FLANN: Fast Approximate Nearest Neighbour Search Algorithm for elucidating Human-Wildlife conflicts in Forest areas

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Abstract—Elephant accidents have been an increasing phenomenon in recent years. To mitigate these casualties, we propose a system Flann Based Matcher and FLANN (Fast Approximate Nearest Neighbor Search Library) using image processing to monitor the path of elephant movements. This involves the following functionalities
1. Monitoring elephant movement over the track
2. Alerting the nearby railway station, the locomotive pilot and the forest range officer if any such movement is detected
Monitoring involves elephant detection using image processing by applying the techniques of background subtraction and foreground enhancement. The result shows significant improvement in detecting and preventing elephant accidents compared to the existing system (without FLANN).

Keywords—background subtraction;foreground enhancement; image processing

I. INTRODUCTION

During the past decades, the acceleration and diversification of human induced conflict upon natural ecosystems has led to wildlife habitat fragmentation. Wildlife conservationists have been driven to reconsider the benefits previously credited to the edge effects on wildlife diversity due to these changes in land use. The transformation in natural environment is very rapid due to the growing demands of men but many animal species are not able to adapt to these changed conditions. As a consequence many species are facing the threat of extinction and perish eventually. This is the problem today. Such forces of change have to be controlled to prevent extinction of wildlife.

One of the main reasons for the threat to wildlife is deforestation. The results of various statistics conducted on estimation of forest cover in India indicated that forests covered an area of 869,012 km^2 in 1930 which has decreased to 625,565 km^2 in 2013, a net loss of 243,447 km^2 (28 %) in eight decades. All these leads to encroachment of space occupied by wildlife, threatening their peaceful co-existence.

The International Union for Conservation of Nature includes the Asian elephants in their endangered species list. The Human-elephant conflict is a major preservation, socio-economic and political subject across Asian elephant range in Asia and Africa which also threatens their survival where some new technologies are proposed. The largest population of the Asian elephants is in India— around 28,000 in number. There are conceivable multilevel impacts of some scene properties on elephant conveyance in the Western Ghats, India, that are analyzed by applying a current and basic scientific technique to measure such natural connections crosswise over space and scales[9]. A report by the Elephant Task force, commissioned by the Ministry of Environment, revealed that 150 elephants were crushed to death by speeding trains between 1987 and 2010. Also every year in India more than 100 people and 40-50 elephants are killed during elephant crop raids.

A. Threats to wild elephants

Many techniques have been used since the olden days to prevent elephants from entering human territory. Some of them are bursting crackers to scare the animal or using trained elephants by their mahouts to chase the wild one back to the forest. Beating drums and throwing rocks is also another technique used for this purpose. But it is very hard to stop a determined elephant. One major problem is that elephants are very intelligent animals. They can become used to various tactics used on them. So a technique that once scared them away no longer works. But using such techniques often endangers the lives of these animals. Some of them are mentioned below.

1. No space to roam

Forests cover 31% of the land area on our planet. Many of the world's most threatened and endangered animals live in forests. But forests around the world are under threat from deforestation, jeopardizing their benefits. Some 46-58 thousand square miles of forest are lost each year. This impacts people's livelihoods and threatens a wide range of plant and animal species. The figure.1 below shows the forest spread in million hectares, both tropical and temperate over the years.

Forest Survey of India has been carrying out mapping of forest cover at the national level on a biennial basis. For

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2009-2011, compared to the global average of -0.6%, the current estimation of gross deforestation in India is quite low (–0.43%).The gross deforestation rate continues as a focal hindrance even though substantial improvement has been made in the protection of forests. The graph below shows the decrease in forest cover throughout the world. This has led to reduction in space for wildlife habitat, threatening their survival. Naturally the wild elephants start entering the human terrain leading to human-wildlife conflicts. So it becomes very important to track their movements. Unmanned Aerial Vehicles (UAV) are used for tracking of these animals [12].

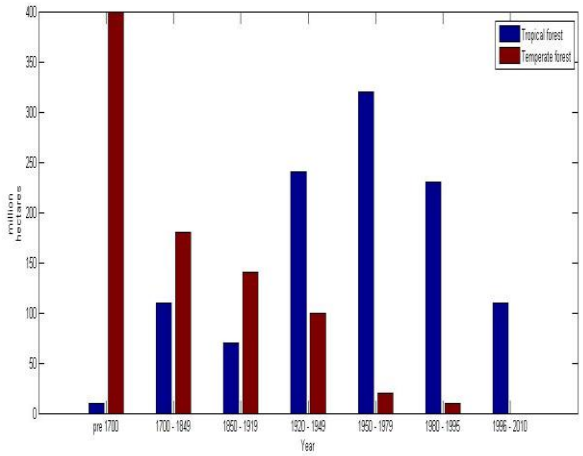

Figure.1. Forest spread in million hectares, both tropical and temperate over the years

2. Conflicts with humans

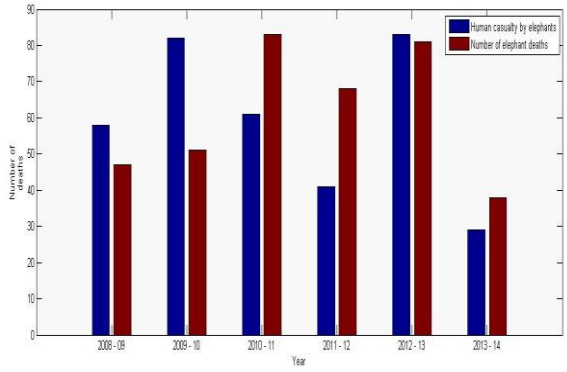

Figure.2. The human casualty caused by elephants and the number of elephant deaths

The negative impact created by the interaction between wildlife and people has led to a growing conflict between humans and animals. It occurs when rising human population overlaps with established wildlife territory, causing decline of resources or life to some people and/or wild animals. This conflict causes many problems ranging from loss of life or injury to humans and animals to competition for limited resources to loss and degradation of habitat. The fig.2 shows the annual report on the human casualty caused by elephants and the number of elephant deaths. Also many elephant deaths are caused due to the roaming of elephants on railroads [14].

3. Ivory poaching

According to a new study that offers dependable continent-wide estimation of illegal kills, ivory-seeking poachers have killed 100,000 African elephants in just three years. Roughly one of every twelve African elephants was killed by a poacher during 2011 alone. Another important problem recognized is that an increasing number of African elephants are now born tusk less because over decades these animals have been targeted consistently by poachers for their ivory. This has fundamentally altered the gene pool. In some areas 98 per cent of female elephants now have no tusks compared to between two and six per cent born tusk less on average in the past. In the past ten years almost a third of Africa's elephants have been illegally slaughtered by poachers to meet demand for ivory in Asia, where there is still a booming trade in the commodity, particularly in China.

4. Capture of young elephants

In a case study conducted it was found that Zimbabwe plans to capture and send more wild elephants to zoos and safari parks in China, a country not known for strong animal-rights . Last year's sale of 24 baby elephants for about $40,000 each to China has been deemed as legal by the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) focusing on promises that the elephants would be free to roam 1.3 million square meters of land and not be used for performances.

Many young elephant calves are captured from the wild and either killed to prevent any untoward incidents in the future or they are exported to various countries where the ivory is used for some medicinal purposes.

B. Problems on losing elephants

Elephants are among the smartest creatures with whom we share the planet, with compound perception that are capable of strong emotions. They are also one of the basic species, playing a significant role in preserving the biodiversity of the ecosystems in which they live. When forest elephants eat, they create gaps in the vegetation. These gaps pave way for new plants to grow and create paths for other smaller animals to use. They are also one of the major methods in which trees disperse their seeds; some species depend completely upon elephants for seed dispersal. Elephants leave dung that is full of seeds from the many plants they eat wherever they live. When this dung is deposited the seeds are sown and grow into new grasses, bushes and trees, boosting the health of the ecosystem.

The other role of elephants is to pull down trees and break up thorny bushes. This forms grasslands and salt licks which makes the survival of other animals easier in their environment. Their final role is that they create water holes by digging in dry river beds which helps other animals and also tribes to obtain access to watering holes which is used as a vital source of water. So when the existence of these animals is threatened due to many reasons stated above, it creates an

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imbalance in the ecosystem affecting the peaceful co-existence of humans and animals.

What is our plan towards it?

In the last couple of years wild elephant killings due to train accidents is found to be 15-20 elephants annually. Also many elephants are killed due to human wildlife conflicts where these animals enter the human terrain in search of space and food. This is not just an ecological disaster; it is an economic and security threat as well.

To help end this crisis, we need a complete systems change and realize that elephant poaching is present within its own market system .Nowadays elephants can also be tracked using infra sounds [10]. The killing and trafficking of elephants must be stopped and their demand must be reduced by educating end consumers. These issues can be sensitized by government organizations by creating innovative programs to offer incentives and reward local populations in the successful protection of elephant populations. Also some structural constraints are to be perceived regarding its visiting activity [5] where noninvasive methods for tracking elephants can be used [7].

The hunting of elephants can be reduced by preventing them from entering human encroachments so that it avoids unwanted interaction between them. Also small elephant calves must be protected from being sold to other countries for tourism and preparation of medicines. Rail road accidents leading to the death of many elephants is also a concern that must be addressed. One solution is to monitor the railroads using wireless sensors [8].Also many broad approaches have evolved based on for algorithmic wildlife monitoring in real time [15].

II. Related Works

A. Mitigate collision of animals and vehicles

Identifying huge animals on roadways using automated framework is a vital assignment. This can be accomplished utilizing traditional apparatuses, for example, ultrasonic sensors, or with creative innovation in light of brilliant cameras. A vision based solution is proposed for this purpose where relative review between three identifiers : 1) Haar-AdaBoost; 2) Histogram of Oriented Gradient (HOG)-AdaBoost; and 3) Local Binary Patterns (LBP)- AdaBoost, which were at first created to distinguish people and their appearances is used[1]. These identifiers are executed, assessed, and compared to each other in terms of precision and processing time. In light of the assessment and examination, outline a two-stage architecture which beats the previously mentioned indicators. The proposed architecture identifies candidate regions of interest utilizing LBP-AdaBoost as a part of the first stage, which offers vigor to false encouraging points in real time conditions. The second stage depends on support vector machine classifiers that were prepared utilizing HOG features. The preparation information are generated from novel dataset called extensive creature dataset, which contains regular and thermographic pictures of huge street creatures.

B. Applying behavioral principles in human wildlife conflict

There is no notorious silver projectile for alleviating humane wildlife strife, however the investigation of human-wildlife conduct is foundational to understanding issues of concurrence amongst individuals and wild creatures. The elephants can also be located using acoustic sensor [7] and seismic sensors [13]. The motivation is to inspect the hypothetical and connected part that behavioral standards play in comprehension and moderating humane wildlife strife, and depict crevices in behavioral hypothesis with respect to relieving these clashes [2]. In particular, two diverse, yet contemporary, parts are considered that are cases of human wildlife struggle: animal vehicle collisions and carnivore devastation of domesticated animals. Although apparently disconnected, both struggle regions share regular topics with respect to creature behavioral reactions to unsettling influence and impression of hazard. The impacts on untamed life because of these contentions in the extent of populace manageability, and afterward look at ebb and flow examine with respect to the accompanying three inquiries. How is behavioral environment significant to these specific zones of contention? Are advances toward comprehension the systems by which creatures prepare data and settle on choices being converted into administration techniques? In what manner may administration endeavors be influenced after some time by individual practices, strategy mix and habituation/sharpening? As to collisions, just in the last decade have scientists connected an anti-predator theoretical ecology with tactile biology to understand parts of marine warm blooded creature, terrestrial well evolved creature and winged animal reactions to vehicle approach, speed furthermore, related boosts. In any case, the size and speeds of cutting edge vehicles request that we move forward financial models and conceivably create novel hypothetical systems to better foresee creature reactions to vehicle approach. Inside the setting of carnivore livestock plunder, our comprehension of individual predator conduct in respect to perceived hazard and variables adding to the improvement of issue people will impact the adequacy of the most encouraging, nonlethal administration approaches (e.g. distractive methods, conceptive restraint and olfactory hindrances). In both cases, fruitful administration is dependent upon an unthinking comprehension of how creatures react to aggravation and the data used to evaluate chance.

C. Conflict transformation in wildlife conservation

Unaddressed or inadequately tended to clashes show progressively troublesome deterrents to successful conservation and administration of numerous untamed life species around the globe. The material, unmistakable indications of such clashes are regularly established in less noticeable, more perplexing social clashes amongst individuals and gatherings. Current endeavors to join partner engagement regularly don't completely recognize or address the social clashes that lie underneath the surface of protection issues, nor do they reliably make the necessary conditions for profitable change of the underlying drivers of contention. However, a definitive level of social conveying limit with respect to

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numerous species will rely on upon the degree to which preservation can accommodate these social clashes, in this manner expanding social receptivity to protection objectives. To this end, Conservation Conflict transformation (CCT) offers another viewpoint on, and way to deal with, how conservationists recognize, comprehend, avert, and accommodate strife. Standards and procedures from the peacebuilding field illuminate CCT and offer valuable direction for uncovering and tending to social clashes to enhance the adequacy of preservation endeavors. The Human-Wildlife Conflict Collaboration (HWCC) has adjusted and illustrated these standards for application in preservation through limit building and struggle mediations, changing what number of specialists in the preservation field address strife. The current constraints of the practice are considered[3], when tending to strife in protection, characterize struggle change, delineate two logical models to situate the per user to the benefit of CCT, and present two contextual investigations where CCT was connected helpfully to a protection related clash.

D. Optoelectronic Profiling and Ranging Sensor for Monitoring of Perimeters

Electronic checking of edges assumes fundamental parts in country security, administration of activity and of human-natural life strife. The created sensor framework can decide the separation of the question from the detecting units and its transient tallness profile as the question crosses the framework [4]. Together, these amounts can likewise be utilized to characterize the question and to decide its speed. The sensor is composed, fabricated, and assessed. The plan empowers conservative development, high affectability, and low estimation crosstalk. The assessment shows exactness superior to 98.5% in the assurance of stature and more than 94% in assurance of the separation of a question from the detecting units. At last, a methodology is proposed to characterize the items in light of the acquired profiles. The methodology is shown to accurately group the items regardless of contrasts in their speed and the area at which they cross the framework.

III. PROPOSED SYSTEM

In our proposed framework, the main aim of our work is to caution the general population in and around the forest border zones and to protect their lives from the threat brought about by wild elephants going into their towns.

It deals with building a system that monitors elephant movements. The system consists of a camera that is fixed in a remote target area where the conflicts between the human and elephants generally occur. The camera captures video of the region within its range. This video is constantly monitored by the system. It is matched with the reference frames that have already been fed to the system. By image processing using the background subtraction technique, the live video is analyzed if there are any elephants. Not only are the mere presence of the elephants but the direction towards which the elephants are headed to is also determined. In case the elephants are headed towards the village or the railway tracks then a call is made to the concerned people to be informed and alerts them by playing a pre-recorded video. The numbers of these person are already fed to the system by the system admin. If the elephants are detected to head towards the forest then the elephant detection system remains idle. The alert also consists of the id of the elephant detection device. Every village base station maintains a database regarding the details of the detection device. Using the Latitude / Longitude coordinate of the device the current location of the elephant can be determined.

Hardware Components:

The elephant-location framework (elephant identification gadget) equipment will include certain parts, for example, Raspberry pi for preparing detected information and Arduino UNO board for serial communication. Camera module is used for capturing the pictures of elephants, communication by means of 3G technology for sending information to the field transmission stations. Storage space for picture database is obtained by using SD card. Solar boards and related parts are used for power supply.

How would we recognize an elephant from the pictures that the camera gets?

The most difficult part of the venture is correlation of taken pictures of associated elephants with known pictures with elephants. Raspberry pi acts as an interface over which OpenCV in Python is utilized to either look at histograms (the quickest and minimum serious re-handling and assets) or to coordinate features (slower and more asset specific). Particularly highlight coordinating (Brute-Force matcher and FLANN Matcher) is utilized; in spite of the fact that this is somewhat moderate. Maybe outright histogram correlation will be sufficient. This is truly quick, and elephants do have an unmistakable shading. An outline of using Flann Based Matcher and FLANN (Fast Approximate Nearest Neighbor Search Library) in OpenCV is mentioned below:

1. Detect the key points using SURF Detector
2. Calculate descriptors (feature vectors)
3. Matching descriptor vectors using FLANN matcher
4. Quick calculation of max and min distances between key points
5. Report only "good" matches (i.e. whose distance is less than 2*min_dist, or a small arbitrary value (0.02) in the event that min_dist is very small)

The flow of the proposed system is illustrated in figure.3.

IV. IMPLEMENTATION AND EXPERIMENTAL RESULT

The proposed system uses the FLANN classifier in order to train the process of selection of features for image processing.

- A classifier is trained with a few hundred sample views of a particular object
- After a classifier is trained, it can be applied to a region of interest in an input image
- The classifier outputs a “1” if the region is likely to show the object and “0” otherwise

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- classifiers are applied subsequently to a region of interest until at some stage the candidate is rejected or all the stages are passed

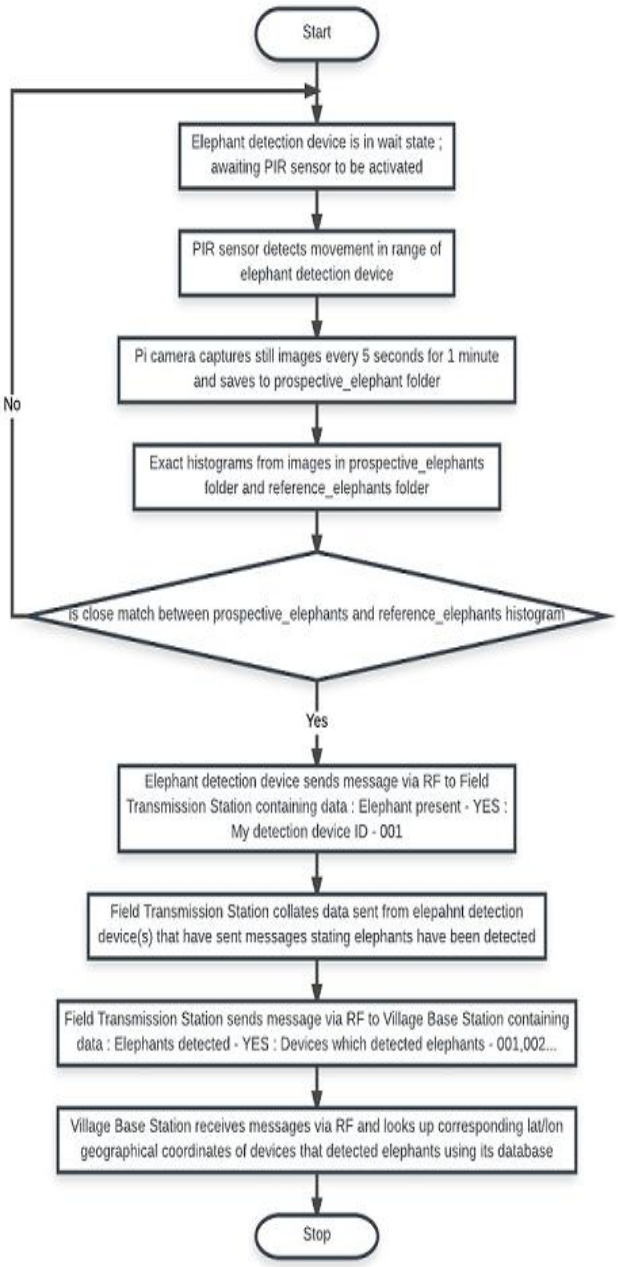

Figure.3. Flow chart of the proposed system

The FLANN cascade classifier is trained by the following steps.

- Collect NEGATIVE Images
- Collect POSITIVE Images
- Create a positive VECTOR file by stitching together all the positives
- Train Cascade

FLANN feature detection

The FLANN feature detection uses a method **detectMultiScale()** which compares the features of an image and finds out if it is a prospective elephant by matching with some predefined features of an elephant. The technique used for matching is backward subtraction in image processing.

detectMultiScale
(**const Mat& image,**
vector<Rect>& objects,
double scaleFactor=1.1,
int minNeighbors=3,
int flags=0,
Size minSize=Size(),
Size maxSize=Size()
)

Where,

- image – represents possible features of the object used for comparison with prospective object
- objects - Vector of rectangles where each rectangle contains the detected objects
- minNeighbors – represents how many neighbors each rectangle need to retain it
- minSize – represents Minimum possible object size. Objects smaller than that are ignored
- maxSize – represents Maximum possible object size. Objects larger than that are ignored

It was observed that the proposed technique gives a decent exactness of elephant detection which is identical to existing techniques. While in the meantime there is a trade off with false positive rate which is quite high. Table 1 illustrates a comparison of the existing technique and proposed strategy. The exactness of elephant detection was observed to be 98.5% while the false positive rate was observed to be 21.0%.

The figures Figure.4 and Figure.5 shows the difference between the proposed and existing system in detecting the elephants. As the preparing and testing information were just of 250 seconds commutatively and the clamor substance is less when contrasted with motions in the database; it could have prompted to improvement of less streamlined system.

This could be the conceivable reason of such a high false positive location. Another test in this work was to physically mark the elephant and moving objects. As this is the work of a specialist and the general population required in this work do not have any ability learning with respect to the elephants, this may have prompted to incorrect marking.

From the figures.5 it is clear that the proposed system acts more efficiently than the existing system in identifying the given data, the output details were found to be as follows. From Data 1 in TABLE 1, a four minute video 300frames are tested for the presence of elephants. The target detection that is frames where presence of elephants are detected is found to be 204 frames. Of this 71 are found to be false positives (Water pattern, leaf pattern & people are detected as target images) and 46 are detected as false negatives (Elephants are not recognized as

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elephants).We compared accuracy of the system without FLANN System and with FLANN Algorithm and the experimental result are represented in Table 1 and graphical data representation in Figure 6.We calculated Accuracy by using the formula

Accuracy = **(Number of Elephants Detected/Total Number of Elephants in the video)/*100**

Figure.4. Detection of elephants without FLANN

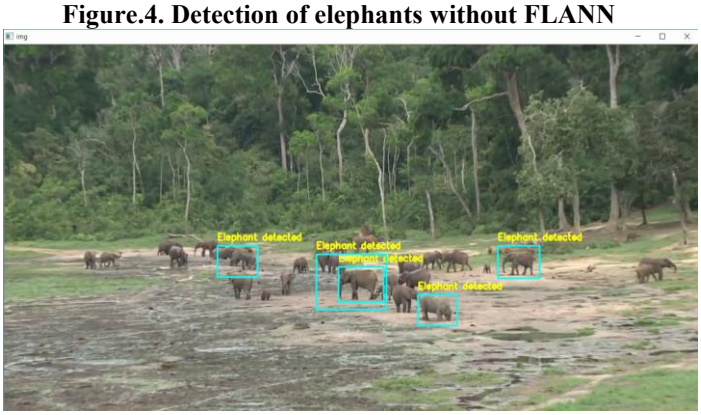

Figure.5. Detection of elephants with FLANN Algorithms

TABLE 1 : COMPARISON OF RESULTS

Videos in Minutes	Accuracy in Existing System(Without FLANN)	Accuracy in FLANN Algorithm
4	87	89
6	86.7	87
8	73.5	75
10	71	72
15	68.4	69
20	69	72
30	81.33	84

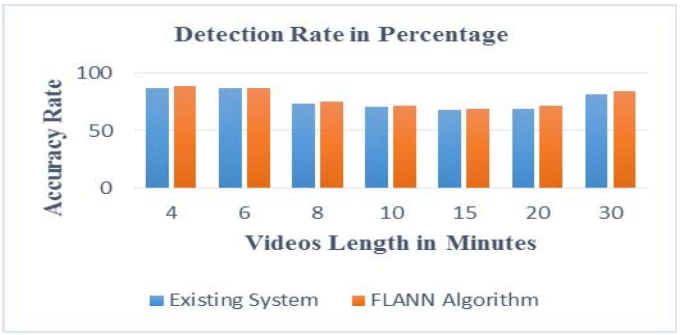

Figure.6. Comparison of Results in Graph

V. CONCLUSION

The proposed strategy gives a recognition rate of 76.7% yet can additionally be enhanced by noise cancellation techniques. Also in the event that this strategy is actualized with a more exhaustive informational index and with the assistance of specialists who could recognize between elephant detection and moving detection, the false positive rates may go down. Such an approach could give better outcomes since it eliminates noise factor in the video or Live Camera Stream

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