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Intrusion Detection through Image Processing and getting Notified Via SMS and Live Streaming

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Abstract - *Probably, the most invaluable resource of a city is its residents and their belongings. Smart intrusion detection system is the contemporary urban concept which is absolutely necessary for residents of a system to have a quality life. Over the past decade, the use of the smart home intrusion technology along with the concerning security has been increased due to a variety of crimes and intrusion. Using Internet of Things, Image processing and Mobile Computing, our project proposes security system for homes. In this system, we are concentrating on providing immediate notification to the users along with Live Streaming and Image Processing techniques for intruder detection. Also, face recognition techniques will be used for detecting the intruders face.*

This review paper is written with the goal of implementing smart home intrusion detection systems for residents of the country by collecting all the admissible research. The goal of this paper is to understand the current research topics, challenges and future directions from a technical point of view.

Key Words: Intrusion, Notification, Image Processing, Live Streaming, Face recognition

1. INTRODUCTION

The Earth is passing through a purplish patch of technology, where there is increasing demand of machinery and intelligence behind it. Every day there is been at least one new invention from people round the globe. This is making people easier to live life due to which there is been increasing demand of engineering science. In this 21st Century humans are surrounded with technology as they are the constituent of our day to day life cycle. With this we are always focusing on the safety and security for ourselves and our earned valuables respectively.

For own safety people have been spending money because that is the first thing. Then as for our valuables which we retain in our places, always want it to be secure. For this there are security systems implemented like CCTV camera for surveillance which has continuous streaming for which you need to maintain an additional person for video surveillance as it is performed in opulent societies. This takes our unwanted time by continuously keeping watch along the sieve.

Our basic idea is to develop a system which will detect and capture the details of the intruder in the premises via infrared camera and also provide live streaming. It should immediately notify the user about the intrusion along with the image captured. The system will compare the image with the datasets provided in the database. If the image matches the datasets then it should notify specifying the name of the intruder along with captured image. If not, the image should be sent. After this a prompt will come up asking whether you want to save the image in the database. If you click on yes, it will be saved in the database, if not it will go to the recycle bin. We will be using an Orange Pi PC or Orange Pi 2G / 4G Kit for the system through which we would be operating our camera which would provide dual channel. A GSM module will be attached to it which will help to get the update in case of connection failure. This is important to get the instant update through which we can take necessary action about the intrusion before loss. Also, in case of power loss, lithium battery or a juice box zero battery are attached to provide backup. The system would be connected to database which will store and process the image forward it on the application. An application will be deployed which will send the captured image, push notification and live streaming

The main feature will be the image processing in which we will be using Spatial operations such as Median filter, Directional smoothing to remove the unwanted noise so that you get a clear image. Another technique is Contrast Stretching for low contrast images in low light or poor lighting conditions to occur more natural enhanced and contrast in it. Pseudo-inverse filter and Wiener Filter would also be used to remove the noise in the captured image.

2. PROPOSED SYSTEM

2.1. System architecture and implementation

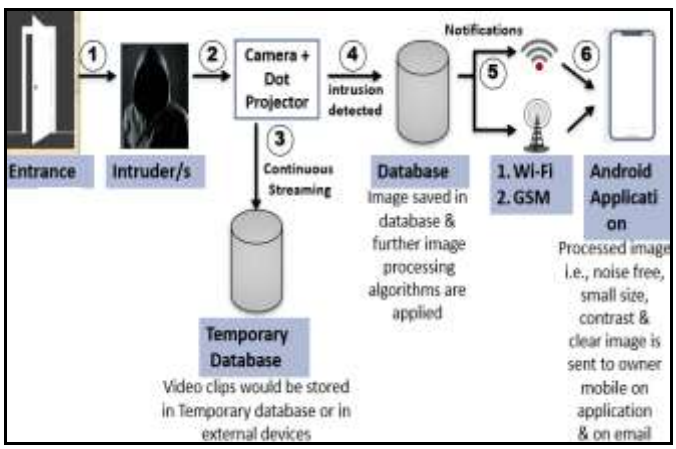

Fig -1: Proposed System Architecture

In this system, we are concentrating on providing immediate notification to the users about the intrusion. Image Processing techniques will be used for intrusion detection. Face detection and recognition using a Dot Projector will also be done in this project. Fig. 1 presents the block diagram of the proposed system architecture

For detection of an intruder, an Infrared Camera is used (with dual channels) to ensure image detection even in the dreary surroundings. Through one channel, the image captured will be crosschecked with the database. The database will be provided with a few datasets. Further, the image will be preserved in the database if the interloper is new and sent along with the notification. The notification will be sent over the internet or GSM to user application. which is its primary work. The other channel of the camera will provide live streaming. The captured image will be saved in the permanent database and the live streaming will be saved in the temporary database. The microcontroller will control appropriate appliance.

Median Filter will be applied to remove noise from the image and KL Transform Algorithm will be applied for compression of the image produced from an infrared camera.

Spatial Operations: Removing noise from images and inserting median filter.

- Consider each pixel in the image in turn and looks at its nearby neighbors to decide whether or not it is representative of its surroundings
- Instead of simply replacing the pixel value with the mean of neighboring pixel values, it replaces it with the median of those values.
- The median is calculated by first sorting all the pixel values from the surrounding neighborhood into numerical order and then replacing the pixel being considered with the middle pixel value.

Example:

123	125	126	130	140
122	124	126	127	135
118	120	150	125	134
119	115	119	123	133
111	116	110	120	130

Neighborhood values: 115, 119, 120, 123, 124, 125, 126, 127, 150
Median value: 124

KL Transform: Store image in fewer bits as compared to original image. There are four major steps in order to find the KL transform:

(a) Find the mean vector and covariance matrix of the given image x. The mean vector is found out as shown below.
$mx = E(x)$ ... (Equation1)

Where Ex is the expected value
N = number of columns

The Covariance(x) of the vector population is defined as
$Cx = E[(x-mx)\ (x-mx)^1]$ ....(Equation2)

b) Find the Eigen values and then the eigen vectors of the covariance matrix.

Let viand λI be the eigen vectors and eigen values of Cx where 1 <= I <= N
Eigen value can be found out using the equation
$|Cx - \lambda I| = 0$

Where
Cx = Covariance Matrix
I = Identity Matrix
λ = Eigen Value

Eigen Vector can be found out corresponding to each Eigen vector as shown below
$Cxv1 = \lambda v1$ (Finding the first Eigen Vector)

(c) Create the transformation matrix T, such that rows of T are eigen vectors.

- The KL Transformation matrix is formed using the Eigen vectors.
- Each eigen vector is arranged as a row of the transformation matrix.
- The vector corresponding to the largest Eigen value is placed on the first row.
- This KL Transform matrix, T, is orthogonal

i.e. $T^{-1} = T^1$
$T.\ T^1 = 1$

(d) Find the KL Transform

- We obtain the KL Transformed image by simply multiplying the transformation matrix with the centralized image vector.
  $(x-mx)$
- Therefore,
  $X = T.(x-mx)$

Contrast Stretching: Low-contrast images under poor lighting conditions to occur more enhanced.

2.2. Development of android application

After the internet part would be developed and the methods worked properly, we would develop an android application for facilitating the internet part.
The android application would be developed using Android Studio for this project. Through this application, the user will get the notification and also the live streaming. When an unknown intruder is detected, the image would be sent along the notification. After the notification is received, a prompt will come up asking whether you would like to save

the image. If yes, the image will be saved in permanent database along with the name specified by the user. If not, the image goes to recycle bin.

3. HARDWARE INTERFACES

1. Infrared Cameras -Logitech C310 HD Webcam
2. Dot Projector
3. Microcontroller-Orange Pi
4. CPU - H3 Quad-core Cortex-A7 H.265/HEVC 4K
5. GPU - Mali400MP2 GPU @600MHz, Supports OpenGL ES 2.0
6. Memory -1GB DDR3 (shared with GPU) Wireless – Wi-Fi with antenna
7. Power Source - DC input can supply power, but USB OTG input don't supply power
8. GSM Module-SIM800C Development Board GSM GPRS Module Support Message Bluetooth TTS DTMF Quad-band Alternative SIM900A With Glue Stick

4. CHALLENGES

A number of systems are deployed for intrusion detection, some work with sensors and some with cameras while others have notification. Some systems have live streaming but not notification system. In some cases, the image captured by the cameras might also be blur and some might not be able to capture proper images in the dreary environments. Some systems need continuous energy supply. A few systems may not be able to send notifications due to weak connection. Some systems may not be able to detect multiple intruders at the same time.

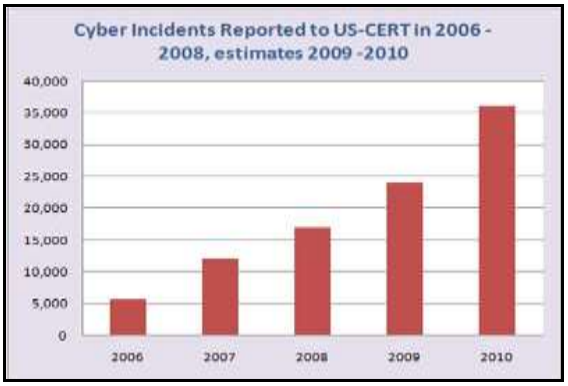

Chart -1: Number of incidents reported

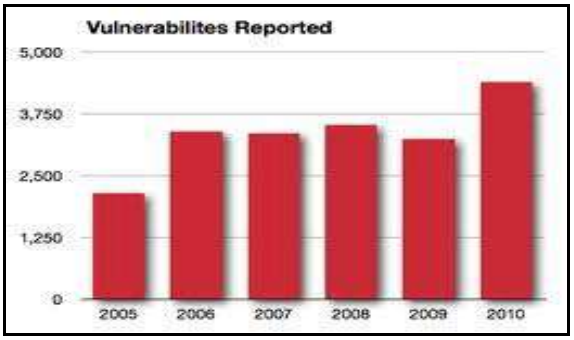

Chart -2: Vulnerabilities reported

5. CURRENT RESEARCH

It has been observed that many Intrusion Detection systems are being deployed with limitations like a few might have a feature which is missing in the other. A system which overcomes all the limitation of an intrusion detection system has not been implemented. [13]. Some of the terms should be understood to develop such a system:

A. Image Processing

Image processing is a method to convert an image into digital form and perform some operations on it, in order to get an enhanced image or to extract some useful information from it. It is a type of signal dispensation in which input is image, like video frame or photograph and output may be image or characteristics associated with that image. Usually Image Processing system includes treating images as two-dimensional signals while applying already set signal processing methods to them.

Image processing basically includes the following three steps.

1. Importing the image with optical scanner or by digital photography.
2. Analyzing and manipulating the image which includes data compression and image enhancement and spotting patterns that are not to human eyes like satellite photographs.
3. Output is the last stage in which result can be altered image or report that is based on image analysis.

The purpose of image processing is divided into 5 groups.

They are:

1. Visualization - Observe the objects that are not visible.
2. Image sharpening and restoration - To create a better image.
3. Image retrieval - Seek for the image of interest.
4. Measurement of pattern – Measures various objects in an image.
5. Image Recognition – Distinguish the objects in an image.

B. Face Recognition using Infrared Camera

An IR image of the human face presents its unique heat-signature and can be used for recognition. The characteristics of IR images maintain advantages over visible light images, and can be used to improve algorithms of human face recognition in several aspects. IR images are obviously invariant under extreme lighting conditions (including complete darkness). IR face images are less affected by changes of pose or facial expression and enable a simple method for detection of facial features. There are several aspects of face recognition in IR images. First, we compare the effect of varying environment conditions over IR and visible light images through a case study. Finally, we propose a method for automatic face recognition in IR images, through which we use a preprocessing algorithm for detecting facial elements, and show the applicability of

commonly used face recognition methods in the visible light domain. [14]

C. Live Streaming

Live streaming is the broadcasting of real-time, live video to an audience over the internet. All you need to be able to live stream is an internet enabled device, like a smart phone or tablet, and a platform to broadcast on. Live streaming refers to online streaming media simultaneously recorded and broadcast in real time to the viewer. It is often simply referred to as streaming. [15]

6. CONCLUSIONS

Our system would instantly notify the user about the in-house scenario along with the live streaming. The system incorporates security using IoT (Internet of Things). The security module successfully sends notifications upon detecting intruder using wireless and wired techniques where owner further can take necessary actions thus enhance convenience and comfort, save energy efficiently and enjoy completely security.

As an extension to our project, we propose a generic loT framework and use cloud computing infrastructure for connecting and managing remote devices. In addition, we also plan to productize proposed home automation solution so that a greater number of people can use loT in a smart environment.

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