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Smart Surveillance System Using Convolutional Neural Network

Vatsalya Singhi

Student, Department of Information Technology, SRM Institute of Science and Technology, SRM Nagar, Kattankulathur, Tamil Nadu, India

ABSTRACT: Today's data period, goes for digitizing information and executing it to a proficient, instinctive and easy to use framework for the welfare of human life. Creating a Smart Surveillance System that doesn't require a human operator to monitor the system is a huge leap towards futuristic and fully automated public safety and security. Smart Surveillance cameras provide help in tracking law offenders as well provide important detailed footage for further investigation. These systems are currently being used in most developed countries for public services like traffic management, monitoring movement in a crowded place etc. By automating these surveillance tools we can reduce the chances of human error caused by individuals and thus help taking life critical decisions. The Smart Surveillance camera consists of a portable computational device such as a raspberry pi , a cam pi for getting the video feed and alarm and notification mechanisms to inform concerned authority. Instant detection with notification mechanism and real-time surveillance are the two main objectives of this intelligent system. Furthermore it helps police to take critical decisions with real time data from any location. Automation has its own problems. Absence of human operators can potentially lead to inconvenience when the underlying technology fails. To provide solutions to those problems, we propose and discuss the implementation which has redundancy built into it, in order to reduce the probability of failure and keep the system online.

KEYWORDS: Smart Surveillance System, Automated public safety, Raspberrypi, Instant detection, Notification mechanism, Automation

I. INTRODUCTION

Technological advancements both hardware and software help in keeping the society safe and track miscreants. Using smart security cameras allows authorities to monitor larger parts of surrounding locality and take swift action. The greater part of association and organizations are influencing utilization of such savvy cameras with the aim to screen and protect their business. These days, the surveillance cameras have turned out to be substantially more sophisticated, compact and keen. Some of the key benefits of Smart Surveillance systems are: availability, low cost, scalability and most importantly real time tracking and feeds. Our goal is to focus on development of a smart surveillance system application for firearm detection. Machine learning techniques, algorithms for handling complex pictures and comprehension of compound human activities are few testing territories that got much consideration in previous years. Real time Surveillance is one of the active research topics in Image Processing. Basic Surveillance frameworks began with straightforward CCTV cameras with the principle reason to assemble data and to screen occasions and exercises. Existing advanced systems give the foundation just to capture and store recordings, while leaving the assignment of danger recognition totally to human administrators. Human checking of observation video is an extremely arduous assignment. Identifying numerous activities progressively in a video is troublesome in manual investigation. Thus the emergence of Smart surveillance system. The software processes the video , frame by frame to check for objects of interest. The efficient surveillance system identify circumstances that speak to a security danger, here being the presence of firearms, and advises the client by means of sms and email.

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II. RELATED WORKS

Jang and Turk proposed a framework for vehicle acknowledgment in light of the SURF highlight recognition calculation [1]. The idea of computerized CCTV picture investigation and discovery of perilous circumstances has been proposed and broke down.

The first tests made by an indistinguishable group for using CCTV from a mechanized sensor for firearm recognition rose next . A case of a later approach is FISVER, a system for savvy open security in video-overviewed vehicles, which has the capacity of general protest recognition, including objects, for example, firearms[2]. The underlying idea of robotized location of weapon wrongdoing was proposed by Darker et al. as a component of the United Kingdom-based MEDUSA venture [3]. This group likewise chipped away at recognizing the signals that may demonstrate that an individual is conveying a covered gun [4].

Mechanized techniques for video observation have begun to rise as of late, basically with the end goal of smart transportation frameworks (ITS). They incorporate activity reconnaissance [5] and acknowledgment of autos [6]. In this investigation, we have concentrated on the particular undertaking of computerized location and acknowledgment of hazardous circumstances material when all is said in done for any CCTV framework. The issue we are handling is the robotized location of perilous weapons—blades and guns, the most as often as possible utilized and dangerous weapons. The presence of such questions held in a hand is a case of an indication of threat to which the human administrator must be alarmed.

III. PROPOSED SOLUTION

There are a number of products already available in the market from various vendors with general purpose of surveillance, monitoring and recording . Some of the most noticeable ones are Pelco,ADT and Tycois. Our project describes an architecture that takes into account the distributed nature of the individual systems and the processing capacity required by them. Similar systems have been implemented, integrated, and tested in several developed nations like United States, China and other European Countries. Specifically, creating absolute answers for ensuring basic foundation and open security has been on the bleeding edge of R&D exercises in this field. The solution presented is far more complex than just video analysis. It must cover object detection through machine learning algorithms and other decision making parameters.

Our main contribution to existing system is using efficient image processing techniques and advance machine learning algorithms to give system the ability to detect objects of interest in complex scenarios. This is clearly a first step towards providing ambient intelligence in such complex scenarios.

Video analysis covers a wide range of applications such as tracking, pedestrian detection, face recognition, as well as more complex detections like events of interest as reported. This can then be coupled with control capabilities to allow control from a remote location. The Praetorian suit of programming bundles gives such a domain. The open engineering of Praetorian fundamentally fills in as a working framework that can ingest cautions created from different video expository frameworks. Disadvantages: It should be noted that certain specialized capabilities are only available in some and not all systems. Some people may simply wish not to be recorded as they have no desire in having photos or videos of themselves being viewable by other people.

Our solution takes action incase an event of interest is detected and eliminates the limitations of existing solutions by offering three main benefits. First,it creates a better, faster and more efficient monitoring facility. Second,it minimizes the man-power required for monitoring, as the process is handled by the system. Lastly,it monitors for any event of interest and notifies through e-mail and sms automatically.

The low powered computing device, raspberry pi is equipped with Pi cam and running on Raspbian OS that serves as a host for video capturing , processing, identification of object of interest and later notifying the user. The camera helps in capturing and monitoring its surrounding . Each frame captured is pre-processed before prediction. Image processing techniques like image scaling,pixel subtraction and grayscale conversion are performed for faster processing and better accuracy. The frame is now passed through a pre-trained model for prediction . If any object of interest is found in the frame,it is dumped to a file directory. The dumped image frame is sent as an email to the user and notification is sent via SMS. The process cycle is repeated to check for any other abnormal actions. This is depicted in figure 1. The

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system can be trained to identify other objects, thus with more datasets, the model predicts with even better accuracy. All the processing, storing and retrieval of the frames is currently done on individual raspberry pi's but with the help of cloud computing and networking techniques the entire process can be speeded up and done far more efficiently.
The capabilities of the proposed Smart Surveillance System are :

1) The user gets notified as soon as the event of interest is detected. Therefore, the client can make fitting move immediately.
2) Reduced storage and increased processing capabilities by incorporating cloud computing techniques in possible future.
3) Intelligent System to identify threats using pretrained models and datasets to reduce human error significantly thus results in more precise and accurate results.
4) Is low cost,fast,efficient,scalable,simple and provides real time tracking compared to current system.

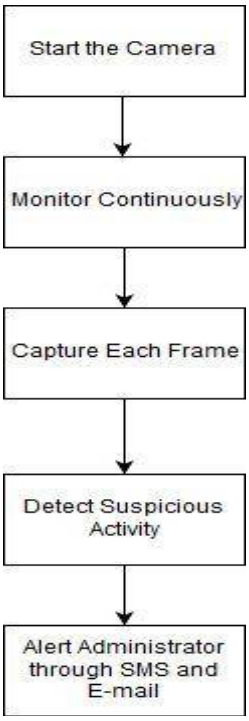

Fig. 1. Smart Surveillance System

IV. DETAILED DESCRIPTION OF THE SMART SYSTEM

A. System Design

As the goal of the Smart Camera is automating threat detection , the hardware required are pi camera for video capture,batteries serving as power source,a wifi module for networking and notification purpose. Python libraries such as keras,numpy,openCv,zerosms,getpass and smtplib are few required softwares. The operating system used is linux based raspbian os with GPIO pins support . Hence,our design includes a Pi-camera and wifi lan card which is fitted to the Raspberry pi running Raspbian OS and an external battery as power source as shown in fig 2 . The system starts executing the script thereby scanning right after initial boot up. After the system detects a threat it dumps the frame to a predefined file directory and sends notifications with the frame as attachment to the administrator through email and

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SMS for text based notification . The monitoring process continues to run and process repeats . The real time video capturing, frame dumping and sending alerts are all done in the raspberry pi making it

1) energy-efficient
2) use minimal network traffic
3) reduce computational load over low powered systems like raspberry pi
4) ensures a closed system

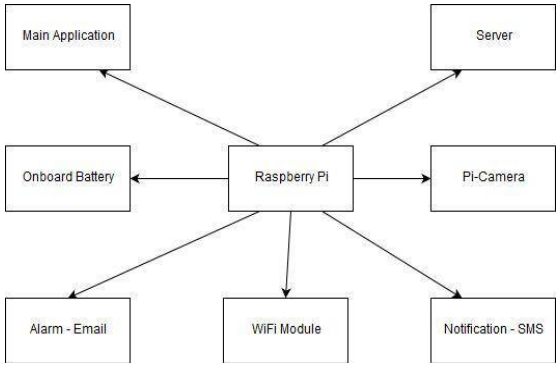

Fig 2. System Design of Smart Surveillance System

B) **Operation of the Smart Camera System**

A typical smart camera system is expected to look like the one shown in Figure 2. The functioning of the system is listed below.

1) Every smart camera is strategically placed to have at most range and to work efficiently.
2) The camera module attached to the raspberry pi provides real time video surveillance.
3) Each frame is pre-processed to improve the quality of data by suppressing unwanted distortions and enhancing important features prior prediction.
4) The preprocessed image is fed into the model which results in an list of possible labels detected. If the list contains a label for firearm or shotgun , the led glows indicating a distress call and notifies the user.

This procedure is repeated continuously. If probability of firearm detection is above 0.6, a value which can be toggled ,an alarm is set off and notifications are sent via sms or email with the image attached to concern authority.

V. IMPLEMENTATION

A prototype has been made based on the design based on figure 2 . The various components that are used in the implementation along with the respective applications of the choices made are explained in detail.

Fig. 3. Smart Camera

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A) Raspberry Pi Camera

The model is completed using a Raspberry Pi Camera. The v2 Camera Module has a Sony IMX219 8-megapixel sensor. The Camera Module can be utilized to take superior quality video and does valuable for constant checking of encompassing.It also has numerous third-party libraries built for it, including the Picamera Python library thus our ideal choice . Video capturing is done with the help of Raspberry pi Camera. It captures each frames and sends it to the pi for processing and prediction.

Fig 4. Wifi Lan Card

B) USB WiFi Adapter

The Edimax EW-7811 USB WiFi Adapter is utilized for setting up association with the web. It utilizes broadcom chipset,has control sparing highlights and backings all the 802.11 b/g/n associations

C) Image Recognition

Deep learning is a subset of machine learning that automates standard manual component extraction from data. It can be classified as either

1) Supervised (labeled dataset),
2) Semi-supervised (partially labeled and unlabeled datasets)
3) Unsupervised learning (unlabeled dataset).

Convolution Neural Network is a computing system enlivened by the natural neural system. Such a system progressively learns and improvises by analyzing labeled datasets and uses analytics for better results.
Neurons in CNN are by and large spoken to by genuine numbers, ordinarily in the vicinity of 0 and 1. Neurons and neurotransmitters may likewise have a weight that differs as learning continues, which can increment or decline the quality of the flag that it sends downstream. Every neurotransmitter between neurons can transmit a flag to another neuron. Further, they may have a limit with the end goal that exclusive if the total flag is underneath (or over) that level is the downstream flag sent. Diverse layers may perform various types of changes on their sources of info. Signs go from the main (contribution), to the last (yield) layer, potentially in the wake of navigating shrouded layers numerous circumstances. Not at all like neural systems where the info is a vector,input is a multi-directed picture for the most part 3 in general cases. We take a channel and slide it over the total picture and en route take dab item between the channel and hurls of the information picture. The consequence of each speck item is a scalar and joins into a solitary esteem. The model constructed would now be able to be approved and tried.
Deep Learning applications like Image recognition and speech processing requires working with enormous frameworks in parallel. In this investigation, Tensorflow with its effective grid preparing capacities, library actualizing profound convolutional neural systems for picture acknowledgment and enormous engineers gathering is utilized for the execution.
Transfer or inductive exchange is an exploration issue in machine discovering that spotlights on putting away information picked up while tackling one issue and applying it to an alternate yet related problem. 'Bottleneck' is the penultimate layer just before the last yield layer that really does the arrangement. This layer contains the data on arranging diverse items prepared already. By sparing this layer which is a softmax relapse we can prepare our new

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information on the pre-prepared model along these lines diminishing preparing time in long keep running with better precision.
Transfer learning helps in lessening the required calculation power and time required in building another model starting with no outside help. Transfer learning is along these lines a speedier method to actualize a classifier with little measures of information. We utilize this method to rapidly prepare a model. We test and talk about the exactness utilizing imagenet dataset in the bottleneck layer of the prepared initiation v3 display in section VI.

D) Processor

All the Pi-Camera are equipped with low cost Raspberry Pi running Raspbian Operating System equipped with a wireless LAN card. The pi can be powered by a power bank for mobility which can last for a day on a single charge even under heavy usage or directly connecting it to the power source. The system is programmed to monitor and capture frames continuously in real-time, it compares each frame with the pretrained datasets and models. The frame processing activity is carried out and done with the help of processor.

The program activity can be divided into

- Frame identification
- Frame processing
- Frame Dumping
- Send Alerts and Notifications

The alerts and notifications is done through e-mail and SMS

- Using SMTP for emails
- Way2SMS API for sending SMS to phones

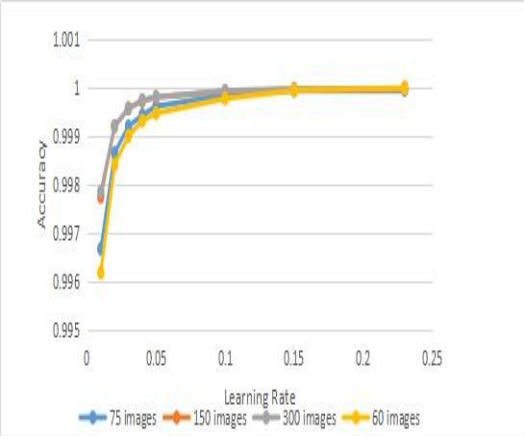

Fig. 5. Accuracy vs learning rate

VI. RESULTS AND FEASIBILITY

For product identification, CNN extracts feature points of the object in the image to provide a detailed description of the object. The implementation with deep CNN works well even in poor lighting conditions . The image identifier is built using transfer learning using 60 , 75, 150 and 300 images and the accuracy is measured for each. This is plotted in Figure 5. It is clear that with a larger number of training images, the accuracy with which images are identified is

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higher.

On 22th March 2018, a survey was conducted among people from all walks of life. The purpose of the survey was to discover their opinion regarding our work and if automation can help in making the process more accurate and its implications on public safety. The survey consisted on two parts. The first dealing with their details and public safety issues faced. This included their age, occupation and travelling routine. The second part described to users the smart surveillance system and users were asked to rate the automation process, give their feedback and how it can be improved.

From the data collected, the most significant insights are as follows. 77% of the survey takers were undergraduate students who either lived on campus or off campus,remaining 23% were working professionals. 70% preferred public transport for commuting atleast 5 or more times a day .Rest 30% preferred either rarely or never use public transport finding it finding it unsafe .

The result of the survey and test output is shown in figure 7 and figure 8 respectively. 80% are strongly convinced that the automated system shall be helpful. 10% found it to be good alternative but would need further improvements and additional features. 8% felt ambiguity in the system such as system response in case of power failures and wished for more simple option as hiring security guards . A meager 2% were not convinced by the effectiveness of the system and thought it to be a costly setup.

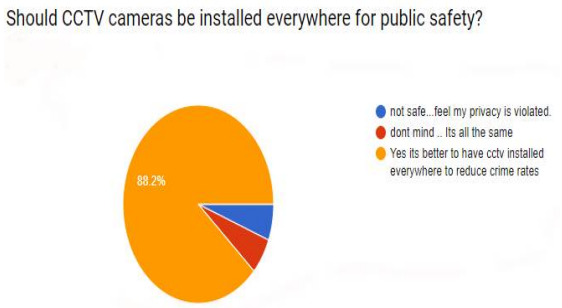

Fig.7.Customer Response to Smart Surveillance Cart.

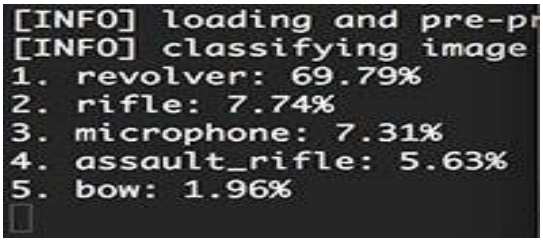

Fig.8 Output Screenshot

Overall, majority took automation of surveillance systems with positive response and found it to be more feasible and in favour of public safety . Also adding similar hazardous objects and human actions was welcomed by many as it would be an extension to the work and further help in the field of public safety.

VII. CONCLUSION

The project demonstrates the possibility of developing a Smart Surveillance System which automates the entire surveillance process. The system proposed and the prototype built is highly reliable, fair, cost-effective and hassle free to operate. It is efficient and fair owing to the effectiveness of individual raspberry pi systems combined with a highly

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reliable Image Processing and Prediction techniques using convolution neural networks. The system is also energy efficient. The prediction process is done locally within the system. The system is cost-effective as it requires only one active sensor (the raspberry pi camera) that can be placed on a pi holder. In the bigger picture, it improves Surveillance while reducing the manpower requirements of the work .

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