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Enhancement of IoT based Smart Salvation and Monitoring Devices for Agriculture

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***Abstract*—Agriculture is the process of producing food,feed,fibre and many other desired products by the cultivation of certain plants and the raising of domesticated animals. We can protect the crops from the attack of rodents or insects, in fields or grain stores. Security systems which are being used now a days are not enough to protect the agricultural products.Internet of Things plays a vital role in latest technologies. Keeping this scenario in our mind we have designed, tested and analyzed an 'Internet of Things' based device which is capable of analyzing the sensed information and then transmitting it to the user. This device can be controlled and monitored from the remote location itself and it can be implemented in agricultural fields, grain stores and cold stores for security purpose and delivering real time notification based on information analysis and processing without human intervention. In this device,PIR sensor and URD sensors and electronic devices are integrated using Python scripts.**

***Index Terms*—Internet of Things (IoT); Agriculture; Security; Raspberry Pi; Sensors; Wireless Sensor Network (WSN);**

I. INTRODUCTION

India's agriculture is composed of many crops,with the foremost food staples being rice and wheat. e security in agriculture is the interaction between security devices and to provide them intelligence to control other electronic devices such as cameras, repellers etc to enhance security in various fields. In implementation and adoption of information and communication technologies, cost is also a major factor. It is not easy to achieve exchange of information among devices and upgrading their functionality while keeping their cost to a reasonable level . So, the conclusion is that the security and monitoring systems must be responsible for transmitting data over network, analyzing the information and notify the user with real time information of surroundings.This lack of information transmission and data analyzing has been "solved" by integration of internet of things with currently available security devices in order to achieve efficient food preservation and productivity. Although the food crop loss and debilitation of diseases are due to various threats as rodents, pests, insects and grain pathogens, while this research is the designing and analyzing of security device, considering damages to post harvest crop by rodents and grain stores as applicable area.

In the context of Smart Security and Monitoring System for Agriculture , we address the challenge of integrating Internet of Things with electronic security devices and systems to monitor the field and protect the food in grain stores.

A. Internet of Things

Kevin Ashton is an innovator and consumer who coined the phrase "the internet of things" to describe the network connecting objects in the physical world to the Internet. It's a major tech revolution in information and communication technology with updated infrastructure and networks where all the connected devices are able to identify and communicate with each other [4].

According to Gartner, in near future, about 25b identifiable devices are expected to be a part of this computable net-work by year 2020 [5]. Thus, agriculture can be a vast area to integrate Internet of Things with distributed autonomous sensors to monitor environmental condition of grain stores and to analyze data and pass the information to remote user.

B. Wireless Sensor Network

Wireless Sensor Network(WSN) refers to a group of spatially dispersed and dedicated sensors for monitoring and recording the physical conditions of the environment and organizing the collected data at a central location.WSN measure temperature,sound,pollution,levels,humidity,wind and so on.

The structure of report is as follows. In Section II the literature review, includes theoretical contribution and analysis of current security devices and technologies. Section 3 discusses the Research and development methodology of device.

WSN is the most standard services employed in commercial and industrial applications,because of its technical development in a processor,

Communication and low-power usage of embedded computing devices. The sensor node is a multi-functional, energy efficient wireless device .Network arrangements can be carried out without immovable infrastructure.flexible if there is a casual situation when additional workstation is required.

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which we present our architecture and design modules and the data transmitted between them.

II. Review of Literature

For developing an intelligent security device based on IoT, M2M framework, sensor network and database management are the foundations. The fields like data analytics and pattern matching also influences security devices. Researchers have been developing various IoT based security devices but a little work is done in agricultural area.

According to previous research in crop's security,developing countries, which are using traditional storage facilities for staple food crops, can't protect them, without proper security it leads to 20- 30% loss of agricultural products such as rice, corn etc[8]. Currently available solutions targets only insects, pests and grain pathogens. While other study states 5 to 10% loss in rice crops on average, in Asia is due to damage caused by rodents[9]. These rodent impacts are also associated with the rodent borne diseases. As in Asian and Pacific countries death rate due to rodent borne diseases is higher in comparison with some illness such as HIV-AIDS

Rodents damaging agricultural products is a problem to be managed through smart agricultural systems and support systems for farmers by monitoring data should also be developed for rodents [9].

Based on smart agriculture, by using information and communication technologies, internet of thing can provide us with a security system for private fields and farm products, thus improves the monitoring and security for both pre-harvest and post- harvest grain.

Distribution of resource, delegate control of devices and balance of loads to improve effiiciency of resource devices are using, is achieved by integration of hardware resources into clustures using vitalization technology. To obtain large amount of data, by using various information sensing techniques of IoT using RFID, wireless communication etc. are integrated with agricultural based information cloud to form smart agricultural device[10].

Data collection is also a major part in security devices. Here, data i.e. sensory information using various sensors. Information generated from sensors are transmitted to server or platform (IoT based M2M platform) over network so that it can be accessible through remote location for further processing.

Once the data is transmitted to the server, client machine is used to access it, process it and notify user based upon filtered information [7].

Internet of Things is used with IoT frameworks in order to easily view, handle and interact with data and information. Within the system, users can register their sensors, create streams of data, and process them. In addition, the system has searching capabilities, helping the user with a full -text query language and phrase suggestions, allowing a user to use APIs to perform operations based on data points, streams and triggers. It is also applicable in various agricultural areas apart from security. Few areas are :

- Water quality monitoring
- Monitor soil constituent, soil humidity
- Intelligent greenhouses
- Water irrigation
- Scientific disease and pest monitoring

To develop more cost efficient system by avoiding the need of maintenance, free from geographic constraints and to access affordable services, extended "as-a-Service" framework in cloud computing can be integrated with Internet of Things to deliver financially economical IT resources[11].

A. Thing-as-a-Service

In IoT and Cloud era, sensing, actuation, data generation, storage, and computation has extended the cloud services ahead of SaaS, IaaS, and PaaS. Thing-as-a-Service is intro-duced in order to develop a cloud of Things where different kind of resources as sensors can be integrated based on the tailored thing-like schema.[12].

III. Research Methodology

In the proposed scenario, the research is based on to develop security systems with ability to analyze data and transmit information over network to the remote location. Literature survey gives the notion about present work done in field of agriculture security and IoT. This can be developed by integrating few new technologies with present scheme. Current IP base security cameras require network connectivity for monitoring from remote location. It doesn't has ability to notify user by analyzing data. In the device, basic sensors and electronic devices are used. The sensory information are analyzed in order to activate electronic devices and raspberry pi is used as a server to analyze data and transmit information to user.

Components used are :

1) Raspberry Pi 3 Model B+
2) PIR Sensor
3) Web Camera
4) Ethernet cable

Platform and Language Used:

1) Python
2) Linux based Raspberry OS

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A. Architecture

Device uses 3 interface for data collection, analysis and transmission. IoT architecture is categorized in 3 level architecture and five level architecture. Figure - 1 shows the working phenomena of device based upon 3 level architecture[13].

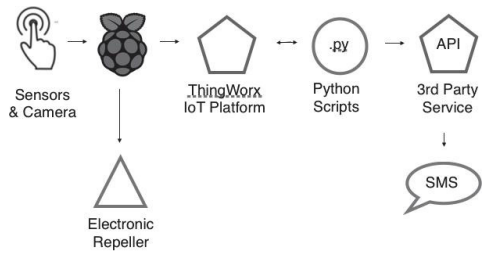
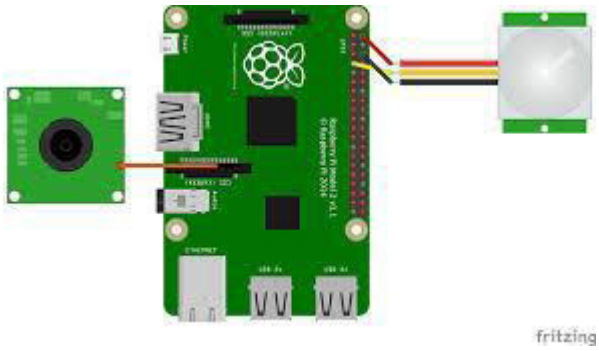


Fig. 1. Device's Architecture

These layers, categorised as

- Perception layer : This Layer is used to differentiate the different type of sensors used in device.
- Network layer :This Layer used for process and transmit the information over network.
- Application layer : For various practical applications this layer is used.

Extra key level mentioned between application layer and network layer is known as middle-ware layer which consists of data analyzing system to take automated actions based upon information [14].



This layer provides dedicated services among connected devices[15].

Fig. 2. Device's connectivity using RasPi's GPIO Header

B. Circuit Design

The sensors and camera is connected to GPIO header. PIR sensor has three pins as VCC, OUT and GND, while ultrasonic ranging device (HC-SR04) contains four pins as TRIG, ECHO, VCC and GND. Device also contains a ultrasonic sound based

Raspberry pi B+ GPIO header (Table-II) is consists of 40 pins which includes 5v, 3.3v, GND and 26 GPIO pins and 2 ID-EEPROM pins to provide connectivity to I/O devices.

TABLE II
GPIO HEADER PIN OUT

PIN	GPIO	PIN	GPIO
1	3.3v	2	5v
3	GPIO 2	4	5v
5	GPIO 3	6	GND
7	GPIO 4	8	GPIO 14
9	GND	10	GPIO 15
11	GPIO 17	12	GPIO 18
13	GPIO 27	14	GND
15	GPIO 22	16	GPIO 23
17	3.3v	18	GPIO 24
19	GPIO 10	20	GND
21	GPIO 9	22	GPIO 25
23	GPIO 11	24	GPIO 8
25	GND	26	GPIO 7
27	ID-EEPROM	28	ID-EEPROM
29	GPIO 5	30	GND
31	GPIO 6	32	GPIO 12
33	GPIO 13	34	GND
35	GPIO 19	36	GPIO 16
37	GPIO 26	38	GPIO 20
39	GND	40	GPIO 21

In circuit design (Figure - 2), we're referencing pins by BCM (Brodcomm SOC channel), and since HC-SR04-ECHO port is rated as 5v, however input pin of GPIO is rated as 3.3v. So, to send 5v signal to input pin, we have to include a voltage divider circuit. Voltage divider is consists of 2 resistors of 1KΩ. and 2KΩ. in series connected to ECHO (V_i) where : $V_o = V_i * R_2/(R_1 + R_2)$

In addition to circuit, web camera is connected to universal serial bus port of raspberry pi, which will be accessible via IP address of server over network.

Table - III states the connectivity of devices' port with particular GPIO location.

C. Area and Device Installation

For circuit (Figure - 3) installation, working area was selected. Since the device is consists of one heat sensor, one ultrasonic ranging device , space selected was a small area with the size of 10 sq. m.; The device was installed in the corner with sensors facing same side and camera fixed at some height.

D. Data Analysis

After installing and activating the device, scripts which was written in python language is used to identify motion of rodents using heat sensor . Considering these discrete values as flag signal, URD sensor was activated to calculate the distance of rodent and simultaneously webcam is activated to capture a snap.

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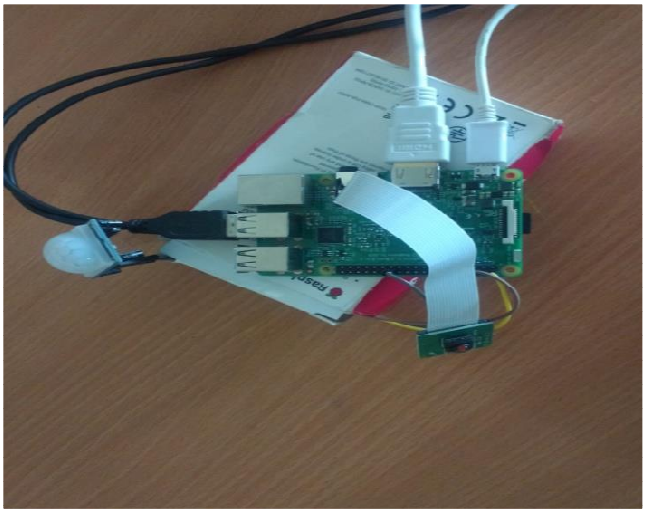

Fig. 3. Screenshot of Prototype

area. Ultrasonic ranging device and web camera is dependent upon the values generated by PIR sensor.

E. Data Transmission

The analyzed data and information is further stored in SQL based database. (Figure-4) using URL command line tool and library through HTTP protocol. Further, a SMS application programming interface is used to deliver analyzed information to user including IP address of the server to access webcam.

F. Application

After data processing, on application interface, a website's link will be sent to the user along with timestamp and information, and based upon the distance calculated by ultrasonic ranging device, repeller will be activated with a particular frequency within range (30kHz to 64kHz) which is aversive to rodents.

IV. Results and Discussion

The proposed smart security system is implemented using Python Programming Language and the devices are controlled using Python scripts and RPi Libraries. After the collection of the data further processing and transmission of the data is needed for that a script is written in Python along with API written in cURL is used. To provide machine to machine services and internet of thing based application. cURL is a computer software project written in C Language which provides library and command line tool for transferring using it's library "lil" which supports common range of protocols including HTTP, HTTPS, FTP, FTPS, TELNET, IMAP, POP3 and SMTP.

Fig. 4. Screenshot of ThingWorx's Platform Test with S2MS

A. Algorithm to access functionality of security system

In Algorithm 1, a REST Client is used to connect with RESTful web services. We're considering the distance between 2 centimeter to 400 cm in one direction. Using wireless sensor network and sensor grids the capability can be increased.

B. USB Camera configuration to access through Raspberry Pi

In our prototype, a basic USB based web camera is used for monitoring purpose along with **Motion** daemon tool and **FSWEBCAM** to capture time lapse images. Following steps were executed in order to configure web camera with Motion:

```
import time
import picamera
    picamera.PiCamera() as camera:
       camera.start_preview()
       time.sleep(2)
```

C. Result Analysis

Table IV represents the value transmitted by security system to database. Distance Measured is in centimeters and Time is in"dd-mm-hh:mm:ss:formet

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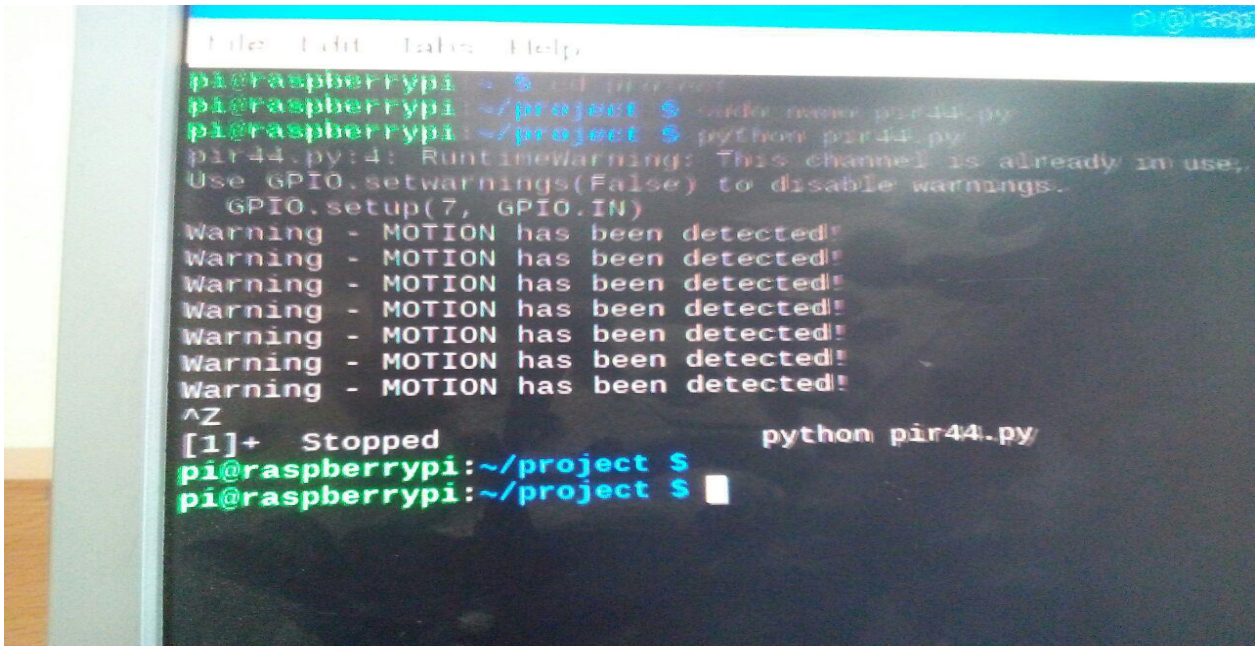
PIR sensor output



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V. Conclusion and Future Scope

'Internet of things' is widely used in connecting devices and collecting information. The system is designed for identification of rodents in grain stores. After collecting and analyzing the data, algorithm is designed to provide accuracy in notifying user and activation of repeller. All the results are calculated by taking several readings. The testing is done in an area of 10 sq.m. with device placed at the corner. Once PIR sensor identifies heat it starts URD sensor and webcam, along with it, device sends random number of notifications (based upon timestamp) to user.

For future upgradation, device will inherit a grid of sensor panels consisting PIR sensors and URD sensors. The device can incorporate pattern recognition techniques for machine learning and to identify objects and categorize them into humans, rodents and mammals, also sensor fusion can be done to increase the functionality of device. Improving these perspectives of device, it can be used in different areas. This project can undergo for further research to improve the functionality of device and it's applicable areas. We have opted to implement this system as a security solution in agricultural sector i.e. farms, cold stores and grain stores.

The results of the work point to the following directions of research that are likely to be needed for further improvement.

- It will be helpful to the farmer to prevent rodents in grain stores.
- It can be further improved for the identification between humans, mammals and rodents.
- Device can be enabled to collect more information about surroundings in the field and presence of threats so that implementation of machine learning is achieved.

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