Agriculture smart protection from animals using smart scarecrow system

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Abstract - A smart scarecrow system to minimize crop raiding and man animal conflict from wild animals and birds was constructed which uses sound, light, movement to fear the animal as well as birds. The system basically comprises servo motors for hand rotation, an irritating audio system, high intensity lights, GSM module and sensors all these peripherals are controlled by the controller placed inside the chest of scarecrow. The scaring system consisted of three parts: object detection, message sending and automatic height adjustment. Object detection is done by the PIR sensor placed on top of scarecrow depending on that preventive action taken by initiating servo for hand movements, sound speaker and high intensity blinking-light. After object detection message corresponding to this is send by GSM to the farm owner. Depending upon seasonal cropping pattern height of the system get automatically adjusted using motor string pulley mechanism after activation of ultrasonic sensor. It is more convenient and cost effective than traditional scaring strategies like trapping, hunting and wood fencing. No manpower is required for scaring. The present system is made up of metal body so it can work in worst weather situation.

Keywords: Hand rotation, high intensity lights, message sending, height adjustment, object detection, PIR, GSM

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I. INTRODUCTION

One of the great dilemmas of our era is the increasing conflict between wildlife-farmers and crop raiding. It has been around since beginning of agriculture. Recently Tamil Nadu reported a total of 7,562 incidents of crop-raiding by wild animals in the last three years. There are many different situations and reasons where wildlife-farmer come into conflict.Some of the reasons for that is in search of water, livestock predation, increase in human populations, increase in agriculture and reduction in forest land, the availability of palatable and nutritious foods near farm edges. For that farmers utilize strategies and traditional methods that are often cruel and ineffective. While arbitrary killing, trapping or poisoning of suspect may provide short-term satisfaction but it fails to address long-term needs. So we must seek to understand sociological, economic and cultural aspects to find solution. Researchers suggest managing pastures to reduce competition for forage between wildlife and domestic livestock. In addition, shifting from farming system with perennial crop may reduce losses [2]. But this cannot be the proper solution for the problem. In general, crop damage by monkey and wild-boar is more serious in northern part epically in lower altitude areas. So farmers usually adopt some crop protection strategies guarded their crop by spending night out in field, wood fencing whereas wealthier farmers used imported barbed wire, trapping, hunting are popular. Use of plastic flags, brightly colored objects, scents and fireworks works sometimes but again that are marginally successful. Some make system consists of sound clips for different animals and red lamp connected to stick which is not durable [9]. There are smartphone controlled systems but here was no provision of movement [5]. For birds unmanned aerial system (UAS) is used to deter birds. To detect birds, background subtraction algorithms have been used [6]. Many systems developed which detects the intruders, monitors any malicious activity and then reports it to the owner of the system but these are unable to fear the wild animals and primates [8]. There is by no means an easy solution to this problem. Wild-animals now a days are smart enough they learn to overcome obstacles such as fences and scarecrow. So there is need of atuomation system in agriculture field which can avoid man animal conflict and crop raiding.So one of the technological solution for this problem is smart scarecrow system which uses high intensity light, sound sensor, arm movement to fear the animal as well as birds. The common form of scarecrow is a humanoid structure dressed and placed in open field to discourage the birds and animals from disturbing and feeding on recently cast seeds and growing crops. This system consists of PIR sensor for detection of the object then servo motors present here performs the motion operation of scarecrow arm and firecracker sound

buzzer is used to demotivate the animal as well as birds and for the night time high intensity lights placed on head is used to keep animals away from farm field. Also the system consists of ultrasonic sensor for detection of the height of crop depending upon different seasonal cropping pattern based on that scarecrow height gets automatically set using motor and after detection of the object message will convey to the farmer. Scarecrow basically work in two different phases first is object detection and message conveying and second is automatic height adjustment using pulley arrangement. In the first phase after switching on the system PIR sensor activate it is connected to the microcontroller once the object detected by sensor the message is send to controller depending upon this controller activates other three peripherals that are two servo motors connected on two sides of system works as the arms of scarecrow normally it rotate with angle 120 degree, second is the activation of firecracker sound sensor and the last is activation of high intensity light at night time here day and night is configured by LDR, while doing this the message will convey to the owner of the farm. In the second phase ultrasonic sensor is connected to the microcontroller when any crop is detected in front of it then message is given to the controller and it activates motor which is placed at bottom of system and system and motor is connected by string using pulley mechanism when motor rotates clockwise and anticlockwise direction it wound and relax the string so that system will able to adjust its height. As per 2018, agriculture employed more than 50% of the Indian work force and contributed 17–18% to country's GDP 70% of country's income is from agriculture and rank 2nd world wide in farm output so the technological advancement is needed in this sector too. The rest of the paper is structured as follows. Section 2 gives the information about proposed scaring methodology for animal detection and prevention of farm along with height adjustment in detail. Section 3 provides the block diagram. Section 4 provides specifications next section gives experimental results and discussion on the results. Finally, last section presents the conclusion of the proposed work.

II. METHODOLOGY

In this paper, smart scarecrow system uses irritating sound, high intensity lights and arm movement to fear the animal as well as birds. And automatic height adjustment mechanism to increase accuracy in the object detection.This system consists of PIR sensor for detection of the object after detection other three peripherals are activated servo motors present here performs the motion operation of scarecrow arm and firecracker sound buzzer is used to demotivate the animal as well as birds and for the night time high intensity lights placed on head is used to keep animals away from farm field.Simultaneously message of detection is instantly send using GSM module on smartphone of the farm owner. Ultrasonic sensor present here for detection of the height of crop depending upon different seasonal cropping pattern based on that scarecrow height gets automatically set using pulley and motor mechanism.Wild-animals now a days are smart enough they learn to overcome obstacles such as fences and scarecrow. This system use available technology to reduce manpower. The automatic height adjustment concept is used here to detect the object clearly varying height of the crops should not be the barrier for detection. And this is achieved smoothly by using pulley arrangements. Main body of the system is made up of hollow metallic box in which controller circuit is placed so system can work in worst whether situation. There are different scarecrow system available but these are very specific to particular animal or birds but in present system we try to make a scarecrow by taking consideration of most of the animals and birds.

III. OBJECTIVES

- Make use of available technology to avoid man animal conflict by making cost effective smart scarecrow.
- Built a system which can monitor the farm and prevent the farm from most of the wild animals, primates and birds by using sensors and body movement.
- Implement a system which only avoid crop raiding and man animal conflict without doing actual damage & killing of animal and birds.

1 Block schematic and Working

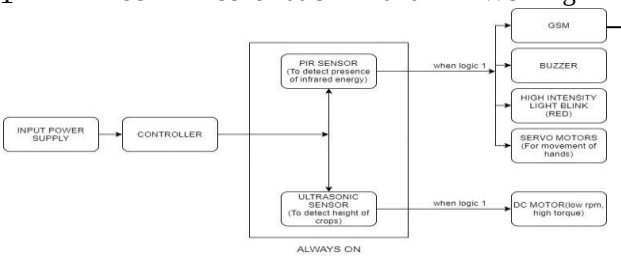

Fig. 1. Block diagram of proposed system

IV.WORKING

- The whole operation is controlled by controller which is feed by input power supply.
- Controller always keeps PIR and Ultrasonic sensor on for surveillance of field.
- When PIR sensor detect any type of infrared energy then give instructions to the controller to active the successors such as GSM, buzzer, high intensity light and servo motor.
- GSM inform the owner that object is detected further buzzer will make a loud noise to scare the animals, light will be highly intense so that able to visible even in a fog and finally servo motors attached to the two sides of model so that it will rotate at certain angle which will looks like a arms of the scarecrow (movement purpose only).
- When ultrasonic sensor detect any increase in crop height it get activated and it will turn on the DC motor to rotate at certain angle to align height of bot higher than the object (crops).

SYSTEM COMPONENTS AND SPECIFICATIONS

Table 2. Specifications of the components

Sr. no.	**Parameters**	**Specifications**
1	DC MOTOR	High Torque Motor-10 RPM Rated Voltage 12V DC. Shaft Diameter 6mm, Motor Length 63mm. Rated RPM 10, Weight 180gm, Load Current 7.5A (Max.), Motor Diameter 28.5mm Torque up to 120Kgcm, No Load Current 800mA (Max.), Shaft Length 30mm
2	SERVO MOROR	Model: MG995 Weight: 55 gm Operating voltage: 4.8V~ 7.2V Stall torque @4.8V : 13kg-cm Stall torque @6.6V : 15kg-cm
3	ULTRASONIC SENSOR	Operating Voltage: 5 V Sonar Sensing Range: 2-400 cm Max. Sensing Range: 450 cm Frequency: 40 kHz
4	PIR SENSOR	Standard detection type 82° vertical, 100° horizontal detection angle White lens colour 170uA operating current Long Distance(12Mtr) Detection range
5	CONTROLLER	Power input: 4.5V ~ 9V Transfer rate: 110-460800bps Support UART / GPIO data communication interface Working temperature: -40°C ~ + 125°C Drive Type: Dual high-power H-bridge A great set of tools to develop ESP8266 Flash size: 4Mbyte

6	GSM	Network support: Quad-Band 850/900/1800/1900 MHz TTL serial interface compatible with 3.3V and 5V MCU Power supply: 5 -20 V. Power Interface: 2.54 mm Pin header or MICRO USB
7	BUZZER	Operating voltage 3.3V-5V PCB Dimension: 3.1cm*1.3cm.
8	LED	LED draws approximately 50 mA at 5 V with red 24-bit colour control (8-bit PWM per channel); 16.8 million colours per pixel

2 FLOWCHART & ALGORITHM

Here first step shows initialization of the system by switching on the supply. Next step after that is controller it takes decision depending upon sensors detection. The step ahead defines the different peripherals connected to controller this step shows completion of the operation whereas the last step shows the termination of the process. The flowchart of operation is as shown in the figure below

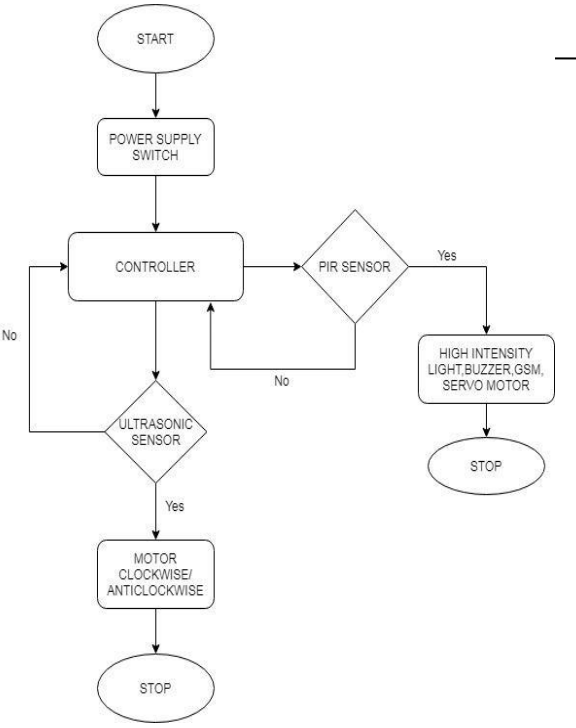

Fig. 2. Work flow chart of smart scarecrow system

ALGORITHM

1] Power supply is provided to whole system.

2] Controller will be ON.

3] Then PIR sensor will ON through controller and try to detect presence of animal in field.

4] As animal is detected then high intense light, buzzer, GSM, servo motor will be ON.

5] If not then go to step 3.

6] For height adjustment Ultrasonic sensor will ON.

7] As height of crop increases it will be detected by ultrasonic sensor then motor will be ON for height adjustment.

8] If not then go to step 6.

3 RESULT & DISCUSSION

India is home to a diverse set of habitats – rainforests, deserts, mangroves, grasslands, etc. – sheltering even various wildlife species. It roughly accounts for 7-8

percent of the world's recorded species. The country's protected areas network comprising Wildlife Sanctuaries, National Parks, Conservation Reserves, Community Reserves, and Marine Protected Areas, occupies just 5.02 percent of the total area. Consequently, a large percentage of India's wildlife lives outside protected boundaries. They inhabit or move through farms, gardens, lakes, coasts, and so on in villages, towns, and cities.

OBJECT DETECTION BY PIR SENSOR

Sr. No.	Animal in detection range	PIR sensor output
1	1 meter	Object detected
2	2.58 meter	Object detected
3	3.5 meter	Object detected
4	5 meter	Object detected
5	7.3 meter	Object detected
6	8.2 meter	Object detected
7	12 meter	Object not detected
8	14 meter	Object not detected

Table 2: observation through pir sensor

1.1 Auto Height Adjustment

As from ultrasonic sensor controller receives the activated signal auto height adjustment function will start performing using motor, pulley and belt. Fig. 7 shows the height adjustment scenario of the scarecrow robot. Table 3 shows the performance of the system for the increasing height of the crop. We have implemented the system in the farm consisting of cotton crops.

Table 3. Different height adjustment using motor depending upon sensor output

Sr. No.	Ultrasonic Sensor detection	Height adjustment
1	Crop height increases by 15cm	System will increase its eight by 20cm
2	Crop height increases by 20cm	System will increase its eight by 25cm
3	Crop height increases by 25cm	System will increase its eight by 30cm
4	Crop height increases by 30cm	System will increase its eight by 35cm
5	Crop height increases by 35cm	System will increase its eight by 40cm
6	Crop height increases by 40cm	System will increase its eight by 45cm
7	Crop height increases by 45cm	System will increase its eight by 50cm

1.2 Graphical Representation of Season wise Object Detection

In our country different seasons and cropping pattern is responsible for attracting various animals as well as birds towards farm field. So depending upon three seasons the attempts of crop raiding varies. And we can also saw the differences on day and night time. As the object that is animal came in the detection range of PIR sensor then PIR sensor will pass this activated signal to controller to perform further operation which is linked through this signal. Table 2 shows the performance of the system by keeping the animal prototype in the detection range and out of the range.

To study this we implement proposed system on three dissimilar farm land with different types of crops and after averaging the sensor outputs we got some results which are shown in the form of responses below. Following graphs shows the object detection on different interval of time in particular season.

This fig.3. Implies variation in animal detection at day and night in winter season. Here animal detection is low after 12 am because of heavy winter but it starts increasing from sunrise and around 12 pm to 5 pm it is maximum up to 82% shown in graph that means in day time animal detection is maximum in winter. And again it starts falling for night time.

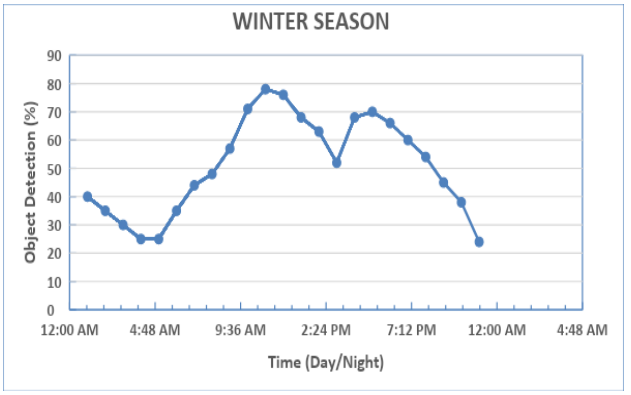

Fig. 3. Rate of object detection by PIR sensor on various time interval in winter season

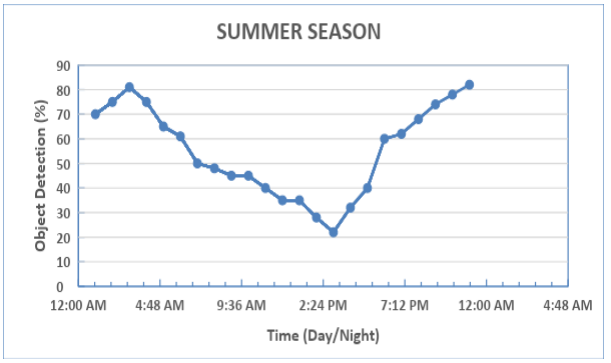

Fig. 4. Rate of object detection by PIR sensor on various time interval in summer season

From this fig.4. It is observed that in summer season major crop raiding is done during night time and early in the morning i.e. from Object detection by sensor is good from 12 am to 9 am and afterwards it will decrease drastically up to 20% shown in response because of high temperature but from sunset again it rises.

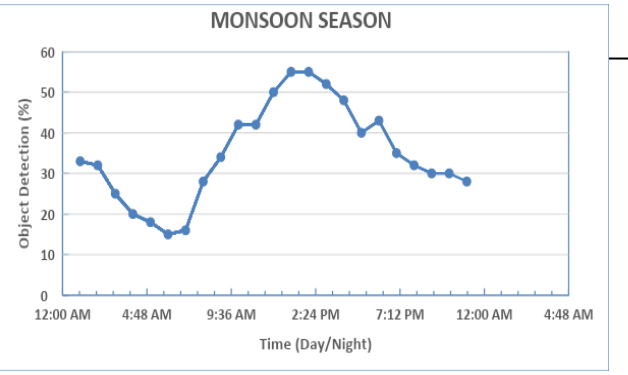

Fig. 5. Rate of object detection by PIR sensor on various time interval in monsoon season

In this fig.5. Shows variation in animal detection at day and night in monsoon season. Object detection is maximum after sunrise and at day time between 1 pm to 7 pm and at the time of clean and dry climatic conditions but if there is cyclonic wind and heavy rain then sensor accuracy get decrease and proper animal detection is not easily possible.

Hence from above three responses we got different pattern of object detection at day and night in fig.3. It is observed that maximum raiding attempts are detected by our proposed system efficiently in winter similarly from fig.4. In summer most of attempts are detected maximum up to 80% but from fig.5.In monsoon season attempts are effectively detected probably in good whether condition maximum up to

55% so its rate is less as compare to winter and summer season.

1.3 Graphical Representation of System performance in different months

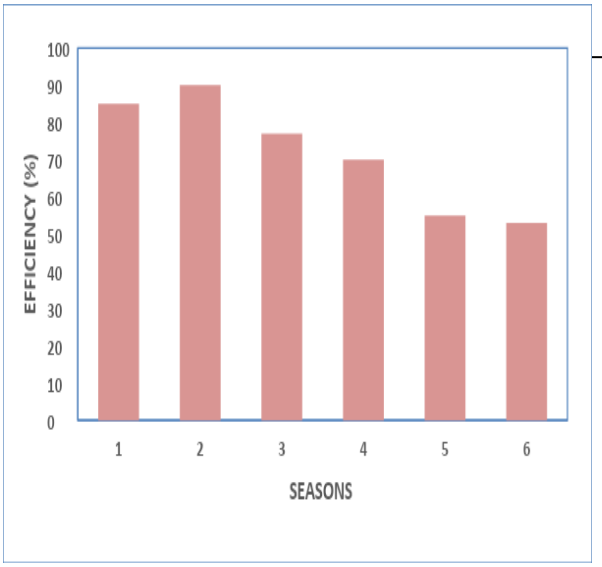

Fig. 6. This graph shows how efficient system can work in three seasons

From above fig.6. Represents the monthly efficiency of the system after studying this it is observed that Smart scarecrow system perform its operations very efficiently in winter season as compare to summer and monsoon because in summer due to high temperature sensors range reduces this is because difference between background temperature and body temperature is less and signal generated by PIR sensor is smaller similarly in monsoon due to the bad weather conditions like high winds, thunderstorms, snowstorms affect the accuracy of sensor and overall system..

a)

b)

Fig. 7. a) and b) Height adjustment of the scarecrow robot

This fig.7. Shows the photograph of actual proposed system here height adjustment using mechanical pulley arrangement and sliding drawers are shown particularly fig. 7 a) represent low level position of bot for better detection of object when the crop height is less and fig.7 b) represent middle level position of bot for better detection of animals when crop height is moderate

CONCLUSION

The technology brings changes in the agricultural sector in India. Scarecrow system can minimize the loss in the farm ultimately provide safer growing condition, no any night out spending in farm is required for crop protection. Detection from distance and preventive detection is possible using this system. Height adjustment with help of pulley in the proposed system helps exact detection of object. All the sides of the farm can cover by connecting two PIR sensor to the controller. Outer part of the system is made up of metallic box and rod so not easily damageable by wild-animals. It will be more efficient and cost effective than traditional guarding methods. In general, crop damage by wild-animals is more serious in northern part epically in lower altitude areas. And traditional methods of fencing are ineffective so at such situation Smart scarecrow

system can resolve the problem. This is the man-animal friendly system can resolve conflict.

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