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Different applications of IoT based Smart Monitoring Devices for Agriculture

Dr. Balakrishnan M[1], Dr. Arockia Christopher A. B[2], Dr.Vellingiri J[3]

[1]*Assistant Professor (SG), Dept. of IT, Dr. MCET, Pollachi, TN, India.*
[2]*Assistant Professor (SG), Dept. of IT, Dr. MCET, Pollachi, TN, India.*
[3] *Assistant Professor (Sr.), School of Information Technology & Engineering, Vellore Institute of Technology, Vellore.*

ABSTRACT

In the real world, many farmers face problem in monitoring their farms. The farmers have more difficulties to monitor all the farms at the same time. Hence the project is developed to monitor the farms in the field using the concept of Internet of Things (IoT). Here all the data's are parsed into the server and are able to monitor the plants continuously and easily able to monitor the health of farms. By applying the Internet of Things, the improvement time gets diminished and thus time for observing the farms. Also demand not to care about the health of crops and the readings are displayed in the server accordingly through the wireless network. This device can be measured and supervised from remote location and it can be executed in agricultural fields, grain stores and cold stores for security purpose. Agriculture sector being the backbone of the Indian economy deserves security and hence an agricultural product needs security, monitoring and maintenance at very initial stage. These challenges should be taken into consideration. The combination of traditional method with software technologies like Internet of Things and Wireless Sensor Networks can lead to agricultural development. Keeping this scenario the concept " Internet of Things" have been tested and analyzed based on the device and is capable of analyzing the sensed information and then transmitting it to the user. In this device, cited sensors and electronic devices are incorporated using Python scripts. Based on attempted test cases, we were able to achieve success in 84.8% test cases.

Keywords: Internet of Things (IoT), Agriculture, Security,Raspberry Pi, Sensors, Wireless Sensor Network (WSN).

1. INTRODUCTION

Agriculture plays a vital role in the development of agricultural country. Security in agricultural field is required not only in terms of resources but also for agricultural products. Protection at very initial stages, like protection from attacks of rodents or insects, in fields or grain stores are needed. In the context of providing smart security and monitoring the system, for agriculture can be addressed by integrating the agricultural system with Internet of Things (IoT). Using Raspberry pi and various sensors, the efficiency in agriculture can be improved. The information generated from different sensors are sent to main server using Raspberry pi. All the parameters in the agricultural field can be controlled and monitored from remote location.This paper addresses, solving problems like identification of rodents, threats to crops and delivering real time notification based on information analysis and processing without human intervention.

So, the natural 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. Damages to post harvest crop by rodents and grain stores as applicable area.In the context of Smart Security and Monitoring

System for Agriculture (S2MSA), we address the challenge of integrating Internet of Things with electronic security devices and systems to improve the efficiency of food preservation in grain stores.

A. Internet of Things

The term Internet of Things was first proposed by Kevin Ashton in 1982. Internet of Things (IoT) is an environment of connected physical objects that are accessible through the internet. The "thing" in IoT could be any object with build-in-sensors that have been assigned an IP address and have the ability to collect and transfer data over a network without manual assistance. IoT is a combination of hardware and software technologies along with embedded devices which enables to provide services and facilities to anyone, anytime, anywhere required using any network. The connectivity then helps us to capture more data from more places, ensuring more ways of increasing efficiency and improving safety and IoT security. IoT is transformational services that can assist companies improve performance through IoT analytics and IoT Security to convey better outcome.

B. Wireless Sensor Network

Wireless Sensor Network abbreviation WSN is a distributed collection of small devices, capable of local processing and wireless communication. To transmit the information generated by various sensors along with commands for controlling them, the implementation of wireless communication technologies in industrial area is necessary due to inaccessibility to remote location. So, to achieve interoperability between devices in industrial areas, design and implementation of wireless communication system is done. The structure of report is as follows. In the literature review, includes theoretical contribution and analysis of current security devices and technologies.

The structure of report is as follows. In Section 2 the literature review, includes theoretical contribution and analysis of current security devices and technologies. Section 3 discusses the research and development methodology of device in which we present our architecture and design modules and the data transmitted between them. Section 4 presents example on how our device operates and the statistics of efficiency. Finally, Section 5 concludes the paper.

2. LITERATURE REVIEW

Rodents may significantly affect crop production and livelihoods of farmers in both developed and developing countries but their impact as related to the choice and associated costs of management actions is poorly known (Stenseth et al., 2003). In Asia, preharvest rice losses are estimated to be between 5 and 10%. A loss of 6% of SE Asia rice production amounts to approximately 36 million t, i.e. enough to feed the population of Indonesia (215 million people) for 12 months (Singleton, 2003). Rodents are considered as one of the most important pests in Egypt. They cause great economic loss to farmers (damage the growing crops, stored products, poultry and animals farm); and to food manufactures by damaging the structure and fabric of buildings. Besides, they gnaw through almost any object in their ways to obtain food and shelter, Abdel-Gawad and Maher Ali (1982).

Distribution of resource, delegate control of devices and balance of loads to improve efficiency of resource devices are using, is achieved by integration of hardware resources into clusters 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.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 and monitoring. Once the data is

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

Internet of Things is used with IoT frameworks in order to easily, 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.

3. RESEARCH METHODOLOGY

In the proposed scenario, the research problem is to develop intelligent 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 enhanced by integrating few new technologies with present scheme. Current IP based CCTV 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 analyse data and transmit information to user.

Components used are:

1) Raspberry Pi 2 Model B+
2) PIR Sensor
3) Ultrasonic Ranging Device
4) Web Camera
5) Ultrasonic Sound Repeller

Platform and Language Used:

1) PTC’s ThingWorx’sIoT platform for M2M Services
2) Python
3) Linux based Raspbian 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.

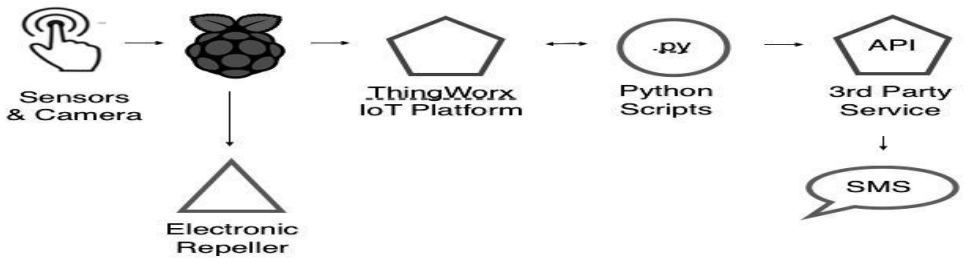

Figure 1. Five Level Device's Architecture in IoT

These layers, categorized as

- Perception layer: Layer which is used to differentiate the different type of sensors used in device.
- Network layer: Layer used for process and transmit the information over network.
- Application layer: This layer is responsible for various practical application based on users' need.

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. This layer provides dedicated services among connected devices.

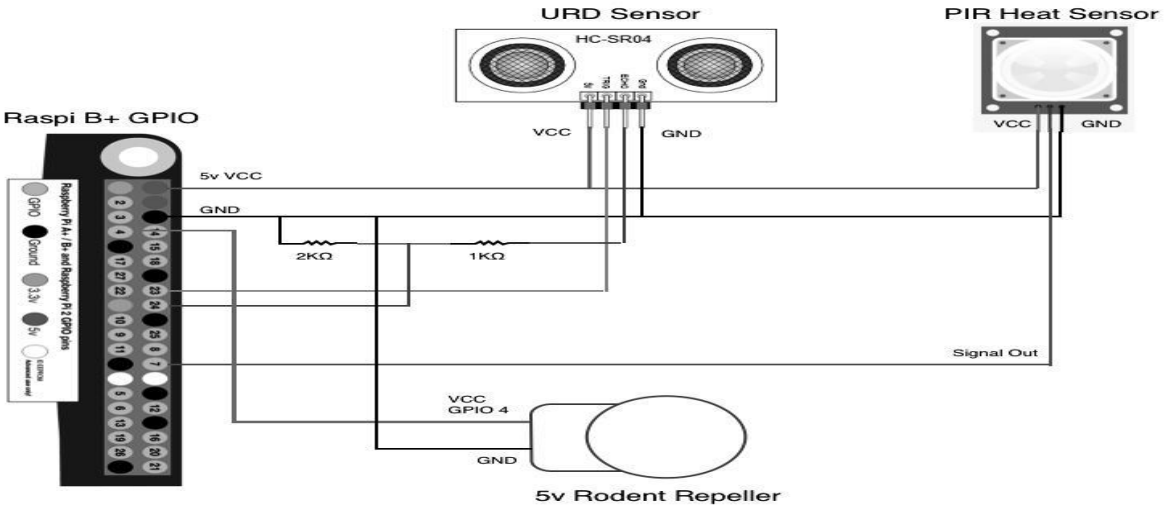

Figure 2. Circuit design connectivity using Raspberry Pi's

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 rodent repeller which will be activated by server based upon data analysis.Raspberry pi B+ GPIO header (Table-I) 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.

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 (Vi)

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 1GPIOHeader 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

C. Area and Device Installation

For circuit (Figure - 3) installation, a space was selected as working area. Since the device is consists of one heat sensor, one ultrasonic ranging device and repeller, 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 which provides discrete values. Considering these discrete values as flag signal, URD sensor was activated to calculate the distance of rodent and simultaneously webcam daemon is activated to capture a snap of 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 provided by Thing Worx'sIoT platform (Figure-4) using cURL 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 daemon.

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 (30 kHz to 65 kHz) which is aversive to rodents.

Table2 GPIOHeader Sensor Connection

Device	Port	GPIO Pin
URD Sensor	TRIG	GPIO 23
	ECHO	GPIO 24 with Voltage Divider
	VCC	PIN 2
	GND	PIN 6
PIR Sensor	VCC	PIN 2
	OUT	GPIO 7
	GND	PIN 6
Repeller		
	VCC	GPIO 4
	GND	PIN 6
Camera		Universal Serial Bus

4. 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 to ThingWorxIoT platform's server is needed for that a script is written in Python along with API written in cURL is used. ThingWorx is a internet of thing based platform provided by PTC LLC.

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 "libcurl" which supports common range of protocols including HTTP, HTTPS, FTP, FTPS, TELNET, IMAP, POP3 and SMTP.

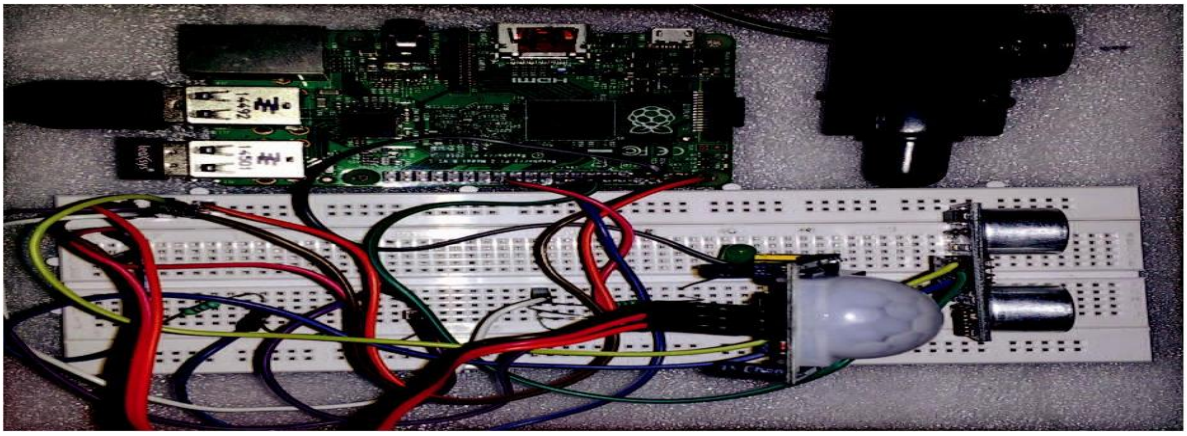

Figure 3. Prototype for screenshot of area and device installation.

A. Algorithm to access functionality of security system

In Algorithm 1, a REST Client is used to connect with RESTful web services of ThingWorx'sIoT platform. We're considering the distance between 2 cm 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:

- Setup 'Motion'
- Configure 'Motion'
  - 'daemon' = ON
  - 'webcam_localhost' = OFF
  - 'stream_port' = Default, 8081
  - 'control_localhost' = OFF
  - 'control_port' = Default, 8081
  - 'framerate' = 40
  - 'start_motion_daemon' = YES

C. Result Analysis

Table 3 represents the value transmitted by security system to database. Distance Measured is in centimeters and Time is in "dd-mm-hh:mm:ss" format. After configuring web link *i.e.172.16.0.207:8081* for prototype, the API template is modified and transmitted into thyrox server.

Table 3. Value Transmitted by Security System

S.No.	Time	Distance	Contact
1	2015-07-04 20:01:23	3.39	919872583672
2	2015-07-04 21:01:23	7.15	919872583672
3	2015-07-04 23:12:05	5.33	919872583672
4	2015-07-05 01:36:22	4.58	919872583672
5	2015-07-05 01:58:34	57.18	919872583672
6	2015-07-05 01:58:58	51.31	919872583672
7	2015-07-05 01:59:38	53.37	919872583672
8	2015-07-05 02:01:31	59.91	919872583672
9	2015-07-05 02:01:31	55.63	919872583672
10	2015-07-05 02:13:40	5.63	918437479642
11	2015-07-05 03:32:52	7.39	918437479642
12	2015-07-05 03:47:06	34.27	918437479642
13	2015-07-05 04:11:25	33.84	918437479642
14	2015-07-05 04:11:41	34.18	918437479642
15	2015-07-05 04:19:12	33.75	918437479642
16	2015-07-05 04:19:26	33.86	918437479642
17	2015-07-05 08:07:45	5.74	918437479642
18	2015-07-05 08:07:54	5.77	918437479642
19	2015-07-05 08:23:08	6.24	918437479642
20	2015-07-05 10:27:17	129.38	918437479642
21	2015-07-05 10:27:31	3.65	918437479642
22	2015-07-05 11:53:47	4.78	919872583672
23	2015-07-05 14:09:46	5.35	919872583672
24	2015-07-05 14:10:05	22.31	919872583672
25	2015-07-05 14:42:59	5.28	919872583672
26	2015-07-05 14:59:45	9.54	919872583672
27	2015-07-05 15:01:49	5.8	919872593672
28	2015-07-05 15:02:14	10.36	919872583672
29	2015-07-05 15:02:38	7.75	919872583672
30	2015-12-18 14:46:00	289.44	919872583672

%RPi.GPIO is imported as GPIO and GPIO mode is set as BCM Mode%

```
PIRPIN = 7 TRIG = 23 ECHO = 24 while (true) do

    Set GPIO.IN as PIRPIN
    if ( GPIO.input(PIRPIN) ) then Set GPIO.OUT as TRIG Set GPIO.IN as ECHO
       %Below mentioned 3 steps are used to initialize the URD Sensor%

        Set TRIG output to FALSE for 2ms Set TRIG output to TRUE for 0.01ms Set TRIG output
        to FALSE
        while (GPIO.input(ECHO)==0) do pulseStart = time.time()

        end while

        while (GPIO.input(ECHO)==1) do pulseEnd = time.time()

        end while

        pulseDuration = pulseEnd - pulseStart distance = pulseDuration * 17150 distance =
        round(distance, 2)

        if (distance >2 and distance <400) then

                        %Save Information into Database% Initialize subprocess as (fswebcam -r $date.jpg)
            Initialize REST API

            $content=’’’DistanceMeasured”:”’+str(distance)+ ’’’,”Time”:”’+str(datetime.datetime.now())+’’’’

            Post $content to database using cURL Set GPIO Output to GPIO PIN 4


                                %Turn on Pest Repeller% GPIO.output(4, true)

                                % Wait%
            time.sleep(min)

            GPIO.output(4, false)

        end if

    end if
    GPIO.cleanup()

end while
```

so the device is also able to generate record if it founds any human near heat sensor.

5. CONCLUSION AND FUTURE SCOPE

This proposed work is made to help the farmers and make their harvest economical by helping them in security purpose travelling side, college and for every bodies etc. This system provides complete monitoring action of sensors in fields that is very easy to control the field. It also provides huge security to the plants. " Internet of

things‟ is widely used in connecting devices and collecting information. The system is designed for identification of rodents in grain stores. The security system for agriculture is implemented which is highly accurate in notifying user and thus the activation of repeller based on the information gathered from various sensors. The results of the work point to the following directions of research that are likely to be needed for further improvement.

- It may be helpful to extend the security system to prevent rodents in grain stores.
- It can be further improved for the identification and categorization between humans, mammals and rodents.
- Device can be enabled to collect more information about surroundings and presence of threats so that implementation of machine learning is achieved.
- Location of device in area can also be change based upon the location of grains for more effective results.

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