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Smart Surveillance System For Crops From Peacocks Us- Ing Wireless Sensor Networks And Iot

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Abstract. Wireless Sensor Networks (WSN) are implemented in most of the applications areas where human beings cannot monitor continuously for long time. Few of which include monitoring gas emissions in chemical plants, mili- tary surveillance, patient monitoring system etc. Of these, smart agriculture is the pressing priority of the day. Smart agriculture includes effective farm man- agement and monitor of crops against diseases and animals to ensure high yield. The greatest peril is the menace caused by wild animals besides human thefts. This paper proposes a smart protection mechanism for crops against peacocks using WSN. Due to a drastic increase in peacock population, farmlands espe- cially cereals, grains, groundnut, tomato, and pumpkin are being grazed. This leads to low productivity and becomes a great threat to farmers. The solution is to carry out smart management to monitor the peacocks and protect crops against them without harming the national bird.

Keywords: Crop Surveillance, Smart Irrigation, Wireless Sensor Networks, In- ternet of Things.

1. INTRODUCTION

Farmlands are the basic sources of food production in any part of the world. Farmers plan the seasonal crops to have high yield. Farm lands are also expanded into wildlife locality. Besides resource depletion such as rainfall and water, poor planning of sup- ply chain management, etc farmers face a major threat in protection of crops against animals. Damage due to domestic animals like cows and goats grazing maize and paddy fields can be avoided

through proper personal supervision. The biggest chal- lenge is the smash up incurred by wild animals and non-domestic animals. Cultivation areas underneath the hills and hillock mounds are more likely to be attacked by ani-mals especially by elephants, boars, monkeys, and rabbits etc. Protecting crops from these animals is a real challenge to the cultivators.

Another major concern of today's situation is the enormous population of peacocks causing severe damage to food crops especially tomato, groundnut crops and maize plants. With a population of 1,00,000 or more in southern zone of India, farmers face a difficult situation where peacocks cannot be harmed as well as crops need to be protected. It has been reported in several journals across south India especially in Karur, Dindigul, Erode, Namakkal and Coimbatore areas that peacocks live off the crops and grains. They claim compensations from state governments for the damage incurred by this national bird.

Fig. 1. Menace caused by Peacocks over crop field

Currently, farmers protect crops using several manual fencing types like chain link fence, barbed wire fence, green PVC type fence, concertina coil type fence etc. Some of these techniques like green PVC don't harm animals as the fly and sit over the fence, while others may cause injure as a bird like peacock fly and sit on it. The in- stallation cost spent in such fencing includes rupees 1500 or more per Sq. Ft. Other kinds of electrical fencing are ineffective and are cruel to be used. Manual wire, plas- tic or wooden fencing shall not assure intrusion of peacocks. Certain other techniques of protecting crops include spilling of chemical products. Besides the cost factor, it also may spoil the vegetable crops and grains especially tomatoes and groundnuts. Hence some other smart sensing application needs to be instilled to protect crops [1].

Smart surveillance system plays a significant role in monitoring environments [2]. The upcoming era is sensor based and shall easily perform smart agriculture. Wireless Sensor Networks (WSNs) help agriculturists to promote cropping by smart agriculture techniques. They generate a way to analyse and crop according to climatic conditions, provide intelligent farming through precision agriculture [3]. Besides providing smart solutions to enable profit in cultivation, they also help in surveillance. WSNs are used to perceive the farm lands and gather information about the intrusion of animals. Fur- ther process shall take place based on the obtained data from sensors [4]. Thus WSN provide an intelligent solution to protect crops against peacocks.

2. RELATED WORKS

Y. Ma et. al. [5] proposed LoRa communication technology in WSN to perform intel- ligent agriculture service using Arduino. The modelled platform analyzed various environmental parameters such as soil temperature, light intensity, carbon dioxide concentration, air humidity, and other climatic conditions and commutes the data to remote computers for further analysis through LoRa. Furthermore, the data are ana- lyzed and quick decisions are made to perform efficient farming. The middleware is responsible for performing data collection, classification and analysis and control execution.

Ramaprasad S S et. al. [6] presented smart monitoring of agricultural fields using Arduino. Humidity, temperature and moisture levels of the soil are captured using PIR sensor and sent to remote database using GSM module. The measured data is compared with threshold value and stimulates pump to work accordingly. When an animal is detected, the IR sensor detects using infra red waves and generates an alert using a buzzer. The mechanism is controlled by Arduino UNO board. Thus the ap- proach provides an intelligent monitor of crops using IoT.

R. Vera-Amaro et. al. [7] addressed the problem of wild animal vandalizing the agri- cultural fields. The approach uses PIR sensors to detect the intrusion of wild animals and uses a sonic electronic repellent to make the animals move away from the fields. Repellent uses rotten egg spray circuit, electronic fire cracker unit and a buzzer to alert. Raspberry Pi is used to control the entire scenario and is stored in cloud and sent to the farmer's mobile.

Dr. N. Srinivasa Rao et. al. [8] proposed smart crop fencing method that detect birds and repel them through low voltage electric fencing. The circuit is developed using Raspberry Pi and ultrasonic sensor with USB camera. This provides a wide range of accessibility with increased security. A buzzer is installed to act as a scarecrow for the birds entering the crop field.

3. PROPOSED WORK

Crop fields like tomato and groundnut crops are a great source of food for the pea- cocks and peahens. To protect the tomato crops against the national bird, without harming it, we propose a protection system that identifies the animal intrusion and alerts using sensors [9].

1.1 Network Model

The network also possesses two types of sensor nodes, namely static and sink nodes. The static nodes capture data and identify the occurrence of peacocks nearer to the field. When the intrusion is encountered, the data is communicated to the sink node through intermediate nodes. The sink node is responsible for collecting the data from multiple sensors and intimates the intrusion of peacocks to the Arduino UNO kit.

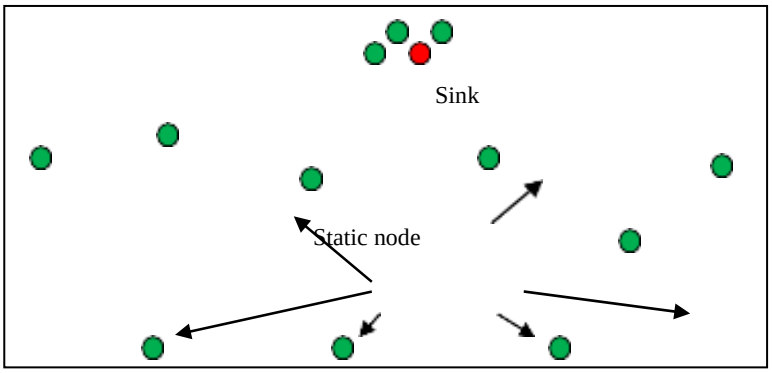

Fig. 2. Network Model for Crop Protection

Ultrasonic sensors act as static nodes that capture the intrusion of peacocks. Sensors form a group to create clusters. To avoid overhead among the nodes, clustering is enabled with each cluster having a cluster head to communicate inside and outside the cluster. The members inside a cluster work proactively that communicates with each other without request[10][11][12]. Each node contains a table of data about the members in the cluster using DSDV routing protocol. The inter cluster communication is proactive that the information s obtained on demand based using AODV or DSR routing proto- cols. The reactive protocol sends a REQ message to find the route to reach the sink.

1.2 Network Architecture

The network is composed of several components such as

1. HC-SR04 Ultrasonic Sensor
2. Camera Module and Image Processing
3. 400ST/R160 Module
4. Peacock Deterrent Module
5. Arduino UNO Board

3.2.1 HC-SR04 Ultrasonic Sensor

Special type of low cost terrestrial sensors named ultrasonic sensor with 02 cm to 440 cm communication range and 40 Hz frequency is deployed over the farm land.

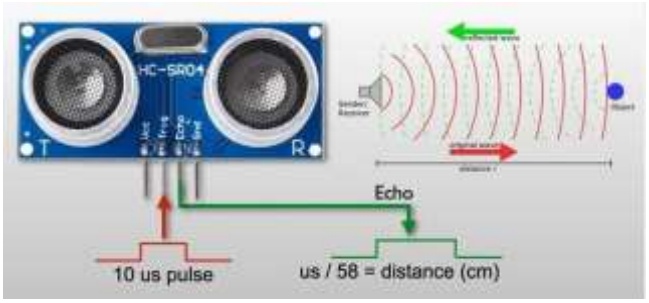

Fig. 3. Ultrasonic Sensor for detecting animals

It has a coverage angle of 15° and calculates the distance at which an animal intrudes using the speed of the ultrasonic waves and time taken to travel from the sensor to animal and animal to sensor. Unlike PIR sensors, ultrasonic sensors never use IR waves to calculate distance as in figure 3. The code to calculate distance of an object detected using HC-SR04 is given below.

```
//animal_detection_distance.cc void setup() {
Serial.begin (9600); pinMode(trigPin, OUTPUT); pinMode(echoPin, INPUT);
}
void loop() {
long duration, distance; digitalWrite(trigPin, LOW); delayMicroseconds(2);
digitalWrite(trigPin, HIGH); delayMicroseconds(10); digitalWrite(trigPin, LOW); duration =
pulseIn(echoPin, HIGH); distance = (duration/2) / 29.1; Serial.println(duration)
Serial.print(distance); Serial.println(" cm"); delay(100); }
```

Since the cultivation area is accessible, node deployment can be structured smartly by placing them in strategic positions surrounding the farm area, usually in rectangles. Here, every node possesses a radio range and is connected with at least one other node in the structured sensor community. The antenna range is low and energy saving capacity is also low for these nodes. Hence energy efficient multi-hoping technique is deployed, for which the nodes need to be deployed nearer to each other. When the nodes are long apart, data transmissions needs larger power, in turn the node may die out of energy.

3.2.2 Camera Module and Image Processing

When the sensor detects intrusion of any object, the camera module is triggered to capture the object. The image is verified to be a peacock using Image processing module, after which peacock repellent mechanism is triggered. This module ensures that the detected object is peacock.

3.2.3 400ST/R160 Module

Several techniques are available to prevent peacocks from entering the farm and graze fruits, cereals and vegetables. Traditional techniques include setting up of different types of scarecrows, flying large eyed scary balloons and distractive cassette films surrounding the farm field. Modern techniques include smart protection mechanisms such as pumping of water against the animal/bird, providing large sounds to scare the

animal etc. These have their own disadvantages that the former technique cannot be applied during water scarcity while the later method disturbs the entire surroundings.

To eliminate aforesaid limitations, smart protection of crops from peacocks shall be ensured by generating ultra sonic sound against the bird after detection. Here, 400ST/R160 module is used to transmit ultrasound of frequency range 40 kHz and up to 30 cm distance. The sound level SPL includes -61dB to repel the peacocks out of the farm land.

3.2.4 Peacock Deterrent Module

The module is composed of a stand and a pump mechanism with bird repellent fla- voured water. This additional module is activated by Arduino as a secondary means of repelling the

peacocks. The bird repellent liquid is an organic liquid that doesn't harm crops and peacocks. It irritates the peacocks through its scent and thus making them get off the field.

3.2.5 Arduino UNO Board

Arduino board receive various information detected in the agriculture field. With this obtained information received from sensors through the GSM module, the Arduino is programmed to send the control signal to the Wi-Fi module. The GSM module sends the message to the farm owner's mobile regarding the detection of peacock. The ob- served data are sent to cloud database through the Wifi module. The data stored in the IoT can be used for further analysis purposes.

3.2.6 Architecture

As portrayed above, the sensor detects peacocks and intimates to the Arduino mod- ule. Ultrasonic sensor shall transmit the sound waves that propel the birds. The archi- tecture is given as in Figure 4.

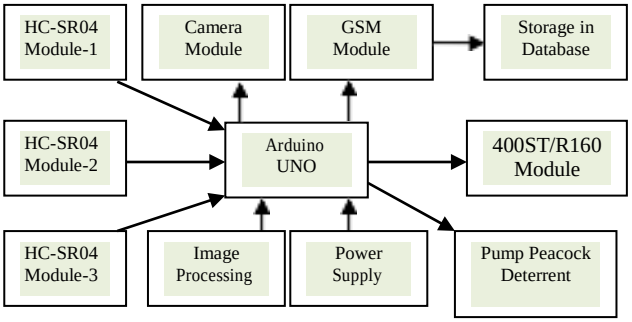

Fig. 4. Architecture of Crop Protection from Peacock

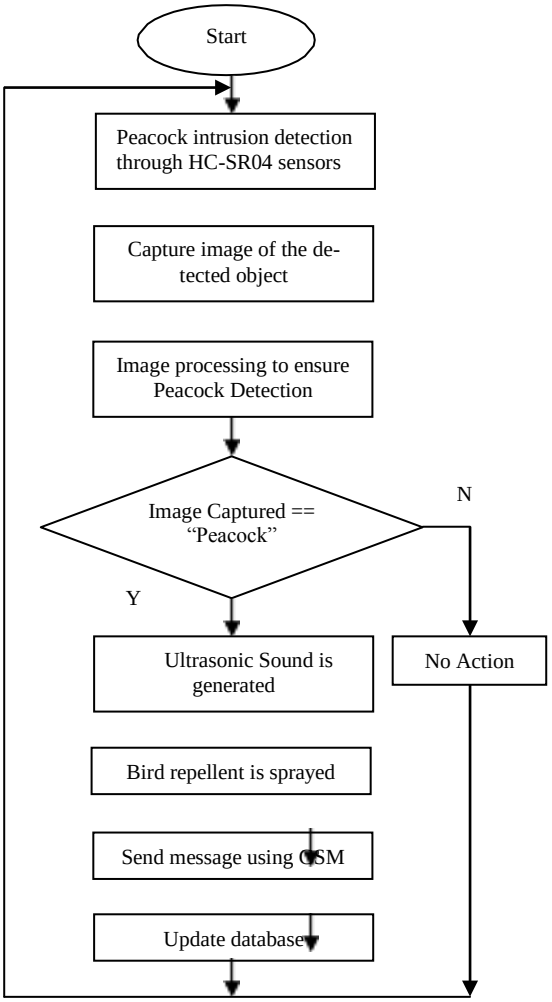

Fig. 5. Flow Diagram depicting Crop Protection against Peacock

Once the peacocks are detected by the ultrasonic sensor, they are verified using the camera and image processing module and the data is conveyed to the Arduino board. The Arduino is battery powered and activates the ultrasonic sound using the speakers installed along with the ultrasonic sensors. Besides the peacock deterrent pump is activated along with. The peacocks being scared of with the ultrasonic sound and the irritating smell of the bird repellent liquid, moves away. The same is stored in the database of the farmer for future research. Thus the proposed mechanism protects the crops against peacocks with no harmful effects using WSN and IoT technology.

4. RESULTS AND DISCUSSIONS

Figure 6 depicts the grazing of peacock and peahen in groundnut field.

Fig. 6. Before installing Smart crop protection kit

To implement the afore presented mechanism, Arduino board, HC-SR04 sensor, USB camera, Water Pump, Ultrasonic Speaker, Wifi and GSM module. The microcontrol- ler is embedded with C Program to implement the aforesaid functionalities using Ar- duino IDE. If the captured data is proved to be a peacock, then appropriate ultrasonic speakers and pump circuit are enabled to repel the peacock. The message is delivered to the database through GSM module. Figure 7 shows the scenario of a peacock mov- ing away from the crop field. The alert message received by the farmer.

Fig. 7. After installing Smart crop protection kit

5. CONCLUSION AND FUTURE WORK

Farmers face a huge productivity loss due to the menace caused by peacocks. Crop protection against the national bird is implemented using WSN and IoT techniques. The proposed work enables detection of peacock and repels them in a harmless manner. Previous techniques or chemical fencing or electrical fencing may cause damage to the birds or animals unknowingly. The work focused on detection of peacock through ultrasonic sensor and deter

them using water shower and ultrasonic sound. The information is conveyed to the farm owner. The work ensures a safe and intelli- gent way of protecting the crops. Furthermore, the work shall be enhanced by intro- ducing rotating detection module with image processing capability that detects and classifies animals and birds. Also, research shall be made on finding natural repellent mechanism to prevent the animal and bird intrusion into the farm land.

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