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WSN Based Closed Loop Automatic Irrigation System

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Abtract :- In last few years, remotely monitored embedded system for irrigation purposes have become a new necessity for farmer to save his energy, time and money. This paper is proposing a complete agricultural solution for the farmer based on Wireless Sensor Networks and GSM technology. The data acquired about environmental factors of the field is transmitted to the farmer enabling him to control the actuators in the field. Zigbee based low power devices are employed to enable cost saving, and the valves and sprinklers are employed to save the water usage for irrigation. The technology used is simple and easy to implement and the parameters recorded helps a great way to farmer to enable the "Smart farms" theory work for him. The microcontroller is the heart of the idea which controls all the devices and activates it and runs them in synchronization. So real time processing of the information is done and the required action is taken to increase the productivity of the field.

Index Terms **--- Climatologically Sensors, GSM, Irrigation Control, PIC 32, Zigbee.**

I. INTRODUCTION

Agriculture is the backbone of Indian Economy. Because without agriculture living is impossible since agriculture produces the main source of food for us. The farmer has to toil himself day in and day out to produce the crop which brings him little revenue, so he has to try some other options for his sustenance, also today the availability of labor for carrying out agricultural activities is less, therefore the automation in agricultural process is needed. Thus this paper has proposed a system so that even after devoting less time to the field, the farmer can carry out his agricultural activities efficiently from remote places. In this system all the devices work on their own with the help of inputs received from the sensors which are monitoring the agricultural land round the clock and farmer can monitor whether everything is going normal or some action is needed to be taken. The entire process is controlled and monitored by programmable controller.

The main technology used here Wireless Sensor Networks (WSNs) have attracted much attention in recent years. They are used for collecting, storing and sharing sensed data. The potential applications of WSNs are numerous that includes cattle monitoring, agriculture, nuclear reactor control, security surveillance etc. The architecture of a WSN system comprises of a set of sensor nodes and a base station that can communicate the information recorded to far away places. With the recent developments in wireless networks regarding power requirements and cost, it has become possible to conceive an Automated Model for Precision Agriculture. The process is that the conditions of the temperature, humidity, moisture etc. in the crop field are transmitted to the central station using ZigBee wireless sensor modules and the information is further transmitted to the farmer's mobile by using GSM technology and he can take the necessary action thereupon by activating the motors and water pumps for irrigation or sprinkling pesticides for pest control.

ZigBee is a specification for high level communication protocols using small, low-power digital radios based on an IEEE 802 standard for PAN. ZigBee devices are often used in mesh network form to transmit data over longer distances, passing data through intermediate devices to reach more distant ones. This allows ZigBee networks to be formed ad-hoc, with no centralized control or high-power transmitter/receiver. The microcontroller used here is the PIC which is base on the Harvard architecture. It controls all the processes and is low cost, widely available, has large user base, extensive collection of application notes, availability of low cost or free development tools, and serial programming capability. PICs are also commonly used in educational programming as they often come with the easy to use 'pic logicator' software. The PIC architectures have advantages like small instruction set to learn, RISC architecture, Built in oscillator, Easy entry level, Inexpensive ,Wide range of interfaces including I^2C, USB, USART The main advantage here is even a professionals can work in the agricultural field. If the idea is implemented, there will be a remarkable change in the agricultural field and the yield will also be high when compared to normal procedure used for irrigation purposes.

II. LITERATURE REVIEW

In [6] Chavez et al. (2009) discussed limitations of the conventional PLC based irrigation control systems and a

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new approach to automate the irrigation is presented which uses a Single Board Computer (SBC) using the Linux operating system to control solenoids connected to individual or groups of nozzles based on prescribed application maps. The main control box houses the SBC connected to a sensor network radio, a GPS (Global Positioning System) unit, and an Ethernet radio creating a wireless connection to a remote server. A C-software control program control the overall working of system.

A wireless drip irrigation system using soil moisture sensors is presented in [7] by Mahir Dursun et al (2011) and in [8] by V.I. Adamchuk. This paper describes an application of a wireless sensor network for low-cost wireless controlled irrigation solution and real time monitoring of water content of soil based on soil moisture sensors. Data acquisition is performed by using solar powered wireless acquisition stations for the purpose of control of valves for irrigation. The designed system has 3 units namely: base station unit (BSU), valve unit (VU) and sensor unit (SU). The system is energy efficient.

Precision water-saving irrigation automatic control system by plant physiology is discussed in [9] by Yandong Zhao et al. Precision water-saving irrigation automatic control system by plant physiology described in this paper is one of the Olympic games facilities projects, which takes standards of water plant physiologically need and soil water content as the basis.

Anurag et al [15] build such a wireless sensor network for precision agriculture where real time data of pest control in order to offset the adverse conditions. The climatological and other environmental properties are sensed and relayed to a central repository. The architecture comprises of three distinct sections (a) the sensor-nodes (b) the wireless mesh network and (c) the actuation components.

In [16], Smart fields monitored by wireless Nano Sensors are studied to realize system that automatically detects, locates, reports and applies water, fertilizers and pesticides.

Blackmore et al [17], in 1994 defined a comprehensive system designed to optimize agricultural production by carefully tailoring soil and crop management to correspond to the unique condition found in each field while maintaining environmental quality.

Subhodip Maulik [19] proposes the realization of a low cost wireless visual sensor node for blue tooth based measurement network, designed in such a manner that the energy consumption will be less. The sensing nodes is generally in sleep mode and only awaken when triggered by a pulse from a central weather station. İn [24] Rajesh et al., to overcome the problem of power distribution provided an overview of wireless sensor network by managing the equal power distribution by using zigbee network sensor. He compared Bluetooth and Zigbee and concluded that ZigBee helps to keep costs down, ensure interoperability, and is a future-proof investments made by both utilities and consumers.

In [26], Indu et al. mainly focuses on reviews in the field of remote monitoring and control, the technology used and their potential advantages. The paper proposes an innovative GSM/Bluetooth based remote controlled embedded system for irrigation. The system sets the irrigation time depending on the temperature and humidity reading from sensors and type of crop and can automatically irrigate the field when unattended. Information is exchanged between far end and designed system via SMS on GSM network. A Bluetooth module is also interfaced with the main microcontroller chip which eliminates the SMS charges when the user is within the limited range of few meters to the designated system. The system informs users about many conditions like status of electricity, dry running motor, increased temperature, water content in soil and smoke via SMS on GSM network or by Bluetooth.

Wireless SCADA[37] is required in those applications when wire line communications to the remote site is prohibitively expensive or it is too time consuming to construct wire line communications. In particular types of industry like Oil & Gas or Water & Wastewater, wireless SCADA is often the only solution due to the remoteness of the sites. Wireless SCADA replaces or extends the field bus to the internet. It can reduce the cost of installing the system. It is also easy to expand. In this paper an Architecture of SCADA in wireless mode described. The transmission of communication through the internet, its advantages and disadvantages are also discussed.

III. CLASSIFICATION OF CONTROL AND MONITORING SYSTEMS

To understand the different technologies and monitoring schemes properly, the systems studied can be broadly classified under different heads as below and the table is given showing the classification of the existing systems based on different criteria:

Technology Used

Processors Embedded

Sensors Incorporated

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Cropfields Monitored

A. Technology Used

In [1], Chandrika et al surveyed several GSM based farm irrigation systems and compared them. The result of the survey conducted has lead to a very positive approach on the impact of GSM technology in farm irrigation methods and techniques. The approaches studied had various pros and cons in the time required for operations or complexity or feasibility and use interactions. With technology advancing everyday new techniques have been implemented for further minimizing the irrigation process like using prebuilt mobile phone or standalone application software for conduction the irrigation process.

In [2], Mahesh focused on automizing the irrigation system for social welfare of Indian agricultural system and also to provide adequate irrigation in particular area. The set up consists of GSM which serves as an important part as it is responsible for controlling the irrigation on field and sends them to the receiver through coded signals. GSM operates through SMSes and is the link between ARM processor and centralized unit. The project aims to implement the basic application of automizing the irrigation field by programming the components and building the necessary hardware. This project is used to find the exact field condition. GSM is used to inform the user about the exact field condition. The information is given on user request in form of SMS. GSM modem can be controlled by standard set of AT (Attention) commands. These commands can be used to control majority of the functions of GSM modem In [3], Wenbin et al. introduced a WSN used for an intelligent temperature measurement system. It uses WiFi technology for the same.

In [4], Nirmal et al. Proposed idea about monitoring the crop field area without man power. The fundamental concept of this paper is to provide a highly enabled monitoring of paddy crop field. In this paper they have detailed how to utilize the sensors in paddy crop field area and explained about Wireless Sensor Network (WSN), Zigbee technology, Protocol stack of zigbee. They checked out the zigbee technology with two different commercial modules (Xbow and Xbee and analyze battery life under sensor deployed in the wet conditions and the evaluate the reliability of communications and measurements.

In [5], Neelam R. et al presented a closed loop automatic irrigation system along with the temperature and water usage monitoring. The real time values of soil moisture, temperature(useful in greenhouse cultivation) are wirelessly transmitted using Zigbee technology from field to substation which controls the state of the motor and irrigation valves according to the desired moisture levels set by the user. All the information viz. temperature, current soil moisture level in field, upper and lower moisture levels to be maintained in field (set by user), motor status, water usage and flow rate are displayed on LCD.

Anurag et al [15] build such a wireless sensor network based on the IEEE-802.15.4 standard and they developed a new static routing algorithm suited for the sensing application. The algorithm overrides the deficiency of the Hierarchical Routing scheme inherent in the ZigBee specification where the Cskip addressing algorithm limits the possible depth of the network topology due to address wastage. The new algorithm maintains the hierarchical network topology and thus is the routing at its optimal best. The algorithms for both addressing and routing are provided. The actuation components are also a part of mesh network and are activated wirelessly for controlling irrigation and fustigation. He proposed Test bed framework based on WPAN technology. He focused on the need of tree based topology for pointing deficiencies in Cskip Algorithm. He proposed the new routing algorithm is based on a static hierarchical architecture of the sensors where the need for mobility of the sensors is not high. In such networks, we can quickly build a network based on apriori information

The paper by ZHU Xiaojing and LIN Yuanguai [20] briefly presents the architecture of ZigBee technology, designs the hardware architecture of ZigBee nodes on CC2531 (ZigBee coordinator and end node) and the software architecture of ZigBee nodes. The test result demonstrates that the nodes can obtain the temperature, humidity and illumination information in real time, and then transferred to the remote monitoring center.

In [21], Alka et al.analysed that sensing technologies allow the identification of pests in the crops, drought or increased moisture. Having such information at a real-time interval, automated actuation devices can be used to control irrigation, fertilization and pest control in order to offset the adverse conditions. They concluded that Zigbee technology can be applied for wireless applications in agriculture sector. İn [22], Awati et al. founded that in the field of agriculture, use of proper method of irrigation is important and it is well known that irrigation by drip is very economical and efficient. In the conventional drip irrigation system, the farmer has to keep watch on irrigation timetable, which is different for different crops. The purpose of their study is to provide more facility in agriculture field by using Zigbee. Paper describes an application of a wireless sensor network for low-cost wireless controlled and monitored irrigation solution. The developed Drip Irrigation method removes the need for workmanship for flooding irrigation because efficient water management plays an important role in the irrigated agricultural cropping systems.

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İn [23], S.S Riaz discussed about Zigbee characteristics like self-organizing, self-healing networks that can manage various data traffic patterns, low-cost, low-power, easy to be deployed in wireless control and monitoring applications, longer life with smaller batteries, high reliability and larger range. He discussed various traffic types handled by Zigbee like Periodic, Intermittent, and Repititive etc. He elaborated on Zigbee architecture and its Frame structure. He compared various Wireless technologies based on Bandwidth, Power consumption, Protocol stack Size, Applications etc. He concluded Zigbee as the best suited technology for its low power and reduced costs.

B. Processors Embedded

In [2], Mahesh focused on automizing the irrigation system for social welfare of Indian agricultural system and also to provide adequate irrigation in particular area. The set up consists of ARM7TDMI core.

In [3], Wenbin et al. introduced a WSN used for an intelligent temperature measurement system. In the system, temperature signals are acquired by digital multipoint thermometers, and transmitted to the advanced RISC microprocessor (ARM) by using WiFi technology. Then they are stored in SD card which is controlled by the microprocessor. The software design of data acquisition and the progress of transplanting Linux operating system to the ARM hardware platform is described. The system fully makes advantage of SD card's characteristic of huge and long-time storage, remedying the defect of Nor Flash's small storage in ARM. Long-distance control is accomplished; the huge data stored in SD card can be transferred to the control center.

Subhodip Maulik [19] proposes the network where the sensing nodes is generally in sleep mode and only awaken when triggered by a pulse from a central weather station. The sensing hardware consist of a low cost CCD camera, while the transmission hardware use a Blue Tooth RS232 300 m slave module for visual data transmission. The sensing nodes act as a node in a medium range Blue Tooth measurement network The measurement network will sense presence of insects pests and diseases of Rice based crop system and the processor is a low cost intel 8051 micro controller. [27][28][29] used a 16-bit MSP (mixed signal processing) microcontroller. Its peripheral circuits include Liquid crystal display, keyboard functions, A/D converter and so on and it is suitable for applications that requires extremely low power consumptions.

In [32], Purnima et al. gives a review of the systems based on existing technologies and also proposes an economical and generic automatic irrigation system based on wireless sensors with GSM-Bluetooth for irrigation system controller and remote monitoring system. This system has simpler features designed with the objective of low cost and effective with less power consumption using sensors for remote monitoring and controlling devices which are controlled via SMS using a GSM module. A Bluetooth module is also interfaced with the main microcontroller chip. This Bluetooth module eliminates the usage charges by communicating with the appliances via Bluetooth when the application is in a limited range of few meters. The system informs user about any abnormal conditions like less moisture content and temperature rise, even concentration of CO2 via SMS from the GSM module or by Bluetooth module to the farmer's mobile and actions are taken accordingly by the farmer. In future, the farmer will be able to monitor and control the parameter by GSM and Bluetooth technologies.

C. Sensors Incorporated

In [5], Neelam R. et al presented a closed loop automatic irrigation system along with the temperature and water usage monitoring. The system can be used in greenhouses as well as open fields. The real time values of soil moisture, temperature(useful in greenhouse cultivation) are wirelessly transmitted using Zigbee technology from field to substation which controls the state of the motor and irrigation valves according to the desired moisture levels set by the user. A flow sensor is also interfaced to the main water supply which continuously tracks the water applied to the field. All the information viz. temperature, current soil moisture level in field, upper and lower moisture levels to be maintained in field (set by user), motor status, water usage and flow rate are displayed on LCD. They discussed on sensor and substation module in detail and recorded the results for five different crops by measuring Soil Matrix Potential to initiate or terminate the irrigation process.

Rafael Muñoz-Carpena [10] et al. in Automatic irrigation based on soil moisture for vegetable crops studied the water conservation and new irrigation technology. They surveyed on the various types of sensors used. They focused on ways to minimize environmental effects caused by excess water supply. They focused on studying and comparing different tensiometric techniques which includes Tensiometers sensors and Granular Matrix Sensors. They also studied the effect of volumetric sensors that are suitable for irrigation by measuring Dielectric Constant in the field. They concluded that as water supplies become scarce and polluted, there is a need to irrigate more efficiently in order to minimize water use and chemical leaching. Recent advances in soil water sensoring make the commercial use of the technology possible to automate irrigation management for vegetable production. However, research indicates that different sensors types may not perform alike under all

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conditions. Reductions in water use range as high as 70% compared to farmer practices with no negative mpact on crop yields.

Dukes et al. (2003) used a commercially available dielectric sensor for lawns and gardens to control irrigation on green bell pepper. They found 50% reduction in water use with soil-water-based automatically irrigated bell pepper when compared to once daily manually irrigated treatments that had similar yields; however, maximum yields and water use were on the farmer treatment that was irrigated 1-2 times each day.[14]

D. Cropfields Monitored

Rafael Muñoz-Carpena [10] et al. in Automatic irrigation based on soil moisture for vegetable crops studied the water conservation and new irrigation technology. They surveyed on the various types of sensors used. They focussed on ways to minimize environmental effects caused by excess water supply. They focused on studying and comparing different tensiometric techniques which includes Tensiometers sensors and Granular Matrix Sensors. They also studied the effect of volumetric sensors that are suitable for irrigation by measuring Dielectric Constant in the field. They concluded that as water supplies become scarce and polluted, there is a need to irrigate more efficiently in order to minimize water use and chemical leaching. Recent advances in soil water sensoring make the commercial use of the technology possible to automate irrigation management for vegetable production. However, research indicates that different sensors types may not perform alike under all conditions. Reductions in water use range as high as 70% compared to farmer practices with no negative mpact on crop yields.

In [25], Kalaivani focuses on providing an overview of zigbee based wireless sensor network (WSN) as applied in agriculture for intelligent farming. In this research work, a survey on wireless sensor networks and their standards and technologies in the field of agriculture was carried out. Based on the analysis and survey, the need for intelligent farming especially in developing countries like India, has grown to a greater extent. In this paper they surveyed different applications of zigbee based wireless sensor network in agriculture such as monitoring of environmental conditions like weather, soil moisture content, soil temperature, soil fertility, weed-disease detection, monitoring leaf temperature/moisture content and monitoring growth of the crop, precision agriculture, automated irrigation facility, storage of agricultural products etc. This paper also provides the possible research issues existing in Physical layer of ZigBee.

So now we compare various systems on the basis of the WSN network used for transmission, the properties of the field that were monitored (mostly being temperature and moisture) ,the method adopted for irrigation and the microcontroller used for the same purpose.

Table 1 Classification of Existing Remote Monitoring and Control Systems

References	Technology	Processor	Monitoring station	Tools	Programming code	Modules interfaced
[3]	GSM	MSP430F149	PC	C430 IDE	C	Siemens TC 35
[4]	GSM, Zigbee		Mobile, PC	Kiel IDE		
[6]	Wireless, GPS	AT89S52	7 segment display	Kiel IDE	Assembly	
[7] –[8]	GSM	AT89S52	Mobile	Kiel IDE	Embedded in C	Granular Matrix Sensors
[15]	GPRS, Zigbee	MSP430F2274	PC	C430 IDE	C	Chipcon CC2420
[18]	GPRS, Zigbee	8051 family, Open source database	Mobile, PC	Kiel IDE	Embedded in C	
[19]	Bluetooth, RF Modules	8051 family	Mobile, PC	Kiel IDE		PIR sensors 325

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[20]-[24]	GSM, Zigbee CC2531	ARM 7 MicroController	Mobile, PC	Kiel IDE		Moisture sensors
[27]	GPRS, Zigbee	MSP430F2274	PC	C430 IDE	C	
[28]	WSN	MSP430	PDA	C430 IDE	C	
[29]	WSN,GPRS , Internet	MSP430F1611	Mobile, PC	Tiny OS 2.1.0 Google visualization API	-	
[30]	Zigbee	SPCO61A	PC, Smart phone	XILINX SPARTAN 3	C	
[31]	GSM,WSN	PIC16F74(DIP Configuration)	Mobile, PC	AVR Studio, MPLAB IDE	C	
[33]	GSM - WSN	PIC16F74 (DIP Configuration)	PC , Mobile	AVR studio, MPLAB IDE	Assembly, C	Linx TXM and RXM-315 -LR
[34]	GSM	8051 family	Mobile, PC	Kiel IDE, Linux	C ,JAVA	Nokia FBUS

IV. ANALYSIS OF EXISTING SYSTEMS

The systems studied are well equipped for Remote Monitoring of crop field depending upon the techniques used and the field requirements. Systems based on PC as the main controlling device make it possible to control remotely from any part of the world provided internet access is available to user. The system is of high cost due to the requirement of a computer. And special hardware and software installation is required to control the devices in a particular design. It is difficult to monitor and control the status of different sensors and devices in case of power failure unless you have a battery backup which is an additional cost. Zigbee based systems are better because they offer low power consumption, high reliability and has a place in the short distance wireless transmission technology and is the most suitable wireless technology for agriculture applications. It allows the administrator to instrument, observe and react to events and phenomena in an agriculture environment. Zigbee can also work on different networks like star, cluster tree, and mesh. However, in each of these cases, Zigbee will provide data exchange when nodes are down because the signaling information can be re-routed to other nodes easily. In fact, Zigbee can support 65,000 nodes. This makes it available for very large networks. GSM based systems offer advantages of being controlled from far flung places and simplicity of command. In GSM based system, the information is exchanged between far end and designed system via SMS on GSM network. A Bluetooth module is also interfaced with the main microcontroller chip which eliminates the SMS charges when the user is within the limited range of few meters to the designated system. The system informs users about many conditions like status of electricity, dry running motor, increased temperature, water content in soil and smoke via SMS on GSM network or by Bluetooth. Sensors based classification helps in selecting the crop specific and season specific sensors. Processors based on AVR, the Programming hardware is easy and Learning Curve is shorter compared to any other chip. High Performance to Cost ratio is there when compared to microcontroller 8051.Also 8051 consumes more power than AVR and PIC which are RISC based but their instruction Sets are entirely different.

From Programming point of view: 8051s are easy to code, next come PIcs and last comes AVRs. 8051 has very powerful instruction set; it has commands which do more complex calculations. Whereas PICs and AVRs have simple single instructions but the programmer has to tell each and every step to get the results. 8051 is still in use because of its simplicity and popularity and less cost. AVRs and PICS are costly and come with many on chip peripherals like: hardware SPI, ADC, I2C, USART, Analog comparator, internal RC oscillator etc.PIC micros are also pretty good and for applications with demanding analog input requirements they are probably better than AVRs. They have ADCs that have high sampling speed as compared to the AVR.

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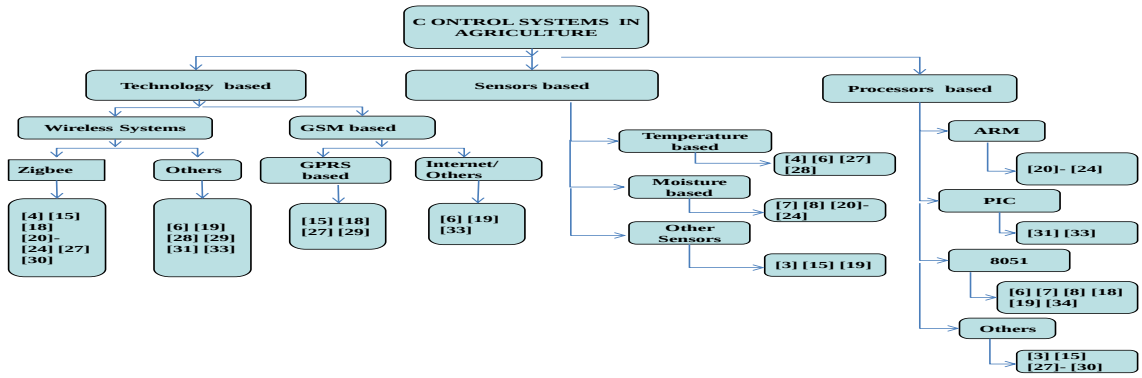

Fig 1 Classification of Existing Agricultural Control Systems

V PROPOSED SYSTEM

The technical questions arising in precision agriculture are all focusing upon increasing the efficiency of the field which results from networking sensors to monitor important spatiotemporal patterns in the field and integrating the data to display or record information, and also to actuate further human or automatic responses. The sensors that can be used in agricultural field are temperature, soil makeup, humidity, mechanical stress level monitoring. Here a system is developed based on ZigBee which consists of four parts: wireless sensor networks, gateway, transmission network, remote monitoring center. The sensor nodes can obtain the temperature, humidity information in real time, and then transferred to the remote monitoring center by the gateway via the transmission network. This intelligent agriculture monitoring system has the useful characteristics of low power consumption, low cost, large network capacity, flexible disposition, and minor influence on the natural environment. ZigBee module used here is based on IEEE 802.15.4 standard. It is used in wireless transmission over the range of 100 m.

In irrigation process the water level is sensed by the sensors and the information are processed by the controller and transmitted over the ZigBee module. At the base station the data is received by the ZigBee module and transferred to PC through RS232 interface. The data will be processed by the PIC microcontroller and then can be transmitted to farmer's mobile phone using GSM module by using AT commands that are instructions used to control a modem. AT is the abbreviation of Attention. Every command line starts with "AT" or "at". Then these commands can be further given by the farmer through GSM which will initiate or terminate the irrigation process via relay controlled motor in the field depending on the moisture conditions of the soil. The pesticides can also be sprinkled in case of the need if mixed with the water sprinkler. The readings can also be displayed on the LCD interfaced with the controller and the record can be maintained so as to make a comprehensive report to take the farmer proper decision about the timely irrigation and pest controlling. It was observed that the technology is new in its idea and the implementation has not been very wide, so the knowledge if percolated to the farmer's at lower level then the increase in the efficiency of crop management will be much greater.

VI. BLOCK DİAGRAM

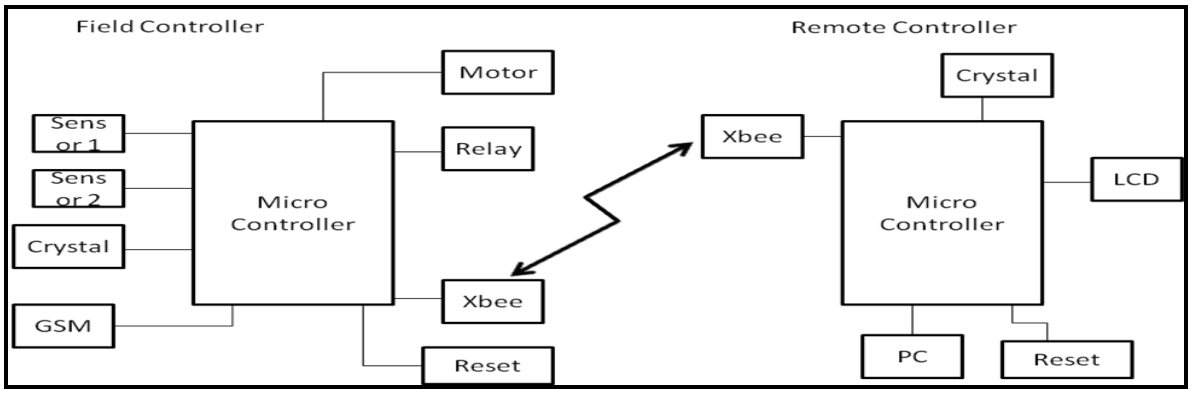

Fig 2: Block diagram of proposed system

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VII.CONCLUSION AND FUTURE WORK

The study has incorporated major WSN based automated agriculture monitoring system. The Zigbee module used has the range of about 150 metres. 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 design of the innovative GSM and Zigbee based remote controlled embedded system for irrigation. The proposed system is a low cost system where information is exchange via SMS on GSM network. As we know the appropriate level of water in the farm field contributes to the quality of grains and highly affects the incidence of pests and diseases on crops. By using this system the farmers can get the information of electricity status at farm field, warning message like smoke in farm field due to fire or due to burning of motor in the farm field and the environmental temperature exceeds information from home or any where using a mobile phone. With this the farmer can switch on the motor for irrigation/pesticide spray from anywhere far from the actual field. The availability of the GSM network is a prerequisite for the system implementation. The system is highly beneficial for precise irrigation in farm fields and thus responsible for efficient utilization of water resource and men power.

The real time video of the field can also be integrated with other parameters that are sent to the base station. The ZigBee device here can further be attached with the camera module that can be placed in different locations of fields to take the snapshots of the plant at predefined intervals of time. Now these images can be used by the farmer to monitor the growth of the plant and also can control the population of the pests that may be growing symbiotically with the crop by applying proper pesticides. The pesticides can also be mixed with the water sprinkler or can be drizzled separately via valves controlled by the microcontroller. The fertilizers and pesticides can also be stirred and send through the pipe or sprayer

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