Implementation of Wireless Sensor Network for Real Time Monitoring of Agriculture

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Abstract- ***In a past few decades, there is rapid growth in technology of monitoring agricultural parameters in order to improve the farm field. Various agricultural parameters like light, soil moisture, temperature, and humidity etc. are monitored and controlled by monitoring and controlling units. This project report reviews some of this monitoring system and proposes to add more parameters like wind speed, wind direction for monitoring as well as the automated control system for light, soil moisture, humidity, soil temperature. We can get good error recovery, higher error rate handling, speed, simplicity using TCP/IP and microcontroller, which may help the farmer to know about relevant agricultural parameters with more ease in order to improve the farm field. To make the greenhouse automation system work satisfactorily, several measurement points are needed to trace down the local climate parameters in various parts of the large greenhouse. In modern greenhouses, the cabled measurement point is also difficult to relocate once they are installed as well as it also makes the measurement system expensive and vulnerable. Thus, a Wireless Sensor Network consisting of small-size wireless sensor nodes equipped with one or several sensors, is an attractive as well as cost efficient option to build the required measurement system.***

Index Terms-Wireless sensor network, Embedded operating system, Base station, GPRS/GSM Modem, TCP/IP protocol.

I. INTRODUCTION

In the field of real time monitoring the temperature and humidity of soil and other factor such as monitoring of conditions like weather, wind direction, wind speed, water level, flood. monitoring, automated irrigation facility and providing alarming system that is warning alarm to farmer's phone when certain condition occurs based on Wireless Farming System can correctly guide agricultural production and improve crop yield.

Conventional wired communication has various application possibilities in real time monitoring sector but it exists with lots of problems. Wireless sensor network is becoming one of the essential component of networking these days. The technology of wireless sensor network aids in satisfying the technical needs with the use of Transmission control protocol/internet protocol (TCP/IP), Web Services and GPRS technology. It has an advantage of low cost, low power.

The system consists of wireless sensor network nodes and network management platform. The automatic networking is achieved by the use of many jump routing processes, flexible automatic networking monitoring system for temperature, humidity of soil. Users don't have to go into the field, from any corner of the world, can bring to notice the changing conditions of soil like temperature, humidity and other factors.

II. REVIEW OF LITERATURE

It has been assumed that yield rate in an agricultural is not improving. Therefore, many researchers have developed various features and came up with related monitoring system. Some of this are summarized follows.

In this paper, the advanced development in wireless sensor networks was used in monitoring various parameters in agriculture. In this context, due to the advancements in small scale sensor devices with wireless technologies, one is able to remotely monitor humidity, temperature and moisture. In this paper it was proposed to implement a wireless sensor network connected with centralized basic node using ZigBee, which was connected to a Central Monitoring Station (CMS) through Global System for Mobile (GSM) technologies or General Packet Radio Service (GPRS). The system acquires Global Positioning System (GPS) parameters related to the field then transfers them to a central monitoring station. This system was presumed to evaluate soil conditions and act accordingly in order to help farmers [7].

To monitor high tech poly house wireless sensor developed with AVR ATmega8L microcontroller and RF ZigBee module for secure data transmission. Accuracy and reliability can be enhanced by the use of smart sensors. Humidity is continuously monitored on base station [4]. This system implies monitoring various factors such as humidity, soil moisture and provide remote monitoring using ZigBee which sends data wirelessly to a central server which collects data store it and allow it to be displayed as needed and also be sent to the client mobile [16].

This paper presents the automatic irrigation remotely which is based on embedded system to boost up not only farmer's energy but time and money also. When there is

need of water in this approach, the chemical constituents, water content, salinity and fertilizer requirement are tested by taking soil test. Data collected by wireless sensors is processed for better drip irrigation plan. This was the review of different automatic monitoring system models which uses Wireless Sensor Network (WSN) which makes easier for the farmers in order to improve the yield [2].

The Greenhouse monitoring and controlling system developed by AjiHanggoro and Rizki Reynaldo is based on the use of Android mobile application, which was designed to monitor and control the humidity inside a green house. Here software uses an android mobile phone and using Wi-Fi, which connects via serial communication to a microcontroller and humidity sensor [1].

Smart sensor based monitoring system remotely monitors various agricultural parameters. Here the proposed inductor model for monitoring with wireless protocol is implemented using field programmable gate array (FPGA), a display element which is used for the analysis and monitoring of data and a relay as a control unit [18].

This review aims to provide monitoring of marine environment and provide advantage of easy deployment, in real time monitoring. System provide architecture of oceanographic monitoring systems based on WSN with a general architecture of an oceanographic sensor node, sensors and sensing parameters, deployment of wireless sensor networks for marine environment monitoring [6].
Multi parameter monitoring system is designed by using wireless sensor network and low-power ZigBee technology which is wireless communication technology for system automation and monitoring. Wireless sensor nodes collect Real time data and transmit it to base station with the help of ZigBee. Data is received, saved and displayed at base station to achieve monitoring of soil temperature, soil moisture and humidity. The data is continuously monitored at base station and if it raises beyond the desired limit, a message is sent to farmer on mobile through GSM network for controlling actions. Benefits of flexible networking for monitoring as well as removing of equipment is low cost, reliable nodes, high capacity and convenient installation [3].

Monitoring greenhouse environment parameter and controlling takes place efficiently by both automatic and manual manner. The control room from which we can control the activities receives status of agricultural environment parameter from ZigBee which is manually controlled network and send to the controller back. To monitor values of parameter which are continuously modified and controlled to optimize them in order to achieve maximum plant growth and yield, we use these microcontrollers based circuits. Communication of controller with the variety of sensor modules results in Controlling the light, aeration and drainage process efficiently inside a greenhouse by actuating a cooler, fogger, dripper and lights correspondingly according to the required condition of the crops [17]. Various parameter inside and outside greenhouse are controlled and monitored using microcontroller by an automated multi sensor greenhouse monitoring system [15].

This paper based on modernizing the irrigation technology in agriculture and also to provide adequate irrigation by using ARM7TDM1 core and GSM. Which serves as an important part and responsible for controlling the irrigation on field and send to receiver through receiver signals. This project used to detect the exact field condition as well as weather condition in real time. The information is given on user request in the form of SMS. The standard set of AT (Attention) commands helps in controlling the GSM modem. To control majority of the functions of GSM modem, these commands are used [12].

For raising the yield of the farms, optimum water usage is necessary. Irrigation system can be used to improve water management. Wireless sensor network stores and utilizes rain water to increase their crop productivity by the controlling the parameters of irrigation system used in farm, which can decrease the cost for cultivation moreover it makes use of real time values [11].

With the help of wireless sensor network agricultural parameter guarantees increase in production and lower input costs in precision farming by real time monitoring of location based specific environmental and soil conditions. It also not only improves crop management but reduces waste and labor costs also. The test bed implementation of a wireless sensor network has been presented in this paper for automatic and real-time monitoring of soil and environmental parameters which influences crop production. The paper demonstrates technical challenges including energy management scheme, placement of sensors in outdoor environment, the integration of sensors, actual power consumption rates and remaining practical issues [19].

By using low power ZigBee wireless communication technology, this system monitors multi parameter of agricultural for system automation. A wireless sensor node collects real time data and transmits to base station using ZigBee. In order to achieve soil temperature, soil moisture and humidity monitoring, data is received, saved and displayed at base station. At base station, the monitoring of data is continuously done. If it exceeds beyond the desired limit, a message is sent to farmer on mobile for controlling actions through GSM network [5].

This paper reviews monitoring and control of various agricultural parameters by using peripheral devices like valve, watering pump using microcontroller to improve the farmer yield [14].

Based on a wireless sensor network, this paper presents a Monitoring System for Vegetable Greenhouses. It's designing is done to monitor the life conditions of vegetables in greenhouse. The whole system architecture consists of a base station, an internet data center and a set of sensor nodes. The JN5139 micro-processor was adopted as the core component for the design of wireless sensor node. For wireless communication between nodes, the ZigBee protocol has been used. A proprietary gateway node was developed by using an ARM7 microprocessor and embedded ZKOS operating system in ordered achieve screen display, system configuration and GPRS based remote data forwarding. The management software for remote data center achieves time-series analysis and real-time data distribution through a Client/Server mode. In order to send real-time environmental measurements, a GSM-short-message-based interface is developed and for alarming, a measurement is over some pre-defined

threshold. After testing the whole system for over one year and satisfactory results are found. This result indicates that this system was very useful for monitoring of greenhouse environment [21].

In paper proposed by LIU Yumei, ZangChangli developed system for monitoring of soil using a wireless sensor network as processing platform and information acquisition. The coverage was big, effectively resolves the disadvantages of wired communications. It has adopted the technology based on ZigBee, GPRS and Web Services. It's designing has an advantage of low cost and low power consumption [10].

An algorithm is used for designing an automated irrigation system where the threshold values of soil moisture and temperature are required for the it. Specially to control water quantity, it was programmed into a microcontroller based gateway. This system is used for optimizing water resources for agriculture production, the places with water scarcity. The root zone of the plants subsists with the distributed wireless network of soil-moisture and temperature sensors. Sensor information is handled by gateway unit which can trigger actuators, and transmit data to a web application also. By photovoltaic panels, the system was powered. It had a duplex communication link which is based on a Cellular-Internet interface. In a sage crop field for 136 days, the automated system was tested. The water savings of around 90% has been observed. Three replicas of the automated system have been used successfully for 18 months in other places. The system has the potential to be useful in water limited geographically isolated areas because of its energy autonomy and low cost [9].

To measure four climate variables, system uses three commercial sensors are capable. For detecting the microclimate layers, collected data is used to evaluate the network reliability and its ability, which typically exist between lower and upper flora in the greenhouse. The local differences such as direct sunshine near the greenhouse walls in the greenhouse climate can get detected by the network. It is all about the developed sensor network reliability and feasibility [20].

An effective method for crop monitoring is presented in this system. It has been attached with several external sensors namely soil moisture, soil pH, leaf wetness, atmospheric pressure sensors. The water sprinkler is switched off just after the field is sprinkled with adequate water. This results into conservation of water. The base station receives the value of soil pH sensor and messages to the farmer about it through GSM modem. It helps farmer to select the crop and necessary fertilizer for his next season by observing the soil pH value. Thus it can result into reducing the amount of fertilizer. This project results in automated control of water sprinkling and ultimate supply of information to farmers with the help of wireless sensor network [13]. In order to not only overcome the lack of information and technical support but to increase the rice production, this development of rice cropping monitoring using WSN is designed. It also contributes in providing a helping hand to farmers achieving precision agriculture as well as for real-time monitoring.

Intelligent humidity sensor and low power SWT is used by the proposed irrigation management system for facilitating irrigation management. The laptop/computer or PDA is used as a monitoring device in this paper. Open loop automatic irrigation controller is used in this proposed system is adaptive. The determination of necessity of water to crop and the soil moisture is made for supplying just the right quantity of water just for moisture level maintenance. Along with the relay switch and pump, for controlling the operations, a microcontroller is also used. The sensor node that include JN5121 module, an IEEE 802.15.4/ZigBee wireless microcontroller is used in it. The sink node based on ARM9 was used for data aggregating. For long distance data transmission GPRS gateway had been used. As the monitoring device, a mobile unit was used. A study of wireless sensor network based on ZigBee in agriculture was carried out for this proposed system. The factors like node spacing, crop canopy, antenna height and density of leaves affects the signal strength. Therefore, these few issues regarding ZigBee in agriculture are reviewed in this paper. The energy efficient WSN for agriculture proposed in Texas. It uses the 8051 MCU sensor node and equipment with CC1110 system on chip. For getting LCD and LED buttons readily available for control and monitoring, a CC 1110 evaluation module is plugged into smart RF04 evaluation board. The hardware allow user to change sensitivity of a receiver and radio transmission in multiple power levels also. The behavior of two nodes, a receiver and a sender was simulated using TOSSIM to compare the performance of PDMAC with SMAC.

The CC2420 ZigBee/RF module and MSP430 are used in proposed system of node design as RF Tran's receiver core unit of wireless communication system and as microcontroller unit respectively. The RF module is linked through MCU to SPI. The communication web server, expert system of agriculture and the Centre of monitor based on web are also included in this system. The information is uploaded to the real time data base on the internet by GPRS only after the real time data is transferred to the sink node through the sensor node.

The camera nodes and cattle sensor network along with the soil moisture sensor are also included in it. For attaching the sensor nodes to cattle, custom collars are used. The paper has proposed and analyses the use of programmable system on chip technology as a part of WSN to monitor and control various parameters of green house. In this we have used CC3271 PSOC as it is the first touch starter kit with low cost USB thumb drive with low power RF. It also consists of related IDE software for sense and control of the data collection. It includes multifunction board with power amplifier, PC dongle with RF, two battery boards and it was used for light sensing, touch sensing, temperature sensing and proximity sensing according to the requirement of green house. The instrument is created to monitor humidity of agriculture environment and the soil temperature.

In order to verify the reliability and accuracy of the temperature as well as humidity monitoring system, two different sets of test (i.e. in close room and open room environment) were conducted.

In DongbuHandong Seed Research Centre and a management sub-system provides various and convenient services to consumers with hand-held devices such as a PDA. To monitor the growing process of them and also to control the environment of the green houses, A2S was used.

The proposed system can monitor the greenhouse environments, control greenhouse [3]. To realize modern precision agriculture, the real deployment of WSN based greenhouse management is designed and implemented.

Cluster based routing algorithm reduces energy consumption of node transmitting data. Based on the acoustic emission principle for crop water stress, the application of wireless sensor networks (WSN) to precision irrigation system is explored. The new type of routing protocol for WSN called PECRP (Power efficient Clustering Routing Protocol) is proposed in this paper. It is suitable to long-distance and complex data transmission (e.g. patient-surveillance or chemical detection in agriculture). PECRP is the combination of benefits as same as those of some excellent cluster-based routing protocols together, such as PEGASIS (Power-Efficient Gathering in Sensor Information Systems) and HEED (Hybrid Energy Efficient Distributed Clustering Approach) etc. Since establishing an application development environment for WSN is essential, this paper focuses its research on the integration of existing computer tool by uniting the robustness of programming languages with the usability of a friendly interface. It presents two applications of WSN in which the first is about monitoring of a mushroom crop and the second is e-health. Both applications are monitoring oriented and supported by the IEEE 802.15.4 protocol. Their result shows the usefulness of WSN for supporting requirements of applications. The researchers built and deployed a WSN in a sugar farm in order to study how current irrigation practices affect the environment. The system transmits the data through microwave link to back-end server only after acquiring that data from the sensor network.

In this paper, a self-organizing ad-hoc sensor network is deployed in vineyard. It collects the temperature data throughout the vineyard. The back-end application calculates and shows a map of powdery mildew risk which is based on the temperature data [8]. This helps in vineyard management.

III. PROPOSED WORK

Farming depends on various agricultural parameter like temperature, moisture, humidity, wind speed, wind direction etc. These parameters get affected due to the condition of weather and eventually causes problem in growth of plants which results in lesser yield. Hence, the real time monitoring is the fundamental step. But there are some drawbacks in these monitoring techniques.

To overcome the drawbacks of previous techniques following method will be proposed like

i. Sensors notes various parameter's readings. The microcontroller which has in built 10 bits A/ D convertor receives these readings. Proposed system is expressed with the help of fig.1 which consists of different types of sensing unit.

ii. This convertor converts all analog data to equivalent digital form, and then sends to GSM mobile.

iii. At GSM, the user mobiles receive various AT commands SMS. One is able to visualize the data on TCP/IP protocol suit at the same time.

At the moment, the very lowest price microcontroller available from any manufacturer is the Atmel AVR.

Their advantages are high performance at low power. It has high endurance non-volatile memory segments and advanced RISC architecture.

Different agricultural parameters are measured using advance sensors which holds the great part in real time monitoring. For ex. wind speed is measured using air velocity sensors.

GSM (Global System for Mobile) is a cellular network, which means that cell phones connect to it by searching for cells in the immediate vicinity.

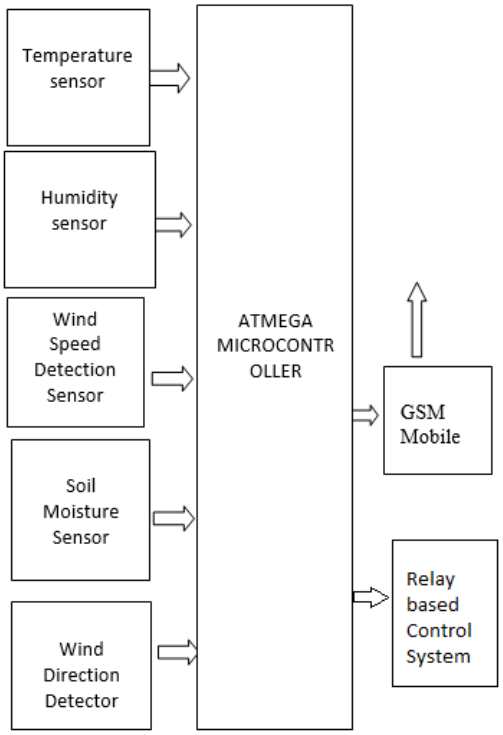

Fig.1 Basic block diagram of proposed system.

IV. SYSTEM IMPLEMENTATION

Sensors note various parameters. The readings are then provided to the microcontroller which has in built 10 bits A/ D convertor. This convertor converts all analog data to equivalent digital form, and then sends to GSM mobile. At GSM, by using mobile, SMS can be sent to the user mobiles. At the same time, we can visualize the data on LCD screen as well as on computer system or any smart phone using the specified URL. Moreover, after it, the automated control system is also works for the parameters such as temperature, light, humidity, moisture. The procedure is as follows.

i. Start
ii. Initializes all the ports
iii. Initializes LCD (Liquid Crystal Display)
iv. Initializes UART (universal asynchronous receiver / transmitter) at baud rate of 9600 bits per second.

v. Initialize SIM900A GSM (Global Systems for Mobile Communications) module to start GPRS (General Packet Radio Service) service.
vi. Read ADC0 to ADC5
vii. Sending the data sensed by all the sensors through TCP/IP (Transmission Control Protocol / Internet Protocol) to specified URL.
viii. If temperature exceeds the specified limit, then first turn on the relay for temperature control system then proceed the next. Else go directly to check humidity.
ix. If humidity exceeds the specified limit, then first turn on the relay for humidity control system then proceed the next. Else go directly to check light.
x. If light declines the specified limit, then first turn on the relay for assumed light control system then proceed the next. Else go directly to check humidity.
xi. If moisture declines the specified limit, then first turn on the relay for assumed moisture control system then proceed the next. Else go directly to exit.

This procedure is graphically shown in fig.2.

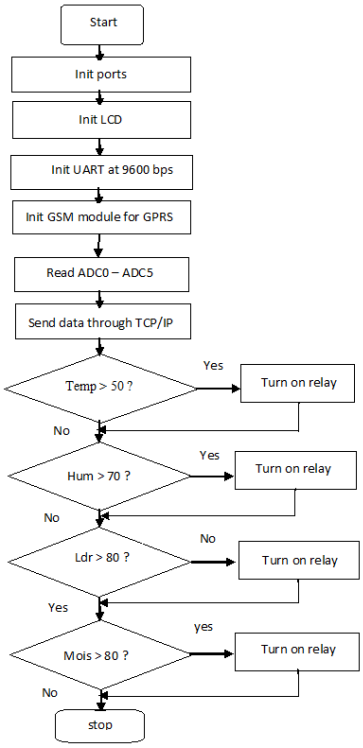

Fig.2 procedural flowchart of proposed system.

V. EXPERIMENTAL SETUP

We have used LM35 temperature sensor, atmega32a microcontroller, LDR (light dependent resistor) sensor, SY-HS-230 humidity sensor, a wind direction detection sensor made of magnetic glass REED switch, a wind speed sensor made using DC motor, 16x2 LCD display, relays and sim900A GSM module.

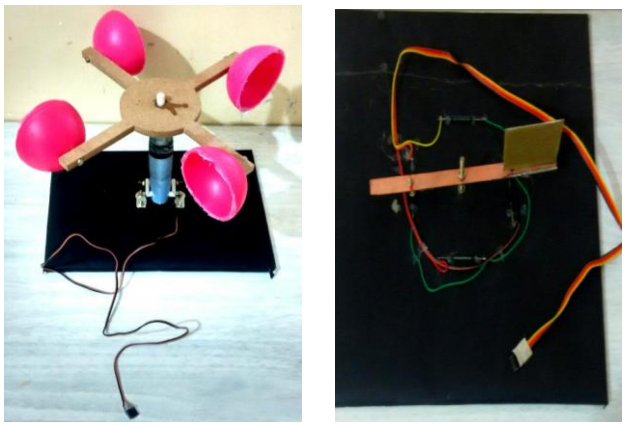

Fig.3 wind speed sensor and wind direction sensor.

Fig.4 project execution.

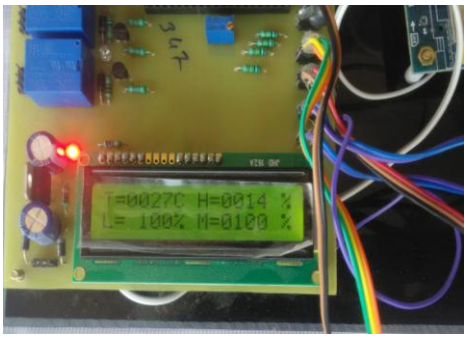

Fig.5 sensed data is displayed on LCD

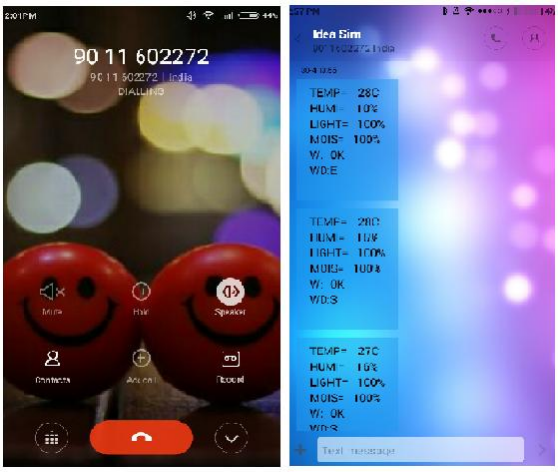

Fig.6 sensed data is sent in message as a response to the call.

In this project, one is able to see the result of deployed WSN on smart phone with and without internet also. Anyone is able to call on sim mounted on GSM module, but the response will get to authorized contact number only after every calling from any number through messaging service. Second way is by using cloud service, one has just enter the specified URL and connect through it by using developed GUI as follows. When connection is established, it will show the response status as connected and will show the sensed data of all the parameters. One is also able to download the log file which contains all the historical readings with date and time. One can also disconnect the cloud service with the click on disconnect button on below GUI, which will stop responding and will not show data.one can see the status of web socket as disconnected. This was the real time execution of the proposed system as shown in fig.5, fig.6 and fig.7 respectively.

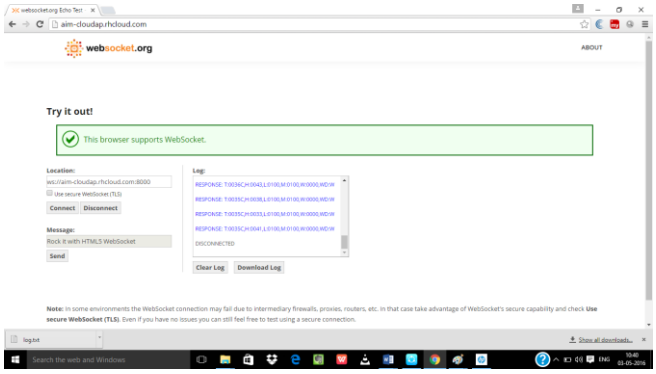

Fig.7 GUI of proposed system.

VI. RESULT ANALYSIS

In comparison with manual soil property monitoring and whether monitoring in greenhouse, an advance wireless sensor network provides better real time humidity and soil moisture readings collection and is the foundation for water saving agricultural application.

In this project, we proposed real-deployment of WSN based agricultural monitoring which is designed and implemented to realize modern precision agriculture. End Users can tailor the operation to a variety of experimental setups, which will allow farmers to reliably collect data from locations previously inaccessible on a micro-measurement scale. Such a system can be easily installed and maintained.

Generally wired and wireless systems provides the same result, but they actually differ in their accuracy and cost estimation. The average cost of this proposed system is reasonably reduced due to changes done in various hardware components and software used. The range of the proposed system is inclined due to the use of GSM and TCP/IP used in proposed system. This is the rough comparison between different wireless technologies. It is conceptual in nature.

This project successfully applies the wireless sensor networks on agro-ecology fields by investigating environmental situations. The complete real-time and historical environment information is expected to help the agro-ecological specialists achieve efficient management and utilization of agro-ecological resources especially for greenhouse.

VII. ADVANTAGES & APPLICATION

It requires no operating system for this hardware which results in reduction of cost and portability. The data collection, monitoring and materials application to the crops allows for higher yields and lower cost, with less impact to the environment. Each area receives only what is required for its particular space, and at the appropriate time and duration. Remote monitoring is possible from field to farmer's home. Continuous surveillance is done through monitoring section. Low power consumption and easy to install.

Intelligent agricultural and environmental sensing is the most important application. Precision agriculture is one of the most promising application domains where wireless sensor networks may deliver a feasible or even optimal solution. It concentrates on monitoring micro-climates in field. It has been instrumented a field with sensor nodes equipped with sensors for measuring air temperature, relative humidity and soil moisture.

VIII. CONCLUSION

This project finds application in domestic agricultural field. This system allows cultivation in places with water scarcity thereby improving sustainability. Furthermore, the internet link allows the supervision through mobile telecommunication devices, such as a smartphone. Besides the monetary savings in water use, the importance of the preservation of this natural resource justify the use of this kind of irrigation systems. This can also be used to ensure faithful irrigation of farm field in civilian domain, as well as for horticulture and floriculture areas, since we have the option of finding out moisture level of soil in a particular area. The automated irrigation system implemented was found to be feasible and cost effective for optimizing water resources for agricultural production.

IX. FUTURESCOPE

The future scope of this project is it can also be designed to detect the particular disease on the plant and suggest the proper curative measures on it. In the same way one can predict the weather if the system is made to communicate with the nearer weather station through satellite communication.

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