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SMART AGRICULTURE MONITORING SYSTEM BASED ON IoT

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Abstract* — *Agriculture plays dynamic part in the development of agricultural country. In India about 75 present of people depends upon agricultural and one third of the nation's money comes from agriculture. Now a day there is huge improvement in technologies, different tools and techniques are available in agriculture sector. Issues regarding agriculture have been always delaying the growth of the country. The only solution to this problem is smart agriculture by improving the current traditional methods of agriculture. The object of the paper aims to make agriculture smart using robotics and IoT technologies. There are three main features included in this paper 1. Smart Global Positioning System based remote controlled robot to do tasks like spraying, humidity sensing, birds and animals alarming, keeping awareness, etc. 2. Smart irrigation with smart decision making based on accurate real time ground data. 3. Smart warehouse management which comprises temperature, humidity maintenance and theft detection in the depository. Monitoring and managing all these processes will be through any remote smart device or computer linked to world wide web and the processes will be accomplished by interfacing sensors, Wi-Fi or ZigBee components, camera and actuators with micro-controller and raspberry pi.

Keywords* — *IoT, Automation, Wi-Fi, ZigBee , Smart Farming, Efficiency

I. INTRODUCTION

The Internet of things (IoT) is the greatest efficient and important techniques for development of answer the question. IoT evolve from different components which includes lots of sensors, software's, network components and other electronic devices. Also it makes data more effective. IoT allows exchanging the data over the network without human involvement. In IoT, we can represent things with natural way just like ordinary human being, like sensor, like car driver etc. This thing is assigned an ip address so that it can transfer data over a network [1][2]. As per the report generated by Garner, at the end of 2017 there will be 25% rise in count of connected devices as compared to 2016. He further says that, this count will increase to 26 billion by 2020.

The IoT technology is more efficient due to following reasons:

- Global Connectivity through any devices.
- Minimum human efforts
- Faster Access
- Time Efficiency
- Efficient Communication

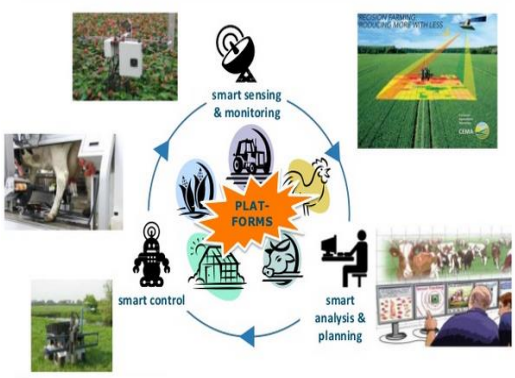

Fig 1: Smart Agriculture Architecture

As the world is moving into new machineries and operation is an essential goal to development in agriculture also. Many researches are done in the field of agriculture. Most projects signify the use of wireless sensor network collect data from different sensors deployed at various nodes and send it through the wireless protocol [3][4]. The collected data provide the information about the various environmental factors. Monitoring the environmental factors is not the complete solution to increase the yield of crops. There are number of other factors that decrease the productivity to a greater extent. Hence automation must be implemented in agriculture to overcome these problems. So, in order to provide solution to all such problems, it is necessary to develop an integrated system which will take care of all factors affecting the productivity in every stage. But whole computerization in agriculture is not achieved due to various

problems. Though it is implemented in the research level it is not given to the farmers as a product to get benefitted from the resources. In this paper discuss about developing smart agriculture using IoT and given to the farmers.

II. LITERATURE REVIEW

[5].In Design and Development of Precision Agriculture System Using Wireless Sensor Network paper discussed about Wireless Sensor and the environmental problem decreasing ground water level and less rain fall because of drying up of rivers and tanks, unpredictable nature present an urgent need of suitable utilization of water. To manage this use of temperature and moisture sensor at appropriate locations for monitoring of crops is implemented in.

[6].Automated Irrigation System Using a Wireless Sensor Network and GPRS Module deals an procedure industrialized with threshold values of temperature and soil moisture can be automatic into a microcontroller-based entry to manage and control water measure. The system can be motorized by photovoltaic boards and can have a two way message link based on a cellular Internet boundary that allows data inspection and irrigation scheduling to be involuntary through a web page. The technical development in Wireless Sensor Networks made it thinkable to use in monitoring and controlling of greenhouse strictures in correctness agriculture.

[7] In Real- Time Automation and Monitoring System for Modernized Agriculture paper discussed about the research in the agricultural field, researchers found that the yield of agriculture is decreasing day by day. The use of new technology in the area of agriculture plays important role in increasing the manufacture as well as in reducing the extra human power efforts. Some of the research attempts are done for betterment of farmers which provides the systems that use technologies helpful for increasing the agricultural yield.

[8]. Remote Sensing and Control of an Irrigation System Using a Distributed Wireless Sensor Network paper aiming for variable rate irrigation, real time in field sensing, controlling of a site specific precision linear move irrigation system to improve the efficiency with minimal use of water was developed by Y. Kim. The paper offers deep details about the design and equipment of variable rate irrigation, wireless sensor network and real time in area of sensing and control by using suitable software. The whole system was developed using five in field sensor stations which collects the data and send it to the base station using Global Positioning System (GPS) where necessary action was taken for controlling irrigation according to the database available with the system. Advantage of this system is low cost wireless solution as well as remote controlling for precision irrigation [9].

[10]. A Novel Soil Measuring Wireless Sensor Network paper provides idea to researchers measured soil related parameters such as temperature and humidity. This paper explains sensors and how placed below the soil which communicates with relay nodes by the use of effective message protocol gives less duty cycle and hence increasing the life time of soil monitoring system. The system was established using microcontroller, universal asynchronous receiver transmitter (UART) interface and sensors while the transmission was done by hourly sampling and buffering the data, transmit it and then checking the status messages. The drawbacks of the system were its cost and deployment of sensor under the soil which causes attenuation of radio frequency (RF) signals.

III. SYSTEM OVERVIEW

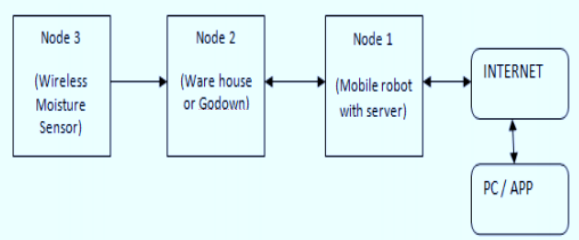

Fig 2: System overview

The paper consist of four sections; node1, node2, node3 and PC or mobile app to control system. In the present system, every node is integration with different sensors and devices and they are interconnected [11] to one central server via wireless communication modules. The server sends and receives information from user end using internet connectivity. There are two modes of operation of the system; auto mode and manual mode. In auto mode system takes its own decisions and controls the installed devices whereas in manual mode user can control the operations of system using android app or PC commands [12].

IV. ARCHITECTURE OF THE SYSTEM

Node 1: Node1 is GPS based mobile robot which can be controlled remotely using computer as well as it can be programmed so as to navigate autonomously within the boundary of field using the co-ordinates given by GPS module [13].

The Remote controlled robot have various sensors and devices like camera, obstacle sensor, siren, cutter, sprayer and using them it will perform tasks like; Keeping vigilance, Bird and animal scaring, Weeding, and Spraying Node 2: Node2 will be the warehouse.

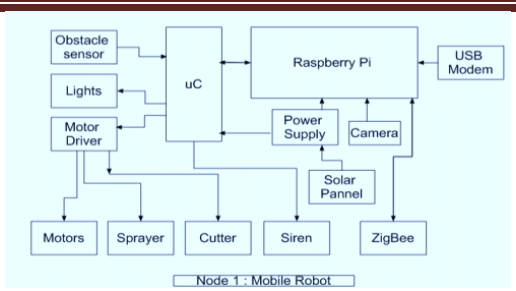

Fig 3 : Node 1

It consists of motion detector, light sensor, humidity sensor, temperature sensor, room heater, cooling fan altogether interfaced [14][15] with AVR microcontroller. Motion detector will detect the motion in the room when security mode will be ON and on detection of motion, it will send the alert signal to user via Raspberry pi and thus providing theft detection.

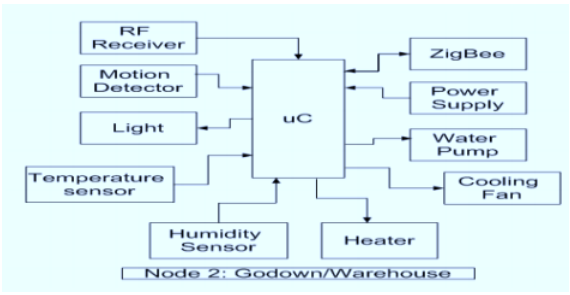

Fig 4: Node 2

Temperature sensor and Humidity sensor senses the temperature and humidity respectively and if the value crosses the threshold then room heater or cooling fan will be switched ON/OFF automatically providing temperature and humidity maintenance.Node2 will also controls water pump depending upon the soil moisture data sent by node3. Node 3: Node3 is a smart irrigation node with features like ; Smart control of water pump based on real time field data i.e. automatically turning on/off the pump after attaining the required soil moisture level in auto mode, Switching water pump on/off remotely via mobile or computer in manual mode, and continuous monitoring of soil moisture.

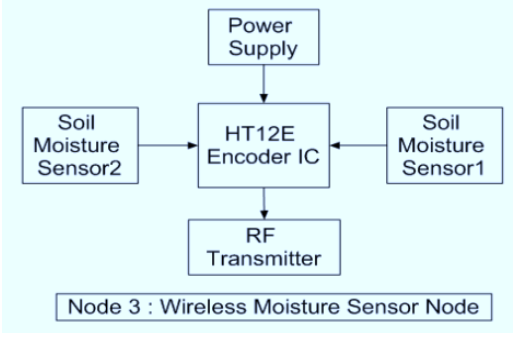

Fig 5: Node 3

In node3, moisture sensor transmits the data using HT12E Encoder IC and a RF transmitter. The transmitted data is received by node2 and there it is processed by microcontroller in order to control the operation of water pump [16][17][18].

Hardware used:

a) AVR Microcontroller Atmega 16/32: The microcontroller used is, Low-power AVR® 8-bit Microcontroller, having 8K Bytes of In-System Selfprogrammable Flash program memory, Programmable Serial USART, 8-channel, 10-bit ADC, 23 Programmable I/O Lines.

b) ZigBee Module: ZigBee is used for achieving wireless communication between Node1 and Node2. The range for Zigbee is roughly 50 meters and it can be increased using high power modules or by using network of modules. It operates on 2.4 GHz frequency. Its power consumption is very low and it is less expensive as compared to other wireless modules like Wi-Fi or Bluetooth. It is usually used to establish wireless local area networks.

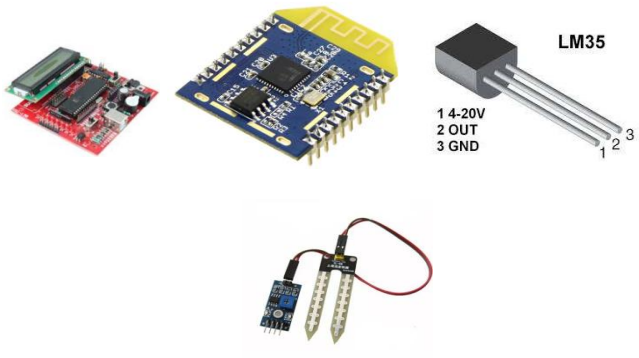

Fig 6 : Hardware

c) Temperature Sensor LM35: The LM35 is precision IC temperature sensor. Output voltage of LM35 is directly proportional to the Centigrade/Celsius of temperature. The LM35 does not need external calibration or trimming to provide accurate temperature range. It is very low cost sensor. It has low output impedance and linear output. The operating temperature range for LM35 is −55˚ to +150˚C. With rise in temperature, the output voltage of the sensor increases linearly and the value of voltage is given to the microcontroller which is multiplied by the conversion factor in order to give the value of actual temperature.

d) Moisture sensor: Soil moisture sensor measures the water content in soil. It uses the property of the electrical resistance of the soil. The relationship among the measured property and soil moisture is calibrated and it may vary depending on environmental factors such as temperature, soil type, or electric conductivity. Here, It is used to sense the moisture in field and transfer it to microcontroller in order to take

controlling action of switching water pump ON/OFF. Humidity sensor: The DHT11 is a basic, low-cost digital temperature and humidity sensor. It gives out digital value and hence there is no need to use conversion algorithm at ADC of the microcontroller and hence we can give its output directly to data pin instead of ADC. It has a capacitive sensor for measuring humidity. The only real shortcoming of this sensor is that one can only get new data from it only after every 2 seconds.

e) Obstacle sensor (Ultra-Sonic): The ultra-sonic sensor operates on the principle of sound waves and their reflection property. It has two parts; ultrasonic transmitter and ultra-sonic receiver. Transmitter transmits the 40 KHz sound wave and receiver receives the reflected 40 KHz wave and on its reception, it sends the electrical signal to the microcontroller. The speed of sound in air is already known. Hence from time required to receive back the transmitted sound wave, the distance of obstacle is calculated. Here, it is used for obstacle detection in case of mobile robot and as a motion detector in ware house for preventing thefts. The ultra-sonic sensor enables the robot to detect and avoid obstacles and also to measure the distance from the obstacle. The range of operation of ultra-sonic sensor is 10 cm to 30 cm.

f) Raspberry Pi : The Raspberry Pi is small pocket size computer used to do small computing and networking operations. It is the main element in the field of internet of things. It provides access to the internet and hence the connection of automation system with remote location controlling device becomes possible. Raspberry Pi is available in various versions. Here, model Pi 2 model B is used and it has quad-core ARM Cortex-A53 CPU of 900 MHz, and RAM of 1GB. it also has: 40 GPIO pins, Full HDMI port, 4 USB ports, Ethernet port, 3.5mm audio jack, video Camera interface (CSI), the Display interface (DSI), and Micro SD card slot.

Softwares used:

a) AVR Studio Version 4: It is used to write, build, compile and debug the embedded c program codes which are needed to be burned in the microcontroller in order to perform desired operations. This software directly provides .hex file which can be easily burned into the microcontroller.

b) Proteus 8 Simulator: Proteus 8 is one of the best simulation software for various circuit designs of microcontroller. It has almost all microcontrollers and electronic components readily available in it and hence it is widely used simulator. It can be used to test programs and embedded designs for electronics before actual hardware testing. The simulation of programming of microcontroller can also be done in Proteus. Simulation avoids the risk of damaging hardware due to wrong design.

c) Dip Trace: Dip race is EDA/CAD software for creating schematic diagrams and printed circuit boards. The developers provide multi-lingual interface and tutorials (currently available in English and 21 other languages). DipTrace has 4 modules: Schematic Capture Editor, PCB Layout Editor with built-in shape-based auto router and 3D Preview & Export, Component Editor, and Pattern Editor.

d) SinaProg: SinaProg is a Hex downloader application with AVR Dude and Fuse Bit Calculator. This is used to download code/program and to set fuse bits of all AVR based microcontrollers.

e) Raspbian Operating System: Raspbian operating system is the free and open source operating system which Debian based and optimized for Raspberry Pi. It provides the basic set of programs and utilities for operating Raspberry Pi. It comes with around 35,000 packages which are pre-compiled softwares that are bundled in a nice format for hustle free installation on Raspberry Pi.It has good community of developers which runs the discussion forms and provides solutions to many relevant problems. However, Raspbian OS is still under consistent development with an main focus on improving the performance and the stability of as many Debian packages as possible.

V.EXPERIMENTATION & RESULTS

The hardware is interfaced with all the sensors in the board. The hardware components include the microcontroller, buzzer, relay, ADC converter, GSM module and all the sensors interfaced. The board is inserted with a SIM card which is used to communicate with the owner and the recorded values. The output shown below denotes the temperature, soil moisture condition and the intruder detection. The second result is the output from the Android Application that is developed in the mobile phone. It determines the temperature, humidity, moisture and the intruder detection

Fig 7 : Android application monitoring

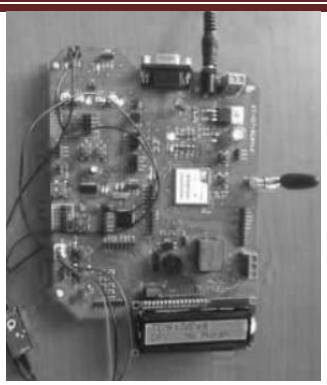

Fig 8 : Output of Temperature, Moisture, PIR detection

VI. CONCLUSION

The sensors and microcontrollers of all three Nodes are successfully interfaced with raspberry pi and wireless communication is achieved between various Nodes. All observations and experimental tests proves that project is a complete solution to field acti
vities, irrigation problems, and storage problems using remote controlled robot, smart irrigation system and a smart warehouse management system respectively. Implementation of such a system in the field can definitely help to improve the yield of the crops and overall production.

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