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An Intelligent Fire Detection and Surveillance System

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***Abstract*—** Fire detectors are designed to detect one or more of the three characteristics of fire-smoke, heat and flame. The fire detection and alarm system function together to provide timely fire warnings to those in emergency zones. But the drawback is that it may include false alarms. The proposed idea is to monitor industries and to detect fire and smoke using sensors and camera. In order to save energy, space and cost, Raspberry pi 3 is used which acts as both processor and controller. The sensors detect flame and smoke using the spectrum range. If it detects any issues, then it signals the motor to sprinkle water either automatically or manually. The camera acts by detecting the thermal motion of any organisms and if any fluctuation is detected, that moment is captured and sent as a mail to the user via a third party authentication system. The videos captured by the camera are stored in cloud and is used as proof during fire accidents to claim insurance. This system also avoids false alarm.

***Keywords*—**Raspberry pi, PIR sensor, Intruder detection, Mail Service.

I. INTRODUCTION

Nowadays security has become a major challenge in the modern world. It is important to achieve utmost security possible. In order to implement it, IOT has paved an easier way. The aim is that the user should enhance security remotely. To achieve this, IOT is widely used as it has remote access control. The user can monitor and access control from remote locations easily. The traditional systems do not tend to perform a continuous detection and it fails in the case where it may produce false alarm.

The system proposed uses two sensors, a PIR sensor [1] to detect intruders and a Flame sensor to detect fire. In order to have a safe storage of data, the use of cloud for storing purposes is implied. Also, to achieve space, time and cost efficiency, this paper signifies the use of Raspberry pi [5].

The security is affected by various issues and in this paper, two important factors are focused. First is the rapid fire break out involving lethal effect. In order to prevent fire at its outbreak, it must be notified immediately so that the situation can be cleared or at least major issues can be prevented. Many papers have been proposed to detect fire before it creeps, though they tend to have a disadvantage of producing false alarm. This paper mainly tends to avoid this false alarm by introducing another part of analysis. The second major focus is to detect the intruders and notify the user concurrently. This part also adds up to avoid false alarm. Once it is known that fire is detected, the system captures pictures of the corresponding spot with is location [8] and sends it to the user by the alert mail.

The rest of the paper is organised as follows. Section 2 gives the efforts made by different experimenters along with the shortcomings. Section 3 specifies the propounded system and the methods to overcome hindrances. Section 4 discusses about the results achieved. And, Section 5 wraps up the work.

II. RELATED WORK

In this section, the works contributed by some of the researchers in this area are presented. The following are the ideas that were previously presented:

Sanoob.A.H et al. [1] proposed Smartphone Enabled Intelligent Surveillance System which introduced a new design involving smart phones, PIR sensor and MCU (Micro Controller Unit) for surveillance. In order to detect motion, this system includes a PIR connected to a Smartphone using a MCU. The camera is activated and video is captured only when any thermal motion is recognised and an alert message

in the form of SMS is sent to the user immediately. The records are generally stored in cloud and links to the records are sent in mail.

S.Tanwar et al. [2] introduced An Advanced IOT based Security Alert System For Smart Home that allows the user to watch all the inside home activities from a remote location thereby detecting any unusual event or intruder. The usage of Raspberry pi along with PIR minimizes the delay in email alert process. The system starts the process without any user input and also achieves the required objectives of home security. On adding a GPS system, this model could be updated either by transferring captured data to nearby police station or closing the entrance.

Ahmed et al. [3] propounded An IOT Based Fire Alarming and Authentication System for Workhouse Using Raspberry Pi which not only detects fire but also provides the affected region location. This model uses raspberry pi so as to control several Arduino incorporated with sensors and camera. A 360^0 is also assembled with the camera such that it can capture images in all angles. Any impeachment can be confirmed by the admin, on which an alarm is promptly raised and a message is automated to accessible fire brigade.

Mobin et al. [4] introduced An Intelligent Fire Detection and Mitigation System Safe from Fire that assembles SSF along with several actuators, sensors and MCU. Input signals from sensors placed in different locations are collected and consolidated with integrated fuzzy logic so as to discover the location of the fire breakout and its extremity. Any misleading circumstances like cigarette smoke, welding, incense smoke, etc. can be discarded using data fusion algorithm. It breaks electric circuits of the affected area, thereby preventing the fire from spreading out.

The existing idea [1] tends to produce false intruder alarm as it also detects movement of animals which may trigger the sensor. It is more costly as it uses many sensors for localising fire. These systems [4, 5] involve numerous computations in the process.

III. PROPOSED WORK

A system always has usage based upon its effectiveness and accuracy. The proposed idea seems to avoid false alarm for the intruders and fire by suggesting the use of PIR sensor and image processing algorithms.

The system includes gas sensor for detecting gas leakage and to actuate exhaust fan PIR sensor [7] detects intrusion and activates camera to capture surveillance video. From the video key frames is detected using background subtraction algorithm and hallucinated by Singular Value Decomposition to obtain high resolution images. Face region is segmented from the key frames using Viola Jones algorithm. Recognition is done using multi key point descriptor. Fire detection is done using color and shape evaluation and fake fire is recognized using growth evaluation. If any intruder or fire is detected, then an alert mail [10] will be sent to the user.

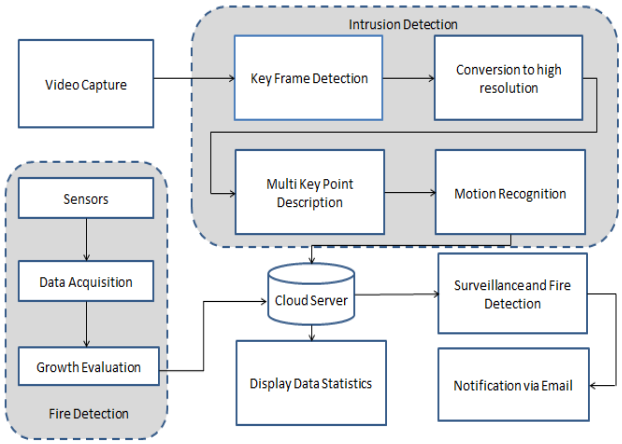

Figure1. Architecture of Intelligent Fire Detection and Surveillance System

The architecture depicted above can be explained by analysing the four modules. The working of the architecture starts from collecting the data from the sensors. The entire system is activated only based upon the data from the sensors. Thus, the data from the sensors act as input to the system which results in notification to the user as the output. Data are stored in cloud the user can have a view of the data logs. This system mainly promotes remote observation and hence surveillance is made smarter.

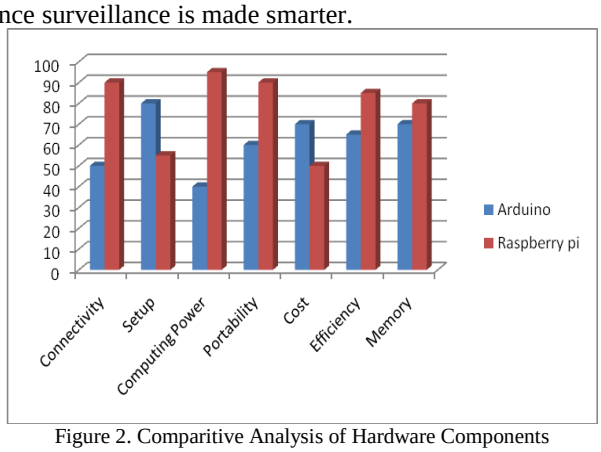

Figure 2. Comparitive Analysis of Hardware Components

The figure 2 depicts the effectiveness of using Raspberry Pi instead of Arduino [6]. This adds to the evidence that a low-cost security system is built without having to spend millions of rupees in providing remote security.

A. Raspberry Pi 3

Raspberry pi 3, a powerful credit-card sized single board computer that acts as processor as well as controller has been utilised to make the model compact. It is the main computational device used in the propounded design. This has its own advantage as sensors can be connected as well as data can be processed with a power supply of only 5V. It fetches signals from PIR sensor and camera and emails the captured images to the user.

Fig.3 Raspberry Pi 3

B. Background Subtraction Algorithm

The aim of background subtraction algorithm [9] is to detect moving objects in videos. The basic concept is to find the difference between the current frame and the reference frame and this is known as "Background Image".

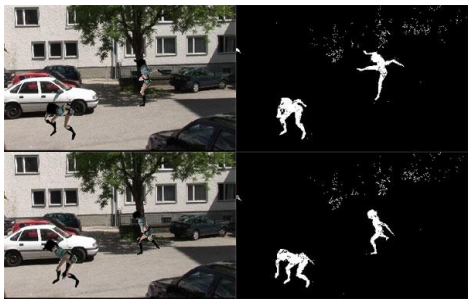

Fig.4 Background Image

The output from this algorithm is fed as input to Viola Jones Algorithm to recognise images using multi key point descriptor. The differences between the pixels of instant images are verified to confirm the motion of the intruder rather than the PIR sensor.

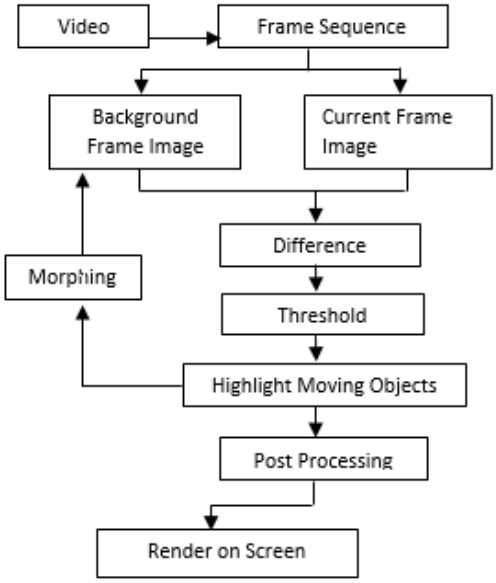

Figure 5. Background Subtraction Algorithm

C. Fire Detection

The fire detection is done using a flame sensor which has its characteristic features as given below:

The output of the sensor is an Analog value ranging from 0V to 5V based on infrared radiation from fire flame falling on the sensor. Detection angle of the sensor is about 60 degrees; it is sensitive to the flame spectrum. Comparator chip LM393 makes module readings stable.

Once the reading from the sensor is collected, the Analog volt values are converted to the integer values which are then fed to the system. These values are stored in the cloud. If the values from the sensor indicate flame, then the camera is turned on and it captures the instant image of the spot.

D. Intruder Detection

The intruder detection is done using a PIR sensor which has its characteristic features as given below:

The PIR (Passive Infra-Red) Sensor is a pyroelectric device that detects motion by measuring changes in the infrared levels emitted by surrounding objects. It is Compatible with all Parallax microcontrollers.3.3V & 5V operation with <100uA current draw.
The PIR sensor is a digital sensor which indicates if there is a thermal motion or not inorder to predict the presence of a person. The value from the sensor is converted and sent to the system, only then the camera is turned on and the instant image of the spot is captured. Once the PIR sensor activates

the camera, the background subtraction algorithm is implemented to verify the images as the background action.

E. Data Storage

This is the important module where the data from the sensors are collected and stored in cloud. The storage and backup for files is very important in any system. In order to store a large set of data without any failure and easy access, this system implies the use of cloud storage of data.

The cloud is a data storage model where the data is stored in remote servers accessed with the help of internet named as cloud. Many companies offer such cloud platform where the cloud computing services may also be done in the same infrastructure such as Google Cloud Platform maintained by Google.

The data stored in cloud can be viewed from remote location by the user anytime he needs. The data cloud can be accessed by opening the browser followed by selecting the corresponding log bucket. The data can be viewed by selecting the respective log object. The cloud page provided for the system has an option to clear the data log. The live data upload can be viewed by the user any time from any place.

F. Notification

This is the last module in the system where the images captured from the previous modules result are sent to the user via mail. The system has a valid mail address of the user and it sends a mail to the user whenever the system detects any issue.

To perform this notification by mail, the system uses the Gmail port 587. The port 587 is used to send email for client to server communication purposes. To use the port 587, TLS (Transport Layer Security) is required where dynamic IPs is allowed. Using this port, mail can be sent only to Gmail or G Suite users. In order to send mail successfully, the email address is required to be authenticated.

To send the mail to the user, the system uses an admin account from the cloud to send the mail notifications to the user. The system uses the admin account with the username lumiraspberry18. The system thus activates this account while sending the user notifications. The user receives a mail from the admin account with the message body stating, Message from Raspberry pi".

IV. RESULTS AND DISCUSSION

The proposed approach has been tested at various levels. First, the intruder detection is done by the system. Next, the Fire detection is done. Finally, the system is checked under false impact of fire. All these experiments are done in a room under the influence of camera and sensors connected to a Raspberry pi. The images captured are processed using Background Subtraction Algorithm and Viola Jones Algorithm and the values of instant images are compared to detect the motion of the intruder. Future work may include additional features like electronic device control and power management.

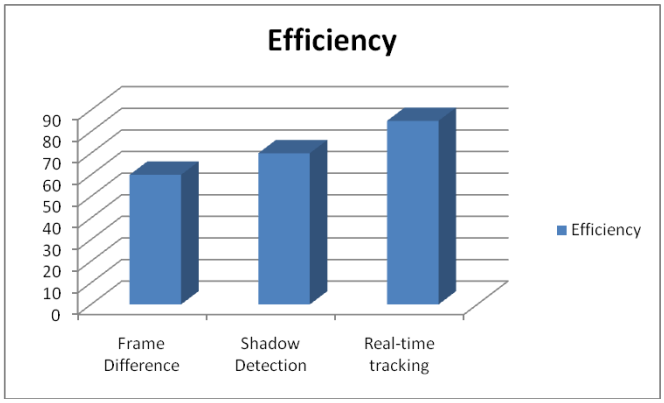

Fig.6 Comparitive Analysis of Background Subtraction Algorithm

V. CONCLUSION

The system provides a modern approach for intelligent surveillance by integrating all devices and also their activities such as examining, supervising and warning in a new way. Chances for delusive alarm are highly reduced in this system. The use of Raspberry pi implies high dimensions of portability, efficiency, computing power and connectivity. Owing to the fact that the camera gets activated only when thermal motion is detected, power usage is highly minimized. Data loss is avoided by uploading it in cloud. This compact system propounds cost effective and remote observation. It also confirms minimum delay during email alert process.

Future work may include model improvement either by transferring captured data to nearby police station or closing the entrance. To enhance the video quality during night, lights may be automated to turn on when any intruder is detected.

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