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Review Article

Producing More Crops in Automated Irrigation System using WSN with GPRS and Zigbee –A Review

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Abstract

Increased demands on the implementation of wireless sensor networks in automation of different applications in various fields including medicine, transportation, and precision agriculture results in relatively new wireless standards for improvement of the automation. Agricultural environment for various factors like soil moisture, temperature and humidity is very significant . This paper presents the use of zigbee wireless technology in automated irrigation management system which uses wireless sensor networks. Zigbee carries some advantages like being of low cost, low power and wireless mesh topology networking standard. Gsm/gprs or mobile phone can be used to access following information and service such as information and configuration pertaining to mobile device and sim card, sms services, data and voice link over mobile network. This paper provides us with a method to control the level of water supply to the crops which aims at high efficiency of water and electricity. This system utilizes sensors, zigbee modem, and gprs. The control is done automatically without any human interpositin by design, development and trial work of a monitoring system.

Keywords: *Irrigation, Zigbee, wireless sensor network, Internet, Automation, Bluetooth.*

1. Introduction

Water is one of the most important resources of our living. Water occupies 70% of total capacity in this world, but not full capacity of water can be used as it contains various impurities but due to growing pollution there is much stress on the water requirements and the shortage of water is growing day by day. Hence it is necessary to use the present water in a commensurable manner. The automated control is implemented here to avoid damage of crops due to surplus or deficit usage of water. The already existing system uses simple water pumps to supply water to the crops as and when required by manual control. Another disadvantageous method is the discontinuous monitoring of the water level by using gsm (global system for mobile communications) technology but the proposed system uses automatic control by using continuous monitoring by grps (general packet radio service). This is because when long distances are involved. It leads to damage of the coils and also disruption in communicating information between the field and the centre and the use of coils for communication purpose is economically not possible. This paper presents a view on coupled usage of zigbee and gprs wireless system on the agricultural land by regulating with the use of microcontroller. The benefits of wireless communication extend beyond simply not using wireless. Wireless technology has an overall positive impact on the costs and efficiency of home internet installations to the operations of large corporations worldwide. Hence the use of wireless communication for the monitoring and controlling on the agricultural land is highly essential. [sinduja. r. m, Sowmya, September 2013].

The objective Of the System is

1. To conserve energy & water resources.
2. To handles the system manually and automatically.
3. To detects the level of water, soil moisture and temperature.
4. To builds such system which enhances crop productivity.
5. To learn selection methods of irrigation based on different parameter.

2. Irrigation System

2.1. Surface Irrigation

The type of surface irrigation is

1. Level basin

In this technique the top end of the field is applied with water where it will blow low over the whole field. The

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water reaches the end of field it starts run off to ponds. Water wastage is not good for dry area. [Rashid Hussain 2013].

Figure 1 Level basin flood irrigation

2. Furrow irrigation basin

This irrigation basin is used in the production of vegetables. Furrows are sloping channels which are established in the soil. This technique makes plant to get water in its root zone and therefore plant is not in direct contact with water.

Figure 2 Furrow irrigation

3. Border strip irrigation basin

In border strip irrigation basin which uses land formed into strips which is leveled across the narrow dimension that is width and the sloping is done in long dimensions that is length, is formed.

Figure 3 Border irrigation

Disadvantages of conventional irrigation system

Large amount of water is used in above irrigation techniques. Efficient use of fertilizers is not possible this requires large man work. Net yield or productivity is also not high. Problems related to soil attrition are major problem. More amount of ground water goes waste.

2.2. Micro irrigation methods

Two main micro irrigation systems are.

1. Drip irrigation

It is also called as micro irrigation or tricle irrigation. It is an efficient technique which is primarily used in hot tropical conditions. It allows water to drip slowly to the root of plants through pipes, tubing etc. It is done with the help of narrow tubes which delivers water directly to the base of the plant.

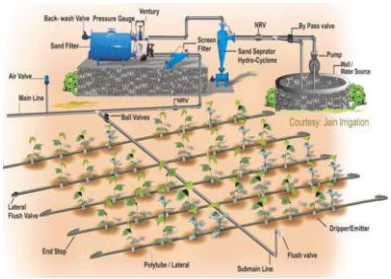

Figure 4 Layout of drip irrigation

2. Sprinkler irrigation

In sprinkler irrigation delivery of water is through a pressurized pipe network to the nozzles of sprinkler which spray the water into the air. We can say that, it is a type of artificial rain. The sprinklers to spray the water over the ground and valves to control the water flow.

Figure 5 Layout of sprinkler irrigation**.**

Advantages of micro irrigation

1. It saves water due to possibility of using saline water.
2. Efficient and welfare use of fertilizers.
3. Installation is easy & flexibility in operation.
4. Suits to all types of land terrain & also suitable waste lands.
5. Enhances plant growth and yield & better quality of produce.
6. Weed growth is less.
7. Saves labor works.
8. No soil erosion which saves land.
9. Minimum diseases and pest control.

3. Detailed study

In this paper, the development of the deployment of an automated irrigation system based on microcontroller and wireless communication at experimental scale presented within rural areas is. The aim of the implementation was to demonstrate that the automatic irrigation can be used to reduce water use.

The implementation is a photovoltaic powered automated irrigation system that consists of a distributed wireless network of soil moisture and temperature sensors deployed in plants root zones. Each sensor node required a soil-moisture probe, temperature probe, microcontroller for data acquisition, and radio transceiver, the sensor measurements are transmitted to a microcontroller based receiver. in the wireless information unit the soil moisture and temperature data from each wireless sensor unit are received, identified, recorded, and analyzed. The wireless information unit consists of a master microcontroller pic, an xbee radio modem, a gprs module, two electronic relays, two 12v DC1100 gph live well pumps driving the water of the tanks. 12 V at 100-Ah rechargeable battery L-24M/DC-140, which is recharged by a solar panel KC130TM of 12 V at 130 W through a PWM charge controller SCI-120.All the WIU electronic components were encapsulated in a waterproof PVC box as shown in Fig.1 WIU.

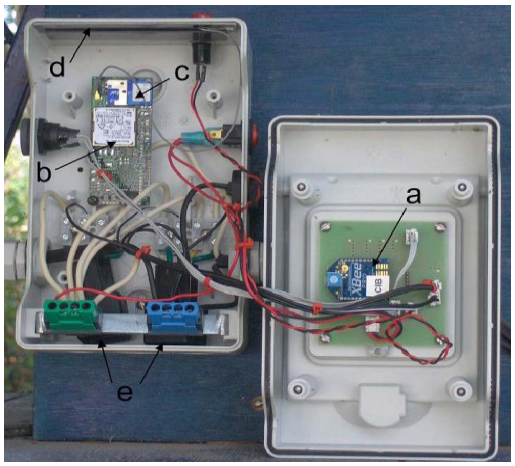

Figure 6 Inside view of the WIU. (a) Radio modem ZigBee. (b) GPRS module(c) SIM card. (d) GPRS PCB antenna (e) Pumps relay.

1. Wireless sensor unit

A WSU is consisting of a radio frequency transceiver, sensors, a microcontroller, and power sources. Several wireless sensor units can be deployed in-field to configure a distributed sensor network for the automated irrigation system. In this each unit controlled by the microcontroller pic that controls the radio modem xbee pro s2 and processes information from the soil-moisture sensor vh400, and the temperature sensor ds1822.

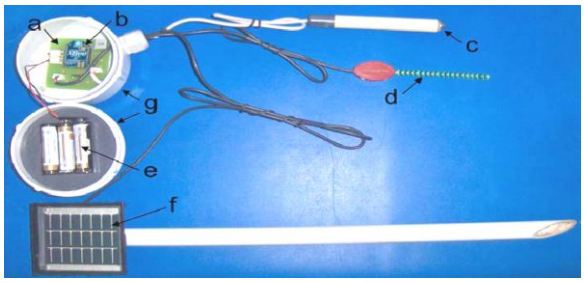

Figure 7 WSU. (a) Electronic component PCB. (b) Radio modem ZigBee. (c) Temperature sensor. (d) Moisture sensor. (e) Rechargeable batteries. (f) Photovoltaic cell. (g) Polyvinyl chloride container.

2. Wireless sensor network

A wireless sensor network is a collection of dispersed and dedicated sensors for accumulating and disseminating environmental data.

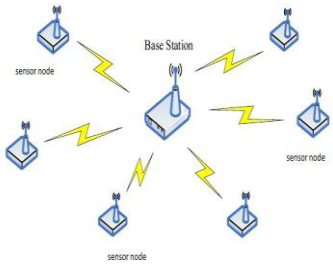

Figure 8 Structure of WSN

The WSN is built of nodes from a few to several hundreds or thousands, where each node is connected to one or sometimes several sensors. Each such sensor network node has several parts: a radio transceiver with an internal antenna or connection to an external antenna, microcontroller, an electronic circuit for interfacing with the sensors and an energy source, usually a battery or an embedded form of energy harvesting. [Anjum awasthi α & s.r.n reddy 2013]

The main characteristics of a WSN are

a) Power consumption constrain for nodes using batteries or energy harvesting.
b) Ability to cope with node failures.
c) Mobility of nodes.
d) Communication failure.

Limitations

Environmental changes not consider for sensor reading. System user is not able to the program application. There is no controlling system for applications.

3. Zigbee network

Zigbee module is a low cost, low power wireless mesh networking system. The low cost allows the technology to be widely exert in wireless control and monitoring

applications, the low power allows longer life with smaller batteries and the mesh networking provides high reliability and bigger range. Temco has developed an embedded antenna of wireless data communication module, which adopts standard zigbee wireless technology.

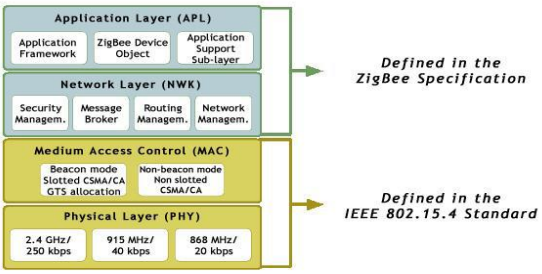

Figure 9 Communication layers of Zigbee

In fig the top most layers is a application layer which actually provides a wireless communication with another paired zigbee module. This all the four layers are based on ISO/OSI model [vara manthan kantilal 2014].

The zigbee identifies three devices that incorporate zigbee radios, [josephs haule, 2014]

1. Zigbee coordinator (Zc)

The most useful device, the coordinator forms the root of the network tree and mighty bridge to other networks. There is only one zigbee coordinator in each network since it is the device that started the network originally. It has the capability to store information about the network; it initializes the network, has routing capacity and is able to communicate with all devices

2. Zigbee router (Zr)

When running an application, a router can act as an intermediate router, passing on data from other devices. This device makes it possible to expand network, ensure routing capacity and communicate with all devices.

3. Zigbee end device (zed)

This contains just enough functionality to talk to the parent node; it cannot relay data from other devices. This allows the node to be asleep a significant amount of the time this providing long battery life. A zed requires the small amount of memory and therefore can be less expensive to manufacture than a Zr or Zc. it is able to communicate only with its ancestor, coordinator or router, but not to each other and selectively turns the receiver on/off for power saving.

Features of zigbee / 802.15.4 network:

Zigbee network has the following features [Joseph haule 2014]

1. Transmission distance: 100 meters (can be lesser in indoor and higher in outdoor conditions)
2. Throughput: 250 kbps at 2.4 GHz with 16 channels / 40 kbps at 915 MHz with10channels
3. Frequency: uses unlicensed bands can work anywhere in the world without special permissions
4. System resources required: 4-32 kb
5. Battery life: 1000 days, low power
6. Scalability: highly scalable network using a single coordinator that can assist up to 64,000 nodes
7. Relationship with Wi-Fi: zigbee networks can interfere with Wi-Fi if both are operating in 2.4 GHz and they are not designed to interoperate natively
8. Cost: zigbee routers and sensors cost very less (compared to Wi-Fi) and hence are more suitable for bulk deployment.
9. Network topology: uses mesh, star and peer-to-peer topology, and can working any one of them.

4. Pic 16f877a microcontroller

Pic is a family of modified harvard architecture microcontrollers made by microchip technology, derived from the pic1650 originally developed by general instrument's microelectronics division. The name pic initially referred to peripheral interface controller peripheral interface controller is the most powerful microcontroller which is a 40 pin device which is used as RISC architecture. Reduced instruction set computing, or RISC is a CPU design strategy based on the insight that simplified (as opposed to complex) instructions can provide higher performance if this simplicity enables much faster execution of each instruction.

5. GPRS

General packet radio service is one of the technologies to improve 2g phones to transferring data at higher speed. gprs allows mobile phones connected to network and transfer requested or sent data straightaway if you receive mms from other mobile, you don't need to press a button to check if you have any new mms, instead mobile handset inform you when new mms is downloaded to farmer mobile. Gprs technology can provide up to 32 kbps to 48 kbps. The most common features of gprs technology which makes it even more useful and practical is that data can transfer during the call and there is no requirement of disconnecting call to receiving incoming or outgoing data.

6. Bluetooth

Bluetooth is also known as the IEEE 802.15.1 standard is based on wireless radio system designed for short range and cheap devices to replace cables for computer peripherals like mice, keyboards, joysticks, and printers. The range of applications is known as wireless personal area network. Two connectivity topologies are defined in Bluetooth. the piconet and

scatternet. A bluetooth device may participate in several piconets basically, thus allowing for the possibility that information could flow beyond the single piconet coverage area, a device in a scatternet could be a slave in many piconets but master in only one of them.

7. Relay

A relay is an electrically operated switch. The relay is used to switch the motor and on /off position according to the water level. Current flowing through the coil of the relay creates a magnetic field which attracts a lever and changes the switch contacts. The coil current can be on or off so relays have two switch positions and they are double.

8. Dc motor

A dc motor is a mechanically commutated electric motor powered from direct current (dc). The current in the rotor is switched by the commutate to also be stable in space. This is how the relative angle between the stator and rotor magnetic flux is maintained near 90 degrees, which generates the maximum torque non -rotating armature magnetic field and a static field winding that produce the main magnetic flux. The speed of a dc motor can be controlled by changing the voltage applied to the armature or by changing the field current.

4. Design of WSN

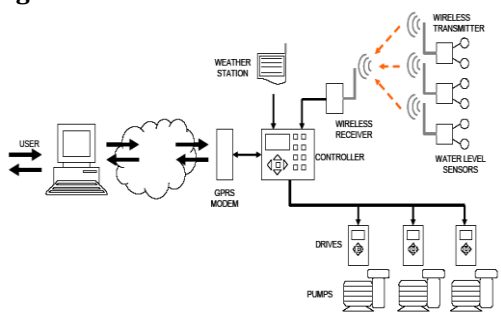

Figure 10 Schematic diagram of the automation system. [SOWMYA.S 2013]

4.1. Sensors ultrasonic sensors

Ultrasonic sensors also known as transceivers when they both send and receive work on a principle similar to radar or sonar which evaluate attributes of a target by interpreting the echoes from radio or sound waves. Ultrasonic sensors generate high *f*requency sound waves and evaluate the echo which is received by the sensor. This is calculating the time interval between sending the signal and receiving the echo to determine the distance to an object.

4.2. Temperature sensor

The temperature sensor used to measure the temperature at the field is lm 35.the lm35 series are precision integrated circuit temperature sensor whose output voltage is linearly proportional to the Celsius. Low cost is assured by trimming and calibration at the water level.

4.3 Humidity Sensors

A humidity sensor is also defined as a hygrometer; it calculates regularly reports and the relative humidity in air. It senses the relative humidity; it means that sensor measures air temperature and moisture together.

4.4. LCD Display

It provides the user with the digital values converted by the PIC microcontroller. LCD driver is a link between the microcontroller and LCD. It is essential for interfacing the LCD according to the driver measurement.

4.5. RS 232

This cable is used for the purpose of serial communication. The resultant signal of PIC16F877A is in TTL level from 0V to +5V. But for COM port on PC, it needs both positive and negative voltage levels. Therefore, a RS 232 Level Converter is necessary to perform +15V and -15V.

5. Simulation result

5.1. Proteus

Proteus is software used for microprocessor simulation, schematic capture, and printed circuit board (PCB) design. It is developed by Lab center Electronics. The proteus is used to program PIC 16F877A which converts the analog values from the sensors to digital values displayed in the LCD screen. The sensors are replaced by variable resistors for the simulation purpose alone. [sinduja. r. m, sowmya.,2013]

5.2. PIC C Compiler

PIC C COMPILER which is the C programming language for the microchip's Peripheral Interface Controller microcontroller.

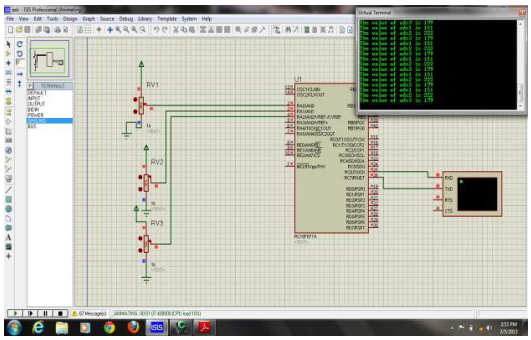

Figure 11 Proteus Simulation Result

5.3. Keil

The name of an ARM company is keil which is essentially concentrating on the applications like complier for the microprocessor. This allows the assembling and debugging of files 2k.

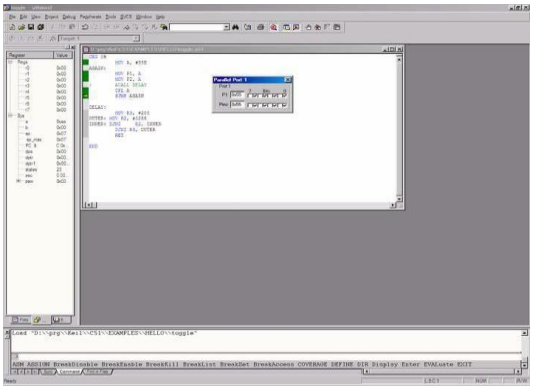

Figure 12 Keil Compiler Output

6. Analysis of existing systems

PC based systems can generally controlled easily from remote places via internet access but it makes the system costlier and complex to access. It is difficult to monitor and control the status of different sensors and devices despite of power failure unless you have a battery backup which is an additional cost. Low power consumption and high reliability makes zigbee based system as the mainly suitable wireless technology used for agriculture applications like irrigation monitoring. Zigbee can also work on different networks like star, cluster tree, and mesh. However, in each case, Zigbee will provide data exchange when nodes are down because the signaling information can be re-routed to other nodes easily. Zigbee support maximum of 65,000 nodes.

GSM based systems offer various advantages of being controlling from the remote places and commands used in GSM are very simple. GSM based system which is proposed here exchanging information between the remote place and designed system via SMS on GSM network. SMS charges are reduced with the help of Bluetooth module interface along with GSM if the user is within the variety of few meters to the designated system.

7. Classification of Existing Control Systems

Table1: Summary of Features of Zigbee, Bluetooth LE, Wavenis, Insteon, Enocean, UWB

	Zigbee	Bluetooth LE	Wavenis	Insteon	Enocean	UWB
Data Rate	20kb/s 40kb/s 250kb/s	720kb/s	4.8kb/s 100kb/s	38.4kb/s	120kbit/s	110mbits/s
Frequency band	868/915 M Hz, 2.4 G Hz	2.4 G Hz	50 K Hz	904 M Hz	868 M Hz	3.1-10.6 G Hz
Modulation Technique	BPSK, O-QPSK	GFSK	GFSK	FSK	ASK	BPSK QPSK
Spread Spectrum	DSSS	FHSS	FHSS	No	no	DS-UWB MB-OFDM
Indoor Range	100m	10 m	1000 m	50 m	30 m	300 m
Security	128- bit AES	E0 Stream cipher	128-bit AES	Rolling code Encryption	Basic	AES
Cost	Good	-	Good	Good	Excellent	-
Risk of data collision	Medium	High	Low	Medium	Very low	-
Max node count	~6500	8	-	200-300	2^{64}	8
Energy needed	Medium	High	Medium	Medium	Extremely low	High
Market Adoption	YES	YES	NO	NO	YES	YES

8. Proposed work

In last few years, remotely monitored embedded system have purpose to become a new necessity for farmer to save energy, time and money in irrigation. This paper is proposes a complete agricultural result for the farmer based on WSN and GPRS technology. The data acquire s regarding environmental factors about the field is transmits to the planter enables him to control the actuators in the farm fields. Zigbee base small power devices are employed to enables cost saving, and the valves, sprinklers are used to save the water usage for irrigation. The technology used is simple and easy to implement and the parameters recorded helps a good way to farmer to enable the Smart farms theory work for him. The microcontroller is t which controls all the devices activate 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. [Prashant B. Yahide 2015].

Sensors (Light, Temperature, PH_Value, and Moisture):-

It senses the different physical parameters like soil ph-value, soil moisture, temperature and humidity.

Micro-Controllers

It is heart of system, means it control all operation of system.

ADC (Analog to Digital):

It convert analog signal to digital signal and fed this digital signal to microcontroller.

Signal Array

It takes sensor data as input and gives this data as input to signal conditioning.

Signal conditioning

It works as amplifier. It convert weak signal of sensor in its unique state.

Darlington Driver

It is control unit it control fan motor valve etc. It works as per decision.

Valve

Valve can be Solenoid valve work as per soil moisture threshold value and operate by Darlington driver.

Base station

It is master unit to control valve and take data from all sensor node which are at the end.

Server

It combines data from all WSN network and take decision if threshold CROSSES of any sensor unit. Irrigation timing can be synch from server for water management purpose.

Web application

It combines data from server of agriculture field where WSN network application is deployed. Web application provide graphical interface to user and sensor data value is generated so it is easy to understand for user to analyze and take decision. Web application helps to stores data and maintain irrigation time table. User can download irrigation timing from Agriculture University.

Advantages

1. Simple to design and install
2. Enhance productivity and reduce water consumption in agriculture field.
3. Less manpower is required.
4. Reduce soil erosion and nutrient leaching.
5. Use of web application provides remote controlling to 6.farm for water resource management.
7. It helps to maximize profit.

Disadvantages (limitations)

1. Internet access requires.
2. Require frequent maintenance for efficient operation.
3. Factors like weather conditions are not taking into considerations.

Conclusion

1) The automatic irrigation system implementing feasible and cost effective to optimize water resources for agricultural production. This system ALLOWS development in place with water shortage thus improving sustainability [Joaquín Gutierrez 2014].
2) This irrigation system proves that the utilization of water can be reducing for a given quantity of recent biomass production. The utilization of solar power in this irrigation system is relevant and significantly elevated for organic crop plus different agricultural products that are organically isolated.
3) In addition, other applications such as temperature monitoring in compost production can be easily implemented. The Internet controlled duplex communication system provides a powerful decision making device concept for adaptation to several cultivation scenarios.
4) The Internet link allows the supervision through mobile telecommunication devices, like a smart phone.
5) Through GPRS technologies plus Web Services technology, we can realize the function of the data networking, remote monitoring, it shows that the system can meet the requirements of the temperature and humidity of soil environmental monitoring.
6) The Zigbee module used has the range of about 150 miters. The readings of temperature and moisture were recorded and timely sent to farmer‟s mobile enabling him to take the proper action [Deepti Bansal, 2013].

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