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IOT Based Agricultural Field Protection using Wireless Sensor Network

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Abstract— The Internet of Things (IOT) has the potential to transform the present world. The global population is projected to reach 9.8 billion by 2050 according to UN report and the application of IOT in agriculture could have the utmost impact in feeding the ever increasing population. Since IOT enables the objects to be sensed and controlled remotely , the integration of traditional methodology with Internet of Things and Wireless Sensor Networks can surely steer the world in the direction of agricultural renovation. In this paper, the design and testing of an IOT based device that is capable of analyzing the sensed data and transmitting it to the user is presented. This device can be implemented in crop fields and grain stores for security reasons and can be controlled and monitored from remote location. This emphasizes on solving problems like detection of rodents causing threats to food crops and sending of real time notifications to the users without human partaking.

Keywords— IOT, WSN , Raspberry Pi, PIR sensors

I. INTRODUCTION

The use of latest technology in the field of agriculture plays a crucial role in not only escalating the yield and protecting stored food grains but also reducing the extra man power efforts and costs. Various research efforts aimed at the betterment of cultivators leads to new systems that use IOT technology and they often prove effective. The term '*Internet of Things*' was proposed by Kevin Asthon in 1999 which was meant to refer the connection of each and every thing to the Internet.

The major challenging safety measures in agriculture include the interaction between security devices and providing them with intelligence to be in command over other electronic devices like cameras, repellers etc., Any camera mounted in a farm or storehouse cannot be of much use unless the captured or recorded information is accessed. Furthermore, it cannot process the information about what has been going on at a particular scene. In addition, cost is a major factor in efficiently implementing and adopting the most modern communication and information technologies. It is rather hard to achieve a swap over of data between devices and improve their functionality, even as maintaining their price to a realistic level. So, naturally the security and supervising systems must be dependable for sending data over network, analysing it and notifying the user with real time information of neighbouring locations. This lack of information transmission and data analysing has been worked out by integration of Internet of Things with currently available security devices in order to achieve efficient food productivity and food preservation. The loss of food crop and incapacitation of diseases are owing to various threats like rodents, pests, insects and pathogens. This work proposed here is the design and analysis of security device, considering all possible damages to harvested crop from rodents and other creatures roaming in grain storage surroundings. In the perspective of Smart Security and Monitoring System for Agriculture, the challenge of integrating IOT with electronic security devices in order to improve the effectiveness of food preservation in stores is addressed.

II. LITERATURE REVIEW

An overview of related work in this field of IOT in agriculture is given below.

In [1], Nikkila et al. proposed a Farm Management Information Systems (FMIS) with steadily increased level of sophistication that includes Internet based technologies. Since this system for precision agriculture wants additional requirements compared to traditional FMIS, the implementation of such systems seemed more complicated in several aspects. Hence this work aimed at identifying the requirements of precision agriculture on FMIS and then evaluating a novel, web-based approach for implementing an FMIS that fulfilled the additional requirements.

Alexandros et al. presented their work on the use of Future Internet Technologies in Agriculture and Food Sectors by integrating the Supply Chain thereby focusing on development and federation of Future Internet services that will revolutionize the agriculture sector. [2]. In this paper, the explicit qualities of the agri-nourishment division concentrating on how information management in this area will happen under a highly varied group of people and services, based on the EU SmartAgriFood venture.

Juan et al. proposed a Wireless Sensor System based on Internet of Things with the design of a wireless communication system [3]. Here the sensors are connected to the Internet and can be monitored remotely from anywhere in the world. The sensor information is downloaded from the cloud utilizing a graphical programming stage to control and discuss the framework with a programmable logic controller (PLC), which plays out the activities as indicated by the temperature value of the sensors. The checking procedure was performed with a SCADA framework and the modeling was done using the formalism of Petri nets, as a system that responds in terms of distinct events.
In [4], Fan TongKe proposed a Smart Agriculture concept based on Cloud Computing and IOT that promotes faster agricultural modernization and effectively solves the issues relating to farming, countryside and cultivators.
Rafiullah et al. discussed possible applications and key challenges associated with the development of IoT [5]. Chetan et al. proposed a new methodology for smart farming by connecting a smart sensing system and smart irrigator system via wireless network [6]. This system relies on measurement of physical factors in farming activities, like soil nutrient content, moisture content, and pH of the soil. The modeling and implementation strategies of a smart farming system are demonstrated in this paper.

In [7], Farooq et al. have presented a critical analysis on the security concerns of Internet of Things. In a like manner Chun-Wei et al. have discussed the open issues and challenges of future Internet of Things [8].

III. EXISTING SYSTEM

As Agriculture segment frames the backbone of Indian economy it should have security not as far as assets alone but rather additionally agricultural products require security. Other than this, protection at beginning period, from assaults of rodents or creepy crawlies in fields or grain stores should be dealt with. Such difficulties are of much concern these days. Security frameworks which are being utilized at present are not sufficiently brilliant to give continuous notice in the wake of detecting the issue. The coordination of ordinary strategies with the latest advancements, for example, IOT and Wireless Sensor Networks can prompt cultivating transformation. As per past examines in harvest's security, developing nations which are utilizing customary storerooms for staple sustenance crops be short of in providing protection obviously, prompting 20-30% loss of rural items.
As Agriculture sector forms the vertebrae of Indian economy it ought to have security not in terms of resources alone but also need security. Moreover, prophylactic protection is needed against attacks of rodents or insects in fields or grain stores. Such challenges are of much concern nowadays. The present security systems for detection as well as notification of rodents and insect movement in the field are not fool proof. The integration of conventional techniques with the most advanced technologies such as IOT and Wireless Sensor Networks can lead to successful and profitable farming. According to previous researches in crop's security, developing countries which are using traditional storage facilities for staple food crops lack in providing protection as expected, leading to 20-30% loss of agricultural products.
Apart from this aforesaid loss of crops, other disadvantages such as need for huge man power, danger of being vulnerable to rodent borne diseases are there. Moreover acquiring and processing the information about what is happening at particular location is lacking.

IV. PROPOSED SYSTEM

In the proposed system, the concept of IOT is used in order to develop a smart security method with the capability of analysing data and sending information over network to the remote location. The system detects motion and records sensory information that can be used to analyse and activate electronic devices which in turn transmit information to user. The method taken up here intends to solve security crisis by identification of rodents thereby detecting possible ravage to crops and alerting user in real time. This is done based on analysis and processing of information without human intervention. To facilitate effective functioning of the system, sensors and electronic devices are integrated using Python scripts.

A. *Technologies Used*

The following Technologies are used in implementing the proposed system.

- IEEE 802.15.4 LoWPAN which defines the PHY and MAC layer of low power devices.(also supporting 250 Kbps data rate)
- IETF 6LoWPAN (RFC 4944/RFC 6282) that provides flawless integration of LoWPAN devices with the Internet.
- IETF CoAP which is the application layer specification for integration.
- Bluetooth SMART devices that support low energy broadcasting operations.
- RFID devices and smart phones which are useful in object identification and gathering related information.

B. *Components used*

- Raspberry Pi 3
- PIR (Pyroelectric InfraRed) Sensor
- URD (Ultrasonic Ranging Device)
- Web Camera
- Ultrasonic Sound Repeller

C. *Language Used*
Python
Linux based Raspier OS

D. *System Architecture*

System architecture is the conceptual model that defines the structure and behaviour of the proposed system. On the whole, the system consists of a hardware module with a server side and a client side. The hardware module comprises of a raspberry pi, in which the sub-devices like Ultra Sonic Sensor, PIR Sensor, Web camera and Repeller are connected as shown in fig 1. When the rodents come in contact with PIR sensor, the PIR sensor automatically sends the sensed signal to raspberry pi, and also the ultra-sonic sensor measures the distance between the obstacle and the device and sends the measured distance to the raspberry pi. The raspberry pi passes the signal to camera to capture the picture of the obstacle; the camera is enabled and takes the pictures and sends back to the raspberry pi. When a rodent is detected the repeller generates a sound signal. Since the raspberry pi has in-built hotspot, it can connect to a network and hence the user can just type the URL and access the information whenever he wants to know information about rodents and their whereabouts.

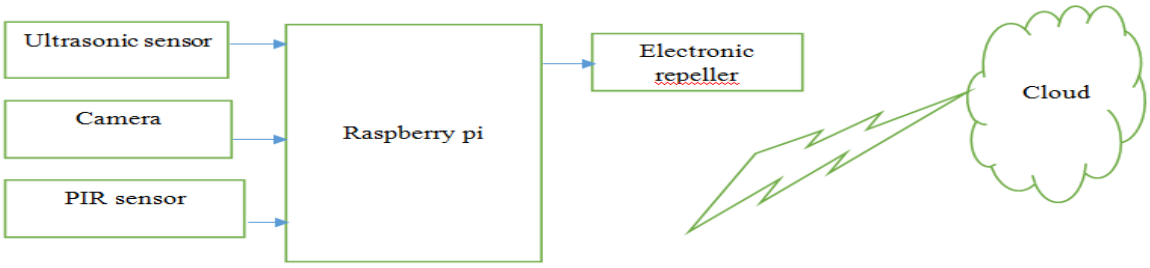
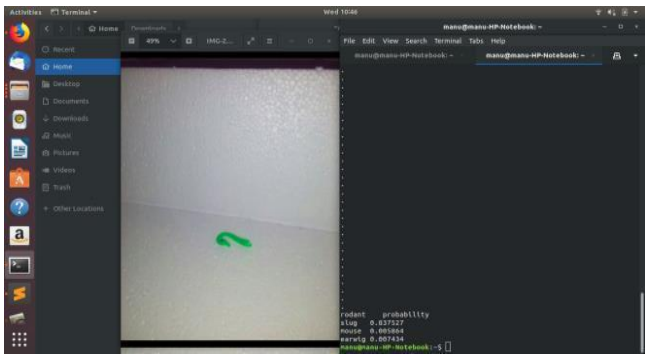


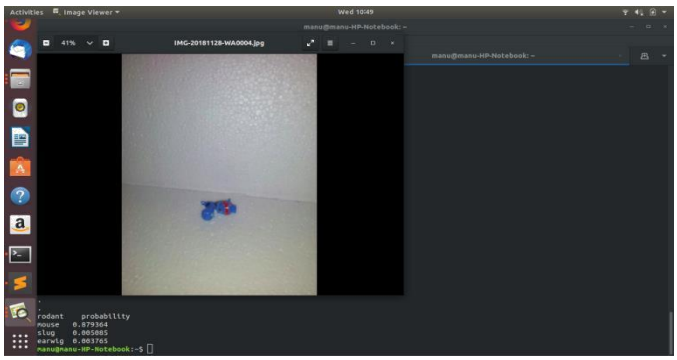
Fig. 1 Block diagram depicting system architecture

V. IMPLEMENTATION AND RESULTS

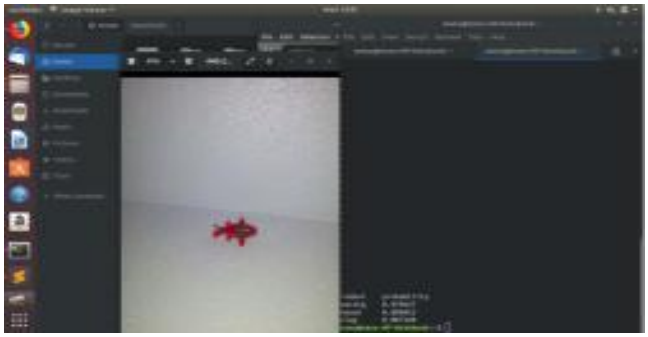
The proposed smart security system is implemented using Python Programming Language and the devices are controlled After the collection of the data further processing and transmission of the data to ThingWorx IoT platform's server is needed for that a script is written in Python along with API written in cURL is used.
Raspberry pi has the capability of connecting all the devices to its GPIO (General-Purpose Input/Output) pins and storing the data in it . OpenCV, the cross-platform library that is used to develop real-time computer vision applications by focusing on image processing, video capture and analysis , captures and saves videos of rodents to perform feature detection. Along with detection of specific objects such as faces, eyes, ears in the videos or images, movement in it is also estimated which leads to tracking of objects.



2. (a) Earwig



2. (b) slug



2.(c) Mouse

Fig. 2 Detection of rodent structures

Three types of rodent structures are taken as inputs. They are Earwig, slug and Mouse; The detection probabilities of earwig , slug and mouse are found to be 0.979627 , 0.837527 and 0.879364 respectively. With slight modification to the inputs , the proposed system can sense creatures other than rodents which try to intrude the agricultural farms or crop fields..

VI. CONCLUSIONS

Thanks to the optimistic approach of IOT integration in agriculture, a system is designed for detection of rodents and other pests in crop fields where an IR Sensor detects the motion of the rodents, calculates the distance and records the video of the rodent. After collecting and analyzing the data, it is stored in database and it can be retrieved by the user through the web interface (URL). All the results are calculated by taking several readings. The testing is done in an area of 10 sq.m. with the device positioned at one corner. Once the PIR sensor senses heat it starts URD sensor and webcam, along with it, device sends random number of notifications based upon timestamp to the user .Through this technique, the user comes to know about the rodents and their whereabouts more exactly and they can protect the crops and grains from getting destroyed by the rodents.

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