computer vision for detection and monitoring purpose. The system basically performs the four operations to perform the task such as movement detection, taking an image, human detection and

sending the notification to the smart device. The PIR sensors detect the movement at any place after the detection of the motion the image will be taken by using a camera. Different algorithms are also applied to the images in order to detect the person to secure a place. This paper describes

- A new approach has been proposed to utilize the computer vision with the internet of things and to improve the security problems in homes, offices, towns and all over the world.
- A new security system is imposed to secure any place by using the PIR sensors and the cameras to detect and monitor the persons.

2. Literature Survey

The IoT devices are widely using all around the world to generate the huge amount of data via the internet and used different sensors for security purpose. These Interconnected sensors are used to get the information as well as a unique system to perform an automated task in any place. Sensors are of various types that play a vital role in the field of the security system that are noise detector, Passive Infrared Sensor (PIR), ultrasonic sensor, microwave sensor, and photo-electric sensor etc. A monitoring device used the PIR sensors in order to detect and recognize the person.

The previous algorithms are not able to give an efficient result that satisfied users e.g. some traditional algorithms and devices does not showing the batter quality of image and sound due to low temperature difference in human and camera or other devices that's why these systems are not more efficient. Following table can show some pros and cons of different sensors

Table 1: Comparative Analysis

IMAGERY RECONNAISSANCE				
Sensors	**Pros**	**Cons**	**Product**	**Timeliness**
IR Line scanner	• Both day and night • High resolution	• Stand of range • Weather obscuration • View time • Field of view • Rain washout • Dusk/dawn crossover	• Hard copy • Video report • In-flight report	• > 4 hours • > 4 hours • NRT
FLIR (Forward looking infrared)	• Both day and night	• Resolution • Weather obscuration • Stand of range • Field of view • Rain washout • Dusk/dawn crossover	• Video report • In-flight report	• > 1 hour • NRT
UV (Ultraviolet) Line scanner	• High resolution	• Day only • View time • Field of view • Weather obscuration	• Hard copy • Video report • In-flight report	• > 4 hours • > 4 hours • NRT
Multi-spectral Fusion Sensors	• Both day and night • High resolution	• Weather obscuration • Field of view	• Video report • In-flight report	• > 4 hours • NRT

Traditional system and algorithms are unable to detect the human in a perfect manner. Use of the thermal camera is degraded the performance of the human detection due to the low-temperature difference between the humans and background (Shutao Zhao, 2005). Another reason is the low accuracy of the thermal image in detecting humans.

These factors make it difficult for the clear detection of a human. High-level algorithms are not introduced for that purpose in the past years that affect the performance and enable to get the useful output for the security purposes (Tom Loten, 2008). In this paper we propose a method for securing our places with the help of computer vision and IoT.

3. Proposed Method

To develop a good security system is our objective so that the user can control this system remotely through android application. An IoT based human detection in computer vision system is proposed to overcome the detection problems. When motion is detected inside the area, the system will send a notification to the device because this system is connected with IoT. For remote security monitoring there is a need to design and implement a reasonable and affordable camera based security. With the use of mobile phone, monitoring system can only be accessed by authorized user through internet and situation is monitored on application.

3.1 Working Material

1. Hardware components PIR Sensor Raspberry Pi Camera Smart Phone SD Card Memory Power Supply

2. Software components/Algorithms Internet Pushetta Application SVM Support Vector Machine Algorithm HOG Histogram of Oriented Gradient

3.2 System Operations

This system has two parts which is face detection and motion detection. If there is no motion discovered then the system will not detect face. But, if any movement is seen then this movement will be processed by detection algorithm. In this system PIR sensors and a camera is connected to the Raspberry Pi 3 which is a microcontroller with four USB modules. The system basically performs the four operations to perform the task such as movement detection, taking an image, human detection and sending the notification to the smart device.

PIR sensor detects the movement at any place after the detection of the motion the image will be taken by using a camera. The captured image is then used to detect the human by applying the computer vision module. The image is passed to the smartphone if a human is detected. An image is taken only when the sensors detect the movement otherwise the system will not go to detect the human. Different algorithms are also applied to the images in order to detect the person to secure a place. Histogram of Oriented Gradient (HOG) is an algorithm which is used to detect the person in the image after that image is sent to the smartphone by

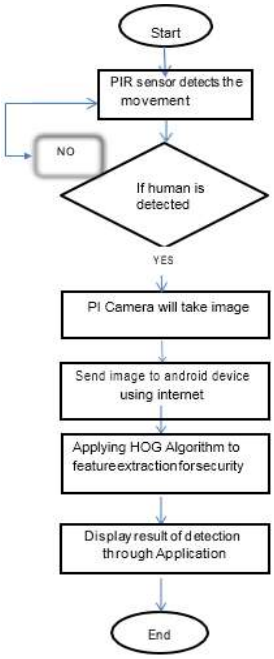


Figure 2: - Histogram of Oriented Gradient (HOG)

4. Experimental Results of Proposed System

This proposed system can detect human movement as computer vision is connected with IoT. It provides a possible way to utilize the computer vision with IoT as well as Pi cameras and PIR sensors (M. Zubal', 2016). When there is any motion detected through sensor, the Pi camera grabbed the pictures and then human is detected. The system is able to discover the human detection in the captured pictures effectively. The algorithm is used for all pictures. HOG algorithm is a good algorithm for human detection.

Raspberry Pi camera is very helpful for display pictures and to see activities on android device because it has wireless technology. When any movement is detected by sensor then the "motion detected" message is shown on output screen. Camera captures pictures and then notifications are sent to smartphone by application.

Fig 3 Human Detection[8]

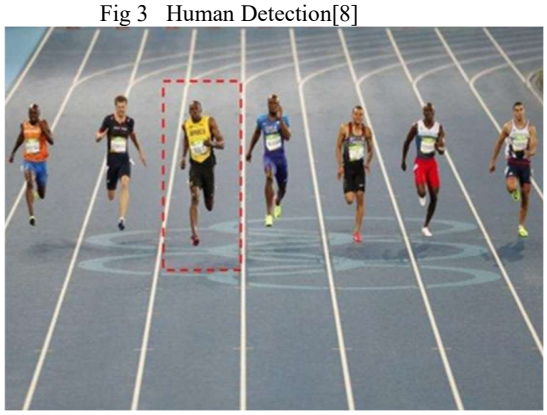


Figure 3 Human Detection[8]

Figure. 4: Image captured [8]

Firstly calculate the features of the image that are necessary to normalize for the HOG calculation. Gamma normalization is applied that is an image enhancement technique. After normalization, the next step is to calculate the gradient scales as well as the orientations of image. To calculate the gradients different equations are used. Gradient image helps to remove the inconsiderable data of the vector image like shaded background etc.

Figure. 5: Applying HOG**[8]**

This experiment is given after applying HOG human detection algorithm. After feature extraction the image is normalized and this detected picture is then sent to smartphone. As this system is connected with IoT so privacy must be taken an essential part so for this, proposed system will be a secure when it uses a smart device and IoT devices. Pi camera only captures pictures when PIR sensor detects any human movement.

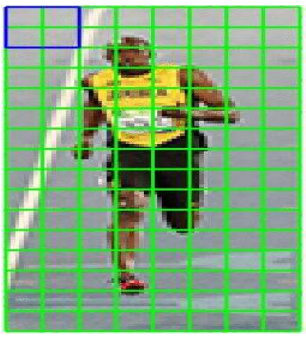


Figure 6 feature detection[8]

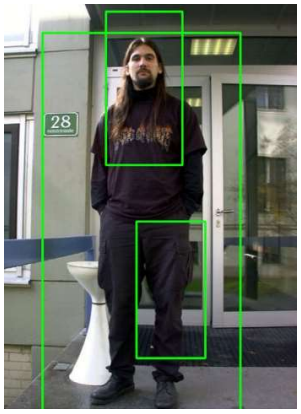


Figure 2-Sensor sense the image

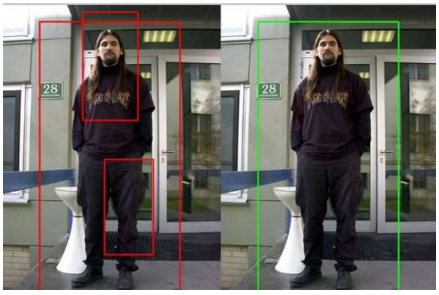


Figure 3-Image detection with camera

4.1 Performance of proposed method

The performance of proposed human detection method is displayed in table 4.2. There is a formula method to calculate the accuracy of this system

*Pohd =p= (C / C + F * 100)*

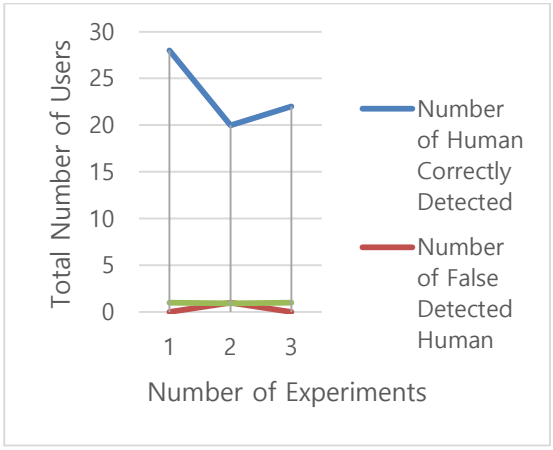
Here, Pohd = Precision (%) of human detection

C = Number of human in Correct detection

F = Number of False detected human

Table 4.1- Human detection method performance

Experiments No#	Total Number of Users	Number of Human Correctly Detected (C)	Number of False Detected Human (F)	Precision % (P)
#1	28	28	0	100%
#2	22	20	1	95.24%
#3	22	22	0	100%



4.6 Discussion

Human detection method performance accuracy is shown in table. In experiments, the accuracy of system is high as seen in figure. Overall performance of the proposed method is very good. The average precision is 98.42%. After the experiments, we can say that this system is efficient and successful. Mainly the idea of this system is to connect IoT with computer vision for secure detection of human.

5. Conclusion

This work describes the human detection in computer vision and connected with IoT devices. It uses PIR sensor, Raspberry Pi camera and HOG algorithm. After experiment we conclude the result that the performance of system is good. This system has great contributions in the field of computer vision and IoT. The contribution of our work can be summarized as follows.

1. A new approach has been proposed to utilize the computer vision with the internet of things.
2. A new path to communicate with the environment.
3. Imposed a new security system to secure any place by using the PIR sensors and the cameras to detect and monitor the persons. The goal of this system is to establish a secure, efficient and user friendly system to detect human. Our achievement from this research is very good.

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