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Agricultural Monitoring System: A Study on Agricultural Monitoring System with Zigbee Mesh Implementation

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Abstract: ***Today energy resources are becoming scarcer and therefore more valuable. In conjunction with the population growth over last century, the need for finding new, more efficient, and sustainable methods of agricultural cultivation and food production has become more critical. To facilitate this process, we are designing, building, and evaluating a system for precision agriculture which provides farmers with useful data about the soil, the water supply, and the general condition of their fields in a user friendly, easily accessible manner. Our system aims to make cultivation and irrigation more efficient as the farmer is able to make better informed decisions and thus save time and resources. The diversity of location and climatic effects upon agricultural cultivation, along with other environmental parameters over time makes the farmer's decision-making process more complicated and requires additional empirical knowledge. Applying wireless sensor networks for monitoring environmental parameters and combining this information with a user-customized web service may enable farmers to exploit their knowledge in an efficient way in order to extract the best results from their agricultural cultivation. The system can scale based on each farmer's demands and the resulting ensemble of collected information may represent a valuable resource for future use, in addition to its use for real-time decision making. The design of the precision agriculture system contains a prototype solution regarding the sensor platform and a customizable service that can be utilized in different ways and by several entities. The main objective of the thesis is to develop a smart wireless sensor network (WSN) for an agricultural environment. Monitoring agricultural environment for various factors such as temperature, gas and humidity along with other factors can be of significance. A traditional approach to measure these factors in an agricultural environment meant individuals manually taking measurements and checking them at various times. This thesis investigates a remote monitoring system using Zigbee which is comprised with X-CTU software with the help of Arduino circuit board. These nodes send data wirelessly to a central server, which collects the data, stores it and will allow it to be analyzed then displayed as needed and can also be sent to the client mobile.***

Keywords: Wireless Sensor Network, Zigbee, Arduino circuit board

1. Introduction

This chapter introduces the general area of research and describes the purpose of this Master's thesis project. The introduction to the scientific area is followed by a description of the problems that set the goals for this project. The chapter ends with a description of the structure of this thesis.

General introduction to the area

1.1 Agricultural Monitoring System

The contemporary world is in a transition stage where problems concerning global issues, such as global warming and alternative energy sources, are combined with new challenges demanding immediate solutions. Society's focus has shifted from economic growth to sustainable development, where environmental, social, and economic aspects are considered together, rather than separately. Policies that promote sustainability in all sectors of the economy (manufacturing, agriculture, and services) are now considered as a part of good governance. Problems such as climate change, population growth, and poverty (especially hunger), occur in a context of a gradual depletion of natural resources and the fear of diminishing coal energy reserves. These are some of the global issues that are thought to require multidisciplinary approaches in order to be addressed successfully. In this Master's project we focus on agricultural production and cultivation. This overall process has a significant role in fulfilling the basic human need for food. The production, preparation, packaging, distribution, etc. of food also generates a lot of income. The aim of this Master's thesis project is to exploit modern technologies and tools to improve monitoring and management of crops, in order to improve the efficiency and sustainability of farming and food production. To this end, we have designed a system for precision agriculture, which relies on a wireless sensor network combined with a service to provide individual farmers with access to data that they find useful. The system utilizes wireless sensor nodes that collect and transmit data about the quality of the water supply, the soil, and other parameters in an agricultural field. While such sensor-based systems have been investigated earlier, one of the key innovations to be explored in this Master's thesis project is the combination of these sensors systems with a service-driven business model to increase their ease of use and to amplify the gains that can be realized via an integrated system. The goal is to give a agriculture a more complete picture of the current and historic crop status in order to faster better informed decision making. It is expected that such decisions will benefit both farming and irrigation by saving time and resources. Factors such as the diversity of conditions which vary depending on location combined with the in ability to predict the future characteristics of the environment during the different seasons over time complicate the decision making process and require specialized knowledge. This project is an attempt to bring some of these micro-environmental sources of information into the decision making process of agriculture.

2. Problem definition

The process of utilizing technology in agriculture and cultivation requires deep knowledge of agricultural processes, biology, chemistry, and empirical knowledge. There are many parameters which must be taken into consideration and investigated in depth when designing a system that should improve cultivation procedures by making the whole process more effective and sustainable. In order to design and build a precision agriculture system that can be widely used by many users and applied in different contexts, many questions need to be addressed. Some of these questions are:

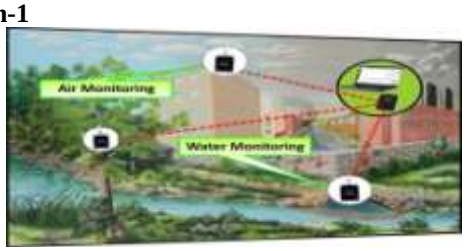
1) Is it feasible to design a system that will accommodate every possible scenario in an agricultural context and do so for all possible users?
2) Is automation in agriculture really useful and in what part or parts of the cultivation process (e.g. seed planting, growing, harvesting, selling) can it be applied?
3) What is the cost of the cultivation process and how can this cost be reduced by automating one or more parts of this process?
4) What is the most costly component of this process that could be reduced? How and how much this cost could be reduced?
5) Are geographic parameters such as location, altitude, solar exposure, ground and air moisture, ground and air temperature, mineral content of the soil, the (micro-) climate, or the season, sufficient to make a significant difference in the way that a crop is cultivated?
6) What are the sensitivities of the crop that should be taken care of when agriculture?
7) What types of plants are to be planted and how long will this crop be planted in this location? What is the planned rotation of seeds? What are the plans for applying fertilizer to this location? What is the level of the agriculture's empirical knowledge?
8) Are there any abnormalities regarding the location, season of the year, previous crops in a specific field, or a combination of all these aspects which need to be considered as part of an informed decision making procedure by the agriculture?

Today, these open questions cannot be answered with confidence even by experts. Agricultural science is a multidisciplinary field and all of the above aspects need to be taken into account when making decisions about cultivation of a field on a farm. Furthermore, research in agricultural science is strongly related to local areas. Climate and soil properties vary from one place to another and from time to time. Climate change and transformation of the plants and soil occur as time passes, thus making successful and sustainable cultivation a tough process for someone who does not know the specific aspects of the locality and how the process needs to evolve over time in this specific geographical and microclimatic area.

Goals

The need for intelligent farming especially in developing countries like India has grown to a greater extent. Moreover, research in area of Zigbee based wireless sensor network in agriculture, such as monitoring of environmental conditions like weather, soil moisture content, temperature and monitoring growth of the crop, precision agriculture, automated irrigation facility has taken a new dimension. Nowadays, awareness about implementing technology for agricultural environment has been increased. Manual collection of data for desired factors can be sporadic, not continuous and produce variations from incorrect measurement taking. This can cause difficulty in controlling environmental important factors. Wireless distinct sensor nodes can reduce time and effort required for monitoring the environment. The logging of data allows for reduction of data being lost or misplaced. Also it would allow placement in critical locations without the need to put personnel in hazardous situations. Monitoring systems can ensures quicker response times to adverse factors and conditions. The utilization of proposed technology would allow for remote measurement of factors such as temperature, humidity, soil moisture, water level. The purpose of proposed system is to improve the irrigation system of Indian agriculture and also to provide adequate irrigation to particular area. Now-a-days every system is automated in order to face new challenges. In the present days automated systems have less manual operations, flexibility, reliability and accuracy. Due to this demand every field prefers automated control systems. Especially in the field of electronics automated systems are giving good performance. And this is realized by making use of Zigbee technology for communication. In this aspect now days the whole world is in our palm, due to IOT concept (Internet Of Thing), WSN, Arduino board, Zigbee Technology using various sensor like Gas Sensor, Humidity Sensor and Temperature Sensor.

Diagram-1



Agricultural Monitoring System Using Various Sensor linked with Cloud

Technology

In the concept of WSN, the new technology has been arise which is implemented on Agricultural Monitoring System are, 1) ARDUINO Circuit Board, 2) XBees- Zigbee S2c.

ARDUINO Circuit Board:

Arduino/Genuino Uno is a microcontroller board based on the ATmega328P (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.. You can tinker with your UNO without worrying too much about doing something wrong, worst case scenario you can replace the chip for a few dollars and start over again.

Uno" means one in Italian and was chosen to mark the release of Arduino Software (IDE) 1.0. The Uno board and version 1.0 of Arduino Software (IDE) were the reference versions of Arduino. The Uno board is the first in a series of USB Arduino boards, and the reference model for the Arduino platform; for an extensive list of current, past or outdated boards see the Arduino index of boards.

Specification for Arduino

Brand Name	:	Arduino
Ean	:	7839426056000
Is Assembly Required	:	No
Item Weight	:	50 grams
Material Type	:	Copper
Part Number	:	R3
Special Features	:	Microcontroller

ATmega328P, Operating Voltage 5V, Input Voltage (recommended) 7-12V , Input Voltage (limit) 6-20V , Digital I/O Pins 14 (of which 6 provide PWM output) , PWM Digital I/O Pins 6 , Analog Input Pins 6 , DC Current per I/O Pin 20 mA , DC Current for 3.3V Pin 50 mA , Flash Memory 32 KB (ATmega328P) of which 0.5 KB used by bootloader

XBees – Zigbee S2C:
XBee ZB / ZigBee modules provide cost-effective wireless connectivity to devices in ZigBee mesh networks. Utilizing the ZigBee PRO Feature Set, these modules are interoperable with other ZigBee devices, including devices from other vendors. The most common factor in determining whether to use ZB is the potential need to tie-in with other ZigBeecompatible networks or mesh networking. If this is not a requirement, the series 1 802.15.4 modules may be perfectly suitable for your project.

Application Area
*Remote Industrial Monitoring System
*Agricultural Monitoring System.
*Long range remote control
*Wireless Networking

XBees S2C-Zigbee S2C Image and MAC Address:

Zigbee S2C Low power Module and MAC Address
Note: Because XBee modules have 2 mm pin spacing, we recommend one of our adapter boards for each module. Our adapter boards provide several advantages to the XBee modules such breadboardfriendly standard 0.1 inch pin spacing, mounting holes, and easy-to-solder connections. Even if you are communicating point-to-point without a PC, its still recommend that a user always have at least one XBee USB Adapter Board (# 32400) so that one can easily configure and test each XBee module prior to putting it in a point-to-point application.

These are the elements normally needed for the layout design for Agricultural Monitoring System.

3. Overview of Zigbee Technology

IEEE 802.15.4:
Abbreviation of Institute of Electrical and Electronics Engineers, pronounced I-triple-E. Founded in 1884 as the AIEE, the IEEE was formed in 1963 when AIEE merged with IRE. IEEE is an organization composed of engineers, scientists, and students. The IEEE is best known for developing standards for the computer and electronics industry. In particular, the IEEE 802 standards for local-area networks are widely followed. ZigBee Technology is one of such progression in wireless technology. Wireless is not a new technology as wireless networking and wireless internet are already in use; yet ZigBee technology set a new aspect in wireless technology. That's why it's usually referred as ZigBee Wireless Technology. Day by day advancement in technology is introducing novel and supportive devices which are used to make life easier and ZigBee Technology is one of them.

To better understand the ZigBee technology it is necessary to know what is ZigBee Technology? It is based on "MICA2DOT433MHz" which is a lowpower frequency, works like a Bluetooth and uses the features of wireless networking. Keep in mind the plus points of each three you can evaluate its worth. Using the networking system ZigBee Technology can connect machines and control through one connection whiles consuming less power. So ZigBee is the cost-effective wireless technology for controlling and monitoring.

Zigbee Technology Features:
ZigBee technology has many useful features and characteristics and these features of ZigBee technology are the reason of its increase demand in the commercial zone particularly in commercial and residential at time lesser but prospects are better.

ZigBee technology allows wireless networking to connect several units to control through one button like in business

industry. This wireless networking avoids the threat of short circuiting. Centralization control system reduces the man power. As a wireless communication system ZigBee technology helps to monitor the activities and manipulates in a better way.

ZigBee technology used in the remote control devices helps to control the function at a specific range. This feature of ZigBee Technology is very attractive and effortless as all the home appliances are mostly coming with remote control system which is the essence of this ZigBee wireless technology. In industry all the units are centralized in one place with the help of remote control or switch-based system. As ZigBee technology based devices are designed on low-power frequency therefore are reliable. Lowpower consumption feature of ZigBee technology helps to run a device for a long duration or sometimes this duration is of years.

Bluetooth application gives a unique feature of transferring information or data from one place to another in a far better way than Bluetooth itself.

Device type and Operating Mode
Zigbee technology is used in three different types of devices which are used in networking according to its functionality.

As prominently ZigBee is a wireless technology for making a network system, Zigbee coordinators (ZC): are the primary devices to help in activation of the system by collecting the data in form of memory.

Zigbee Router (ZR): Then router comes as a secondary device to perform the function by sending information to the destination.

Zigbee End Device (ZED): Third types of ZigBee based devices are the end-user devices.
These are basically receiver so are not able to send information itself. It remains in sleep mode while not in use so less amount of battery us and resultantly longer life.

ZigBee is the set of specifications built around the IEEE 802.15.4 wireless protocol. ZigBee technology is a low data rate, low power consumption, low cost, wireless networking protocol targeted towards automation and remote control applications ZigBee is a communication protocol that uses small, lowpower digital radio signals based on the IEEE 802.15.4 standard.ZigBee operates in ISM radio bands: In USA 915 MHz, in Europe 868 MHz and 2.4 GHz in other parts of the globe. In the 2.4 GHz band there are 16 ZigBee channels, with each channel requiring 2 MHz of bandwidth. The most capable ZigBee node type is said to require only about 10typical Bluetooth or Wireless Internet node, while the simplest nodes are about 2However, actual code sizes are much higher, closer to 50transmission range of Zigbee is over 50 meters and speed is 20-250KB/s, it needs only 32K of system resources. It is simple, effective and cheaper than other WPANs like bluetooth, WiFi. ZigBee solves the needs of remote monitoring and control, and sensor network applications. It takes full advantage of a powerful physical radio specified by IEEE802.15.4, adding logical network, security and application software to the specification. Zigbee based on the IEEE 802.15.4 standard physical layer (PHY) and media access control layer (MAC) which ZigBee defines a system of high-level, including the network layer (NWK), application layer (APL) and security services specification. Each layer is responsible for completion of the task, and provides services to upper layer, the interface between the layers communicate by the defined logical link, of which application layer also provides many other services to enhance the properties of the network self-organization, dynamic management features and secure.ty. ZigBee‟s frequency bands is 2.4GHZ, Europe (868MHZ) and the United States (915MHZ) are free to apply band [2]. Table 1 shows the radio specification of IEEE 802.15.4. ZigBee can establish reliable, open and global standards. As the duty cycle is very short, send and receive messages with lower power consumption, so under normal circumstances, two 1.5V batteries can be support to six months to two years. It achieves energy-saving effect and provides a rich application space.

Works of Zigbee:
ZigBee is a specification for a suite of high level communication protocols using small, low-power digital radios based on the IEEE 802.15.4-2003 standard for wireless personal area networks (WPANs), such as wireless headphones connecting with cell phones via short-range radio. The technology defined by the ZigBee specification is intended to be simpler and less expensive than other WPANs, such as Bluetooth. ZigBee is targeted at radio-frequency (RF) applications that require a low data rate, long battery life, and secure networking. The ZigBee Alliance is a group of companies which maintain and publish the ZigBee standard.

The current list of application profiles either published or in the works are: Home Automation
1) ZigBee Smart Energy
2) Telecommunication Applications
3) Personal Home and Hospital Care (a.k.a. medical)

The relationship between IEEE 802.15.4 and ZigBee is similar to that between IEEE 802.11 and the WiFi Alliance. The ZigBee 1.0 specification was ratified on 14 December 2004 and is available to members of the ZigBee Alliance. Most recently, the ZigBee 2007 specification was posted on 30 October 2007. The first ZigBee Application Profile, Home Automation, was announced 2 November 2007.

The purpose of proposed system is to improve the irrigation system of Indian agriculture and also to provide adequate irrigation to particular area. Nowadays every system is automated in order to face new challenges. In the present days automated systems have less manual operations, flexibility, reliability and accuracy. Due to this demand every field prefers automated control systems. Especially in the field of electronics automated systems are giving good

performance. And this is realized by making use of Zigbee technology for communication [16].

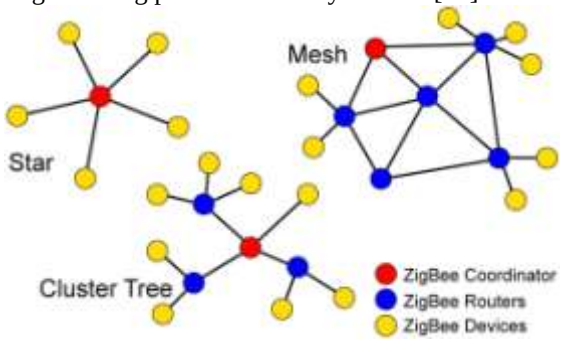
Zigbee Based on the IEEE 802.15.4 standard physical layer (PHY) and media access control layer (MAC) which ZigBee defines a system of high-level, including the network layer (NWK), application layer (APL) and security services specification. Each layer is responsible for completion of the task, and provides services to upper layer, the interface between the layers communicate by the defined logical link, of which application layer also provides many other services to enhance the properties of the network self-organization, dynamic management features and security. ZigBee"s frequency bands is 2.4GHZ, Europe (868MHZ) and the United States (915MHZ) are free to apply band [17]. Table 1 shows the radio specification of IEEE 802.15.4. ZigBee can establish reliable, open and global standards. As the duty cycle is very short, send and receive messages with lower power consumption, so under normal circumstances, two 1.5V batteries can be support to six months to two years. It achieves energy-saving effect and provides a rich application space.

Table 1: Radio Specification:→

	CSMA MAC	IEEE 802.15.4
Frequency Band	315/433/868/916 MHz	2.4 GHz
Data Rates	20-50 kbps	250 kbps
Range	300m outdoor	125m

ZigBee Topology

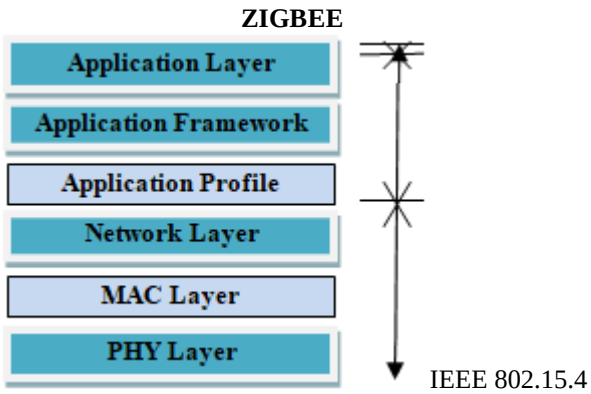
Zigbee supports three topologies, namely, (i) star, (ii) mesh and (iii) cluster-tree as display in below image -1. In star topology, each zed or end node is connected to the coordinator and communication is carried out by Zigbee Coordinator (ZC). In mesh topology, each device communicates with any other device within its radio range or through multi-hop. In cluster tree topology, there is a single routing path between any devices [18].



Zigbee Topolog

Zigbee Framework

ZigBee framework is made up of a set of blocks called layers. Each layer performs a specific set of services for the layer above. As shown in image 2. The IEEE 802.15.4 standard defines the two lower layers: the physical (PHY) layer and the medium access control (MAC) layer. The ZigBee Alliance builds on this foundation by providing the network and security layer and the framework for the application layer. The IEEE 802.15.4 has two PHY layers that operate in two separate frequency ranges: 868/915 MHz and 2.4GHz. Moreover, MAC sublayer controls access to the radio channel using a CSMA-CA mechanism. Its responsibilities may also include transmitting beacon frames, synchronization, and providing a reliable transmission mechanism.



Zigbee Framework Image

Proposed System Design:

The Proposed System design consists of transmitter as well as receiver. The Proposed block diagram of transmitter and receiver is shown in image 3. Transmitter section consist of different type of sensing unit such as temperature, humidity, gas as well as the water level of well. Microcontroller for time domain multiplexing i.e. multiplexing the data
Application Layer
Application Framework
Application Profile
Network Layer
MAC Layer
PHY Layer

Obtained from different type of sensor as well as for converting the analog data into digital one.

PWM Digital I/O Pins : 6
Analog Input Pins : 6
DC Current per I/O Pin : 20 mA
DC Current for 3.3V Pin : 50 mA
Flash Memory : 32KB (ATmega328 P) of which 0.5 KB used by bootloader
SRAM : 2 KB (ATmega328 P)
EEPROM : 1 KB (ATmega328 P)
Clock Speed : 16 MHz
LED_BUILT IN : 13
Length : 68.6 mm
Width : 53.4 mm
Weight : 25 g

Documentation

OSH: Schematics, Reference Design, Board size
Arduino / Genuino Uno is open-source hardware

Temperature Sensor:

The LM35 is an integrated circuit sensor that can be used to measure temperature with an electrical output proportional to the temperature (in oC). It is used to measure temperature more accurately than a using a thermistor. The sensor circuitry is sealed and not subject to oxidation. The LM35 generates a higher output voltage than thermocouples and may not require that the output voltage be amplified. This sensor is used to monitor surrounding temperature. It gives the idea about the increase or decrease in the temperature of

surrounding. If the temperature changes it is observed on LCD.

Temperature LM35 Sensor

Humidity Sensor:
Humidity is an expression of the amount of water vapour in air. It is an invisible gas that varies between 1 - 4% of our atmosphere by volume. SYHS-220 sensor module converts relative humidity (3090%RH) to voltage and can be used in weather monitoring application. This sensor is used to monitor humidity i.e. moisture present in the surrounding.

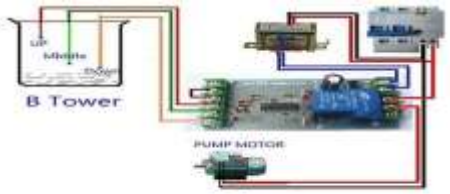
Humidity Sensor

Gas Sensor-ePro Labs MQ-5:
The Grove - Gas Sensor(MQ5) module is useful for gas leakage detection (in home and industry). It is suitable for detecting H2, LPG, CH4, CO, Alcohol. Due to its high sensitivity and fast response time, measurements can be taken as soon as possible. The sensitivity of the sensor can be adjusted by using the potentiometer. This is an Analog output sensor. This needs to be connected to any one Analog socket in Grove Base Shield. The examples used in this tutorial makes uses of A0 analog pin. Connect this module to the A0 port of Base Shield.

It is possible to connect the Grove module to Arduino directly by using jumper wires by using the connection.
Different types of Gas Sensor:
Sensor : Gas Type
MQ2 : Combustible Gas, Smoke
MQ3 : Alcohol Vapor
MQ5 : LPG, Natural Gas, Town Gas
MQ9 : Carbon Monoxide, Coal Gas, Liquefied Gas

Gas MQ-5 Sensor

Water Level Detector:
This is used to detect/sense the water level of the well. The sensor will detect the amount of water present in the well. If the water level goes below minimum level or above maximum level a control signal is send to LCD. In addition to this a message is send to an observer situated at the remote place.

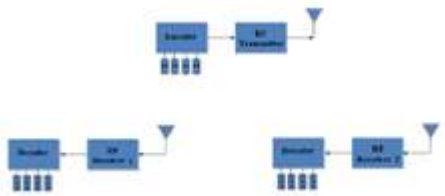


Water Level detector

Zigbee Module:
The XBee RF Modules are designed to operate within the ZigBee protocol and support the unique needs of low-cost, low-power wireless sensor networks. The modules require minimal power and provide reliable delivery of data between remote devices. The modules operate within the ISM 2.4 GHz frequency band. It operates over a range of 100- 200 meters.Image-8, shows the zigbee module.

Zigbee Module

The receiver block diagram is shown in image-9. The receiver module consists of an Xbee RF module which is connected to computer system through MAX232.Thus the monitoring data received by Zigbee module is directly transferred to computer .



Receiver Block Diagram

Description Software

X-CTU stands for XTRA Intermodal. X-CTU is a Windows-based application provided by Digi‟s. This program was designed to interact with the firmware files found on Digi‟s RF products and to provide a simple-to-use graphical user interface to them. XCTU is designed to function with all Windows-based computers running Microsoft Windows 98 SE and above. XCTU is a free multi-platform application designed to enable developers to interact with Digi RF modules through a simple-to-use graphical interface. It includes new tools that make it easy to set-up, configure and test XBee® RF modules. XCTU includes all of the tools a developer needs to quickly get up and running with XBee.

Unique features like graphical network view, which graphically represents the XBee network along with the signal strength of each connection, and the XBee API frame builder, which intuitively helps to build and interpret API frames for XBees being used in API mode, combine to make development on the XBee platform easier than ever.

Other highlights of XCTU include the following features:

You can manage and configure multiple RF devices, even remotely (over-the-air) connected devices.
The firmware update process seamlessly restores your module settings, automatically handling mode and baud rate changes. Two specific API and AT consoles, have been designed from scratch to communicate with your radio devices.
You can now save your console sessions and load them in a different PC running XCTU.
XCTU includes a set of embedded tools that can be executed without having any RF module connected:
Frames generator: Easily generate any kind of API frame to save its value. Frames interpreter: Decode an API frame and see its specific frame values.
Recovery: Recover radio modules which have damaged firmware or are in programming mode.
Load console session: Load a console session saved in any PC running XCTU.

Installing X-CTU
Once X-CTU has been downloaded, the next step is to install the program. When the program asks for updating from Digi, we must answer 'yes' so as to download all the firmware versions for all the XBee modules.

Zigbee Module
Configuring X-CTU
When X-CTU has been properly installed, the Waspmote Gateway can be connected to the computer. It will be recognized as a 'USB Serial Port'. We have to know the COM number given to this device in order to specify it in the X-CTU (in our test, COM1 was the value given by Window.

Finally, we launch X-CTU and the program will start. A window like the one below will appear, showing the different functions and the different COM ports detected.

Step 1
Select the COM ports where you've connected the USB adapters. To confirm you can verify your DEVICE MANAGER for the proper COM ports.

X-CUT

Step-2:
Click on NEXT & accept the default PORT PARAMETERS. 96008N1 is the default. 9600 is the BAUD RATE, 8 Data Bits, No Parity & 1 Stop bit.

X-CTU

Step-3:
Click on FINISH. The XCTU scans the USB ports selected & lists the RADIOs found with their unique 64 bit address.

X-CUT

Step-4:
Select both the devices & click ADD SELECTED DEVICES. Now both the Radios appear on the left pane.

X-CUT

Step-5:
Let us configure the RADIO at COM3 as COORDINATOR first. For this click on the COM3 RADIO to load the module settings.

X-CUT

Step-6:
Once the parameter settings are loaded you can see that the product family is XB24C (in case of old S2 it is XB24-ZB & of S1 is 802.15.4) The function set of Firmware is ZIGBEE TH Reg , the Reg stands for Regular & not PRO. TH stands for THROUGH HOLE & not SMD.

X-CUT

Step-7:
First thing is to set the PAN ID of the Network. This can be from 0 to FFFF hex.In my case I'm setting it to 1234.The other Radios also to be set in the same PAN ID. Scroll down further & Enable the CE (Coordinator Enable)

X-CUT

Step-8:
The Destination address DH is left to default 0. The Destination Address DL is set to hex FFFF which makes the Radio work on BROADCAST mode, so that it can communicate with all Radios in the same PANID. The Node Identifier can be given any name like "Coordinator". This naming is optional.

X-CUT

Step-9:
Click on the PENCIL icon on top to WRITE the changes made.

X-CTU

Step-10:
Now let us configure the second Radio as ROUTER. Click on the second Radio on the left pane to load the settings.

X-CUT

Step-11:
The Router setting is quite simple. Enter the PANID as 1234 , same as that of Coordinator.

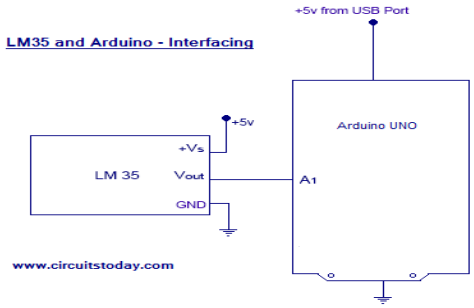
X-CUT

Software design flow for the proposed system:
A simplified operational flow is shown in IMAGE21(A), shows the sensor unit and IMAGE-21(B) Microcontroller section. The sensor unit will sense temperature, humidity moisture, and toxic gas present in the air from the remote place and send the data to microcontroller. For the water level of well is string value „n" given it will start the motor and if „m" given then it will stop the motor pump. In the microcontroller section firstly initiations take place for ADC, UART, and I2C. Then microcontroller receives data from sensor unit and start analog to digital conversion. After ADC conversion completion the data will be displayed on LCD and signal is send to zigbee module for wireless transmission at the receiver section. At the receiver section zigbee module is interface with computer with the help of Max232 and DB9. The data received from transmitter section will be displayed on computer.

4. Simulation Process

Coding for temperature sensor

We are using Arduino Uno as our board and LM35 can be connected to arduino as shown in circuit diagram. Note:- LM35 is an analog temperature sensor. This means the output of LM35 is an analog signal. Microcontrollers dont accept analog signals as their input directly. We need to convert this analog output signal to digital before we can feed it to a microcontroller's input. For this purpose, we can use an ADC(Analog to Digital Converter).If we are using a basic microcontroller like 8051, we need to use an external ADC to convert analog output from LM35 to digital. We then feed the output of ADC (converted digital value) to input of 8051. But modern day boards like Arduino and most modern day micro controllers come with inbuilt ADC. Our arduino uno has an in built 10 bit ADC (6 channel). We can make use of this in built ADC of arduino to convert the analog output of LM35 to digital output. Since Arduino uno has a 6 channel inbuilt ADC, there are 6 analog input pins numbered from A0 to A5. Connect analog out of LM35 to any of these analog input pins of arduino.



LM35 and Arduino – Circuit Diagram

Connect LM35 to Arduino uno as shown in circuit diagram. The +5v for LM35 can be taken from the +5v out pin of arduino uno. Also the ground pin of LM35 can be connected to GND pin of arduino uno. Connect Vout (the analog out of LM35) to any of the analog input pin of arduino uno. In this circuit diagram, we have connected Vout of LM35 to A1 of arduino.

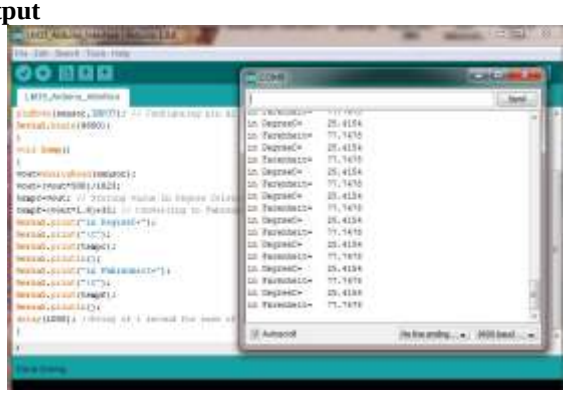
Note:-
LM35 is available in the market in 3 series variations – LM35A, LM35C and LM35D series. The main difference between these 3 versions of LM35 IC are in their range of temperature measurements. The LM35D series is designed to measure from 0 degree Celsius to 100 degree Celsius, where as the LM35A series is designed to measure a wider range of -55 degree Celsius to 155 degree Celsius. The LM35C series is designed to measure from -40 degree Celsius to 110 degree Celsius.

In our LM35 arduino example, we are using the LM35Dz sensor- which falls under LM35D series. So our min-max range of temperature measurement is 0 degree Celsius to 100 degree Celsius.

The Coding – LM35 and Arduino Interfacing
const int sensor=A1; // Assigning analog pin A1 to variable 'sensor' float tempc; //variable to store temperature in degree Celsius float tempf; //variable to store temperature in Fahreinheit float vout; //temporary variable to hold sensor reading void setup() { pinMode(sensor,INPUT); // Configuring pin A1 as input Serial.begin(9600); } void loop() { vout=analogRead(sensor); vout=(vout*500)/1023; tempc=vout; // Storing value in Degree Celsius tempf=(vout*1.8)+32; // Converting to Fahrenheit Serial.print("in DegreeC="); Serial.print("\t"); Serial.print(tempc); Serial.println(); Serial.print("in Fahrenheit="); Serial.print("\t"); Serial.print(tempf); Serial.println(); delay(1000); //Delay of 1 second for ease of viewing }

START
Measure Temp, Humidity and Gas
Send data to MCU
Initiali se ADC, I2C.
MCU Receive data from sensor unit.
ADC Conversion Finish?
Display Result On LCD
Send signal to Zigbee for Transmission
So that's the arduino lm35 code for reading temperature and displaying in degree Celsius and Fahrenheit. The program is self explanatory.

Output



Output Image

Humidity Sensor Coding

The DHT11 humidity and temperature sensor makes it really easy to add humidity and temperature data to your DIY electronics projects. It's perfect for remote weather stations, home environmental control systems, and farm or garden monitoring systems.

Here are the ranges and accuracy of the DHT11:
1) Humidity Range: 20-90% RH
2) Humidity Accuracy: ±5% RH
3) Temperature Range: 0-50 °C
4) Temperature Accuracy: ±2% °C
5) Operating Voltage: 3V to 5.5V

The DHT11 measures relative humidity. Relative humidity is the amount of water vapor in air vs. the saturation point of water vapor in air. At the saturation point, water vapor starts to condense and accumulate on surfaces forming dew. The saturation point changes with air temperature. Cold air can hold less water vapor before it becomes saturated, and hot air can hold more water vapor before it becomes saturated. Before you can use the DHT11 on the Arduino, you'll need to install the DHTLib library. It has all the functions needed

to get the humidity and temperature readings from the sensor. It's easy to install, just download the DHTLib.zip file below and open up the Arduino IDE. Then go to Sketch>Include Library>Add .ZIP Library and select the DHTLib.zip file.

After it's installed, upload this example program to the Arduino and open the serial monitor:

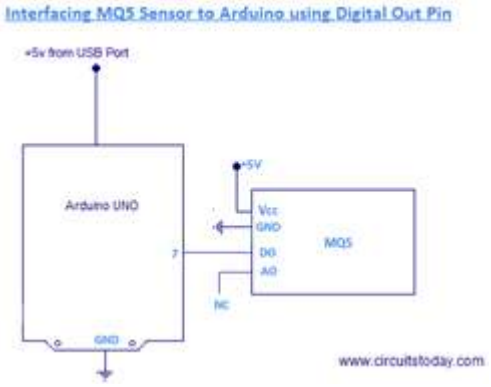
```
#include <dht.h>
dht DHT;
#define DHT11_PIN 7
void setup(){
Serial.begin(9600); }
void loop() {   int chk = DHT.read11(DHT11_PIN);
Serial.print("Temperature=");
Serial.println(DHT.temperature);
Serial.print("Humidity= ");
 Serial.println(DHT.humidity);   delay(1000);
 }
```

Gas Sensor Coding (MQ-5)

We have developed a Gas Leakage Detector using Arduino and MQ5 with SMS Alert, Sound Alarm and Relay activation. You can try this interesting project to gain more knowledge and build a practical application using MQ5 sensor.

Interfacing MQ5 Gas Sensor Module to Arduino using Digital Out Pin This is pretty simple. Connect the D0 pin of MQ5 module to any digital pin of arduino. Lets connect D0 to pin 7 of arduino. Now we need to give power supply (Vcc) and complete the circuit by connecting to ground (Gnd). Refer the circuit diagram given below. Take a +5V connection from arduino and connect it to Vcc of MQ5 module. Finally connect the GND pin of MQ5 module to GND of arduino. That's all and we have finished the circuit.

Circuit Diagram of Interfacing MQ5 to Arduino (Digital Out)



Note:-

MQ5 sensor has preheating requirement. We advise to keep the sensor powered on (from arduino) for some 15 minutes before applying gas to it.

CODING:

```
int sensor=7;
int gas_value;
void setup()
{
pinMode(sensor,INPUT);
Serial.begin(9600);
 }
void loop()
{gas_value=digitalRead(sensor); Serial.println(gas_value); }
```

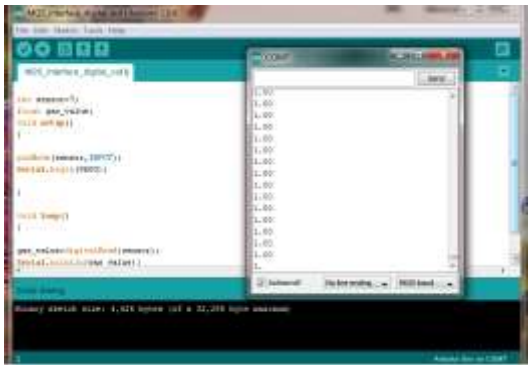
Note:-

To apply a "gas leak" to MQ5 sensor, you can simply use a cigarette or cigar lighter! Press the trigger switch of cigarette lighter gently (gentle enough so as gas leaks and spark is not triggered) to get gas leaked continuously and place the lighter near MQ5 sensor.

Image

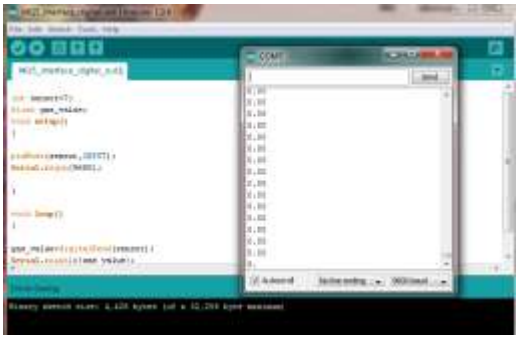
Output: Simulation Output Result

The screenshots below shows serial monitor readings of arduino before applying gas leak and after applying gas leak. Before applying gas leak, MQ5 captures atmospheric air concentration only (we get a HIGH in our digital out pin and is measured by arduino as 1, as shown in serial monitor).



When we apply a "gas leak", the heating element inside MQ5 gets heated up and output voltage varies (we get a LOW in our D0 pin and is measured by arduino as 0, as shown in serial monitor output screenshot)

Output



5. Future Work Based on Conclusion

The System is designed for the betterment of farmers. The uses of smart sensor based monitoring system for agriculture have been used to increase the yield of crop by monitoring the environmental conditions and providing information to observer. It would be a promising technology for the agriculturists all over the world in the present scenario of unpredicted weather conditions.

References

[1] A Survey on Centralised and Distributed Clustering Routing Algorithms for WSNs (PDF). IEEE 81st Vehicular Technology Conference. Glasgow, Scotland: IEEE. Spring 2015. Retrieved March 4, 2016.
[2] I. F. Akyildiz and I.H. Kasimoglu (2004). "Wireless Sensor and Actor Networks: Research Challenges".
[3] Dargie, W. and Poellabauer, C. (2010). Fundamentals of wireless sensor networks: theory and practice. John Wiley and Sons. pp. 168–183, 191–192.
[4] Sohraby, K., Minoli, D., Znati, T. (2007). Wireless sensor networks: technology, protocols, and applications. John Wiley and Sons. pp. 203–209.
[5] Zhizhou Wu, Hao Chu, Yuqi Pan, Xiaoguang Yang, "Bus Priority Control System Based on Wireless Sensor Network (WSN) and Zigbee", IEEE International Conference on Vehicular Electronics and Safety, pp. 148 – 151, 2006.
[6] Wanjing MA, Xiaoguang YANG,"Design and Evaluation of an Adaptive Bus Signal Priority System Base on Wireless Sensor Network", IEEE Proceedings of the 11th International Conference on Intelligent Transportation Systems, pp. 1073- 1077, 2008.
[7] Le et al. proposed an approach to construct a shortest path tree for each sink and dynamically adjust to balance the load among sinks. These works are based on real systems, but do not provide theoretical insight into maximization of lifetime.
[8] Dijun et al. studied the problem of finding an optimal shortest path tree to prolong the lifetime of the network, when in network aggregation is used.
[9] Y. Wu et al. considering the energy depletion in transmitting and receiving messages, which are the two major energy consuming operations.
[10] Yang et al. proposed Turbo-Like (TL) codes with two simplified serial message passing algorithms for star-WSN.
[11] Imad et al. proposed a new routing method for WSNs to extend network lifetime using a combination of a fuzzy approach and an A-star algorithm.
[12] A.S el al.proposed two schemes for key management in clustered sensor networks with changing cluster head. In Simple Secure Logical Ring (SSLR) scheme communication and computation cost incurred for key establishment is constant. Node compromise in the proposed schemes is handled efficiently.
[13] Zhi et al.proposed algorithm considers remaining energy when selecting cluster heads and uses multiround clustering instead of clustering in every round. Algorithm performs better in reducing the energy consumption of nodes and effectively.
[14] Riggio et al.proposed an hybrid mesh/sensor network architecture based on a sharing of tasks between mesh routers and sensor nodes and reduce the network load while preserving data confidentiality and integrity.
[15] Thuy et al. proposed a multipath solution for event-driven clusterbased routing in WSN called EnergyAware Mesh Routing Protocol (EMRP) with main design features: reliable data transmission, load balance and energy efficiency.
[16] T.Kalaivani, Aallirani, P.Priya, "A Survey on Zigbee Based Wireless Sensor Networks in Agriculture": Department of ECE, 2011 IEEE.
[17] Wang Qing Hui, Bian Li Juan, Pang Yu jun, "Design of the temperature monitoring system based on ZigBee wireless sensor network College of Information Technology", 2011 IEEE.
[18] Huang Feng Yi. Design of the temperature monitoring system based on ZigBee wireless sensor network (Master thesis) [J] Shanghai Jiao Tong University, 2010.
[19] Yu Chengbo, Cui Yanzhe, Zhang Lian, Yang Shuqiang, "ZigBee Wireless Sensor Network in Environmental Monitoring Applications", 2009 IEEE.
[20] Swarup S. Mathurkar, D. S. Chaudhari, "A Review on Smart Sensors Based Monitoring System for Agriculture", Volume-2, Issue-4, March, IJITEE 2013.
[21] ww1.microchip.com "PIC 16F87X Datasheet" [7] Mohini Reddy, Vidya Sawant WSN based.
[22] Mohini Reddy, Vidya Sawant WSN based Parameter Monitoring and Control System for DC Motor. Volume-3, Issue-9, February 2014