Animal Detection, Repellent and Soil Water Monitoring in Smart Agriculture using Internet of Things

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ABSTRACT

Monitoring the operational status of IoT devices is a fundamental task for the deployment of reliable IoT-based applications. This task is even more crucial when such applications are deployed in rural environments, as typically occurs in Smart Agriculture, due to the long distance and wide area to be covered for implementing cost-effective solutions. Starting from an innovative IoT deployment for defending crops against ungulates attacks, this paper provides a comprehensive description about the design, development, and assessment of a monitoring application for IoT based soil moisture, animal, birds detecting and repelling devices. To achieve the maximum level of flexibility and scalability, modern virtualization technologies have been adopted for the development of the detection and repelling application. Finally, experimental results obtained from the utilization of the monitoring application in a real-world scenario are reported.

Keyword*:—IoT, virtualization, monitoring, birds detection, soil water monitoring, Smart Agriculture*

I. INTRODUCTION

Sustainable farming systems should be designed for the optimized management of crops and livestock, tailored to local condition and targeted to the reduce of pesticides and off-farm inputs. This can be achieved through the high presence of biodiversity within the farm gate. However, the relationship with the elements of the ecosystem other than crops and livestock must be properly managed, to maintain the profitability of farming and to preserve the traditional production in the rural areas. Wildlife control is a very relevant issue to tackle. In the last three decades, as highlighted by statistical data, there has been a significant increase in the amount of crop damages caused by birds and wild animal predations [1]. Taking Italy as an example, the annual production loss in the wine industry is estimated to be 13 million euros, with an annual cost to the government estimated around 3 million euros. The overall cost of financial reimbursement to farmers due to damages caused by wild animal attacks to crops is estimated more than 10 million of euros. The damage from wild ungulates can be contrasted in many, different ways, lethal or non-lethal. On one hand, lethal ways (e.g., shooting, trapping) are very cruel and not environmentally friendly. On the other hand, non-lethal ways (e.g., scarecrow, chemical repellents, organic substances, mesh or electric fences) have shown so far, a fairly limited effectiveness, environmental pollution effects on both humans and animals, high installation management costs and, last, but not least, high environmental and landscape impact. Indonesia is one of the largest agricultural countries in the world. Rice is a plant that is widely grown in Indonesia. Indonesia is also one of the largest rice producers in the world. Farmers face many challenges before harvest, usually caused by pests. This bird attack is very detrimental to the crop land [2]. Some attempts by farmers to expel the pest by making scarecrows and others, but less effective. An alternative that can be used to repel birds is by using waves [3]. Birds or animals that are sensitive to ultrasonic waves. To answer that problem, we designed an electronics device for detecting and repelling pests and animals using IR sensors [4]. Here we irrigate the soil based on soil moisture, humidity, temperature and at the same time the irrigation status is wirelessly updated to the farmer by means of a notification to his mobile phone as humidity drops below a certain threshold level, sprinklers will automatically be switched on in the field, thereby achieving optimum irrigation using the Internet of Things [5]. The paper is organized as follows. Section II provides a short overview on related works, whereas Section III describes the overall system highlighting the different portions and components of the network infrastructure as well as the

architecture of the monitoring platform. Section IV shows the monitoring platform "in action" reporting graphs and statistics collected from a real-world use case. Finally, Section V concludes the paper with some final remarks.

II. SYSTEM ARCHITECTURE

In this section, we present the overall system architecture, and we analyse in detail the characteristics of each sub-system Animal Repelling Device, Devices Monitoring Application. This paper deployment consists of solar panel to power the repellent device using IR sensor to detect the animal and intimate the message through the WIFI module [6]. An IoT based irrigation system aims to utilize the features of embedded system to make agriculture simple and smart [7]. The prototype in this experiment is divided into the two most important parts of detector and repellent. The detector is designed to detect sounds from birds, then forwarded to run driver relay and Android systems. The ultrasonic frequency generated by the Repelled can be varied by changing the capacitor value [8]. Having sensors connected with controller, the proposed system reads the moisture, temperature, humidity content with the help of soil moisture sensor, temperature sensor, humidity sensor [8]. The Blynk is an iOS and android app to receive the information gathered from Arduino. The device is powered by the solar panel and the power stored in battery Infrared sensor is used to detect the wild animal's intrusion at the entry of the farm and USB camera is to monitoring tries to prevent the crop and repelling animal with the huge speaker noise and reports to the farmer through the Blynk app by the form of SMS and Email warning notification [9].

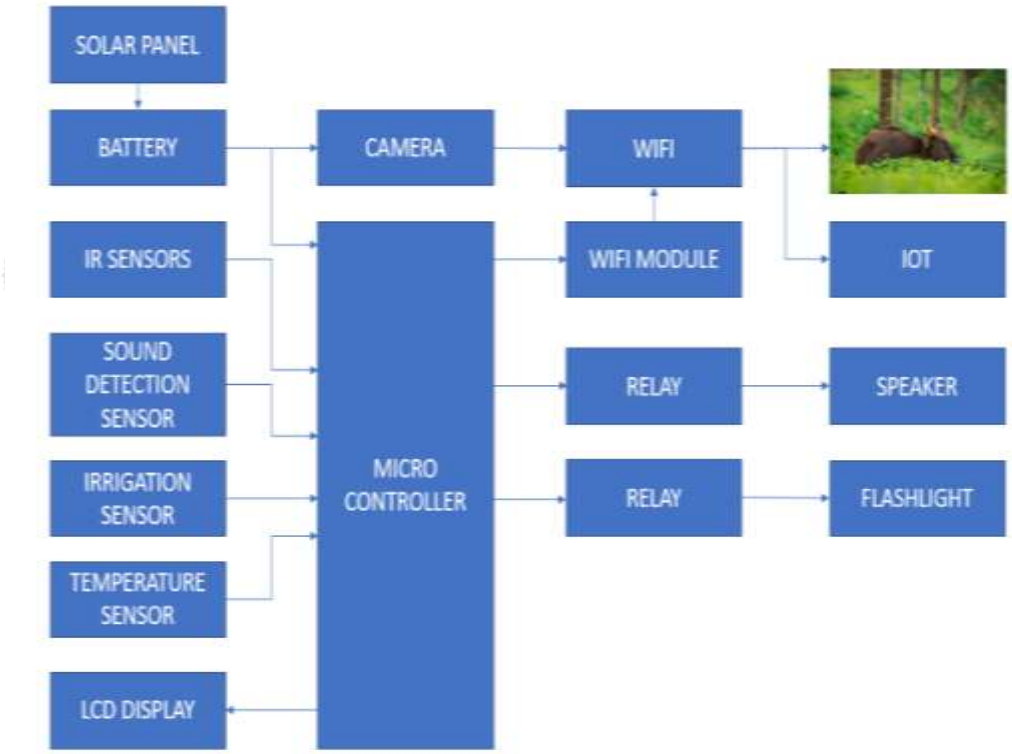

Fig.1 Block diagram of the system

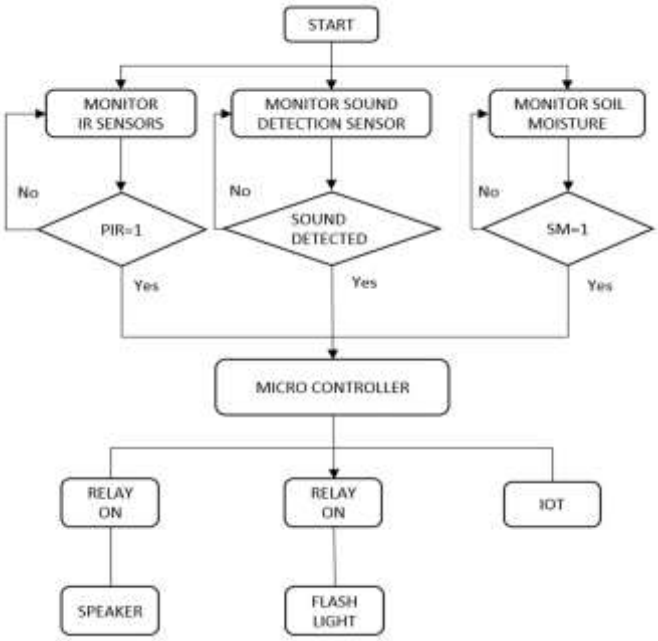

Fig.2 Flow Graph of the system

The purpose of the system is illustrated with a simple flow chart diagram in Above figure 2

Designing of Detector and Monitor

The IR, Sound sensors in this experiment will capture every movement, when the animals, bird approaches the sensors then this prototype will work. The Humidity and temperature sensors are used to monitor the soil moister level, if there any changes in the constant level of the water, and also any movement is detected the sensor readings are fed into the microcontroller to take the corrective actions on the field later by intimating through the IOT.

Automatic Switch Relay Circuit

Driver Relay is used to disconnect and connect the source, when a source movement received from the PIR, the relay will be closed and activate the microcontroller to transmit the information. When this circuit gets high signal from microcontroller, then relay will be closed. Driver relay works like a switch, thus activating LCD function and also intimating the information to the property owner.

III. HARDWARE REQUIREMENTS

A) Arduino Uno Microcontroller

ATmega328 is a single chip microcontroller created by Atmel in the mega AVR family. The Atmel 8-bit AVR RISC based microcontroller combines 32 kB ISP flash memory with read-while-write capabilities1 kB EEPROM, 2 kB SRAM, 23 general purpose I/O lines, 32 general purpose working registers, three flexible timer/counters with compare modes, internal and external interrupts, serial , programmable USART, a byte-oriented 2-wire serial interface, SPI serial port, 6-channel 10-bit A/D converter (8-channels in TQFP and QFN/MLF packages), programmable watchdog timer with internal oscillator, and five software selectable power saving modes. The device operates between 1.8-5.5 volts.

B) Infrared Sensor

This sensor is used to detect the animal intrusions into the farm. After detection it gives the signal to the Arduino. IR wavelength range up to 10m and coverage area is 180^0. if no object is detected then the IR light continues in that direction forever and no signal is recorded.

C) USB Camera

The USB (Universal Serial Bus) camera is used in the proposed system to capture the images of all the wild animals when they are detected by the infrared sensor while entering the farm after the wild animal detection this image is processed by the CNN algorithm to find the animal's name with the available datasets and a huge noise is generated to get rid of the animal.

D) Speaker

This device is used to make the high decibel sound whenever there is an abnormal behaviour in the farm one such example is if there is any wild animal intrusion is detected in the farm this device makes a huge noise to get rid of that animal. Sound range 80 – 90 db.

E) Sound Detection Sensor

The sound detection sensor is a small board that combines a microphone and some processing circuitry. It has the ability to detect different sizes of sound. This module can be used for security and monitoring application. Its accuracy can be easily adjusted for the convenience of usage. It can be easily adjusted by the potentiometer for adjusting the sensitivity.

F) SOIL MOISTURE SENSOR

The sensor for soil moisture consists of two probes used to test the volumetric water content. Usually, the values of this sensor will be in 0's and 1's (0 is no water content and 1 is water is present) whenever there is no water content in the soil it sends a notification saying that moisture level is low and automatically turns on the sprinklers in the field.

I) SOLAR PANEL

The Solar panel (photovoltaic cells or panel) are used in the proposed system to absorb the sun's rays and convert them into the electricity, the energy generated from solar panel are stored in batteries. For the working of the system, the maximum 12v is consumed. Photovoltaic cell that uses a process called radiative cooling to allow for 24hours renewable energy generation.

G) TEMPERATURE & HUMIDITY SENSOR

The temperature and humidity sensors are both combined with a single device that is DHT11 sensor which measures the temperature and humidity of the soil.

J) FLASH LIGHT

When any animal is detected at night the relay automatically pushes the flash light to ON position, it makes contact between two contact strips, which begins a flow of electricity, powered from the battery. The bright light from the device will fear the animals, it is one the easiest and safest way to repel the animals at night time.

H) WIFI Module

A WIFI module is a microchip mainly used for the development of end point IOT applications. It's referred to as a standalone application wireless transceiver.

IV. TESTING AND RESULT

IR sensor is placed inside an open space and wide any animal or bird is detected at a distance of 10 cm to 660 for animal and 10dB to 100dB for birds. The detection array in the system describes about four detection modules which are controlled by a programmed microcontroller and these sensors are placed facing all the four directions which is East, West, North and South. Then the LCD will display for e.g., "SOUTH-EAST SIDE

ANIMAL DETECTED" if no source of movement received then the LCD will still display "NO ANIMAL IS DETECTED".

Here are the results of the tests that are analysed to find out the response of the IR sensor from the distance that changed.

Table.1 IR Testing Result for Animal Detection

SI. No	Distance (cm)	Motion Detectors
1	10	Responding
2	60	Responding
3	100	Responding
4	160	Responding
5	200	Responding
6	500	Responding
7	800	Responding
8	860	Responding
9	900	Responding
10	960	Responding
11	1000	Responding
12	1060	Not Responding
13	1110	Not Responding
14	1160	Not Responding

Table.2 IR Testing Result for Birds Detection

SI. No	Sound (DB)	Sound Detectors
1	10	Not Responding
2	20	Not Responding
3	40	Not Responding
4	50	Not Responding
5	60	Not Responding
6	65	Responding
7	70	Responding
8	80	Responding
9	100	Responding

Android working system in this research is when the PIR sensor captures the movement from outside, it will forward to the router and convey information to smartphone users if there is detected movement. Android system is very important in this research considering the development of an increasingly advanced era. Smartphone used in this study of course that uses the Android operating system.

Fig 3. Smart Agriculture System

Fig 3 shows the prototype of the Smart agriculture system where you can see all the devices used in the proposed system is attached to the cardboard connecting raspberry Pi 3 through the connecting probes

Fig 4. Smart Agriculture System app output

IV. CONCLUSION

In recent years, a wide range of innovative applications, based on the most advanced technologies of the ICT sector. with the aim of promoting forms of sustainable agriculture and, at the same time, satisfy the growing demand for food worldwide. In this paper, we considered a Smart Agriculture application targeted at reducing, as much as possible, damages to crops caused by ungulates through a low environmental impact solution making use of animal repelling devices. The focus of the paper was on the design and development of a monitoring and repelling application for these devices, including all components of the platform. The use of Blynk and sensors that may adapt to deployments with a large and variable number of devices. The proposed solution has been designed considering the specific features and issues of both the IoT Animal, bird Repelling Devices and crop monitoring devices. The implemented smart agriculture system is cost effective for maximizing agricultural farm, crop prediction, and wild animal prevention. Depending on the level of soil moisture the message will be intimated to the property owner, thereby decision making the process easier. The system proposed can be used to predict the crop based on the soil condition, temperature, humidity which helps the farmer grow the proper crops at proper time. Through this system it can be easily achieving significant progress in irrigation. The proposed system is thus a solution to the problems facing in agriculture process.

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