Intelligent Video Surveillance System for Indian Farms

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Security is incredibly significant for farms. Crops may be devastated by the intruders coming to the farm. Besides, because farms are often attacked by the intruders and it is stolen during yield, the farmer is forced to stay and protect the crops. In this paper remote farm monitoring system with video surveillance is described. This system will observe the intruders in the farm and force intruder to leave the farm. The system will also alert farmer regarding weather condition, grass cutting, and crop cutting. The electrical energy is generated by solar to provide sufficient electrical power required to run the system. The main system is fixed on the pole, comprising Raspberry-Pi, Camera, ultrasonic sensors, Humidity sensors, temperature sensors, smoke sensors, Wi-Fi module. The camera takes the frames of intruders, the system will detect the intruder and classify the intruders with time stamp. At the same time the alarm and light will be initiated to scare the intruder. The frames with intruders will be further analyzed for the intruder's classification and its timing of arrival. The smoke sensor is used to protect the farm from fire, if fire is detected, it turns ON the motor. The information collected by humidity sensors and temperature sensors will alert the farmer regarding weather condition to take precautionary measures. Proposed system is designed for Indian farms and it will be cost effective also.

Keywords: Video Analytics, Internet of Things, Deep Learning in Agriculture, Smart agriculture.

1. INTRODUCTION

In India intrusion by thieves and animals at the farm area is common. The farmers take lot off efforts for top yield in various ways but, their yield is condensed due to the interference of intruders in the farm. Thieves and animals intrude the farm and cause lot off harm to crops. Birds, and farm animals cause harm to the crops either by crushing or damaging them. Due to all these farmers incurred loss and the profit of farmers is reduced. Farmers take various measures such as installing electric fencing, manual scarecrow at the field. But these measures are not efficient and affordable. Electric fencing is risky too. To protect farms, farmers need to stay in field area to save his crops. Sometime farmers even lose their life if the wild animals attack the field. If animals spoil the crop, or vegetables and if it is sold to the market it will cause the harm to the people who buys it. Hence, there is need to monitor the crop security of the farm and to detect and to prevent unauthorized entries into the farm.

Now with the advent of internet of things and convergence of it with machine learning algorithms specially for video analytics. We have developed cost effective smart video surveillance system for Indian farms.

Proposed systems will be very much useful for the Indian farmers. As they can monitor the activities at their farm the comfort of their home using mobile app. Farmers will get automatic

updates about the fire and weather change at the farm. Proposed systems will be cost effective also. Even farmers having their farms adjuncts to each other can use the proposed system in the groups.

Paper is structured as follows Section 2 is related work in which literature survey about the video surveillance systems for agriculture is done. In section 3 research gaps identified after literature survey is mentioned. The objectives based on the gaps are enlisted. Section 4 gives details about the proposed methodology. Section 5 presents the results and analysis is also done.In Section 6 conclusion and future scope is presented. Finally, references are mentioned in section 7.

2. RELATED WORK

In 2011 Chomtip Pornpanomchai et.al [1] presented a paper in ACM conference on the topic "Smart Scarecrow" which describes capturing bird images and making loud sound when birds are captured by the camera.
C. Adrian Martinez et.al.[2] discussed the malware detection based on intrusion ontology technique using cloud computing.
In 2007, Discant A. Rogozan et.al [3] published the research article in conference where authors presented the review of sensors used for obstacle detection some are those sensors are also used in the proposed project.
Hamoud M. Aldosari,[4] proposed and discussed the security layer for the communication between IoT devices.
In 2020, Hongkun Tian [5] presented the review of the computer vision technology used in agriculture systems specially in China. Machine vision systems for the detection of the green leaves is explained in the paper written by Huajian Liu and Javaan Singh Chahl [6].
Ilek Koc-San et.al.[7] discussed about citrus tree extraction using UAV rays. They use hough transform technique for image processing. There are some systems developed for farm protection at International level.
Tung-Jung Chan et.al.[19] has discussed about the development of automatic scarecrow which can protect the crop from birds. It uses cameras for detecting the birds but there is no video analytics. So, there is no analysis of videos and could find the patterns of intruders at farm. [8] J. Oberheide et al. in 2012, mentioned that birds are the main reason for the damage of crops. To reduce the crop damage, In 2011 J. John Livingston et.al. [9], suggests the use of habitat management of roosting sites, plant desiccants to accelerate harvest time, [10] Mehrdal et al. presented an eco-friendly technique that would reduce the loss of crops developed using an interdisciplinary approach. They also found that the techniques like using sticks, scarecrows, reflecting ribbons, firecrackers, and catapult (Kavan) are not efficient in repelling birds, though these techniques are eco-friendly.
In 2013, according to research from [11] Nguyen et.al. has demonstrated that methyl anthranilate was effective in repelling birds, but it is expensive and causes damage to crop. The methyl anthranilate can be maintained for a long time due to high concentrations.
In [15] S Ojha and S Sakhare presented a review of object tracking using TensorFlow. In [12] O. L. Barakat et. al discussed details about the "SCARECROW" Malware detection and reporting system. [15] and [17] Sachin Sakhare et.al. describes the real time and embedded operating systems used in embedded devices. Y. Siahaan et.al.[22] presented the idea of bird detection and repellent systems using Arduino. Community alarm systems using MCU is presented in the paper written by Zhaoxia Wang [23].

3. RESEARCH GAPS IDENTIFIED AND OBJECTIVES

From the state-of-the-art literature review we have identified following gaps.

a) No existing system do the video analysis and intelligently identify the patterns in the videos captured.
b) There are no farm surveillance systems developed for Indian farms.
c) Even existing systems does not detect all kinds of intruders including birds and animals on ground.

Objectives of the Proposed System are as follows:

a) To monitor intruders and provide security to farm.
b) To give notifications to the user regarding grass cutting, intruders, crop, weather etc.
c) To provide intruders analysis to the user.
d) To detect fire and alert the farmer.
e) To detect rains and other weather condition in the field.
f) To serve as an intelligent scarecrow for the Indian farms.

4. PROPOSED SYSTEM

Digital video signals are processed using special technique known as Video Analytics. It uses special algorithms to analyze the videos and to uncover the patterns in it. The video analytic techniques are classified into the 3 types:

a) Artificial intelligence learning techniques
b) Facial recognition algorithms
c) Fixed algorithm analytics

Artificial intelligence learning techniques are entirely different than other 2 methods. These algorithms are evolved from scratch. Initially, it captures the data and get trained for several week. Once the camera is installed and start capturing the videos it begins to issue notifications and alerts after some weeks about the abnormalities in the videos means the videos which is not as per the normal patterns. In such a way intruders, fire, rains, and birds are recognized and alerts are generated.
Next two methods produce similar outputs. That is, it detects suspicious behavior in the field using the videos captured by camera and the algorithm in the background will process it and generates the notifications and alerts. However, each takes a dramatically different route to get to its result.
We can use facial recognition algorithms to identify friend or foe. The facial recognition algorithm match feature points of the face with a sample face stored. If the algorithm fails to match the record, then new record is created from the best image available. The 3-D maps of the faces are constructed by latest version of facial recognition systems.
Specific task and specific behavior are determined by the algorithm designed for Fixed algorithm analytics. Each fixed algorithm looks for a very specific behavior.
Proposed video analytics algorithm work like human brain. It recognizes the difference between interesting motion (e.g., a person or car) and uninteresting motion (e.g., swaying branches or clouds). In this project we are proposing the new real-time video analytics algorithm which detects the interesting motion in the environments by combining temporal difference imaging and a temporal filtered motion field. The proposed algorithm effectively recognizes salient motion within a variety of real environments with distracting motions such as lighting changes, raining etc.
Here we are using technique called " Edge Compute". It is an additional layer of control in any IoT solution. It helps reduce latency of event triggered actions as quick analysis happens at the edge. It also helps conserve up link bandwidth and storage space by passing only relevant data to the cloud. In Video surveillance domain is benefited a lot by edge compute technique as Video bandwidth is high. In proposed system we will develop video analytics algorithms such as video

summrization, bird, person, and animal detection, that can be deployed in edge Gateways to optimize an overall IoT solution.

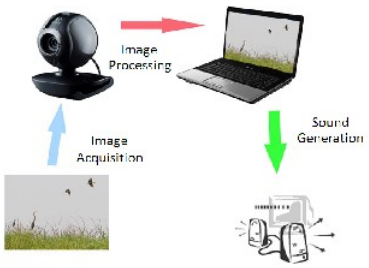


Figure 1. Conceptual Diagram

Proposed system involve following stages.

1) The night vision camera captures the videos of the farm in regular intervals and other parameters like temperature, rain and sound are sensed by the sensors installed at the field.
2) Videos and other parameters are transferred to the node like Arduino /Raspberry pi installed and from there it is transferred to video analytics application on cloud.
3) The application uses video analytics technique such as Convolutional Neural Networking (CNN) to analyze the video and parameters sensed to detect intrusion or fire or some problematic incident.
4) Finally, the system generates a alerts and notification will be send to owner of the farm.

The proposed Video Analytic algorithm has following components.

- Video Acquisition component.
- Video Preprocessing component.
- Intruder Detection component.
- Notification and alerts Generating component.

Video Preprocessing and intruder detection component consists of following stages.

- Segmentation
- Classification
- Tracking
- Activity Recognition

These stages are depicted in the following figure

Segmentation detects changes and extracts the significant changes for further analysis and qualification. The Pixels for which values are altered are referred to as “Foreground Pixels”; those that do not have altered values are called “Background Pixels”. Therefore, segmentation is known as “Background Subtraction”. Pixels remaining after the background has been subtracted are the foreground pixels. In Classification we check weather each blob is qualified or not and assign a class label to it. This categorizes each blob into distinct categorizes such as human, animal, etc. Classification may be done on a single frame or may use information over multiple frames. These features need to be selected in a manner such that they provide sufficient discrimination between each valid class.

The next step is tracking. Tracking means blob association. Tracking of classified foreground blobs takes place over multiple frames as objects move through the field of view.

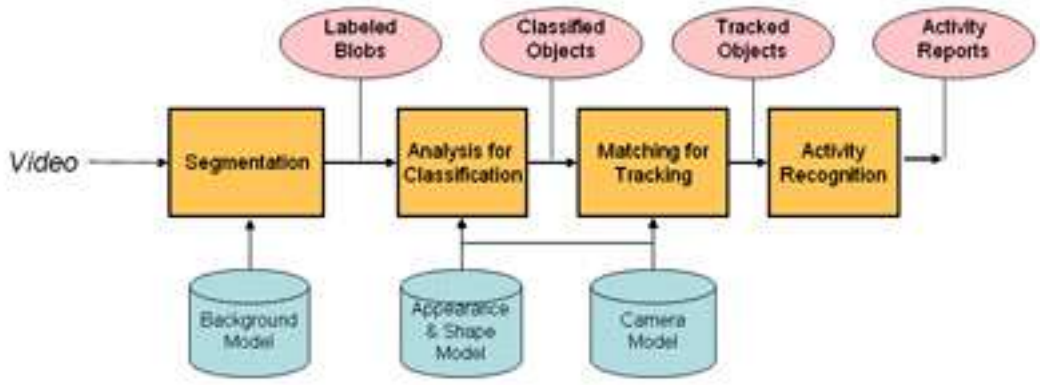


Figure 2. Video Analytics Preprocessing and Object detection stages

In activity recognition we combine the outcomes of classification and tracking stages. It is a final stage in video analytics. In activity recognition, we combine the output of correlating tracks of multiple blobs to infer the activity occurring in the video. Consider the following example: If two blobs corresponding to people progressively come closer, this could be interpreted as converging people. If two blobs, one corresponding to a vehicle and another corresponding to a person happen to merge, this could be interpreted as a person getting into a vehicle.
The mathematical calculation for the image pre-processing can be represented as follows:
More preciously, at the i^{th} layer, we denote:

1) Input: a[/-1] with size (4 11, n[i14, 11, 11), a[13] being the image in the input
2) Padding: p[1], stride : .0]
3) Number of filters :4 where each K(n) has the dimension: (f [l], fng,-1])
4) Bias of the nth convolution: b[1]
5) Activation function: 0[1]
6) Output: a[1] with size (n[I.1]-, n[11417])

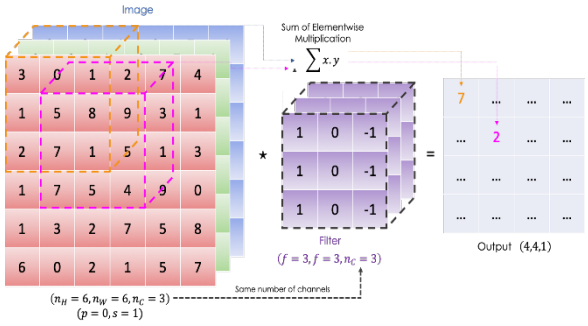
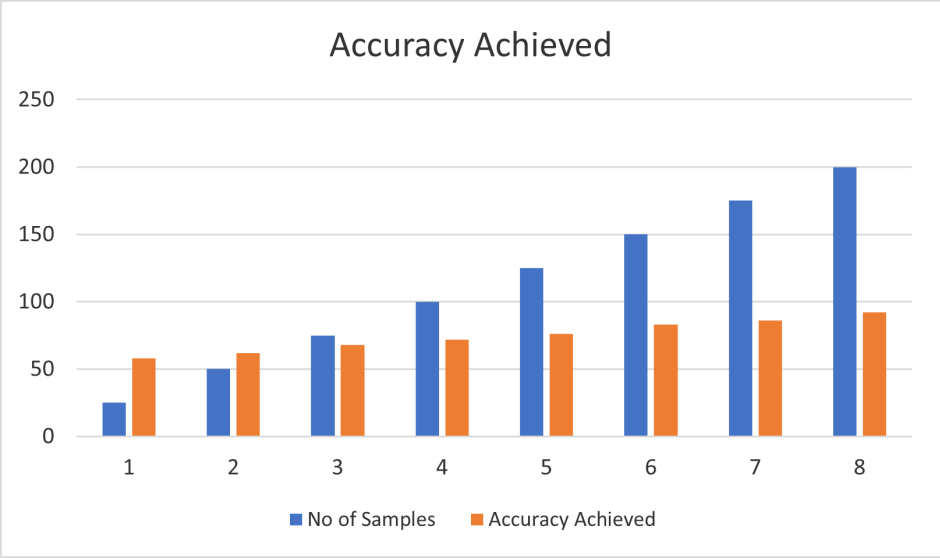


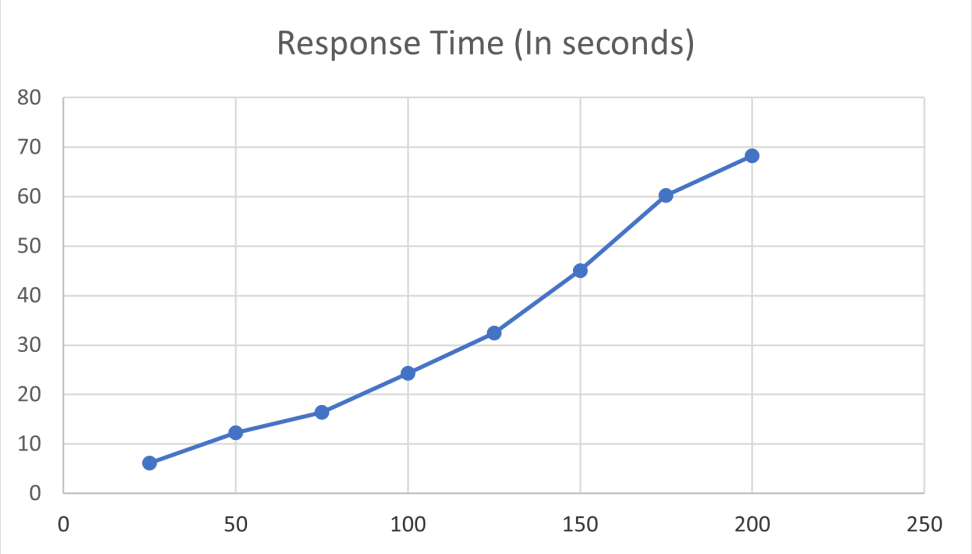
Figure 3. Image Processing Calculation

5. RESULT AND DISCUSSION

We have implemented the system by installing camera and other sensors.at small piece of land and captures the videos in regular intervals and sensed other parameters. We have tested the proposed video analytics algorithm for accuracy achieved and response time.



Graph 1. Accuracy Vs Samples



Graph 2. Samples Vs Response Time

From the above graph 1 and graph 2, we can conclude that as the number of video samples for training and testing is increased more accuracy is achieved. But as samples are increased the response time is also increased drastically. So, for the samples of 200 videos captured, maximum accuracy achieved during the testing is 92%.

6. CONCLUSION AND FUTURE SCOPE

Here in this paper, we have presented the video surveillance system for the Indian farms. This system uses an emerging technique called video analytics for the automated surveillance of the fields. It uses an intelligent camera which has analytics as connected component. It analyzes the videos captured and determines the presence of intruders, animals, and birds. It also interprets

their activities. Suspicious activities e.g. intrusion in the farm, are automatically detected and notified to the farmers. Here we have proposed video analytics algorithm which uses convolutional neural network (CNN) for video processing to determine the suspicious activity at the farm. We have also used sensors such as rain sensor, ultrasonic sensor, temperature sensors to detect the incidents like rain fall or fire at the farm. Applying technology in the agriculture sector has significantly enhanced the country's agriculture sector.
During this research, one of the limitations in the implementation is the internet connectivity for various IoT devices. In future full flesh internet connectivity will be available and the IOT devices will record the data with full functionality. The data and videos will be transferred to the cloud server for processing and storage. For future improvement, proposed system could help the farmers to control and analyze the attacks that may come during the next season.

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