Android based Automatic irrigation system with monitoring and live video streaming

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Abstract- **The proposed system is about remotely managed field and sensor parameter information received using Smart Phone android application and it receives an alert, when you can view the live video of the area under surveillance. Irrigation and security control system has become indispensable in daily life. The design and development of a this proposed system, based on human motion detection and remotely monitoring technology, A PIR motion sensor and Camera module are used to detect motion and capture video respectively. Intelligent irrigation system consists of a wireless communication based on cloud that monitors the weather and soil conditions. Wireless sensor network is used for the monitoring purpose. The monitored data is analysed using the Raspberry Pi and the controlling action is taken, also the data is provided to the farmers through the cloud on their software application.Agriculture sector being the base of Indian economy should be protected and maintained. Security not only for resources only but also agricultural products needs security and protection at very initial stage. This proposed work is oriented to accentuate the methods to solve such problems like suitable for soil according to moisture & temperature in the surrounding, level of water in soil, PIR sensor for security of crops.**

INTRODUCTION

Agriculture plays an imperative role in the economy of India. Moreover 58% of the Indian rural population depends on agriculture as it is the means of subsistence and main asset for secured livelihood. Agriculture is the biggest contribution to the Indian Gross Domestic Product (GDP). In 2009, a study has been released by the NASA, showing the level of ground water across the northern India, that more than one foot of water level has been reducing per decade and the main cause behind it was human activity [1]. One of the main reasons for recession of ground water is agriculture, where the farms are fetching more water from the ground level as rainfall through the country changes rapidly. Over all 92% of ground level water is used alone for agriculture and 49% of that water is from the underground water resources. This consumption of water will dominantly continue because of growth in population and also the increase in the demand of food sources. So there is an essential need to constitute the scenario based on science and technology for feasible management of water.

Volumetric water content of soil information is gathered by the dielectric moisture sensors and by using this information the irrigation system can be automated as it may control the actuators and ground level water instead of pre-arranged irrigation plan at specific duration of time in a particular day. Controller based irrigation is also developed to get a value of solenoid and apply watering to the plants when the level of volumetric water decreases below a set point [2].

Monitoring the moisture level of the soil helps in determining when to irrigate and it significantly helps to improve the water level conversion and conservation of energy, maximization of yield, improvement of water quality and also in reducing the erosion of the soil. In irrigation, a specific crop has a different factor which determines the requirements of water. Irrigation of the plant typically requires actual weather data including relative humidity, speed of the wind and crop factors such as growth stage, variety of the plant, density of the plants in the field, properties of the soil and disease control.

The objective of this proposed work is to improve products quality, and to maintain a sustainable agriculture, by collecting real time data from the environment. So, there is the need for optimizing the resources employed in the agricultural processes, mainly in the irrigation system [2]. For every crop the water required is different according their growth. The water provided by pump is not enough for the plants for their healthy growth. So as per the crop requirement it provides the water by monitoring the moisture level of the crop.

I.I Background and Motivation

The proposed work uses the water efficiently, in right proportion and covers the entire field. It brings wide benefits i.e. water savings, money savings plus the improvement of crop quality. The most important agricultural process, which can be well ordered and adapted to better suit the plants growth, is related to irrigation. Crop selection for the soil is important concept for this. The users then analyse the entire agriculture system using their phone through web. This proposed work pest detection using PIR sensor to monitor movement and alert user so that user can view live streaming through camera installed [3].

Irrigation is of utmost importance for agriculture based country like India. To feed a population of over one billion people, there is a need for production of crops round the year. But for this purpose, irrigation water is needed. So for the production of food crops and cash crops, irrigation is a must [3].

The artificial way of supplying water to the agricultural land at the right moment in an appropriate volume for the proper growth of the plants in order to get the maximum yields of cultivation is technically called irrigation. But irrigation also includes clearing away of excess water from the agricultural land [4]. There is a great necessity of irrigation in Indian agriculture. India has a great diversity and variety of climate and weather conditions. These conditions range from extreme of heat to extreme of cold and from extreme dryness to excessive rainfall. Due to some reasons irrigation is needed in Indian agriculture.

- Uncertainty of Monsoon rainfall both in time and place. Irregularity in distribution of rainfall throughout the year.
- Excessive rainfall causing flood.
- Draught is an annual event in some areas.
- India is a land of Rabi Crops. But there is not rainfall in winter months.
- Some soil need more water.

I.IIOBJECTIVES

Automatic irrigation system:

In the field of agriculture, use of proper method of irrigation is very important from yield point of view and scarcity of water. Various sensors were used to detect need of water supply to the field as soil moisture sensor and rain drop sensor. Soil moisture sensor gives information about moisture level of the soil, which will automatically switch ON and OFF to the water supply pump according to reading taken from sensor to the field. This whole operation is wireless and remotely operated for automation in irrigation system.

Need of Automatic Irrigation

- Simple and easy to install and configure.
- Saving energy and resources, so that it can be utilized in proper way and amount.
- Farmers would be able to smear the right amount of water at the right time by automating farm or nursery irrigation.
- Avoiding irrigation at the wrong time of day, reduce runoff from overwatering saturated soils which will improve crop performance.
- Automated irrigation system uses valves to turn motor ON and OFF. Motors can be automated easily by using controllers and no need of labour to turn motor ON and OFF.
- It is precise method for irrigation and a valuable tool for accurate soil moisture control in highly specialized greenhouse vegetable production.
- It is time saving, the human error elimination in adjusting available soil moisture levels.

II.LITERATURE SURVEY

1. Design and Implementation of Wireless Sensor Network for Precision Anusha P Dr. Shobha K R Mtech, Digital communications Associate professor MSRIT MSRIT

The newly emerged wireless sensor network (WSN) technology has spread rapidly into various multi-disciplinary fields. Agriculture and farming is one of the industries which have recently diverted their attention to WSN, seeking this cost effective technology to improve its production and enhance agriculture yield standard. This paper reports on the application of WSN technology to improve tomato crop production. Water is one of the largest renewable natural resources but fresh water is expected to emerge as a key constraint to future agricultural growth. The Automated Intelligent Wireless Irrigation System using LITE mote provides a real time feedback control system which monitors and controls all the activities of irrigation system efficiently and also monitors the reserve water tank storage so that overflow of tank will be avoided as well as helps in efficient water management so as to get more profit with less cost. This system overcomes the limitations of wired sensor networks and has the advantage of flexible networking for monitoring equipment, convenient installation, low cost, reliable nodes and high capacity. [9]

2. A research by Dr. K.S. Vijula Grace et al has incorporated major WSN based automated agriculture monitoring system.

The ZigBee module used has the range of about 150 meters. The readings of temperature and moisture were recorded and timely sent to farmer's mobile enabling him to take the proper action. This paper proposes the architecture of the innovative GSM based remote controlled embedded system for farming. These system is a low-priced system where information is exchange via SMS on GSM network. As we identify the relevant level of water in the farms, it contributes to the quality of grains and highly affects the incidence of pests and diseases on crops. [11]

3. A research by Nelson Sales, Orlando Remedios et al data can be occupied to automate the irrigation process in agriculture while shrinking water consumption, resulting in monetary and eco-friendly benefits.

The high storage and processing capabilities, the rapid elasticity and pay per-use characteristics makes Cloud Computing an attractive solution to the large amount of data generated by the WSN. Wireless Sensor and Actuator Network (WSAN) communication system is used in these paper which is cloud-based. This solution audits and monitors a group of sensors and actuators, respectively, to access plants water needs. He proposes a cloud-based solution for an intelligent irrigation system organized as a Wireless Sensor and Actuator Network (WSAN). A remote web service is employed to optimize the system with weather knowledge. [15]

4. Pandurang H. Tarange

Proposed WSN which consists of two nodes, coordinator node and Router/End device node. Each node has its own memory, processor and an RF transceiver. The coordinator node is set up on Raspberry Pi i.e. embedded Linux board and End device is set up on Arduino UNO Atmega328 manifesto. The task of the coordinator node in the system is to take up the communication with distributed End device nodes via the ZigBee wireless communication protocol and continuously collects the soil moisture and temperature data is gathered and stored in the database. The database is created on the raspberry Pi board which is a MySQL database. Hence coordinator node allows data gathering over ZigBee, and data monitoring and system control through web browser remotely [16].

5. Automated Irrigation System Using a Wireless Sensor Network and GPRS Module Joaquín Gutiérrez, Juan Francisco Villa-Medina, Alejandra Nieto-Garibay, and Miguel Ángel Porta-Gándara

An automated irrigation system was developed to optimize water use for agricultural crops. The system has a distributed wireless network of soil-moisture and temperature sensors placed in the root zone of the plants. In addition, a gateway unit handles sensor information, triggers actuators, and transmits data to a web application. An algorithm was developed with threshold values of temperature and soil moisture that was programmed into a microcontroller-based gateway to control water quantity. The system was powered by photovoltaic panels and had a duplex communication link based on a cellular-Internet interface that allowed for data inspection and irrigation scheduling to be programmed through a web page. The automated system was tested in a sage crop field for 136 days and water savings of up to 90% compared with traditional irrigation practices of the agricultural zone were achieved. Three replicas of the automated system have been used successfully in other places for 18 months. Because of its energy autonomy and low cost, the system has the potential to be useful in water limited geographically isolated area [17].

III.PROBLEM STATEMENT

- Empowering the farmers to adopt irrigated agricultural practices in place of traditional rain fed agriculture.
- Reduce cost of labours
- To motivate the farmers for adoption of improved agricultural practices for enhancement of crop production and productivity.
- Create specific awareness among the farmers to achieve sustainable agricultural production while maintaining soil health & safeguarding environment.
- To improve agricultural water management towards more resource-efficient and sustainable practices
- Provide security at the location by using sensors and camera for live streaming

These objectives are qualified by concerns at affordability and access to services for the poor. Attention is devoted to the theoretical role of economic instruments - pricing and markets - to encourage productive use and optimal allocation.

At present there is emerging global water crisis where managing scarcity of water has become a tedious job and there are conflicts between users of water. This is an era where human use and pollution of water resource have crossed the levels which lead to limit food production and low down the ecosystem. The major reason for these limitations is the growth of population which is increasing at a faster rate than the production of food and after a few years this population will sum up to 3-4 billion.

The management of these farms which are in greenhouses will require a data acquisition to be located in each greenhouse and the control room where a control unit is located. These are separated from the production area. At present, the data is transferred using wired communication called field bus. This data is transferred between greenhouses and control room.

The objective of this proposed system is to improve products quality, as well as maintain a sustainable agriculture by collecting real-time data from the environment. There is need for water saving irrigation technology for agriculture and security for the crops.

III.I Proposed Work

In the field section, sensors are deployed in the field like soil moisture. The data collected from these sensors are sent to Raspberry pi.

The Raspberry pi processes the data received and compares with the values to be maintained, if there is any fluctuation and need of taking actions, the proposed action to raise an alert or switching on the system is done through the raspberry pi.

The area where crop is grown is under surveillance through motion sensors and there will be an alert raised, when the user can see the live video streaming of the area through the camera set at the location.

IV.METHODOLOGY

The system is developed for smart irrigation is on two ways

A) System Hardware B) System Software

Fig 4.1 below shows the block diagram of smart irrigation system with IoT. Farmers start to utilize various monitoring and controlled system in order to increase the yield with help of automation of agricultural parameters like temperature, humidity, soil moisture, *etc*. are monitored and controlled of systems which can help the farmers to improve the yield.

The system is turned on using the application; this is done using the on\off buttons in the application. Also, this system is turned on automatically when the moisture of the soil is low, the pump is turned on and depending on the moisture content. The application has a future feature of taking the time from the user and irrigates the field when the time comes.

In manual mode, there is a manual switch in the field to make sure that if the system fails, one can turn off the water supply manually. Other parameters like the moisture sensor show the threshold value and the water level in the soil.

A sensor to detect pests/animal intrusion to secure the yield of crop is also used, which sends and alert to user in case any intrusion is detected by this sensor, through which the user can login into application to view the live video stream of the area under surveillance.

IV.I Implementation Strategy

Block Diagram

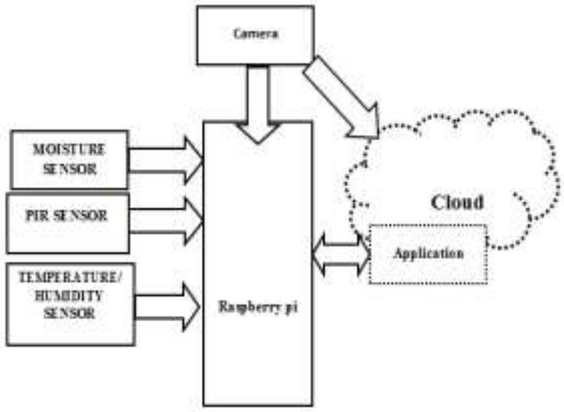


Fig 4.1: Proposed work system design

It consist of different types of sensing units such as Soil moisture sensor to measure water content of soil, temperature sensor to detect the temperature. DC motor based vehicle is designed for Irrigation purpose. Webcam is interfaced to Raspberry Pi using USB port.

If the soil moisture value is less than threshold value and temp is greater, water will be supplied for particular time. If the soil moisture value is less and temp is less than 35, water will be supplied for less time. If the soil moisture value is greater than threshold value, no water supply takes place. The Raspberry Pi will send all the Information to the server using Wi-Fi. We are designing Android App based server. The android app has a GUI which will show all the data to user.

Algorithm

It states the steps that the proposed system undergoes.

Step 1: Start the process.

Step 2: Initialize power is supplied

Step 3: Check the moisture level (less than or more than).

Step 4: If the level will be more than a fixed criteria, no need of irrigation

Step 5: If Moisture level is less than a fixed criteria, start irrigation

Step 6: Initialization of pump

Step 7: Motion Detection using PIR sensor

Step 8: If there is motion, alert user and raise alarm

Step 9: If no motion, then no alert

Step 10: User can view live video through the application

Step 11: Stop the process.

IV.II Data Flow Diagram:

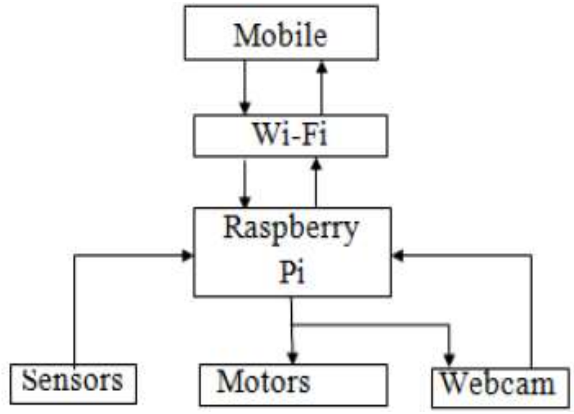


Fig 4.2: Data Flow Diagram

4.3 Tools/Hardware/Software to be used

1. Raspberry Pi

Raspberry Pi 3 Specifications

SoC: Broadcom BCM2837

CPU: 4× ARM Cortex-A53, 1.2GHz

Instruction Set: ARM v8-A

GPU: Broadcom VideoCore IV

RAM: 1GB LPDDR2 (900 MHz)

Networking: 10/100 Ethernet, 2.4GHz 802.11n wireless

Bluetooth: Bluetooth 4.1 Classic, Bluetooth Low Energy

Storage: microSD

GPIO: 40-pin header, populated

Ports: HDMI, 3.5mm analogue audio-video jack, 4× USB 2.0, Ethernet, Camera Serial Interface (CSI), Display Serial Interface (DSI)

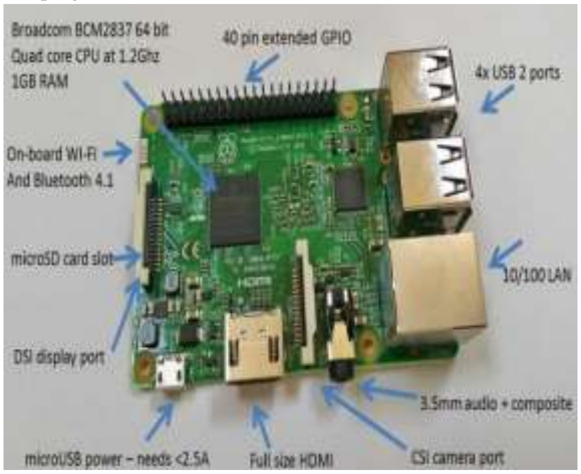


Fig 4.3: Raspberry Pi 3 Model B

The Raspberry Pi 3+ uses a Broadcom BCM2837B0 SoC with a 1.4 GHz 64-bit quad-core ARM Cortex-A53 processor, with 512 KB shared L2 cache.

The Raspberry Pi 3, with a quad-core ARM Cortex-A53 processor, is described as 10 times the performance of a Raspberry Pi 1. This was suggested to be highly dependent upon task threading and instruction set use. Benchmarks showed the Raspberry Pi 3 to be approximately 80% faster than the Raspberry Pi 2 in parallelised tasks.

2. Humidity Sensor

Humidity is defined as the amount of water present in the surrounding air. This water content in the air is a key factor in the wellness of mankind. For example, we will feel comfortable even if the temperature is 00C with less humidity i.e. the air is dry.

But if the temperature is 100C and the humidity is high i.e. the water content of air is high, then we will feel quite uncomfortable. Humidity is also a major factor for operating sensitive equipment like electronics, industrial equipment, electrostatic sensitive devices and high voltage devices etc. Such sensitive equipment must be operated in a humidity environment that is suitable for the device.

The pin configuration of humidity sensor shown in table 5.1.

Table 4.1: Pin configuration of humidity sensor

Pin name	Pin number
Input	To MCP3008 for A/D conversion
Gnd	14^{th} pin of MCP3008 IC
Vdd	16^{th} pin of MCP3008 IC

The output of sensor is connected to MCP3008 for A/D conversion and low pass filter to overcome voltage fluctuation. The image of humidity sensor along with MCP3008 is shown in fig. 5.1.

Figure 4.4: Humidity sensor with MCP3008

V.APPLICATIONS

Agriculture: Irrigation techniques like drip irrigation need accurate moisture content for plants. Also, the moisture in the soil plays an important role in the proper growth of the plant. Other areas where humidity control is required is indoor vegetation.

Electronics and Semiconductor: Almost all electronic devices are rated with a range of humidity values in which they work as expected. Generally, this value will be something like 10% – 50% Humidity. Semiconductor Fabs (Fabrication Plants) should maintain very precise temperature and humidity values as even minute difference can show a huge impact in the production.

Medical: Medical equipment like ventilators, incubators, sterilizers etc. need humidity control. It is also used in pharmaceutical plants and biological processes.

All the above mentioned and many other applications need sensing of Humidity and is done using Humidity Sensors. Before discussing about Humidity Sensors, its types and working principle, we will first see some important terms and definitions related to Humidity.

3. Soil moisture sensor

These sensor determine the volumetric water content in soil. The gravimetric amount of free soil moisture requires removing, airing, and weighting of a sample, it measures the volumetric water composition indirectly by using some additional property of the soil, such as electrical resistance, dielectric constant, or interaction with neutrons, pH as a proxy for the moisture content.

The pin configuration of moisture sensor is shown in table 5.2. The moisture sensor image is shown in the fig.4.2.

Table 4.2: Pin configuration of moisture sensor

Pin name	Pin number
Input	3^{rd} pin of the processor
Gnd	9^{th} pin of the processor
Vdd	4^{th} pin of the processor

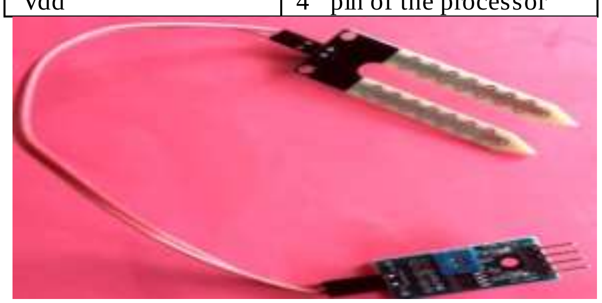


Fig 4.5: Mositure sensor with circuit

4. IR sensor

IR sensor works by detecting light wavelength in the IR spectrum. In our project sensor is inserted at the agriculture field to check any external intruder which will enter into the agriculture field. If sensor identifies any external agent entered the field then as a caution to owner buzzer automatically operates until it stop sensing. The pin configuration of IR sensor is shown in table 2.4.

Table 4.4: Pin configuration of IR sensor

Pin name	Pin number
Output	7^{th} pin of the processor
Gnd	14^{th} pin of the processor
Vdd	2^{nd} pin of processor

Fig 4.5: IR sensor

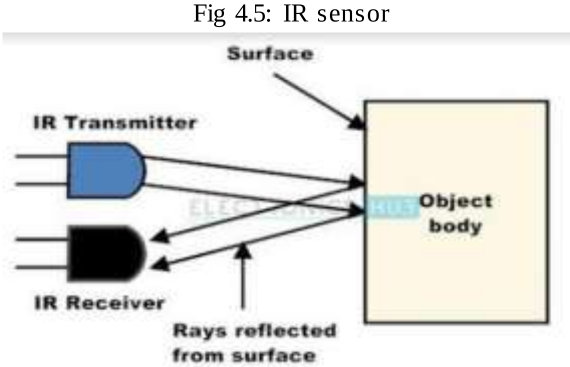


Fig 4.6: IR sensor working

5. Webcam:

A webcam is a video camera that feeds or streams its image in real time to or through a computer to computer network. When "captured" by the computer, the video stream can be viewed live from your web browser in your mobile or laptop. Standard camera with specifications supporting the raspberry pi 3 model has been used.

6. Temperature Sensor

The LM35 sensor is used in our project to measure surrounding temperature in the agriculture field. The LM35 temperature operates at the range of -55^0 to $+150^0$. Like humidity sensor the temperature sensor output is analog valve. The measured analog temperature valve is converted to digital with the help of MCP3008. The pin configuration of temperature sensor is shown in table 4.5. The temperature sensor lm35 is shown in the fig. 4.7.

Table 4.5: Pin configuration of temperature sensor

Pin name	Pin number
Output	To MCP3008 for A/D conversion
Gnd	14^{th} pin of MCP3008
Vdd	16^{th} pin of MCP3008

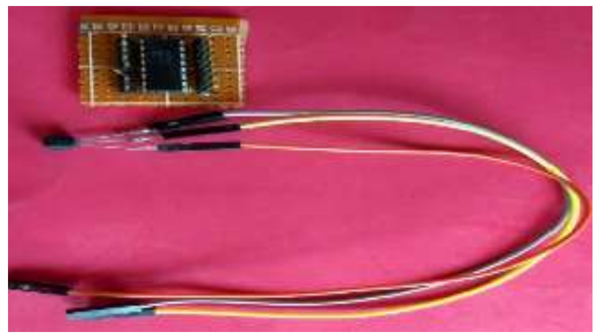


Figure 4.7: Temperature sensor with MCP3008.

4.4 Expected outcomes

- The farmers are empowered to adopt irrigated agricultural practices in place of traditional rain fed agriculture.
- Improved agricultural practices for enhancement of crop production and productivity.
- Specific awareness among the farmers to achieve sustainable agricultural production
- Maintenance of soil health & safeguarding environment.
- Video processing involves monitoring the movement in the area and notifying the user in case of any intrusion. Provide live video streaming anytime.
- Improved agricultural water management towards more resource-efficient and sustainable practices

VI.IMPLEMENTATION

This includes the details about technologies used for the implementation of this project and control flow of all the modules and sub modules.

V.I Software Tools

Software tools helps in building the project as per the aim. Following are the software tools used for the project –

V.I.I RASPBERRY PI PLATFORM & PYTHON PROGRAMMING:

Python, is one of the most popular languages in the world and has been around for more than two decades. It is heavily used in academic environments and is a widely supported platform in modern applications, especially utilities, and desktop and Web applications. Python is highly recommended as a language that is easy for newcomers to program. With its easy-to-read syntax, the introduction is gentle and the overall experience much better for a newbie. The latest version of the Raspbian OS comes bundled with both Python 3.3 and Python 2.x tools. Python 3.x is the latest version of the Python language and is recommended by the Raspberry Pi Foundation too.

VII.EXPERIMENTAL RESULTS AND DISCUSSIONS

Our experimental results show the results on the application developed which is accessible from any platform. Different sensors are connected to Raspberry pi.

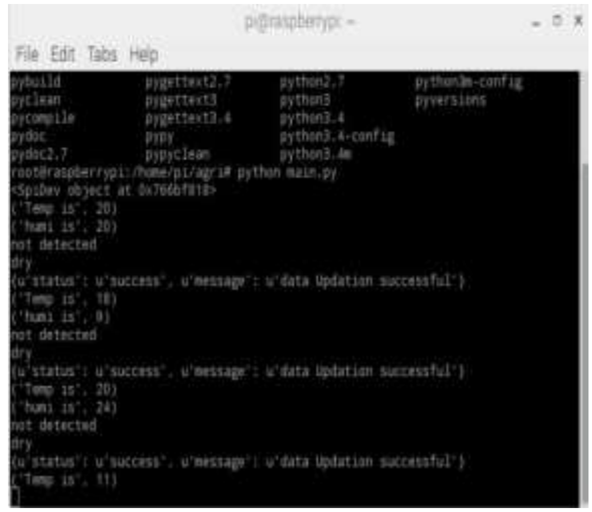
To open terminal icon select in the toolbar or select menu> accessories> terminal is shown in fig. 4.3.

Figure 6.1: Choosing terminal page in the operating system

In the terminal page to become super user type “sudo su”

Cd to agri folder and run the main program by typing >python main.py

The program will start running as shown in figure below.



Make sure that pi is connected to internet. Once connected, you can access the application from any platform and view results as below.

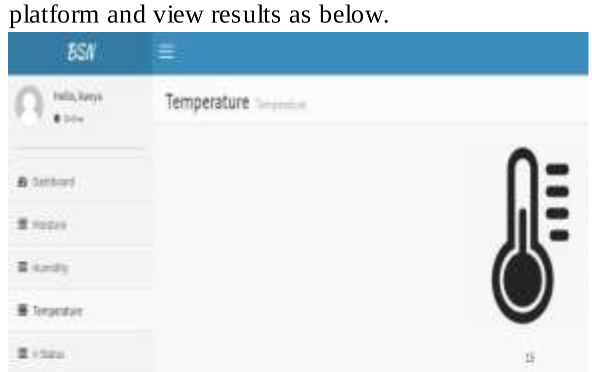


Fig 6.2: Temperature Reading

Fig 6.3: Soil Moisture Reading

Fig 6.4: Motion Detection

Fig 6.5: Humidity Reading

VIII.CONCLUSION & FUTURE SCOPE

The proposed work achieves the goal to overcome the problems stated in the chapter above and increases the fertility of the farm by monitoring various aspects of the agriculture at a low cost for the farmers to increase the yield and help maintain the soil moisture that is required for particular products grown in the area. The proposed work for this project meets all the requirements and has an added advantage of motion sensor to detect human or animal intrusion which raises an alert to the farmer, by which the farmer can take necessary action.

The Future scope that can be done to this is by taking pictures of the product grown and identifying if there is any disease that has happened by image processing techniques.

REFERENCES

[1] K. S. V. Grace, S. Kharim and P. Sivasakthi, "Wireless sensor based control system in agriculture field," 2015 Global Conference on Communication Technologies (GCCT), Thuckalay, 2015, pp. 823-828.doi: 10.1109/GCCT.2015.7342701

[2] P. B. Chikankar, D. Mehetre and S. Das, "An automatic irrigation system using ZigBee in wireless sensor network," 2015 International Conference on Pervasive Computing (ICPC), Pune, 2015, pp. 1-5.doi: 10.1109/PERVASIVE.2015.7086997

[3] Chetan Dwarkani M, Ganesh Ram R, Jagannathan S and R. Priyatharshini, "Smart farming system using sensors for agricultural task automation," 2015 IEEE Technological Innovation in ICT for Agriculture and Rural Development (TIAR), Chennai,2015, pp.49-53. doi:10.1109/TIAR.2015.7358530

[4] N. Agrawal and S. Singhal, "Smart drip irrigation system using raspberry pi and arduino," International Conference on Computing, Communication & Automation, Noida, 2015, pp. 928-932.doi: 10.1109/CCAA.2015.7148526

[5] N. Sales, O. Remédios and A. Arsenio, "Wireless sensor and actuator system for smart irrigation on the cloud," 2015 IEEE 2nd World Forum on Internet of Things (WF-IoT), Milan, 2015, pp. 693-698.doi: 10.1109/WF-IoT.2015.7389138

[6] P. H. Tarange, R. G. Mevekari and P. A. Shinde, "Web based automatic irrigation system using wireless sensor network and embedded Linux board," 2015 International Conference on Circuits, Power and Computing Technologies [ICCPCT-2015], Nagercoil, 2015, pp. 1-5.doi: 10.1109/ICCPCT.2015.7159327

[7] Pandurang H. Tarange," Web based Automatic Irrigation System using wireless sensor,"2015 international conference on circuit, power and computing technologies.

[8] Chandankumar Sahu, Pramitee Behera, "A Low Cost Smart Irrigation Control System", IEEE Sponsored 2nd International Conference on Electronics and Communication System (ICECS 2015)

[9] X. Wang, W. Yang, A. Wheaton, N. Cooley, and B. Moran, "Efficient registration of optical and IR images for automatic plant water stress assessment," Computer Electronics Agriculture, vol. 74, no. 2, pp. 230–237, Nov. 2010.

[10] G. Yuan, Y. Luo, X. Sun, and D. Tang, "Evaluation of a crop water stress index for detecting water stress in winter wheat in the North China Plain," Agriculture. Water Management, vol. 64, no. 1, pp. 29–40, Jan. 2004.

[11] K. S. Nemali and M. W. Van Iersel, "An automated system for controlling drought stress and irrigation in potted plants," Sci. Horticult., vol. 110, no. 3, pp. 292– 297, Nov. 2006

[12] Shivam Agarwal "An algorithm based low cost automated system for irrigation with soil moisture sensor"

[13] JoaqunGutirrez, Juan Francisco Villa-Medina, Alejandra Nieto-Garibay, And Miguel ngelPorta-Gndara, "Automated Irrigation System Using A Wireless Sensor Network And Gprs Module", Ieee Transactions On Instrumentation And Measurement, Vol. 63, No. 1, January 2014.

[14] Vimal.P, Priyanka.V, Rajyasree.M, SanthiyaDevi.P.T, Jagadeeshraja.M, SuthanthiraVanitha.N, "A Novel Approach For Automatic Irrigation And Fertigation Using Embedded System," International Journal Of Vlsi And Embedded Systems-IjvesVol 05, Article 03257; March 2014.

[15] Sathiyabama P, Lakshmi Priya C, Ramesh Sm, Preethi B, Mohanaarasi M, "Embedded System Design For Irrigating Field With Different CropsUsing Soil Moisture Sensor," International Journal Of Innovative Research In Computer And Communication Engineering Vol. 2, Issue 8, August 2014.

[16] LiaiGao, Meng Zhang, GengChen,"An Intelligent Irrigation System Based On Wireless Sensor Network And Fuzzy Control,"Journal Of Networks, Vol. 8, No. 5, May 2013.

[17] K.Prathyusha, M. ChaitanyaSuman,"Design Of Embedded Systems for the Automation Of Drip Irrigation," International Journal Of Application Or Innovation In Engineering Management(Ijaiem) Volume 1, Issue 2, October 2012.

[18] Orazio Mirabella, Senior Member, Ieee, And Michele Brischetto,"A Hybrid Wired/Wireless Networking Infrastructure For Greenhouse Management," Ieee Transactions On Instrumentation And Measurement, Vol. 60, No. 2, February 2011.

[19] B.Sivakumar, P.Gunasekaran, T.Selvaprabhu, P.Kumaran, D.Anandan, "The Application of Wireless Sensor Network in the Irrigation Area Automatic System", IjctaJan-Feb 2012.

[20] S.MuhammadUmair, R. Usman,"Automation Of Irrigation System Using Ann Based Controller," International Journal Of Electrical Computer Sciences Ijecs-Ijens Vol:10 No:02.May2010.