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A Self Induced Warning System for Wild Animal Trespassing Using Machine Vision System

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***Abstract*—In India an increase in human population caused by industrial and agricultural growth has led to the conversion of the forest lands into human settlements. Animals that wait near forest-village borer for nightfall particularly to eat crops have been known to kill or harm people. Therefore there is a necessity to safeguard human livelihood without endangering the animal population by developing a suitable monitoring system. The development of a monitoring system for elephant intrusion can help to track the presence of animals over forest prone areas and avoid the chance of interference or harm of animal to human life. Animal is identified by matching the present captured image through vision based camera with the template image available. The pattern matching is done for identifying specific parts of the elephants such as ivory, trunk, ear etc. The platform used for processing is Machine Vision using LabVIEW based image processing algorithm. Cameras are fixed at places where animals usually used to enter the villages, and images are sent for processing through a wireless system. If the pattern matches with the template warning signals are produced. This system reduces the time required to detect animal presence. Thus this system becomes effective and preferable to implement. An early warning is sent to the forest officials as well as the villagers about the arrival of elephants towards forest-village prone areas. Thus, this system provides a solution for an unsupervised process for individual species identification specifically for elephants.**

Keywords*—*Image processing, Animal trespassing warning, human-animal conflict, pattern matching, human-animal isolation

I. NOVELTY

A system with novel feature is proposed to extract information from the images (of animals) and signal (presence) acquired from the camera and sensor respectively. The camera and sensors are placed at locations near forest village prone areas. This in turn produces images that are processed invariant to translation, rotation and posture of images obtained. Then, with the information available, warning signals are sent to respective locations through a GSM module. This work focuses on wild elephants to save human life and prevent the animals form human intervention.

II. INTRODUCTION

In recent days wild animals trespassing and destroying of agricultural land has been a common issue among forest-village prone areas. Due to this, the wild animals face acute shortage of resources such as water and food, forcing them move often into the human habitat[1].There has been severe man-elephant conflict in these areas. The surveillance and tracking of animals are difficult due to their size and nature of movement. Venter et al have proposed a method for automatic detection of animals using vocalizations in animal voice recordings [2].According toSugumar et al, poaching for ivory had indeed become a threat with 100–150 tuskers being lost annually [3]. This study explores the correlation of reported Human-elephant conflict incidents within the 58 villages present between from the boundary of Kallar to Walayar, in Coimbatore District, TamilNadu, India [4]. In addition to food crops, forests are being logged for their timber and cleared to grow cash crop plantations such as rubber, tea, and palm. This in turn increases the population density to beyond the sustainable levels by reducing food availability for animals in the forest. The shortage of fodder has a impact on rates of animal reproduction; hence normal birth rate begins to decrease. Therefore animals wait near villages for nightfall and eat crops for balancing their biodiversity. The techniques involved in prevention of wild animals entering the agricultural field uses electrical barriers, crackers and forced throat water. But these techniques will harm the wild animals like elephants [5].

Hence an automated unsupervised elephant image detection system is proposed as a solution to human-elephant conflict in the context of elephant conservation. This system employs an optimized distance metric system to improve the image retrieval time from the database in the context of elephant conservation. Though this idea seems to be simple, agricultural lands and human lives could be saved from animal interference.

III. MATERIALS & METHODS

The proposed system consists of hardware components like ultrasonic sensor, camera, Data Acquisition (DAQ) card,

Personal Computer (PC), Arduino board, GSM module and Vision development module in LabVIEW software. The process of animal detection and alarming has a series of steeps like data acquisition, processing and presentation. The detection stage has two modes, whichare by means of a sensor and a camera. Similarly, the alarming stage has two modes such as, warning tone generation to villagers and a messaging service to the forest authority.

In this system, cameras are fixed at places where animals usually use to enter the villages. An elephant's image is captured in the forest-village border and is sent to a comparator station through an RF transmitter network. With the received image an image feature extraction is performed. The match between the elephant template image and the obtained camera image using machine vision based on LabVIEW algorithm is done. Then a message is sent to the forest officials indicating the presence of elephant in the forest-village border using a GSM module.

A. Hardware

1) Sensing mechanism

An ultrasonic sensor generates pulses, transmits to the surroundings, obtains reflection or echo and thus detects the presence of any obstacle. The detection signal obtained from an ultrasonic senor is processed for further analysis using a signal conditioning set-up. An Arduino board as shown in Fig. 1(b) is an open source micro controller based development board. The compatibility of interfacing ultrasonic sensor with an Arduino board made the process simpler in acquiring and processing signals. Here, the Arduino transfers the signal from the Ultrasonic sensor to the NI-DAQ card; similarly the processed output signal from the DAQ card is sent in turn by Arduino to GSM module.

(a). Ultrasonic sensor (b). Arduino Uno

Fig. 1. Sensing system

2) NI-DAQ card& Camera

The output from the LabVIEW is interacted with the external environment through specified hardware system which is compactable with LabVIEW. The DAQ card is built with device drivers capable of communicating with LabVIEW and external environment as shown in Fig. 2.At the same time the output of the system is to produce an alarm signal and a text message to the forest officials.

(a). NI-DAQ card (b). Camera

Fig. 2. Hardware modules

The camera as shown in Fig.2 (b) is the most important hardware since image processing technique is used. The camera is connected to the PC wirelessly. Radio frequency transmission is established between PC and camera. The quality of the camera determines the effectiveness of the whole system.

B. Software

LabVIEW is graphical instrumentation software capable of receiving real time data and process it accurately.The image processing algorithm is done in NI-Vision development module. The basic image processing techniques such as edge detection, pattern matching, color matching and object detection are effective and are easy to program. This instrumentation software is capable of providing vast features from basics to industrial level analysis. The graphicalicon based programming software is user friendly, GUI (Graphical User Interface). LabVIEW includes modular hardware, hierarchal software in multi-platform.

C. The Technology

Recent survey on mechanical and electrical methods for the detection of elephants includes weight comparison, height comparison, and motion detection[6]. Also, there are conventional methods of preventing elephants from the human habitat [7]. But these conventional methods are not effective, and so the elephant safety will always be a question[8].

Using these materials and methods, the object or animal is identified by matching the captured image with the template image. The pattern matching is done for identifying specific parts of the elephant such as ivory, trunk, ear etc. The platform used for processing is LabVIEW based image vision algorithm. Cameras are fixed in the places which animals usually enter the villages, and are sent for processing through a wireless network. If pattern matches, warning signal will be generated and sent to corresponding officials for alert. The overall setup of the work is shown in Fig.3.

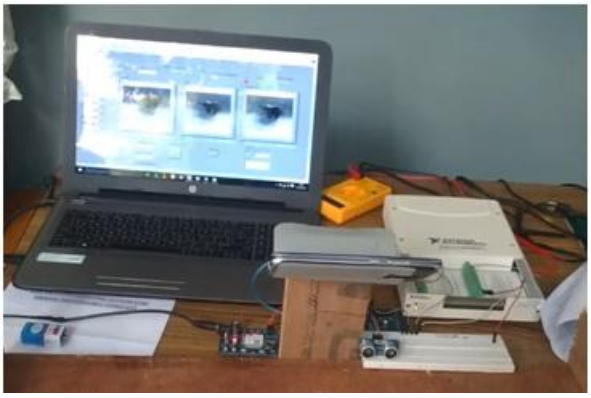


Fig. 3. Overall Setup

For extracting the targeted animal's details from background, Threshold Segmentation approach are used. The basic idea of this approach is simple in which the pixels in the image having intensities or values greater than the threshold are set to white (i.e. intensity 255) and those pixels having intensities or values less than the threshold value are set to black (i.e. intensity 0).

There are different types of thresholding like adaptive thresholding, dynamic thresholding and optimal thresholding.The present work focuses on simple thresholding technique. The object or animal is found using background subtraction method on getting the background image. It is very difficult and tedious to choose the threshold value as the background image changes periodically. So, a nominal value is fixed based on trial runs. The front panel of the LabVIEW programming is shown in Fig. 4.Hence by implementing this project in real time the interruption of wild animals in the residential areas is avoided and safety to human being is ensured.

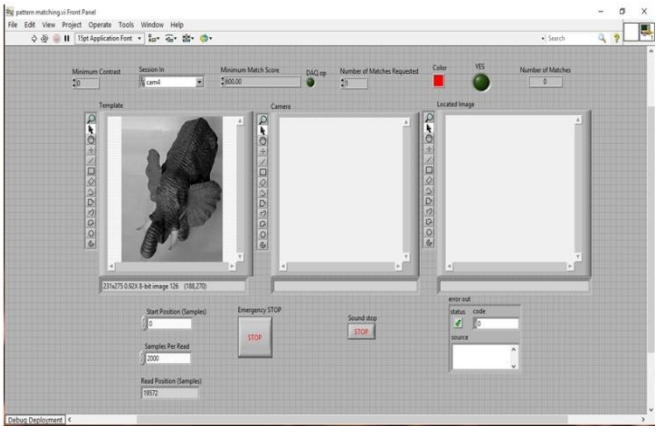


Fig. 4. Front panel of LabVIEW programming

D. Process flow

The process within the LabVIEW programming starts with an acquisition of image through prior channels. The acquired image has to be pre-processed in order to match the requirements of the function to work properly. The pre-processing involves the configuration of IMAQ functions and pattern matching functions.Then, the patterns that are selected are made to flow into the program, as similar to early pre-processing patterns. These patterns are fed to the pattern matching function through a looping system in programming. The acquired image undergoes picture segmentation and pixel matching process.

And then, this process produces a match score for every pattern-source pair. The match score are continuously compared with the ones provided by the user.Once it matches, the whole system produces a meaningful output by means of a warning signal and amessage. The block diagram is shown in Fig. 5.

Fig. 5.Process flow

Step 1: Acquiring the sensor output (sensor will be monitoring for 24x7)

Step 2: If sensor gives positive output, camera will be triggered to capture photo

Step 3: captured image will be sent to comparator station wirelessly

Step 4: Once the image is acquired the image will be pre-processed shown in Fig. 6 (a), at the same time template images will also get ready to pre-process

Step 5: The pre-processed image will be sent for the final process of pattern matching shown in Fig. 6 (b)

Step 6: The Digital Image Processing functions like feature extraction, and data mining happens within the pattern matching

Step 7: The captured image will be compared with the templates and will produce a match score

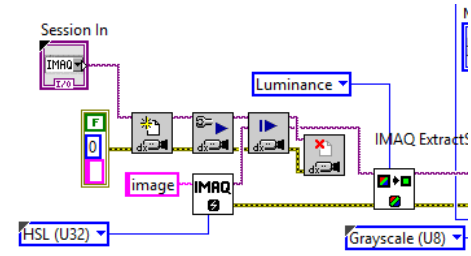
Step 8: The match score will be continuously monitored with the score provided by the operator

Step 9: If score matches the LabVIEW algorithm will produce output via DAQ card to external surrounding as shown in Fig. 6 (c)

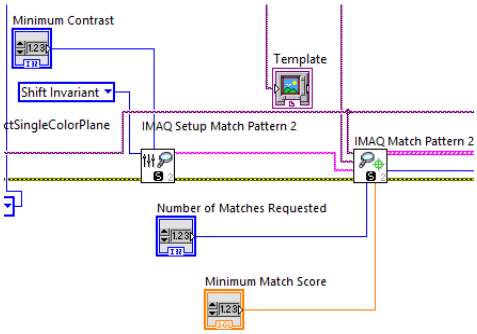
Step 10: Output from the DAQ card will be processed by the Arduino board and a message will be sent via GSM module

E. *Pattern Matching*

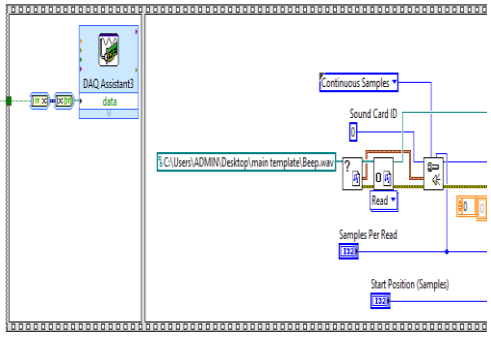
IMAQ-Image Acquisition panel in LabVIEW software uses the pattern matching algorithm. The pattern matching function from IMAQ section need two inputs, one is the actual image which is to be compared and the other is pattern images or template images which are fed by the operator.



a) Pre-processing



b) Pattern matching function



c) Output through DQA and sound generation

Fig. 6. Block diagram of LabVIEW programming

The response of the comparison is the number of matches found similar to the patterns in the captured image. This output is numerical and so the same should be transferredto stimulate a GSM module and a warning sound to external environment.

IV. Result And Discussion

The main objective of the system is to safe guard human as well as animal life. Hence,installation of the system is very important. Five poles are placed 200m apart from the village-forest border considering the speed of the animal (in an average 15kmph), system response time (0.2 sec) and required time for the human to move to safer place. Indian elephants will grow up to heightof approximately 3m and the elephants with height above 1.5m are strong enough to cause destruction.Sothe sensors are placed at a height 1m from the ground level. The cameras in the poles are placed 3.5m from the ground level with 30^{o} inclination from the upper horizontal plane. This facilitates maximum coverage of image through the camera. If any object passes by the sensor, the signal from the sensor induces a change that triggers the control circuit and thus the camera acquisition process. The image processing software is available in the personal computer at the base station. The acquired image will be send to base station through transmission towers wirelessly.

The processing takes almost 0.15 seconds running through all the functional pallets in the LabVIEW machine vision algorithm. The goal of image processing is to identify the structural description and image classification. This work involves feature detection and extraction of image properties. The presence of the specified patterns of elephant like edge, line and shape requires matching of the image with a pattern template. The algorithm will check for pattern in the image and several other properties such as position, orientation and multiple instance of the pattern in the acquired image. The output signal will be send via a GSM module having coverage of 16 km and through sirens that are audible up to 100m from the base station. The text message to the official will be sent once per positive matching and the siren will be signaling 3 times each siren lasting for 5 seconds with 2 second gap. The system also provides online inspection of all the camera visuals in a single system connected to the network in which the system is connected.

The conventional method of determining the presence of animal by direct visual confirmation from the recorded videos has become outdated [9]. This project will help farmers in protecting their fields, save them from financial losses and will save them from the attack of elephants.The materials used are normally available in market, and so there is no trouble in developing this work as a product. Similarly the software system is user friendly graphical environment and modular. While looking the social relevance, this work put forward a permanent solution to human-elephant conflict. This study provides protection to elephants from human activities and reduces the work effort of forest officials.An early warning willsent to the forest officials about the arrival of elephants from the forest borders into the human habitat, which in turn saves human life, animal life, man power and conserves biodiversity. This method is unique as it includes two stage detection and confirmation mechanism.

V. Conclusion

This system is capable of identifying species in forest accurately and their presence in the human habitat. The system is highly applicable in remote areas and can be made to produce output to a longer distance. Thus, human interaction with the animal can be avoided, and both the life of animals and humans can be saved. Conservation of animal species and isolation from humans can be attained.

VI. Future Scope

By modifying the methods described in this work, a system capable of warning the farmer with high efficiency could be developed and is part of ongoing research. A system with multiple cameras must be used instead of a single camera. More trials could be done to evaluate the efficiency, and this is also a part of ongoing research for including thermal detection.

Thermal image processing is an important tool for the improvement of this work and offers potential for reducing elephant death rate in village. For automated detection of animals during mowing operations the use of thermal imaging holds potential. Even though dense forest may disturb the detection of animals, thermal imaging will produce 100% output.

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