CHAPTER ONE

Introduction

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1.1Preface:

A wireless sensor network (WSN) is a collection of nodes organized into a cooperative network. Each node consist of processing capability (one or more microcontrollers, CPUs, or DSP chips), may contain multiple types of memory (program, data and flash memories).it have an RF transceiver (usually with single omnidirectional antenna), have a power source(batteries and solar cells), and accommodate various sensors and actuators. The nodes communicate wirelessly and often self-organize after being deployed in an ad hoc fashion.[1]

Wireless sensors nodes are equipped with sensor unit, processing unit, communication unit and power unit. Each and every node is capable to perform data gathering, sensing, processing and communicating with other nodes. The sensing unit senses environment, the processing unit computes the confined permutations of the sensed data, and the communication unit performs exchange of processed information among neighboring sensor nodes.[1]

Now a day's wireless network is the most popular services utilized in industrial and commercial applications, because of its technical advancement in processor, communication, and usage of flow power embedded computing devices. Sensor nodes are used to monitor environmental condition like temperature, pressure, humidity, sound, vibration, position.[2]

There are many application of wireless sensor network WSN such as the following:

1. Process Management: Area monitoring is a very common using WSNs. In area monitoring, the WSN is deployed spanning a region where some phenomenon is usually to be monitored.
2. Healthcare monitoring: The medical applications might be of two sorts: wearable and implanted. Wearable devices are applied to the body surface of the human or maybe at close proximity from the user.
3. Environmental/Earth sensing.
4. Polluting of the environment monitoring: Wireless sensor networks have been deployed in lots of cities (Stockholm, London and Brisbane) to monitor the power of dangerous gases for citizens.
5. Forest fire detection: A network of Sensor Nodes is usually positioned in a forest to detect every time a fire has begun. The nodes is usually with sensors to measure temperature, humidity and gases which are produced by fire within the trees or vegetation.
6. Water quality monitoring: Water quality monitoring involves analyzing water properties in dams, rivers, lakes & oceans, and also underground water reserves.
7. Monitoring stations in locations of difficult access, while not manual data retrieval.
8. Natural disaster prevention: Wireless sensor networks can effectively act to avoid the results of disasters, like floods.
9. Industrial monitoring.[3]

There are many Advantages of WSN such as the following:

1. Network setups can be carried out without fixed infrastructure.
2. Suitable for the non-reachable places such as over the sea, mountains, rural areas or deep forests.
3. Flexible if there is random situation when additional workstation is needed.
4. Implementation pricing is cheap.
5. It avoids plenty of wiring.
6. It might accommodate new devices at any time.
7. It's flexible to undergo physical partitions.
8. It can be accessed by using a centralized monitor.[3]

1.2 Problem statement:

There is a lot of geological hazards in the world affect people's lives and property, and earthquakes of more causes of disasters as they occur suddenly, and can cause great destruction and loss of life. For this reason we need for system that can discover the seismic. The current system for discovering seismic across wireless network need for feeding by large batteries and generators which will be effect in accuracy and work of device.

1.3 Proposed solution:

Design a system that can discover the seismic by using a certain types of sensors and it able to estimate the position of earthquakes.

1.4 Aim and objectives:

- To make a wireless communication link between TX and RX.
- To use simple chips to reduce the cost.
- To maximize the warning time.
- To minimize the number of stations.

1.5 Methodology:

WSN is used that the sensors can sense the seismic, so numbers of sensors were putted to cover a certain area. And when the number of sensors are increased will have an accurate information about determine the position of earthquakes. When the earthquakes occurs these sensors send waves(primary and secondary waves)with high intensity and some of calculations are achieve to determine the situation. These sensors are related with communication system, its role that send the information to the base station (by using XBee/zigbee) to communicate, and also need to big battery to feed the terminal station. And to relate all of them the aurdiono program is used.

1.6 Research outlines:

Chapter one Includes preface of WSN, problem statement, proposed solution, aim and objectives, and methodology. Chapter two includes background of seismology, history of seismology, types of seismic waves, seismic sensors, types of seismic network, and seismic in Sudan.

Chapter three include component of a system design such as arduino, battery connect and sound sensors, and also include communication component such as XBEE module and XBEE shield. Chapter four includes the design and results, and chapter five includes the conclusion and recommendations.

CHAPTER TWO

LITERATURE REVIEW

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LITERATURE REVIEW

2.1 Background:

Every day there are about fifty earthquakes worldwide that are strong enough to be felt locally, and every few days an earthquake occurs that is capable of damaging structures. Each event radiates seismic waves that travel throughout earth, and several earthquakes per day produce distant ground motions that, although too weak to be felt, are radially detected with modern instruments anywhere on the globe.[4]

Seismology is a science that study of earthquakes and seismic waves and what they tell us about earth structure. Seismology is a data-driven science and it is most important discoveries usually result from analysis of new data sets or development of new data analysis methods. Most seismologists spend most of their time studying seismograms, which are simply a record of earth motion at a particular place as function of time.[5]

Seismology occupies an interesting position within the more general fields of geophysics and earth science.it presents fascinating theoretical problems involving analysis of elastic waves propagation in complex media, but it can also be applied simply as a tool to examine different areas of interest.[4]

An earthquake generates a series of waves that penetrate the earth and, depending on magnitude can be detected by sensitive instruments thousands of miles from the epicenter. The motion of the ground tells us what type of seismic wave arrived. Though its animate individual wave paths, remember

that like sound waves, seismic waves travel in all directions away from the source. It's also greatly exaggerating the motion to illustrate the behavior.[4]

2.2 Seismology background:

- Early 1800 the theory of elastic wave propagation in solid materials is developed by Cauchy, Poisson, stocks, ray Leigh, and others. They describe (P and S waves) and surface waves.
- In 1857 R. Mallet, and Irish engineer, travels to Italy to study damage caused by an earthquake near Naples. His work is generally considered to be first serious attempt at observational seismology. His contributions:

    - Earthquake waves radiated from a central focus.
    - Earthquakes can be located by projecting these waves backward toward the source.
    - Observatories should be established to monitor earthquakes.

- In 1875 F. Cecchi builds the first time-recording seismograph in Italy. And British scientists in japan developed higher quality instruments.
- In 1897 first seismograph in North American is installed at lick observatory near San Jose, California. This instrument will later record the 1906 San Francisco earthquake. And E.Wiechert develops the first seismometer with viscous damping, capable of producing a useful record for the entire duration of ground shaking.
- Early 1900, B.B.Galtizen develops the first electromagnetic seismograph in which a moving pendulum generates electric current in

coil, and establish a network of seismic stations across Russia. And became all modern seismographs are electromagnetic.

- In 1906 F.Reid proposes an “elastic re bound” theory for original of earthquakes.
- In (1900-1910) :
  - Seismograms from many earthquakes recorded at many distances become widely available.
  - R.oldham identifies P-S and surface waves, and detect liquid earth’s core.
  - A.Mohorovicic identifies velocity boundary between earth’s crust and mantle (Moho).
  - The first widely –used travel –tables are published by zoppritz.
- In 1914 B. Gutenberg publishes travel-time tables that include core phases (seismic waves that penetrate or reflect from the core).
- In 1920, seismic surveying using explosions and other artificial sources are developed in the United States for exploring for oil and other resources in the shallow crust.
- In 1935 C.Richter proposes a magnitude scale for specifying the sizes of earthquakes in southern California.
- In 1936 l. Lehmann discovers the earth’s solid inner core.
- In 1940 H. Jeffries and k. Bullet publish final versions of their travel-time table for many seismic phases. They are accurate enough to still be in use today.
- (1950s and 1960s – The Cold War)
  - Soviet nuclear tests in the early 1950s generate intense interest by the U.S. military in detection and measurement of nuclear

explosions, and funding for government and academic seismology programs sugars during the Cold War.

  - The Worldwide Standardized Seismograph Network (WWSSN), consisting of well-calibrated short and long-period seismographs, is established in 1961.This high-quality dataset will contribute to many advances in seismology.

- In 1966 K.Aki introduces “seismic moment”, a more physics-based measure of earthquake size.
- In 1970 :
  - First digital global seismographs installed.
  - First digital portable seismographs used for special studies (source scaling, site response, etc.).
  - Centralized archives of digital seismic data established.[4]

2.3 Seismic Waves:

Seismic waves travel either through the earth’s interior or near earth’s surface with a characteristic speed and style of motion. There are four basic types of seismic waves... two preliminary body wave (S & P) that travel through the earth’s interior , and two slower surface waves (Love & Rayleigh) that travel along the surface of the earth. Their speeds vary depending on the density and the elastic properties of the material they are amplified as they reach the surface. At great distance, the motion is detected by sensitive seismograph station.[6]

Depending on proximity to the focus of the earthquake the seismic waves move the ground, thus any structure according to their wave motion. The different types of seismic-energy waves shake the ground in different ways.

Combinations of waves, as well as reflections and refractions off boundaries within the earth produce many other types of seismic waves, but they can be left to seismologists.[6]

- **P wave** (stands for primary or pressure or push pull) wave is the fastest of the three waves and appears first on seismograph.

  These waves are also called longitudinal or compressional waves that oscillate the ground back and forth a long the directional of wave travel in which the same way that sound waves (which are also compressional) move air back and forth as the waves travel from the sound source to the sound receiver.

  Compressional waves compress and expand matter as they move through it.[6]

- **S wave** (or secondary or shear or shake)waves ,it is travel in the same direction as the p wave ,but instead of being a compressive wave, they oscillate with a shearing behavior at right angles to the direction of motion .they travel about 1.7 times slower than p waves , because liquids will not sustain shear stress.

  S waves will not travel through liquids like water, molten rock or the earth's outer core.

  S waves are more dangerous than P waves because they have greater amplitude and produce vertical and horizontal motion of the ground.[6]

- **Surface waves :**

It is the last type and the slowest, which move close to or on the outside surface of the ground.

There are two types of surface waves:

1. **Ray Leigh waves:**

It moves both horizontally and vertically in a vertical plane pointed in the direction of travel.

2. **Love waves:**

Move like S waves in that they have a shearing motion in the direction of travel, but the movement is back forth horizontally.

- Love and Ray Leigh waves both produce ground shaking at the earth's surface but very little motion deep in the earth, because the amplitude of surface waves diminishes less rapidly with distance than the amplitude of P or S waves, surface waves are often the most important component of ground shaking far from the earthquake source, thus can be the most destructive.[6]

2.4 General consideration of Seismic sensors:

The choice of an appropriate sensor depends on the application, be it local, regional or global monitoring. The most important factors to consider for a particular application are:

- Type of sensor.
- Number of sensor components per seismic station.
- Sensor's sensitivity and dynamic range.

- Sensor's frequency range of operation.
- Exactness of sensor's use (i.e. how demanding are its transportation, handling, installation calibration).[7]

There are two types of seismic sensors: seismometer and/or accelerometer.

Seismometers are very sensitive to small and distant events and are thus too sensitive for strong motion. Traditionally, accelerometers have been considered for strong motion only and seismometer for weak motion. However the latest generation accelerometers are nearly as sensitive short – period (SP)seismometers and also have a large dynamic range (up to 110 dB).[7]

In term of signal processing, there is no difference in using seismometer or an accelerometer. In high seismic risk areas where the main goal of network is future seismic risk mitigation, strong motion recordings play an important role, and two set of sensors will have to be installed. So that the system never clips. [7]

2.5 Seismic network purpose:

The three main purposes of seismic networks are for seismic alarm, or general or specific seismic monitoring, and research on the interior of the earth. However the very first and most basic goal is the determination of accurate earthquakes locations.[7]

2.6 Seismic network configuration:

When the hardware connection among seismic stations is established, the next question is how the data are sent along the connection and what protocols are used for the unit to communicate; this will define the

functionality of the seismic network. Nowadays, more and more seismic stations are connected to the internet or to the public phone system. Such stations usually have a local seismic signal recording capability and sometimes there is not any real time data transmission to a central site. However these stations still can be defined to be in a network since they are all connected to the global communication network, any networked computer can be used can be used to collect data from a number of stations.
By defining a seismic network the distinction between local, regional, and global networks does not exist anymore in term of hardware, but is merely a question of how the data collection software is set up to handle communication, data collection and processing.

This means two type of seismic networks can be defined: physical and virtual networks

- A physical seismic network (usually local) consists of closely linked, remote seismic stations.

The remote stations detect the ground motion and usually send data in real time to a central recording station for event detection and recording. This type of network covers both the old analog system and the current digital system.

- A virtual seismic network consists of seismic recorders connected to a global communication network or a public phone system.

A recorder may be associated with a single seismic station or can be the central – recording site for a physical network. The remote recorders must be capable of local recording as the data are not sent to the central recording

system in real time. The remote recorder must have a 2-way communication capability. The central recording station can manually or automatically connect to select remote recorders and download triggered and/or continuous data and make intelligent evaluation of possible events.

2.7 Seismic network in Sudan:

In Sudan there are two types of seismic network:

- German network.
- Canadian network.

➢ German network:

It is aseismic network that work by Radio system. And the advantage is free. But the station might be line of sight and after 50 kilometer there is no sight. It is consists of sensor which from a few distance from the earth and it record any vibration and send it to the data logger. In data logger there is digitizer to transfer the data to the digital to control it by computer and there is a modern (radio modern) and a transceiver to transmitting and receiving and finally Arial. This system related with GPS to take the accurate time.

➢ Canadian network:

It is seismic network that work by wireless telephone, internet, GSM and vast. It consists of central station, Server and internet (i.e. Zain, MTN, etc.).

Here put an automatic program deal with data logger. Seismometers have three components, one is horizontal and the others are a vertical.

CHAPTER THREE

SYSTEM MODELING

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One of the applications of wireless sensor network is design of seismology network, the system requirements are:

3.1 Arduino:

Is an open source microcontrollers system that very popular prototypes do it yourself enthusiast, interaction designer and educators. The system is designed to be easy to learn, easy to use, flexible and easy to develop with. Microcontrollers are little computers that do certain jobs, such as taken input from switch and senor and also on, take output from (led, buzzer, etc.).

Arduino can sense the environment by receiving input from variety of sensors and can affect the surrounding by controlling, motor and others actuators. The microcontrollers on the board are programmed using arduino programming language and the arduino development environment (based on processing). Arduino is capable to allegation with project that programmed by high language such as java or matlab whereby find ready-made programs libraries for matlab and java.

3.1.1Arduino boards types are of the following:

- Arduino Uno.
- Arduino Mega.
- Arduino Nano.
- Arduino Mini.
- Arduino Lily pad.

- Arduino Demulive.
- Boarduino.

The boards are different from each other in number of input and output ports, type of microcontrollers and speed of processor. In this project used arduino Uno.

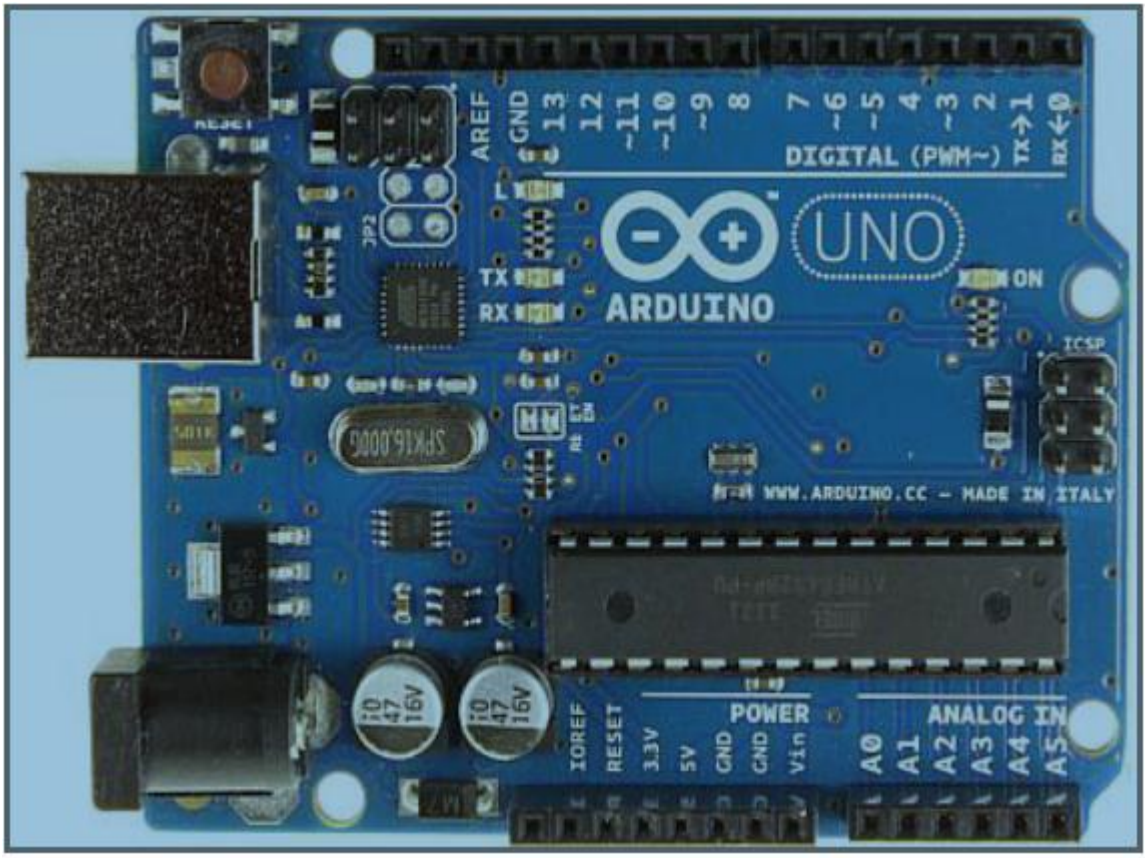

Figure3.1 Arduino UNO [8]

Arduino Uno is small electronic circuit used for programming microcontroller and produced by Atmel Company at Mega 328, this circuit availability ports to connect electronic component directly 14(in/out) ports from digital type.

Six of them are used as PWM outputs (pulse width modulation), also yonder analog ports numbered from (A0 to A5), also arduino Uno consist of crystal oscillator falteringly 16 MHZ, add an USB port to communicate with computer also find separate port for energy. Also (ICSP) that additional way to program a microcontroller where still connected by board opposite USB, The circuit can operate from (6 to 20) volt but chooser (7 to 12) volt.

3.1.2 Input /output power:

- VIN: is input voltage when use external source for energy.
- V5: regular voltage used to insuring energy for circuit elements and additional pieces that used.
- V3.3: voltage source (3.3) volt assurer from internal voltage regulator circuit and maximum value to pulling current is 50 mA.
- GND: ground line.

  Microcontroller resemble by small size computer consist memory equal 32 k byte.

Table 3.1 ATMEGA 328p memory: [8]

Memory	Capacity
SRAM	2 K byte
Flash disk	29K byte
EEPROM	1K byte
Boot loader	0.5 Kbyte

Boot loader: is software responsible about how the circuit understand the arduino.

When used arduino need to:

- **Bread board**

Bread boards provide an easy test bed for hooking up electronic circuits without needing to make parameter connections .they consist of plastic housing riddled with small holes .metal clips that lurk beneath the holes in the bread board provide a way to hold and connect components. Each metal clips called bus, and everything attached to the same bus is connected together electrically.

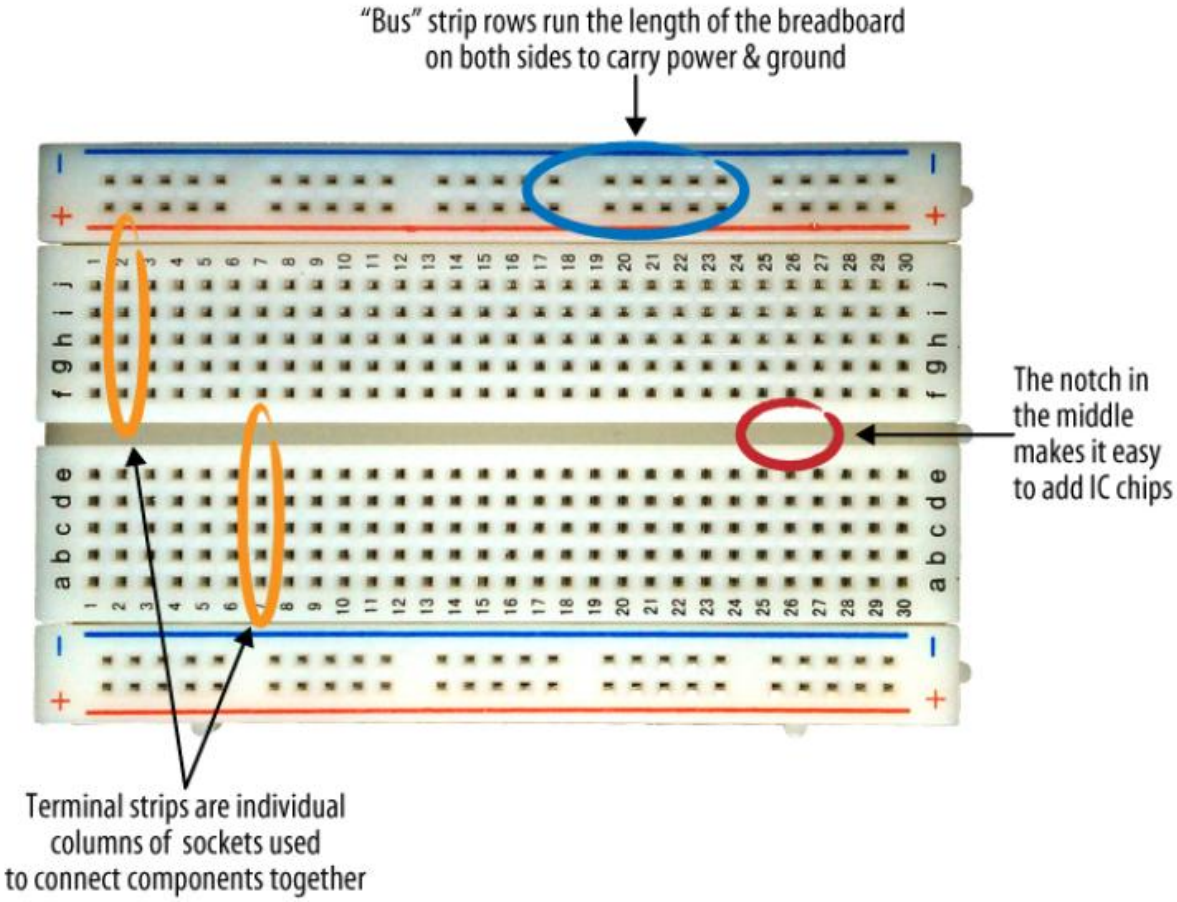

Figure 3.2 Bread board [8]

- Wires: used to connected components together on bread board.
- USB printed cable: to connect Arduino with computer.

3.1.3 Arduino software:

Download arduino IDE

Arduino IDE available for all different operating system (Linux, windows, etc.), thereby downloading from (http://arduino.cc/hu/Main/software) Windows user found compression file and remove compression by using programs such as 7 Zip and operate arduino.exe file.

Basic interface arduino IDE divided into 4 part:

First part: tape lists.

Second part: express command tape.

Table 3.2 Express Command Tape [8]

Command	Function
Verity	To check code for error
Up load to I/O board	Complies code and up load it to arduino board
New	For operate new sketch
Open	Consist program that made
Save	To save programs
Serial	To open serial monitor
Stop	Stop serial monitor

Third part: to write program.

Fourth part: contain message display error and alarming in IDE.

Figure 3.3 Arduino IDE Parts [8]

3.2 Battery connect:

For stand-alone operation, the board is powered by a battery rather than through the USB connection to the computer while the external power can be anywhere in the range of 6 to 24 v, standard 9 v battery is convenient. While the jam the lead of a battery snap into the Vin and GND connection on

the board. It is better to solder the battery snap lead to DC power plug and connect to the power jack on the board.

Figure 3.4 Battery 9v

3.3 Sound sensor:

The sound sensor is a microphone with an internal amplifier. The sensor measures variation in pressure. Because of the high sensitivity, the sensor is very much suited to detect pressure pulses.

3.3.1 Suggestion for experiments

Variety of activities with sound waves such as:

- Demonstration of wave patterns.
- Measurement of frequency and amplitude of sound (also of tuning fork).
- Compression of wave form of different instructions.
- Beat patterns.
- Measure the speed of sound.

Sound sensor have four enders one for analog output and second for voltage and third for ground and last one is digital output here is not used.

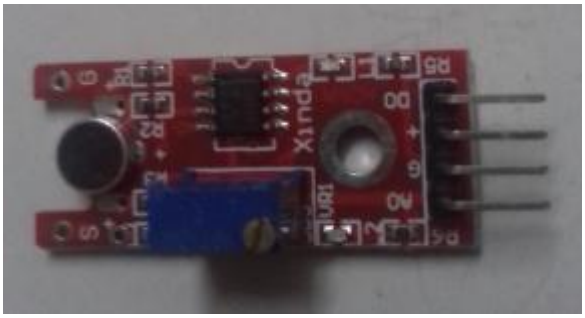

Figure 3.5 Sound Sensor

3.4 XBee module:

XBee is the brand name from Digi International for a family of form factor compatible radio modules. XBees are tiny blue chips that can communicate wirelessly with each other. These modules use the IEEE 802.15.4 networking protocol for fast point-to-multipoint or peer-to-peer networking.

XBee uses the Zigbee standard and adds to it and wraps it up in their own neat little package. Most of the Xbee modules operate at 2.4GHz.

3.4.1 XBee 802.15.4 modules (Series 1)

- XBee Series 1 (also called XBee 802.15.4) - These are the easiest to work with, they don't need to be configured, although they can benefit from it.
- For point to point communication these modules work as well as the Series 2 but without all the work.

3.4.2 XBee (series 2) hardware

The series 2 use a microphone from ember network that enables several different flavor of standard zigbee mesh network.

3.4.3 XBee Modules vs. XBee Pro Modules

There Are a few difference between the regular XBees and the XBee Pros.

The Pros are a bit longer, use more power and cost more money.

Table 3.3 XBee Modules vs. XBee Pro Modules [10]

Specification	Xbee	XBee-pro
Supply voltage	2.8 VDC-3.4 VDC	2.8 VDC-3.4 VDC
RF power	0 dBm,1Mw	18 dBm,63 mW
Outdoor distance(LOS)	300 ft (90 m)	1mile (1.6km)
Indoor distance	100 ft (30 m)	300 ft (90m)
RF data throughput	250 kbps	250 kbps
Current draw , transmit	50 mA	215 mA
Current draw, receive	45 mA	15 mA
Current draw , sleep	<10 µA	<10 µA
Operating frequency , channels	2.4 GHZ,16 channels	2.4 GHZ,12 channels
Receiver sensitivity	-92 dBm	-100 dBm

The 802.15.4 XBee modules provide two modes of communication:

A simple serial method of transmit/receive.

A framed mode- providing advanced features. XBee are ready to use out of the package, or they can be configured through the X-CTU utility or from

microcontroller. These module can be communicated point to point, from one point to point.

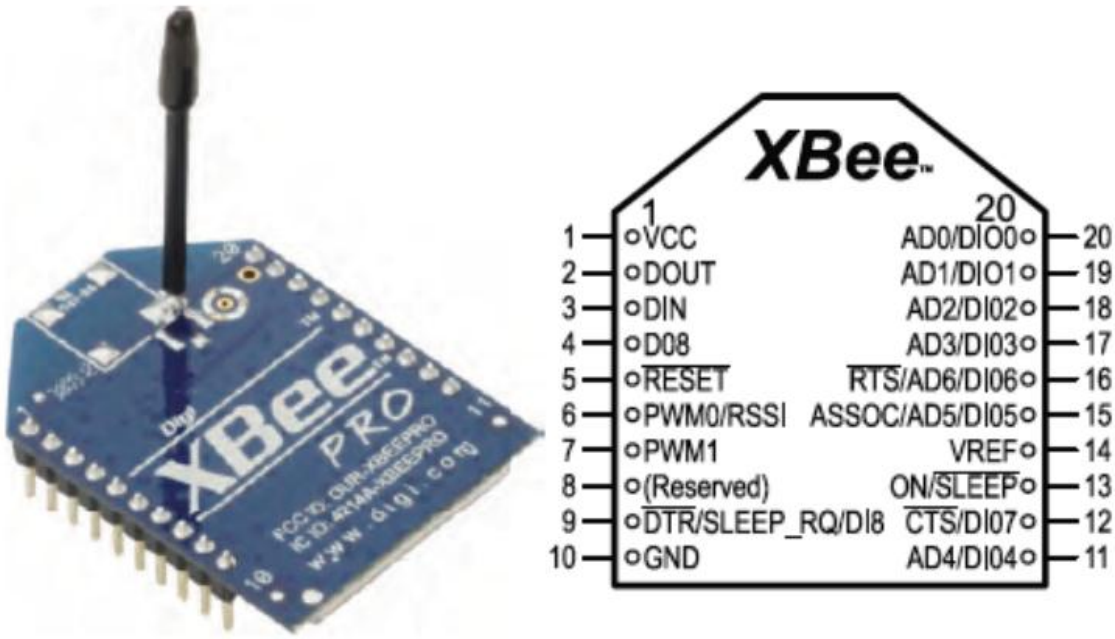

Figure 3.6 Xbee 802.15.4 Module [10]

3.4.4 Antennas

Radio need antennas to transmit and receive signal. There's is more than one way to build an antenna etch with advantages and disadvantages there is kind of antenna such as

- Whip or wire antenna.
- Chip antenna.
- PCB antenna.
- UFL connecter.

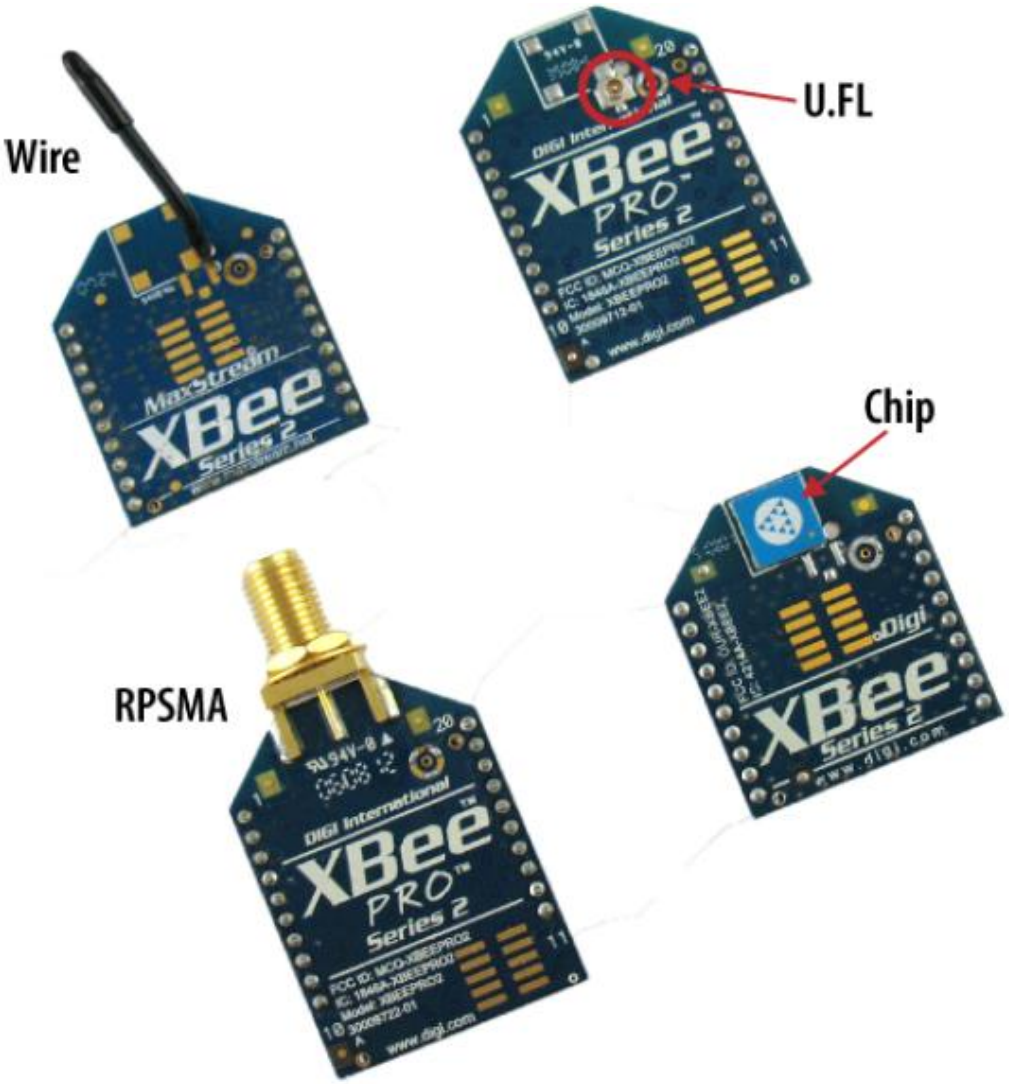

Figure 3.7 kind of antenna uses [10]

There are many Keys feature of the following:

- Outdoor rang up to (300) feat or 90m line of sight.
- Indoor rang to up to (100) feat (30) m.
- Data rate up to (250) kbps.
- 2.4 GHZ Frequency band.

Table 3.4 XBee 802.15.4 Pin Review [10]

Pin	Name	Type	Function
1	VCC	P	2.8 to 3.4 v
2	DOUT	O	Serial data output from xbee
3	DIN	I	Serial data input to xbee
4	DO8	O	Digital data output 8
5	RESET	I	Reset module low
6	PWMO/ RSSI	O O	Pulse width modulated output Resaved signal stream indication as PWM signal
7	PMW1	O	Pulse width modulation output
8	Revers		
9	DTR SLEEP-RQ DI8	I I I	Data terminal Sleep request Digital output 8
10	GND	G	Ground (vss)
11	AD4 DIO4	A IO	Analog to digital convertor Digital input/output 4
12	CTS DIO7	O IO	Clear to send output Digital input/output 7
13	ON/SLEEP	O	Digital output, status indication
14	VREF	A	Analog to digital reference voltage
15	ASSOC AD5 DIO5	O A IO	Associated indication when joining a network. Analog to digital input 5 Digital input/output 5
16	RTS ID6 IO6	I A IO	Ready to send handshaking input. Analog to digital input 6 Digital input/output 6
17-20	AD3-AD0 DIO3-DIO0	A IO	Analog to digital input 3 to 0 Digital input/output 3 to 0

3.5 XBee shield:

The wireless SD shield allows and arduino board to communicate wirelessly using a wireless module. It is based on the XBee module from Digi, but can use any module with same footprint. The module can communicated up to 100 feet indoors or 300 feet outdoors (with line of sight).

figure 3.8 XBee Sheild

3.6 TTI USB:

TTL USB converter is a module can be used with laptop's which don't have standard serial port. This module creates a virtual COM port using USB on computer which can support various standard baud rates for serial communication. Just need to install the driver using a setup file which automatically installs correct driver files for windows Xp/Vista/7. After deriver installation, plug the module into any USB port in PC. Finally anew

COM port is made available to the PC. The feature which makes it more convenient is the TTL level data I /O.

3.6.1 Pin outs

- TXD transmit output.
- RXD receive output.
- GND ground line.
- 3V3 optional output to power external circuit up to 50mA.
- 5V optional output to power external circuit up to 500mA.

Chapter four

Design and Results

Chapter four

Design and Results

4.1 The Design:

Sensors are used to design seismology networks, the type of sensors is sound (voice) sensor and (4 sensors) are used, spreader in specific area. The Best choice that uses the vibration sensor but it was not available in the market; here sound (voice) sensor is used because that is available.

Two XBee are used to communication, one of it is router and the other is coordinator (for sending and receiving) respectively by using XCTU program. Arduino and XBee are connected by using XBee shield; it is function is connecting them together.

In transmitted part four sensor are found called (A B C D) connected by shield, sound sensor have four enders first pin for analog input. here the first pin for sensor A B C and D is connected by XBee shield in inputs A0,A1,A2 and A3 respectively , second pin for ground, third pin for Vcc and the last one for digital input but not used because the nature of seismic is analog. Dispense of breadboard and connect each ground of sensors by one wire which connected it by the ground in XBee shield, reciprocated for Vcc. Sic connected sensors with microcontroller. Battery (9v) is used to feed terminal station.

Table 4.1 Connecting Sensors with Shield

Shield pin	Sensor
A0	Sensor A
A1	Sensor B
A2	Sensor C
A3	Sensor D

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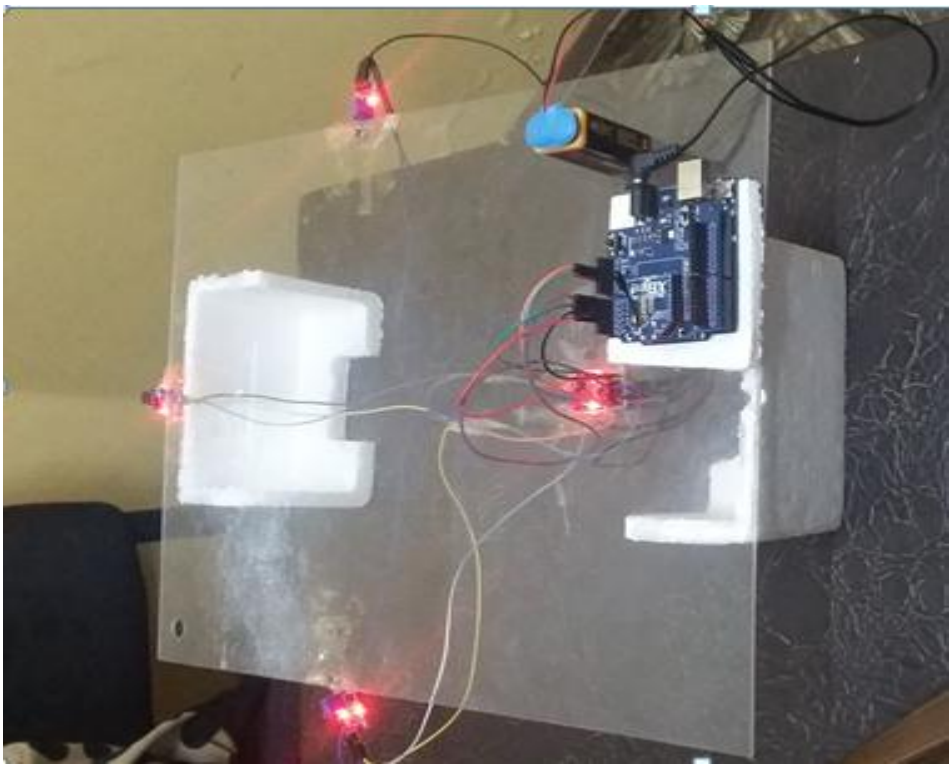


Figure 4.1 Terminal Station

Table 4.2 Connect XBee with TTL

XBee pin	TTL PIN number
VCC	1
TX	3
RX	2
GND	10

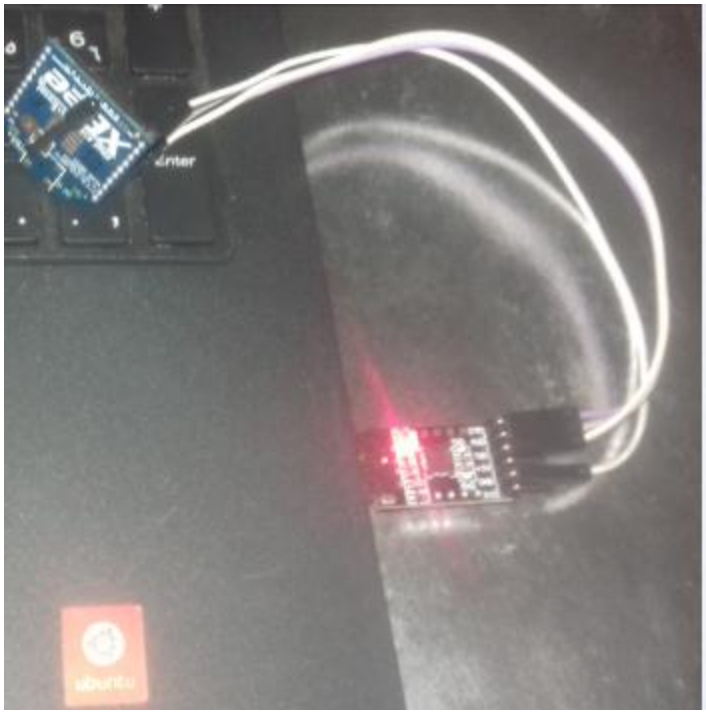


Figure 4.2 Communication System of base station

In base station XBee is used and connected it with TTL module by using female to female connector.

4.1.1 Distance calculation:

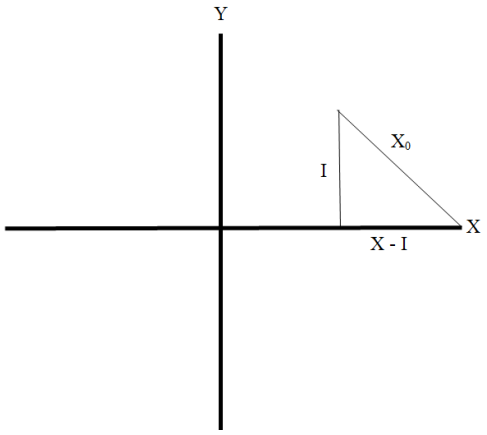
Given intensity values used this values are used to calculate distance by this is formula:

$Xo= \sqrt{(I^2) + (X - I)^2}$

Xo=position of seismic

I=intensity

X=distance form original point



4.1.2 Code overview:

The code is written by arduino C and this program contain three part first one to define constants and variables , second part contain the reserve function called void setup and its responsible from setting microcontroller and determine the inputs and outputs ,third part contain void loop to write the basic program ,in this code define four constant from integer type and connect in inputs A0,A1,A2,A3, and four variable which consider sensors (A B C D).and another two variable called R and V and call the function Serial. Begin(9600) it role to make arduino board to communicate with computer by USB port and used(analog Read) function to read the intensity of sensors that connect by inputs A0,A1,A2and A3and used (Serial.print) function to print the value of sensors by certain delay .

Determining the distance optionally defines the variables R and V, thereby r is the difference between A and C, V is the difference between B and D.

4.2 Results:

In the project the following results are achieved:

- System capable to send the information about the seismic continually and it was successful.
- Earthquakes position Estimation.
- Wireless communication system is achieved.

Figure (4.3) shows the reading of the sensor.

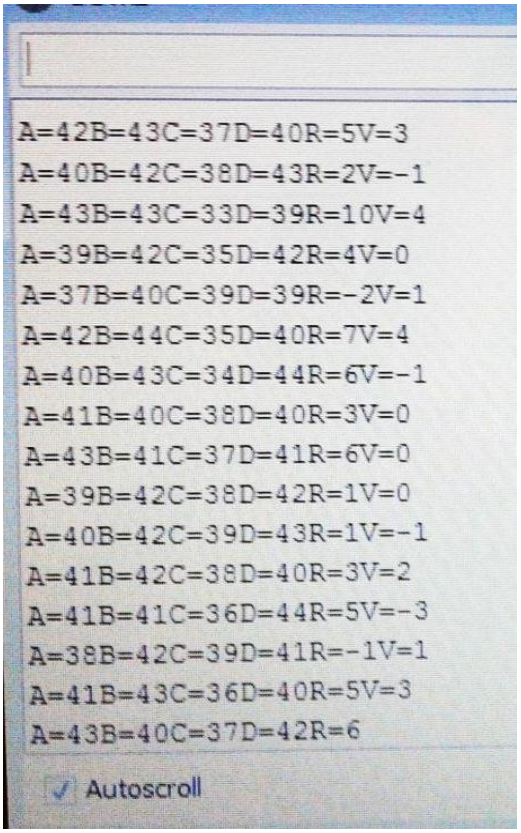


Figure (4.3) the reading of the sensor.

Chapter Five

Conclusion and recommendations

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5.1 conclusion:

Advanced in wireless communication lead to develop in wireless sensor network, it consist of small device which collected information by cooperating with each other , that consist of CPU for processing, memory for storage data, battery for energy and transceiver for transmit and receive information.

Many components are used to design seismology network such as sensors to sense seismology, arduino that easy way to programmable arduino and XBee/ Zigbee to communicate between transmitter and receiver and needed to XBee shield to connect sensor with arduino and provide facility to connect arduino to XBee, battery to feed terminal station.

In receive side used XBee/ Zigbee connect with TTL to receive information about seismology, this design given intensity, in accordance with that calculate distance, thereby find extrusive relationship between intensity and depth.

5.2 Recommendations:

- To achieve high quality must use vibration sensor.
- To achieve high accuracy must increase the number of sensors.
- To send the information to reach far distance using suitable communication system.