# Sudan University of Science and Technology

# College of Computer Science and Information Technology


# Monitoring Insulin Using Wireless Sensors Networks

## PREPARED BY:


**Ahmed AlhadiMadiboo ahmed**

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**Gamar-EldeenAlshaikhAljaili.**


**THIS IS SUMITTED AS PARTIAL FULFILLMENT OF**

**THEREQUIREMENT FOR THE DEGREE OF B.Sc(HONOR)**

**IN COMPUTER SYSTEM AND NETWROKS**

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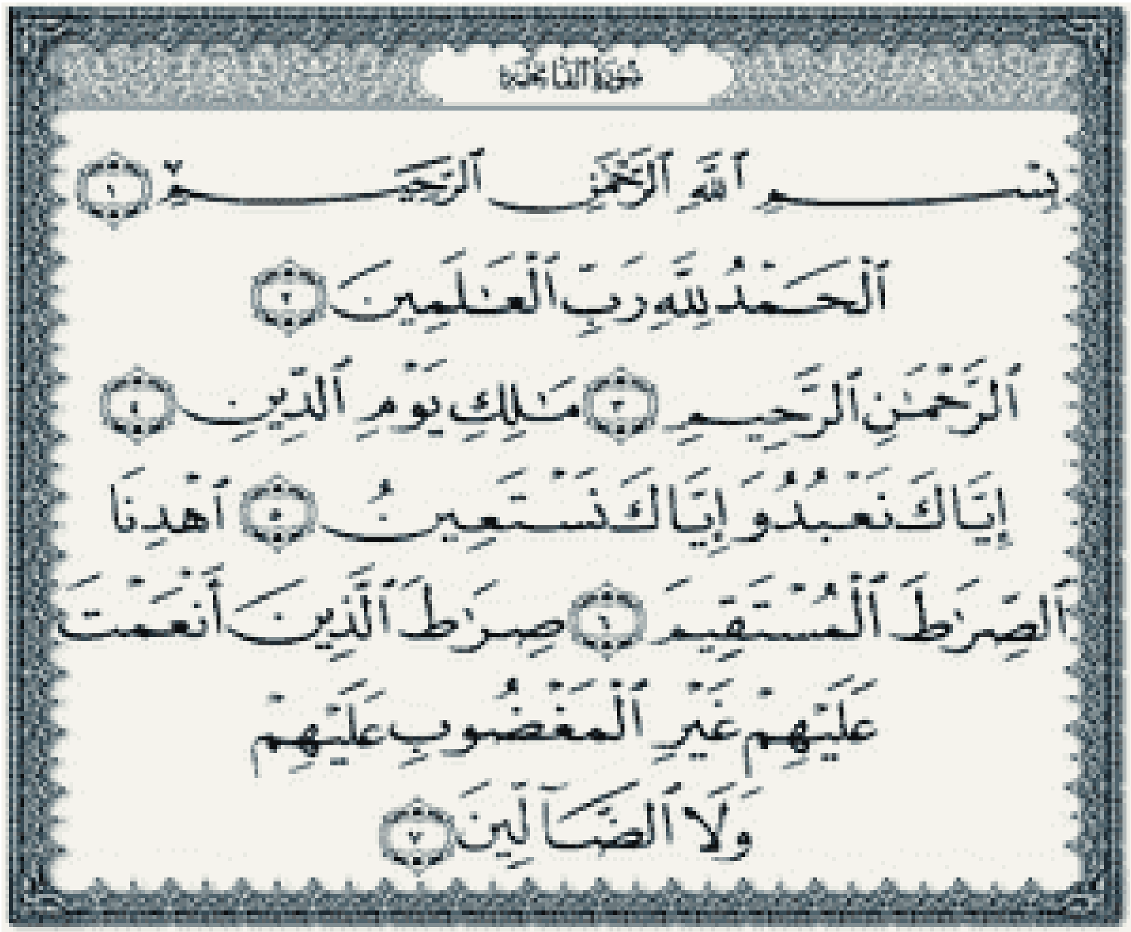
**Signing supervisor………………….. 23-October-2016**

# الآية

**قال تعالى**



سورة الفاتحة

بِسْمِ ٱللَّهِ ٱلرَّحْمَٰنِ ٱلرَّحِيمِ ﴿١﴾
ٱلْحَمْدُ لِلَّهِ رَبِّ ٱلْعَٰلَمِينَ ﴿٢﴾
ٱلرَّحْمَٰنِ ٱلرَّحِيمِ ﴿٣﴾ مَٰلِكِ يَوْمِ ٱلدِّينِ ﴿٤﴾
إِيَّاكَ نَعْبُدُ وَإِيَّاكَ نَسْتَعِينُ ﴿٥﴾ ٱهْدِنَا
ٱلصِّرَٰطَ ٱلْمُسْتَقِيمَ ﴿٦﴾ صِرَٰطَ ٱلَّذِينَ أَنْعَمْتَ
عَلَيْهِمْ غَيْرِ ٱلْمَغْضُوبِ عَلَيْهِمْ
وَلَا ٱلضَّآلِّينَ ﴿٧﴾

**صدق الله العظيم**

**سورة الفاتحة(1-7)**

# الحمد لله

اللَّهُمَّ لك الحَمْدُ كما حَمِدْتَ نَفْسَك في أُمِّ الكِتَابِ والتَّوْرَاةِ والإِنْجِيْلِ والزَّبُورِ والفُرْقَان، اللَّهُمَّ لك الحَمْدُ أَكْمَلُهُ وأَجْمَلُهُ، ولك الثَّنَاءُ القَوْلُ أَبْلَغُهُ، ولك العِلْمُ أَحْكَمُهُ، ولك السُّلْطَانُ أَقْوَمُهُ، ولك الجَلالُ أَعْظَمُهُ.

اللَّهُمَّ لك الحَمْدُ حَمْدًا يَمْلأُ المِيْزان، ولك الحَمْدُ عَدَدَ ما خَطَّهُ القَلَمُ وأَحْصَاهُ الكِتَابُ ووَسِعَتْهُ الرَّحْمَةُ. اللَّهُمَّ لك الحَمْدُ على ما أَعْطَيْتَ ومَنَعْتَ وما قَبَضْتَ وما بَسَطْتَ، اللَّهُمَّ لك الحَمْدُ على كُلِّ نِعْمَةٍ أَنْعَمْتَ بِهَا عَلَيْنَا في قَدِيْمٍ أَوْ حَدِيْثٍ، أَوْ خَاصَّةٍ أَوْ عَامَّةٍ أَوْ سِرٍّ أَوْ عَلانِيَةٍ او حي او ميت او شاهد او غائب.

اللَّهُمَّ لك الحَمْدُ في السَّرَّاءِ والضَّرَّاءِ ولك الحَمْدُ فِي النَّعْمَاءِ واللَّأْوَاءِ، ولك الحَمْدُ في الشِّدَّةِ والرَّخَاءِ، ولك الحَمْدُ على حِلْمِك بَعْدَ عِلْمِك، ولك الحَمْدُ على عَفْوِك بَعْدَ قُدْرَتِك، ولك الحَمْدُ على كُلِّ حَال. الحَمْدُ لله في الأُولَى والآخِرَةِ، الحَمْدُ لله الَّذِي لا يَنْسَى مَنْ ذَكَرَهُ، والحَمْدُ لله الَّذِي لا يَخِيْبُ مَنْ دَعَاهُ، ولا يَقْطَعُ رَجَاءَ مَنْ رَجَاهُ.

# DEDICATION

We would like to dedicate this work

To Our dear parents

Who have always been here for us throughout our study

And who gave us a wonderful model of labor and perseverance

We hope that they find in this modest work gratitude and love

To everyone who has helped us to achieve this work

To all friends and relatives

# ACKNOWLEDGEMENT

First of all we give thanks to Almighty ALLAH who gave us the ability and opportunity to accomplish this study in time.

We would like to express our special thanks and gratitude to our supervisor Doctor **NiemahIzzeldin** who gave us the golden opportunity to do this wonderful project on **Wireless Sensor Networks**, and who didn't keep any effort in encouraging us to do great a job.

Also we would like to thank  parents and friends who helped us a lot in finalizing this project within the  limited time frame.

# ABSTRACT


Diabetes is a chronic disease that is very common in Sudan. Insulin is the only treatment for diabetes and has to be stored in suitable weather conditions.

Due to the hot temperature in Sudan, storing insulin becomes challenging.

With advancement in electronic technologies, these must be a strategy to remotely monitor insulin to ensure that is it not damaged .

Wireless sensor network (WSN) refers to a group of spatially dispersed and dedicated sensors for monitoring and recording the physical conditions of the environment and organizing the collected data at a central location.
WSNs measure environmental conditions such as temperature, sound, pollution levels, humidity, wind speed and direction, pressure, etc.

In this project we developed a system that uses sensor to periodically read temperature and humidity to monitor stored insulin.

The aim of project is to continuously monitor insulin to protect it from being exposed to temperature and humidity level outside the acceptable range.

The system provides periodic weather reading that are collected from the sensor, which is storedin a database .this data is analyzed and displayed  for valid and quick decision making to protect the product.

# المستخلص


يعتبر مرض السكري من الامراض المزمنة الشائعة في السودان .

الانسولين هو العقار الوحيد لمرض السكري، ويجب تخزينة في الظروف المناخية المناسبة . تشكل حساسية الانسولين للحرارة مشكلة نسبة لإرتفاع درجات الحرارة في السودان . ومع تقدم التقنيات الاكترونية كان لابد من وجود وسيلة لمراقبة بيئة تخزين الانسولين من على البعد لضمان صلاحيتة.

شبكة الاستشعار اللاسلكية هي مجموعة من أجهزة الاستشعار تم توزيعها في منطقة بغرض رصد وتسجيل الحالة البيئية للبيئة وتنظيم البيانات التي تم جمعها في موقع مركزي.تقوم هذة الشبكة بقياس بيانات مثل درجة الحرارة ، والصوت ، مستويات التلوث والرطوبة وسرعة الرياح واتجاهها، والضغط وغيرها

في هذا المشروع، قمنا بتطوير نظام يستخدم حساس لرصد درجة الحرارة والرطوبة لمراقبة الانسولين .الهدف من المشروع هو المراقبة المستمرة للانسولين من على البعد للحفاظ علية من التلف بسبب خروج درجة الحرارة او الرطوبة عن المدي الذي يتحملة المنتج . يوفر النظام وسيلة للمراقبة المستمرة حيث يتم اخذ قراءات دورية لدرجة الحرارة والرطوبة بواسطة الحساس ، ومن ثم تخزينها وتحليلها وعرضها للاستفادة منها في اتخاد قرارت سريعة لحماية المنتج

# TABLE OF CONTENTS

# ListOf Abbreviations

| Term | ABREVIATION |
| --- | --- |
| DARPA | Defense advanced research project agency |
| DHT11 | Temperature humidity sensor |
| DFD | data flow diagram |
| DNA | deoxyribonucleic acid |
| DSN | Disaster sensor network |
| IC | Integrated Circuit |
| ICSP | In-Circuit Serial Programming .Micro-controller unit |
| IOT | Internet Of Things |
| LCD | liquid-crystal display |
| MANET | Mobile ad-hoc network |
| RF | Radio Frequency |
| SPICE | Simulation Program with Integrated Circuit Emphasis. |
| SSMS | SQL server management studio |

| | |
|---|---|
| UCD | Use case diagram |
| UML | Unified modeling language |
| VANET | Vehicular ad-hoc network |
| WSN | Wireless Sensor Network |

# LIST OF FIGURES

# CHAPTER ONE

# INTRODUCTION

# 1.1 Introduction

Today, smart grid, smart homes, smart water networks, intelligent transportation, are infrastructure systems that connect our world more than we ever thought possible.

The common vision of such systems is usually associated with one single concept, the internet of things (IoT), where through the use of sensors, the entire physical infrastructure is closely coupled with information and communication technologies; where intelligent monitoring and management can be achieved via the usage of networked embedded devices. In such a sophisticated dynamic system, devices are interconnected to transmit useful measurement information and control instructions via distributed sensor networks.

Wireless sensor network technologies play an important role in safety monitoring over power transmission and transformation equipment and, the deployment of billions of smart meters.

# 2.1 Problem statement

Having a hot climate in Sudan influences the safety of sensitive material. Insulin is an important cure for a wide spread disease in Sudan, diabetes .insulin is very sensitive to temperature and requires constant and careful monitoring all the time. This project uses a WSN to monitor insulin in storage locations to insure that the temperature is always within the acceptable limits so that the product.

# 1.3 Objectives

The objectives of this project are

1- Monitoring insulin to avoid its corruption.
2- Designing System to work at hard circumstances.
3- Providing fast information to allow fast response to recover emergency situations.
4- Monitor and store temperature periodically to be used for future studies and making decision.

# 1.4Research methodology

This project focuses on monitoring the status of the insulin in storage to be aware of the validity of product, and its current state.

The temperature and humidity of insulin are measured periodically using sensors. Those values are in database and used to generate and monitor information for continuous monitoring of the product .We use Arduino to control sensors and XBee to wirelessly transmit data from the sensors to the collision point.

SQL server is used to develop the database which is connected to the main application, developed using C#.

# 1.5 Project scope

The project focus on temperature and humidity without considering other atmospheric measure such as precipitation and air pressure.it considers the temperature range that is most suitable for insulin.

# Outline

Chapter 2 contains background information about wireless sensor networks and insulin

Chapter 3 discussed previous studies and tools use to accomplish this project.

Chapter 4 Describe the analysis of the System

Chapter 5 illustrates the implementation of the project .

Chapter 6 involves Conclusion and recommendations.

Finally references.

# CHAPTER TWO

## Wireless Sensor networks

# 2.1 Introduction

This chapter overviews Wireless Sensor Networks and explains their types and applications. It also compares them with mobile Ad-hoc networks.in addition it provides background information about insulin.

# 2.2 Wireless Sensor Network (WSN)

Wireless sensor network (WSN) refers to a group of spatially dispersed and dedicated sensors for monitoring and recording the physical conditions of the environment and organizing the collected data at a central location.
WSNs measure environmental conditions like temperature, sound, pollution levels, humidity, wind speed and direction, pressure, etc.[2]

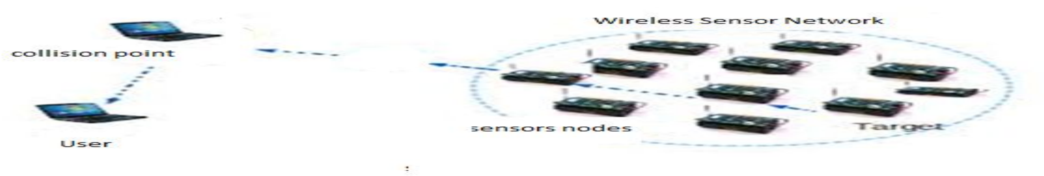



Figure 2.2.1 shows structure of a simple WSN

## 2.2.1 Sensor Definition

A sensor is a device that detects and responds to some type of input from the physical environment. The specific input could be light, heat, motion, moisture, pressure, or any other environmental phenomena. The output is generally a signal that is converted to human-readable display at the sensor location or transmitted electronically over a network for reading or further processing [1].

## 2.2.2 Types of wireless Sensor Networks

WSN are classified with respect to the environment in which they are deployed into the following classis:

1. Terrestrial WSNs

2. Underground WSNs

3. Underwater WSNs

4. Multimedia WSNs

5. Mobile WSNs

### 2.2.2.1Terrestrial WSNs

Terrestrial WSNs are capable of communicating with base stations efficiently, and consist of hundreds to thousands of wireless sensor nodes deployed either in an unstructured (ad hoc) or a structured (Preplanned) manner.

In an unstructured mode, the sensor nodes are randomly distributed within the target area that is dropped from a fixed plane. The preplanned or structured mode considers optimal placement, grid placement, and 2D, 3D placement models.

In this WSN, the battery power is limited; however, the battery is equipped with solar cells as a secondary power source. The Energy conservation of these WSNs is achieved by using low duty cycle operations, minimizing delays and optimal routing.

## 2.2.2.2 Underground WSNs

The underground wireless sensor networks are more expensive than the terrestrial WSNs in terms of deployment, maintenance, and equipment cost considerations and planning. The WSNs networks consist of a number of sensor nodes that are hidden in the ground to monitor undergroundConditions.

To relay information from the sensor nodes to the base station, additional sink nodes are located above the ground.

A sink node is Sensor nodes equipped with a limited battery which is difficult to recharge. In addition to this, the underground environment makes wireless communication a challenge due to high level of attenuation and signal loss.

## 2.2.2.3 Under Water WSNs

These types of networks consist of a number of sensor nodes and vehicles deployed under water. Autonomous underwater vehicles are used for gathering data from these sensor nodes. A challenge of underwater communication is a long propagation delay, limited bandwidth and sensor failures.

Under water WSNs are equipped with a limited battery that cannot be recharged or replaced. The issue of energy conservation for under water WSNs involves the development of underwater communication and networking techniques.

#### 2.2.2.4 Multimedia WSNs

Multimedia wireless sensor networks have been proposed to enable tracking and monitoring of events in the form of multimedia, such as imaging, video, and audio. The networks consist of low-cost sensor nodes equipped with microphones and cameras. These nodes are interconnected with each other over a wireless connection for data compression, data retrieval and correlation.

Challenges of multimedia WSNs include high energy consumption, high bandwidth requirements, complex data processing and compressing techniques. In addition to this, multimedia contents require high bandwidth for the contents to be delivered properly and easily.

#### 2.2.2.5 Mobile WSNs

These networks consist of a collection of sensor nodes that can be moved on their own and are able to interact with the physical environment. The mobile nodes have the ability to compute sense and communicate.

Mobile Wireless Sensor Networks [WSNs] are much more versatile than the static sensor networks. The advantages of MWSN over the static wireless sensor networks include better and improved coverage, better energy efficiency and superior channel capacity. [3]

# 2.2.3 WSN Topologies

The most common network topologies used in wireless sensor networks are star, tree, mesh and hybrid. Following is explanation for each.

## 1. Star

A star topology is a single-hop system in which all wireless sensor nodes communicate bi-directionally with a gateway. As shown in Fig (2.1),

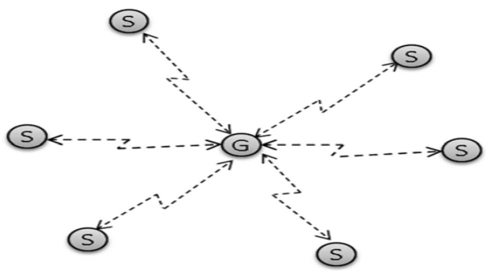



Fig 2.2.3.1)

WSN Star Topology

## 2. Tree

In the tree topology, there are leaf nodes, relay nodes and parent nodes. This topology consists of a central node called the root node, and it is the main communications router and interface with the application or other parts of a larger network. One level down from the root node in the hierarchy is a relay node that may have several children nodes connected to it and so on.
(Fig 2.2) show the tree topology.

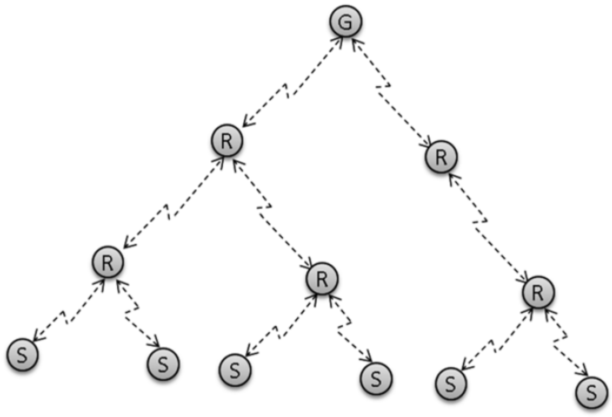



Fig (2.2.3.2)

A WSN Tree Topology

## 3. Mesh

This kind of network topology connects each node to all the nodes within its radio range as shown in (Fig 2.3).

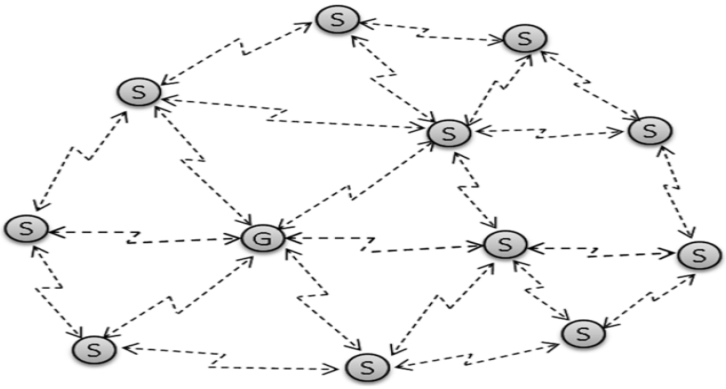



Fig (Fig (2.2.3.3)

A WSN Mesh Topology

### 4. Hybrid

A hybrid network consists of a combination of star and mesh topologies. This Combination results a star-mesh network that seeks to take advantage of the Low power and simplicity of the star topology.[4]

# 2.2.4 Wireless Sensor Network Applications

Wireless sensor network have a variety of applications including the fields of security, monitoring, biomedical research tracking and many more.
Basically these applications are used in Environmental data collection, military applications, Security monitoring, sensor node tracking, health application, home application, and hybrid networks emergency services. Sensor network are categorized into various classes such as:

## 2.2.4 .1 Environmental Data Collection

In environmental data collection application, are used to collect various sensor data in a period of time. In the environmental data collection application, a large number of nodes continuously sense and transmit data back to a set of base stations that store the data using traditional methods. In a typical scenario, the nodes will be evenly distributed over an outdoor environment.

In environmental monitoring applications, it is not essential that the nodes develop the optimal routing strategies on their own. Instead, it may be possible to calculate the optimal routing topology outside of the network and then communicate the necessary sensor data to the nodes as required.
This is possible because the physical topology of the network is relatively constant.

### 2.2.4.2 Military Applications

Most of the development of sensor network applications focused on the defense projects at the beginning, especially two important programs the Distributed Sensor Networks (DSN) and the Sensor Information Technology form the Defense Advanced Research Project Agency (DARPA), sensor networks are applied very successfully in the military.

Now wireless sensor networks have become an integral part of military command, control, communications, computing, intelligence and targeting systems. In the battlefield context, rapid deployment, self-organization, fault tolerance security of the network should be required.

The sensor devices or nodes should provide following services: like Monitoring friendly forces, equipment and ammunition, battlefield surveillance, targeting, battle damage assessment Nuclear, biological and chemical attack detection.

### 2.2.4.3 Security Monitoring

Security monitoring networks are a collection of nodes that are placed at fixed locations throughout an environment that continually monitor one or more sensors to detect an anomaly.

A key difference between security monitoring and environmental monitoring is that security networks are not actually collecting any data. This has a significant impact on the optimal network architecture. Each node has to frequently check the status of its sensors but it only has to transmit a data report when there is a security violation. The immediate and reliable communication of alarm messages is the primary system requirement.

Therefore referred to as “report by exception” networks. It is confirmed that each node is still present and functioning. If a node were to be disabled or fail, it would represent a security violation that should be reported.

For security monitoring applications, the network must be configured so that nodes are responsible for confirming the status of each other. One approach is to have each node be assigned to a peer that will report if a node is not functioning. Quite different from that of a data collection network.

In a collection tree, each. In security networks, a vast majority of the energy will be spend on confirming the functionality of neighboring nodes and in being prepared to instantly forward alarm announcements. Actual data transmission will consume a small fraction of the network energy.

## 2.2.4.4 Node Tracking Scenarios

In which wireless sensor nodes track a number of a tagged object they are mainly important through known area monitored by a sensor network.

Where one would like to track the location of important assets or personnel. Current inventory control systems attempt to track objects by recording the last checkpoint that an object passed through. However, with these systems it is not possible to determine the current location of an object. With wireless sensor networks, objects can be tracked by simply tagging them with a small sensor node. The sensor node will be tracked as it moves through a field of sensor nodes that are deployed in the environment at known locations. Instead of sensing environmental data, these nodes will be deployed to sense the RF (Radio Frequency) messages of the nodes attached to various objects.

The nodes can be used as active tags that announce the presence of a device. A database can be used to record the location of tracked objects relative to the set of nodes at known locations. With this system, it becomes possible to ask where an object is currently located, not simply where it was when it was last scanned. Unlike sensing or security networks, node tracking applications will continually have topology changes as nodes move through the network. While the connectivity between the nodes at fixed locations will remain relatively stable, the connectivity to mobile nodes will continuously change.

## 2.2.4.5 Health Applications

Sensor networks are also widely used in health care. In modern hospitals, sensor networks are constructed to monitor patient physiological data, to control the drug administration and monitor patients and doctors inside the hospital. Long-term nursing home is an application that focuses on nursing of old people. It deploys cameras, pressure sensors, orientation sensors and other sensors to detect muscle activity, fall detection, unconsciousness detection, vital sign monitoring and dietary/exercise monitoring. These applications reduce personnel cost and rapid the reaction in the case of emergency situations.

## 2.2.4.6 Home Application

Along with developing commercial applications of sensor networks it is obvious that sensor application will step into our everyday life in the near future. Many concepts are already designed by researcher and architects.

One Example is the concept of “the intelligent home. At the front door the sensor detects that the home owner is condition to be turned on.

## 2.2.5 Comparison between WSN and MANET

A wireless sensor networks (WSN), or a **mesh** WSN, usually consists of one sink (or base station) able to manage all the communications between other nodes. This kind of network has fixed routes, except when there are nodes' failures. Thus, the base station determines and optimizes the paths of communication in the network. Examples of WSNs are networks monitoring a bridge or network monitoring the temperature in several parts of a city.

A mobile ad-hoc network (MANET) is a WSN if its scope is that of sensing the environment around the network. However, the words "mobile" and "ad-hoc" are often used to refer to all those networks consisting of nodes continuously moving in any direction .Consequently, this kind of network must repeatedly reconfigure its routes. All this work is done by every node in the network since MANET doesn't have a fixed central controller.
Furthermore, this kind of networks usually uses different devices with respect to other WSNs because the management of energy and communications is totally different. Examples of MANETs are networks formed by devices installed within cars Vehicular Ad-hoc Network (VANET) to monitor accidents, traffic and so on.

## 2.3information about insulin

This section gives basic background information about insulin

### 2.3.1 Definition of insulin

Insulin is a natural hormone made by the pancreas that controls the level of the sugar glucose in the blood.

Insulin permits cells to use glucose for energy, as they cannot utilize glucose without insulin diabetes is caused by the failure to make insulin to respond to it Insulin is made specifically by the beta cells in the islets of Langerhans in the pancreas. If the beta cells degenerate so the body cannot make enough insulin on its own, type I diabetes results. A person with this type of diabetes must inject exogenous insulin (insulin from sources outside the body).

In type II diabetes, the beta cells produce insulin, but cells throughout the body do not respond normally to it. Nevertheless, insulin also may be used in type II diabetes to help overcome the resistance of cells to insulin.

By reducing the concentration of glucose in the blood, insulin is thought to prevent or reduce the long-term complications of diabetes, including damage to the blood vessels, eyes, kidneys, and nerves.

### 2.3.2 History of Insulin

In 1921, Frederick Grant Banting and Charles H. Best discovered insulin while they were working in the laboratory of John J.R. Macleod at the University of Toronto. Banting and Best extracted material from the pancreas of dogs. They first used this material to keep diabetic dogs alive and in 1922 they used it successfully on a 14-year-old boy with diabetes. In 1923, James B. Collip, a biochemist, discovered that purifying the extract prevented many of the side effects.

## 2.3.3 The usage of insulin

Insulin is the main treatment of diabetes type I and II. However it doesn’t cure diabetes it regulate and manages the glucose level in the blood therefore, insulin continuously consumed by diabetes it is usually injected into the body.

## 2.3.4insulin importance

**1- Regulate sugar in the bloodstream**the main job of insulin is to keep the level of glucose in the bloodstream within a normal range.

**2- Storage of excess glucose for energy** when insulin levels are high excess glucose is stored in the liver in the form of glycogen.

Between meals when insulin levels are low the liver releases glycogen into the bloodstream in the form of glucose; This keeps blood sugar levels within a narrow range.

If the pancreas secretes little or no insulin or the body doesn't produce enough insulin or has become resistant to insulin's, the level of glucose in the bloodstream increases because it's unable to enter cells, high blood glucose can lead to complications such as blindness, nerve damage and kidney damage.

## 2.3.5 Physical properties

The physical properties of insulin substance is that is a white and it is in the form of white crystalline powder because it is purified by crystallization.It is soluble in water and dilute solution of mineral acids and insoluble in alcohol, Chloroform and ether.

### 2.3.6 Insulin Production

- insulin as medication was extracted in the past from cows, horses and pigs with only slight differences in the amino acid structure compared to human insulin.
- differences in suitability of beef or pork derived insulin for individual patients have been due to lower preparation purity resulting in allergic reactions to the presence of non-insulin substances "impurities"
- synthetic "human" insulin is now manufactured for widespread clinical use through genetic engineering techniques using recombinant DNA technology, which reduces the presence of many impurities.

## 2.4 Conclusion

WSN it's types, applications and comparison between WSN and MANET.

In addition, it explained the definition of insulin, its history, importance, usage, physical and chemical properties and manufacturing.

# CHAPTER THREE

## Literature Review, Tools and Techniques

# 3.1 Introduction

This chapter discusses the previous studies of wireless sensor networks, temperature sensors, and Arduino microcontroller. It shows details of studies and compare them with this project.in addition it explain the tools and techniques that are used to develop this projects.

**3.2.1 Temperature sensor** which project that use DHT11 as a sensor for detecting the accurate centigrade temperature to fix how well over a range of temperature a sensor's output consistently changes.

Output of the Integrate circuit is 10mv/degree centigrade for example if the output of the sensor is 280 mV then temperature is 28 degree C.

The aim of this project is not to construct a thermometer but to activate or deactivate a device at a particular margin temperature.

- **Similarity to our project**
  Using "DHT11" as a sensor.

- **Insufficiency**
  TheOutput of the IC usesa constant value to represent temperature and humidity (10mv/degree centigrade).

- **The main advantage of this project**
  Alert notification when the of temperature degree exceeds a specified degree, and using Arduino microcontroller to control from which sensor the temperature comes.

### 3.2.2Home Alarm System projectWireless Projects

The Aim this project is to transmits clear text temperature readings,
over long distances to Raspberry Pi serial port via a Base Station Receiver unit.

They used Texas Instruments CC1110 wireless transceiver which supports a micro-controller unit (MCU), memory, a sub-1GHz transceiver, an encryption engine and a USB controller.

- **Similarity to this project**
  They used a temperature sensor, USB controller, and microcontroller.

- **The difference**
  They transmit clear text temperature readings that can be received by theserial port via A base Station.
  In our project we transmit temperature sensor degree to the gateway, then store it in database and generate figure ,

  **3.2.3 Car speed controll**

  This project accomplished at AlzaiemAlazhari University, used sensors andArduino microcontroller to control cars speed".

### 3.2.4Fan Speed Controlled by Temperature and Arduino

This project automatically controls the speed of a DC fan according to the temperature read by a DHT11 sensor.

**Similarity to this project**

Used the temperature sensor DHT11and Arduino Uno.

## The difference

This project uses an LCD shield to display the current temperature and speed of the fan.

However we used figure display the insulin status.

### 3.2.5 Controlling electronic device using SMS

Another project has been accomplished at Sudan University Of Science and Technology.

The project aimed to use telephone to control all electronic devices through SMS using Arduino for controlling.

### 3.2.6Electricity Devices Control System

This project wasaccomplished in Sudan University of science and technology at the computer science department.

The project used a mobile computer to control electronic devices.

Similarity to our project they used microcontroller to control other devices.

# Tools

## 3.3 Hardware Tools

### 3.3.1 Arduino

Arduino is microcontroller –based kit that helps beginners and professionals to create device that interact with their environment using sensors or actuators. it provide an integrated development environment (IDE) that support C and C++ programing language .common examples of devices that can be developed using Arduino are simple robots ,thermometers and motion detectors. Arduino has a number of commercially produced versions in this project Arduino UNO was used.

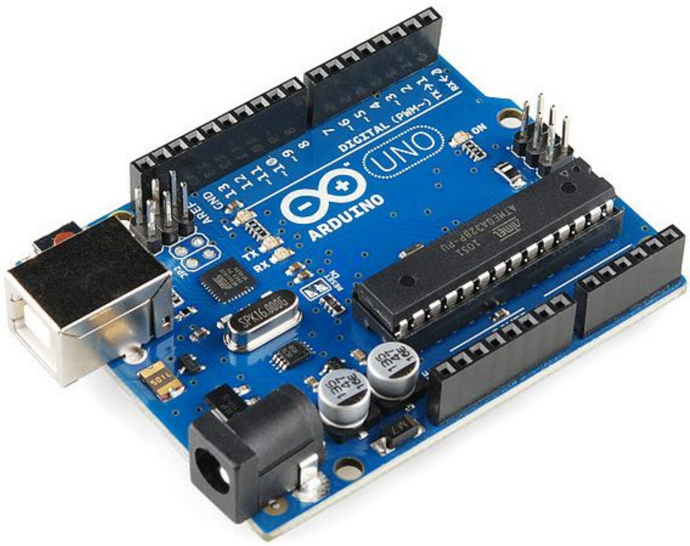



**Fig 3.3.1** Arduino

The UNO is the first microcontroller board in the serious of USB Arduino board's .It has 14 digital input/output pins,6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an In-Circuit Serial Programming (ICSP) header and a reset button. It contains everything needed to support the microcontroller. It can be connected to a computer with a USB cable or powered it with an AC-to-DC adapter or battery. "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 arduinoSoftware (IDE) were the reference versions of arduino, since then, new release has evolved [1].

Arduinois used to sense the environment by receiving input from a variety of sensors or temperature sensor as used in this project.it is then used to trigger creations in the surrounding environment by controlling lights, motors, switches, and other actuators.

Arduinoprojects can be stand-alone or they can communicate with software on running on a computer, Also arduinois a cross-platform program there for the programmers needs to follow different instructions with respect to their personal operating systems (OS).

# 3.3.2 Breadboard

A breadboard is construction tool that is used to build and test circuits easily before finalizing any circuit design. The breadboard is made up of a block of plastic holding a grid of contact points. This contact points are holes into which circuit components like ICs (Integrated Circuit), wires and other devices can be inserted. In this project, the breadboard was used to assemble the circuit.

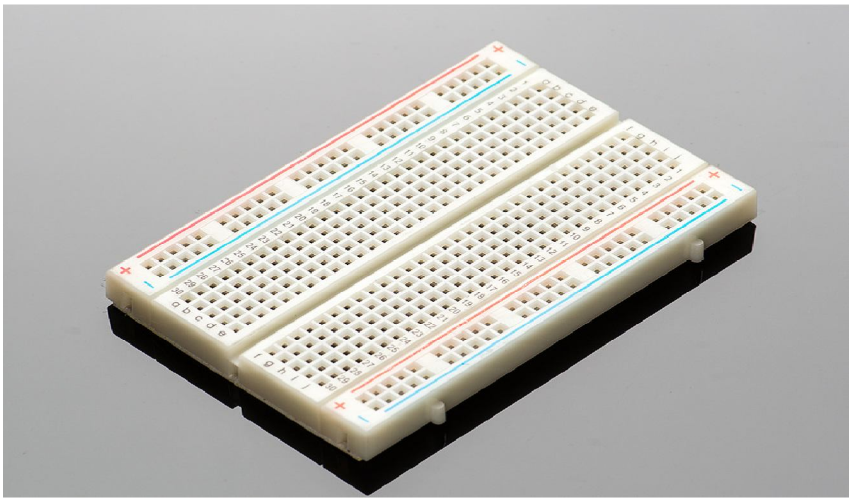


**Fig 3.3.2Breadboard**

# 3.3.3 DHT

A DHT sensor is made of two parts, a capacitive humidity sensor and a thermistor. There is also a very basic chip inside that does some analog to digital conversion and spits out a digital signal with the temperature and humidity. The digital signal is fairly easy to read using any microcontroller.

There are two versions of the DHT sensor, they look similar and have the same pinout, but have different characteristics.

DHT11

The feature of DHT11 are:

- Ultra low cost
- 3 to 5V power and I/O
- 2.5mA max current use during conversion (while requesting data)

- Good for 20-80% humidity readings with 5% accuracy
- Good for 0-50°C temperature readings ±2°C accuracy
- No more than 1 Hz sampling rate (once every second)
- Body size 15.5mm x 12mm x 5.5mm
- 4 pins with 0.1" spacing

**DHT22**

Following are characteristic of DHT22:

- Low cost
- 3 to 5V power and I/O
- 2.5mA max current use during conversion (while requesting data)
- Good for 0-100% humidity readings with 2-5% accuracy
- Good for -40 to 125°C temperature readings ±0.5°C accuracy
- No more than 0.5 Hz sampling rate (once every 2 seconds)
- Body size 15.1mm x 25mm x 7.7mm
- 4 pins with 0.1" spacing

The DHT22 is a little more accurate over a slightly larger range. Both use a single digital pin and are 'sluggish' as they can't be queried more than once every second or two.

In this project DHT11 is used according to its characteristic.

.

## 3.3.4 Wires

**Fig**3.3.4 Connection Wires

**Wires** are essential to Arduino they are used connect Arduino to other devices including sensors, Bluetooth modules, capacitors, resistance, power supply and other devices.

### 3.3.5 XBee

Are tiny blue chips that can communicate wirelessly with each other, they can do simple thing like replacing a couple of wires in serial communication.

There are lots of different types of modules, but one of the advantage about these is that all the modules regardless of the series or type have similar pinouts, Power, ground, and TX/RX lines are in the same place making the chips pretty interchangeable for most of the simpler applications.
In this project we XBee to send sensors data from arduino to the gateway

## 3.4 Software Tools and Languages

### 3.4.1 Arduino sketch

The Arduino Integrated Development Environment - or Arduino Software (IDE) - contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino and Genuino hardware to upload programs and communicate with them.Programs written using Arduino Software (IDE) are called sketches. These sketches are written in the text editor and are saved with the file extension .ino. The editor has features for cutting/pasting and for searching/replacing text. The message area gives feedback while saving and exporting and also displays errors. The console displays text output by the Arduino Software (IDE), including complete error messages and other information. The bottom right-hand corner of the window displays the configured board and serial port. The toolbar buttons allow the program to verify and upload programs, create, open, and save sketches, and open the serial monitor.

### 3.4.2 C#

C# (pronounced "C-sharp") is an object-oriented programming language from Microsoft that aims to combine the computing power of C++ with the programming ease of Visual Basic. C# is based on C++ and contains features similar to those of Java. We used C# to develop desktop application.

### 3.4.3 Proteus

Proteus is a Virtual System Modeling and circuit simulation application. The suite combines mixed mode Simulation Program with Integrated Circuit Emphasis circuit simulation, animated components and microprocessor models to facilitate co-simulation of complete microcontroller based designs. Proteus also has the ability to simulate the interaction between software running on a microcontroller and any analog or digital electronics connected to it. It simulates Input / Output ports, interrupts, timers, Universal Asynchronous Receiver/Transmitter and all other peripherals present on each supported processor. Proteus was used in this project to simulate WSN.

### 3.4.4 Unified modeling language

#### 3.4.4.1 UML Definition

UML Is a programming language that is used for object-oriented software development, to organize program code efficiently.

## 3.4.4.2UML Enterprise architecture

Is visual modeling and design tool based on UML, the platform support the design and construction of software systems ;modeling system processes and modeling industry based domains.It is used by businesses and organizations to not only model the architecture of their system but to process the implementation of these models across the full application development life cycle.

## 3.4.4.3 Sequence diagram

Describe the interaction among classes in terms of an exchange of messages over time.

They are used to represent or model messages, events, and actions between the objects or components of a system.

### Basic Sequence Diagram Symbols and Notations

### 1- Class roles

Describe the way an object will behave in context .use Unified Modeling Language objects to symbol to illustrate class roles but don't list object attributes.

### 2- Activation

Activation boxes represent the time an object needs to complete a task.

### 3- Messages

Are arrows that represent the communication between objects .Half arrowed_ lines are used to represent asynchronous messages.

Asynchronous messages are sent from an object that won't wait for response from the receiver before it continuing its task.

### 4-Lifelines

Are vertical dashed lines that indicate the object's presence over a time.

## 3.4.4.4Use case diagram

Use Case diagrams are used to describe the functionality of a system in a horizontal way. That is, rather than merely representing the details of individual features of the system.

Use Case Diagrams can be used to show all of its available functionality.

### Basic UseCase Diagram Symbols and Notations

### 1- Use Case

Each use case represents a single task that the system needs to carry out.

### 2- Actors

Is anything outside the system that interact s with the system to complete a task.

## 3.4.4.5Data Flow Model

A **data flow diagram** (**DFD**) is a graphical representation of the "flow" of data through an information system, modeling its process aspects. A DFD is often used as a preliminary step to create an overview of the system, which can later be elaborated. DFDs can also be used for the visualization of data processing (structured design).

A DFD shows what kind of information will be input to and output from the system, where the data will come from and go to, and where the data will be stored. It does not show information about the timing of process or information about whether processes will operate in sequence or in parallel (which is shown on a flowchart)

## 3.4.5Virtual Serial Port Emulator

Virtual Serial Port Emulator is software that is used to create virtual ports (coms) to be able to deal with more than one device simultaneously.

## 3.4.6SQL server management studio

SQL Server Management Studio (SSMS) is an integrated environment for accessing, configuring, managing, administering, and developing all components of SQL Server and Azure SQL Database. SSMS combines a broad group of graphical tools with a number of rich script editors to provide access to SQL Server to developers and administrators of all skill levels.

SSMS combines the features of Enterprise Manager, Query Analyzer, and Analysis Manager, included in previous releases of SQL Server, into a single environment. In addition, SSMS works with all components of SQL Server such as Reporting Services and Integration Services. Developers get a familiar experience, and database administrators get a single comprehensive utility that combines easy-to-use graphical tools with rich scripting capabilities

## 3.5 Conclusion

This chapter presented previous studies similar to our project. It also gave brief explanation of hardware and software tools and techniques that are used in this project.

# CHAPTER FOUR

# System analysis and Design

# 4.1 Introduction

The design of the proposed System will be demonstrated through UML diagrams; the use case model, data flow mode land sequence diagram .this chapter explains the system design.

# 4.2 System Description

This chapter describes the System, the functions of the system userand the design of the database.

### 4.2.1System Description

Monitor insulin using wireless sensors network is a system that provides monitoring service of the insulin.

This system provides continuously monitoring service to protect insulin from being exposed to temperature and humidity level outside the acceptable range.

# 4.3Use Case Diagram

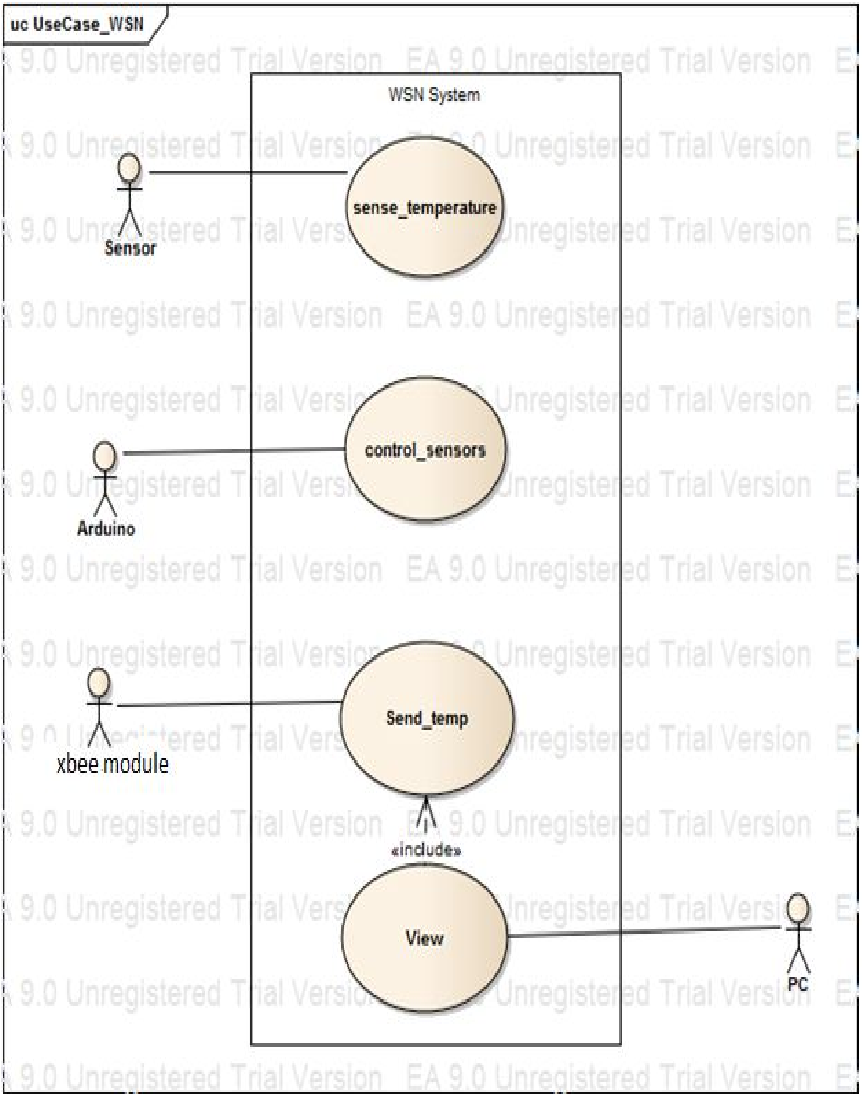



Figure 4.3.1 Tasks of the System Components

Figure(4.3) is the use case model; that shows the system's actors and their roles and specifies the functionality of each component.

# 4.4Data flow model

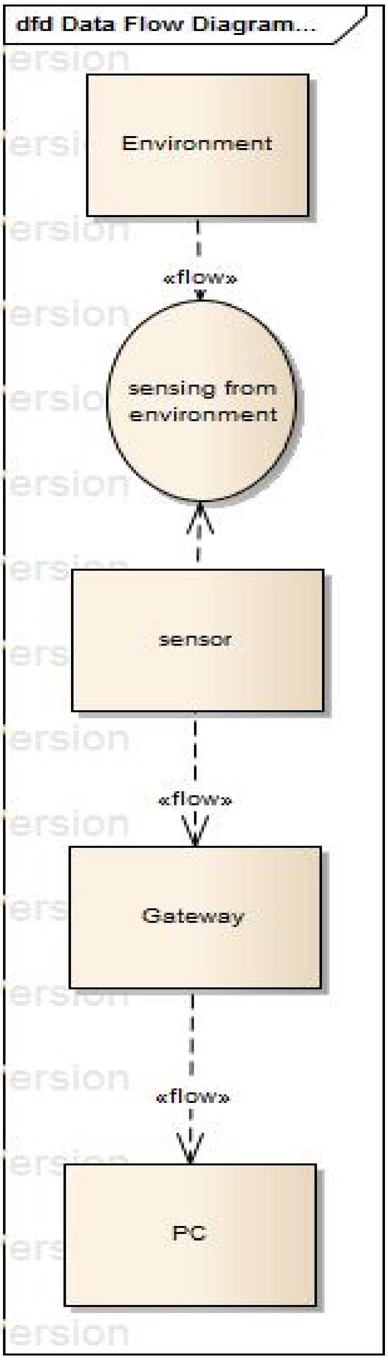



Figure (4.4.1)flow of data between System Components.

The figure (4.4.1)is data flow model the is the graphical representation of the "flow" of data through the system, modeling its process aspects.to create an overview of the system.

# 4.5 Sequence Diagram

## 4.5.1 Sensor

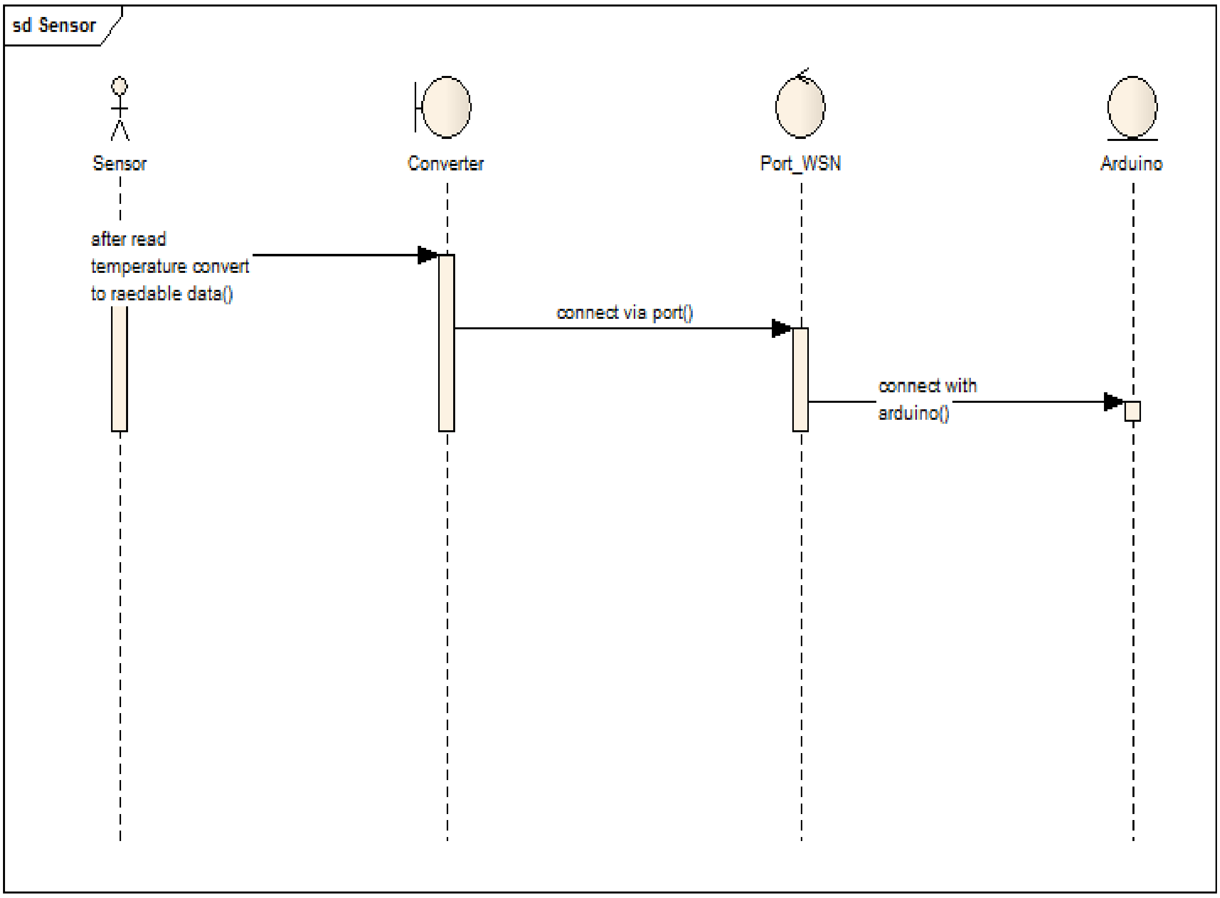



Figure **4.5.1**message flow between Sensors and other WSN components.

Figure 4.5.1shows the message flow between system components. Firstly sensor sense the temperature and humidity as a signal then convert it to readable data and connect to system via a port using  Arduino.

# 4.5.2 Arduino

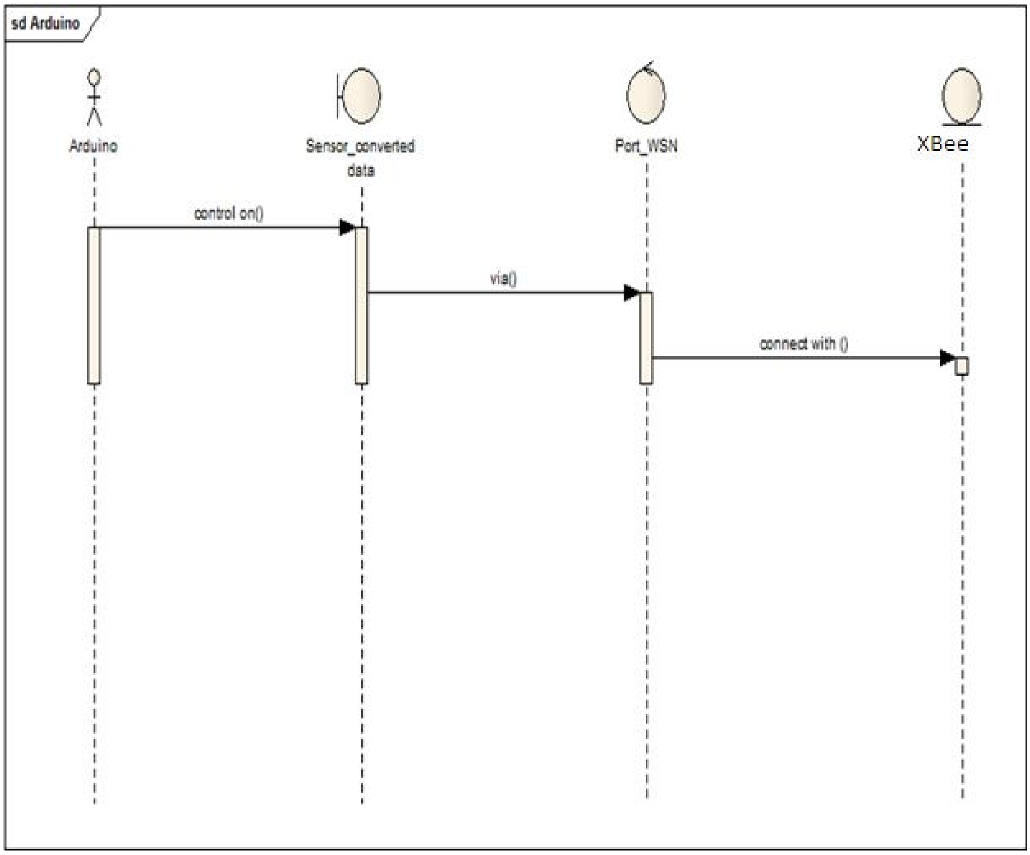



Figure (4.5.2)message flow between Arduino and other WSN components.

Arduino obtains sensor data via aport; interacts with other WSN components via a port and then connects with the Bluetooth to send gained sensor data.This process shown in figure (4.5.2).

# 4.5.3 XBee module

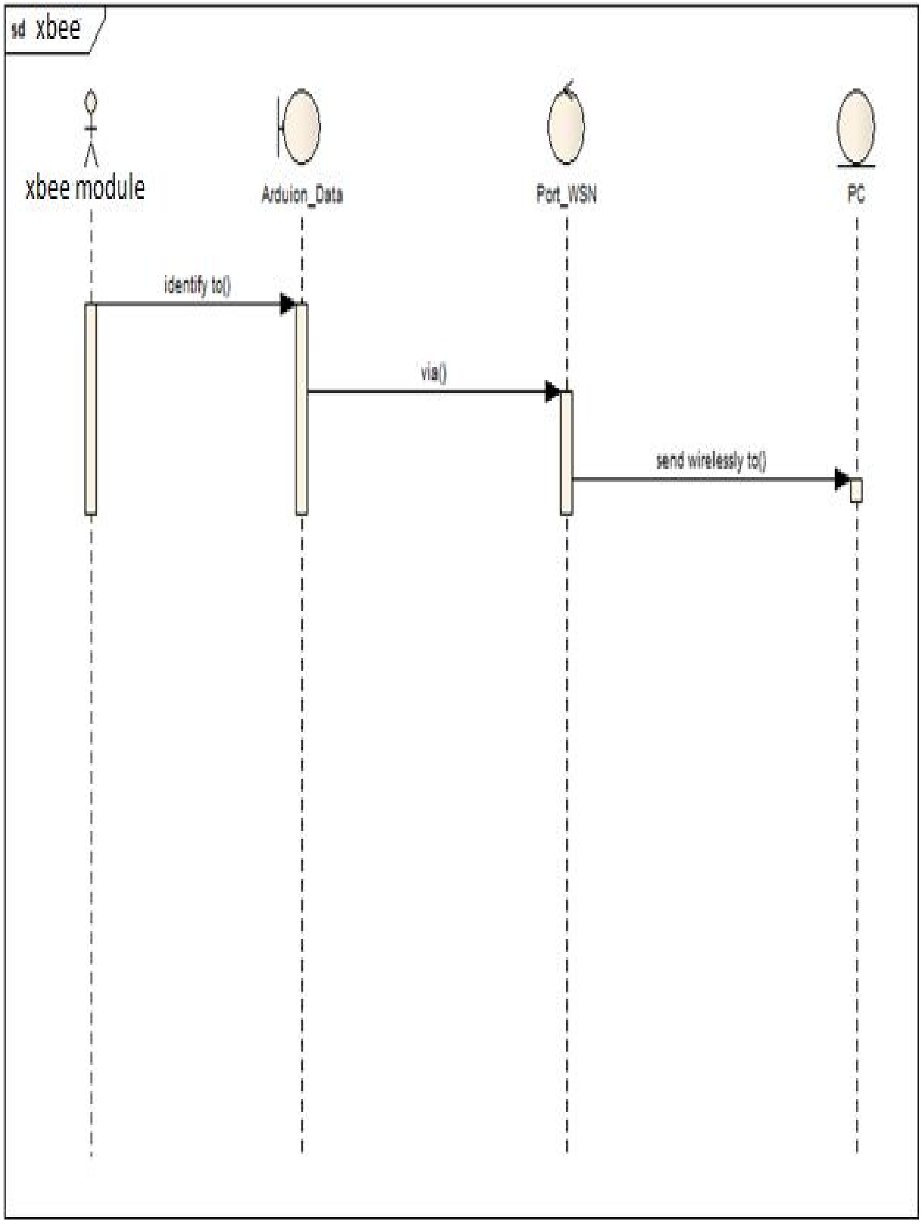



Figure (4.5.3) message flow between XBee and other WSN components.

XBee send sensor data via a port to Arduino and then the datais sentwirelessly to Gateway (PC).this shown in figure (4.5.3).

# 4.5.4 PC

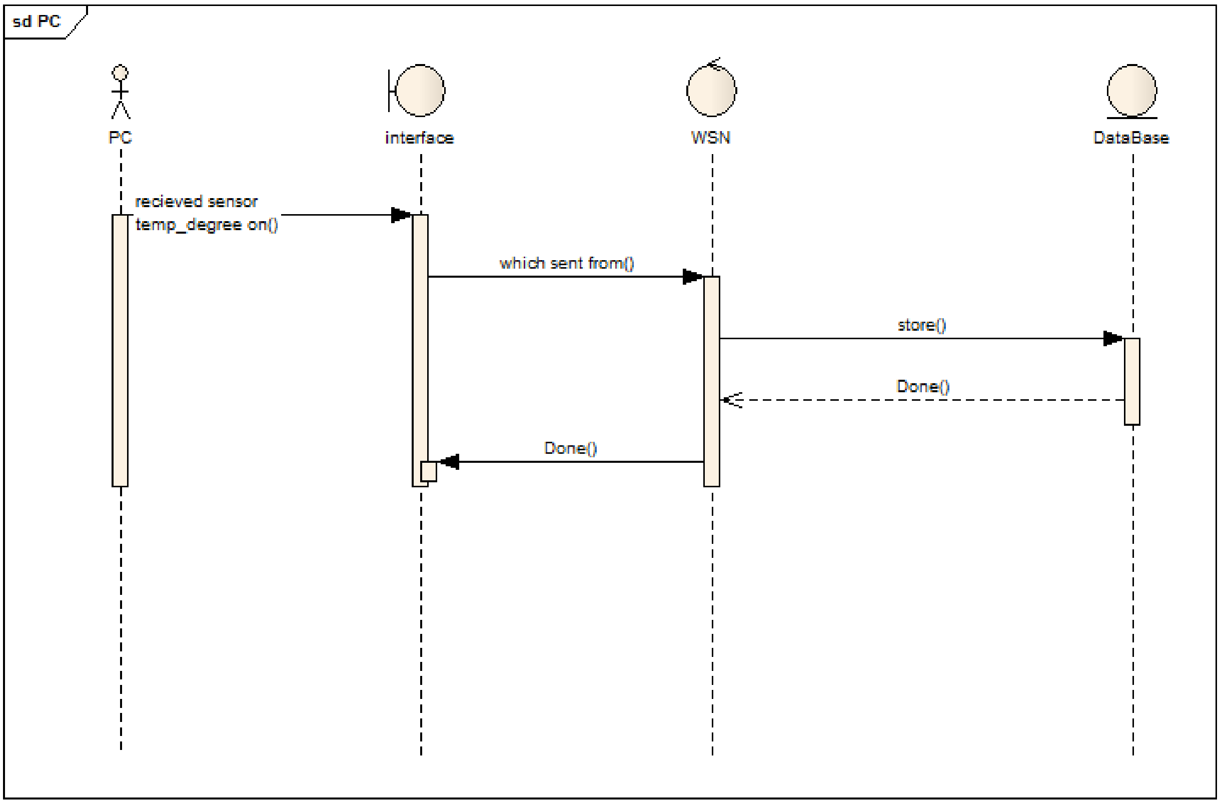



Figure (4.5.4) message flow between the Gateway (PC) and other WSN components.

Figure (4.5.4) shows the message follow between the PC and other system components, the Gateway receives sensor data which sent wirelessly from the WSN this data is stored in database.

## 4.6 Conclusion

This chapter has provided information about the system description as well as system design using UML description.

# CHAPTER FIVE

# IMPLEMENTATION

# 5.1 Introduction

This chapter demonstrates the implementation and the execution of the system.

## 5.2 A brief description about temperature and humidity

Temperatureis a measure of how hot or cold something is. Humidity is the amount of water vapor in the air. Understanding the concept of temperature and humidity helps in determining the best place to store insulin.Insulin can be kept at room temperature [15-25 degrees C] for 28 days. But recommendations are that a single vial may be used repeatedly over a 3 month period, as long as the vial is maintained at the correct storage temperature of 2 to 8 degrees C.

## 5.3 Scenarios

Arduino microcontroller, temperature sensor, Bluetooth module assembled together using the breadboard. Sensors are used to read the temperature from the environment, and Arduino is used as a microcontroller to control those sensors, wirelessly Sensor' data is sent to the desktop application .The desktop application is an interface that receives sent data which is wirelessly sent from a remote node [8], then this data is stored in MySQL database, the data is retrieved from the database and displayed in Application interface to show the current temperature and humidity degree of the stored insulin.

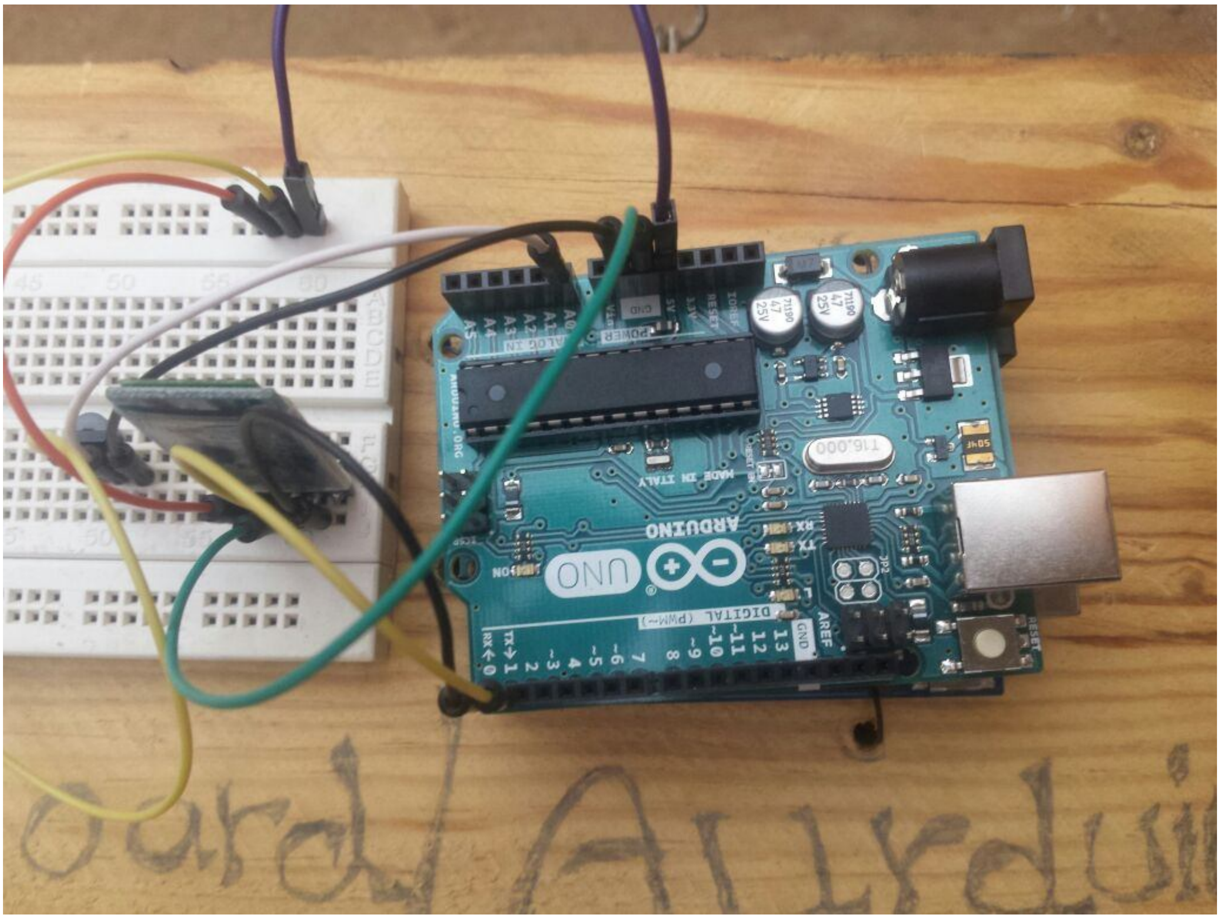



Fig (5.1) Bluetooth circuit

Bluetooth does not allow other nodes to send simultaneously because it is a paired connection. Therefor it doesn't approve the concept of WSN. Therefore we replaced it by the XBee module which enables simultaneous connectivity between nodes and the gateway .For budgetary reasons Proteus to simulate the nodes and VSPE to establish virtual ports to enable connection with multiple nodes because PC has only one port. Three nodes are simulated; each node consists of Arduino, DHT11 sensor, and the XBee module. Each node reads the temperature and humidity and sends it wirelessly through XBee to the collision point. The collision point then sends these data wirelessly to the desktop application through the XBee module.

## 5.4 Simulation Screens

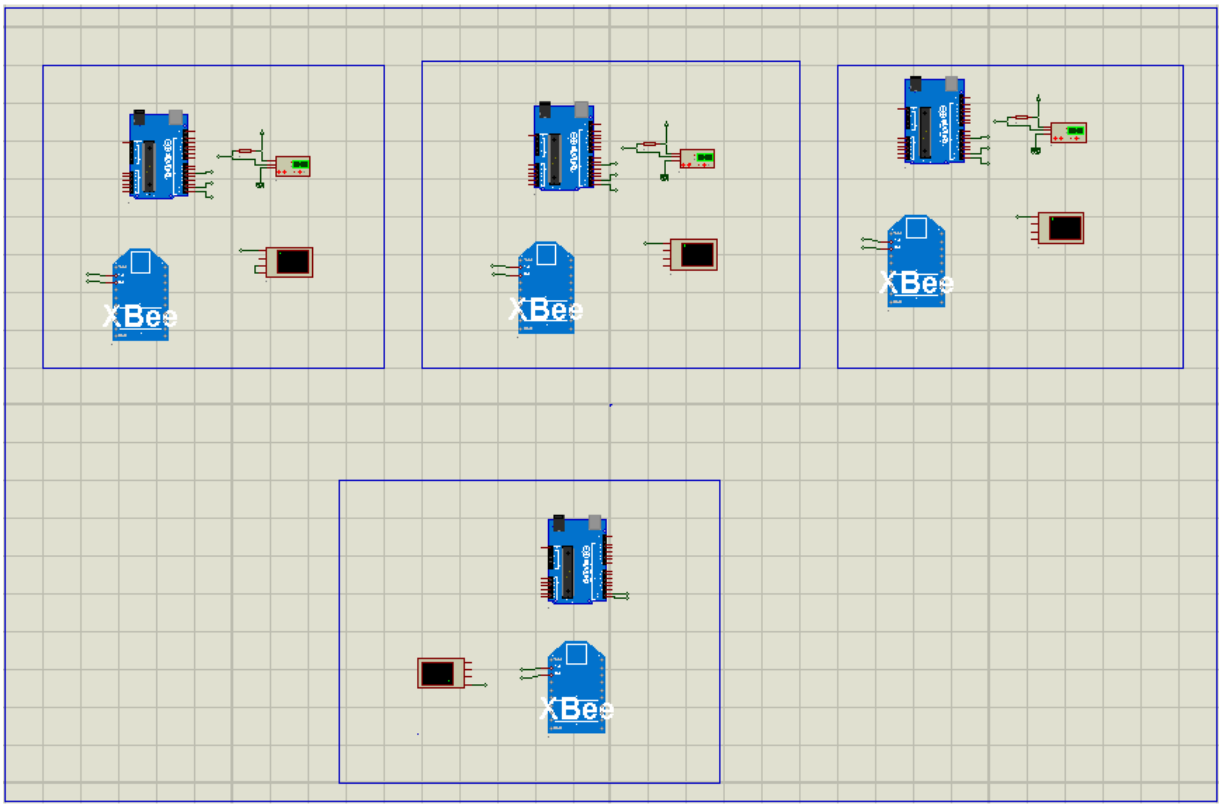



Fig (5.2)simulation screen

The figure above displays the nodes and the gateway.

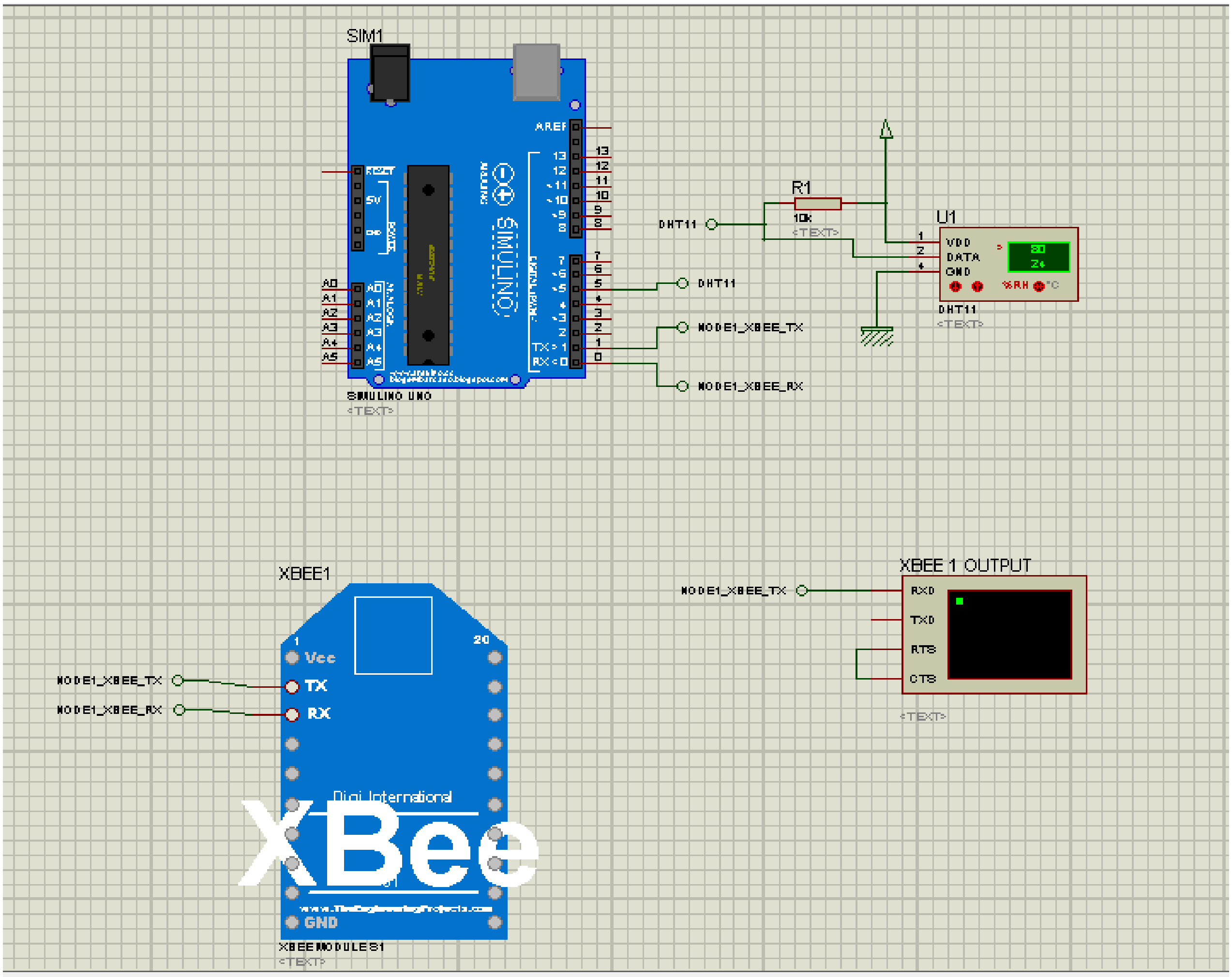



Fig (5.3)node structure

Each node contains a DHT11 sensor to sense temperature and humidity, Arduino to control data transmission from and to sensors, XBee module to send the data wirelessly to the gateway and terminal to show readable data.

After compiling andrunning the simulation above the administrator open the main screen to display, sensed data.

# 5.5 Application Screens

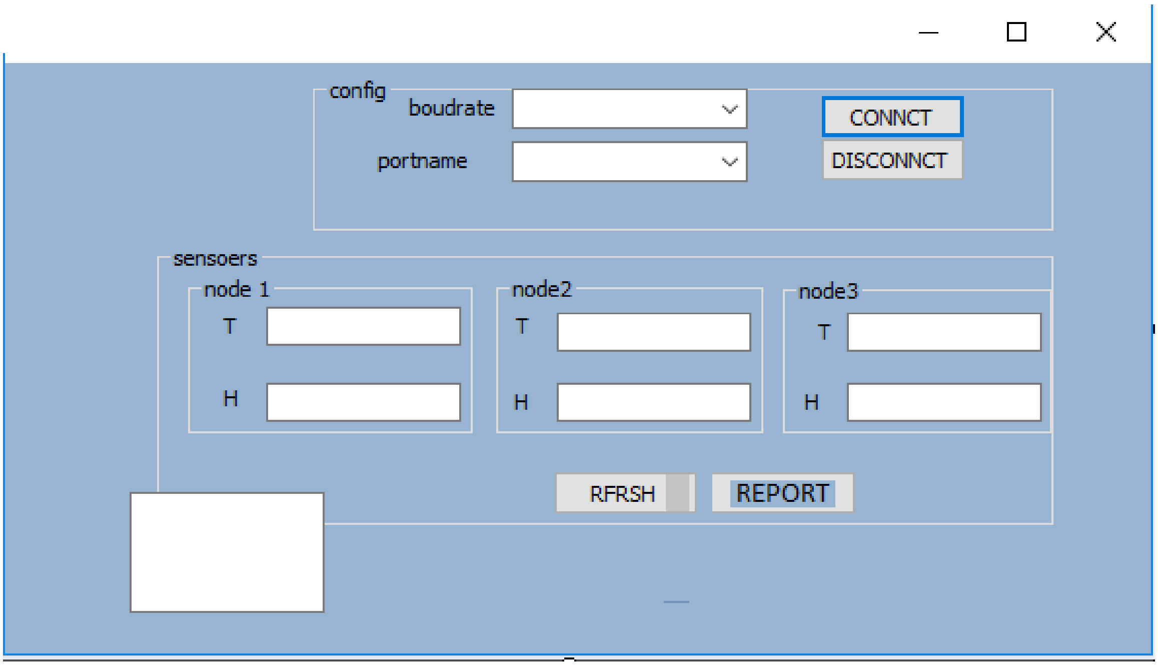



Fig (5.4)application interface

**T**is a temperature fields and

**H**is a humidity fields .

When clicking the CONNECT button, the connection with the database is established.

And when clicking the REFRESH button, the transmitted data from the gateway appears in the Text Fields and is automatically saved in the database.

When clicking the REPORT button, the saved information about insulin status will be retrieved from the database. Figure(5.4) shown the main interface of the application.

# 5.6 MYSQL Database

MYSQL server is used to create the database, the table below shows the database fields for each node.

| ID | Humidty | Temperaure | Date_time |
|---|---|---|---|
| 7 | 67 | 68 | 3-10-2016 |
| 8 | 68 | 70 | 3-10-2016 |
| 9 | 67 | 66 | 3-10-2016 |

# 5.7 Summary

This chapter demonstrated by figures the implementation of the system, and database structure.

# CHAPTER 6

## ~~Conclusion and Recommendations~~

# 6.1 Introduction

This chapter shows the result of using Wireless Sensor Network in monitoring Insulin.

# 6.2 Result

# 6.2.1 Desktop application


Fig (6.2)desktop application interface

At the upper left section, three sensor nodes with their parameters (temperature humidity), nodes id during date and time and report generation. At the upper right section baud rate specifies the rate for transmitting data, port number specifies the port for communication and progressing bar show the progressing process of connection. Button connect to connect with the gateway, disconnect button to cancel the connection with the gateway and the exit button to close the monitoring interface.

The lower section is the curve show the changing of  three sensor nodes monitored parameters(humidity, temperature) with acceptable ,damaged and warning range, during date and time.


Fig (6.3) choose baud rate for data transmission.

Baud rate 9600 bps is chosen because; a software used on a computer ( Arduino IDE's serial monitor) has the same speed in order to see the data being sent.


Fig (6.4) chooses port number to connect with the gateway.

In this section COM5 choose as available port which receives the data from nodes.

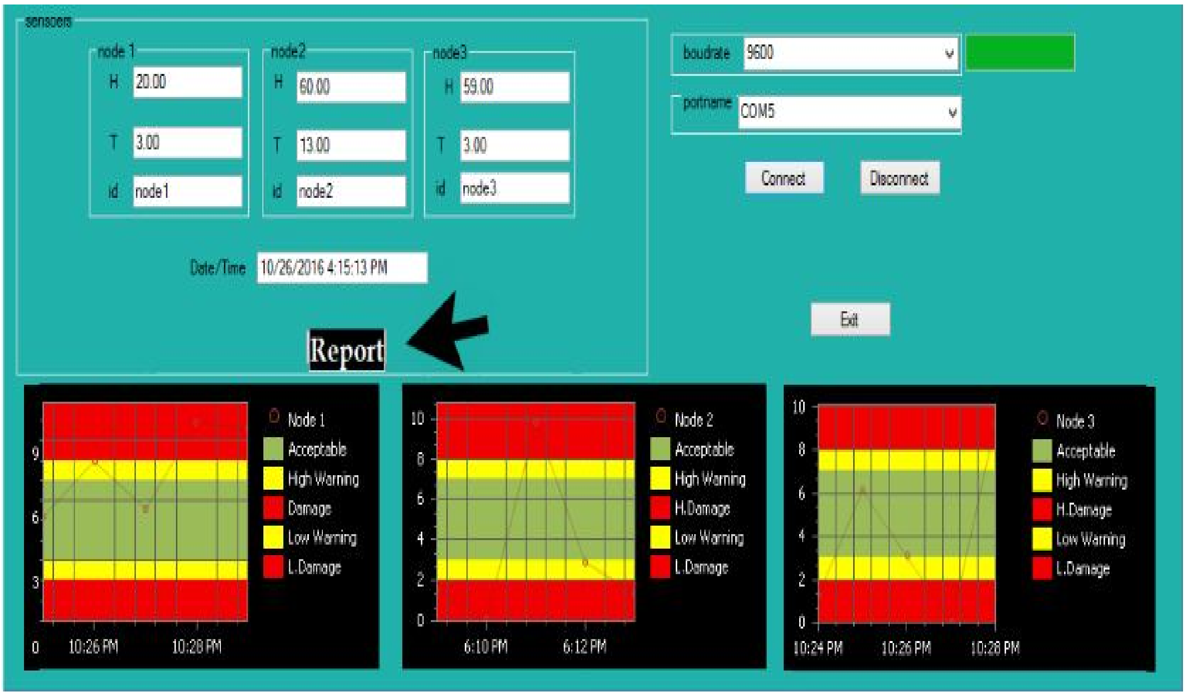

Fig (6.5) connecting with the gateway.


Fig (6.6) sensor nodes monitored parameters, sensed from the stored Insulin location during date and time.

| | id | node_id | h | t | date_time |
|---|---|---|---|---|---|
| 1 | 2446 | node1 | 20 | 4 | 2016-10-26 18:15:13.000 |
| 2 | 2447 | node2 | 60 | 2 | 2016-10-26 18:15:13.000 |
| 3 | 2448 | node3 | 59 | 0 | 2016-10-26 18:15:13.000 |
| 4 | 2449 | node1 | 20 | 4 | 2016-10-26 18:15:17.000 |
| 5 | 2450 | node2 | 60 | 2 | 2016-10-26 18:15:17.000 |
| 6 | 2451 | node3 | 59 | 0 | 2016-10-26 18:15:17.000 |
| 7 | 2452 | node1 | 20 | 4 | 2016-10-26 18:15:22.000 |
| 8 | 2453 | node2 | 60 | 2 | 2016-10-26 18:15:22.000 |
| 9 | 2454 | node3 | 59 | 0 | 2016-10-26 18:15:22.000 |

Fig (6.7) monitored parameters of sensors 'nodes stored in data base, based on date and time.


Fig(6.8) curves change due to the monitored parameter(humidity, temperature) during time.




Fig(6.9) generates report for the stored sensors 'nodes parameters.

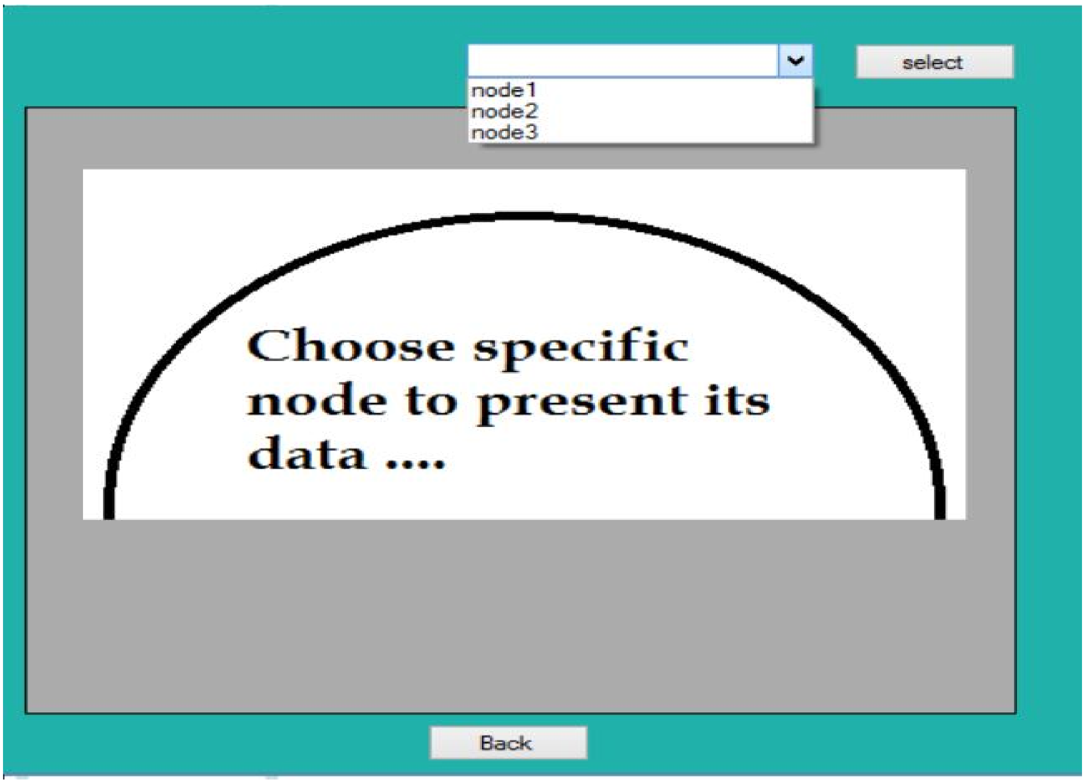
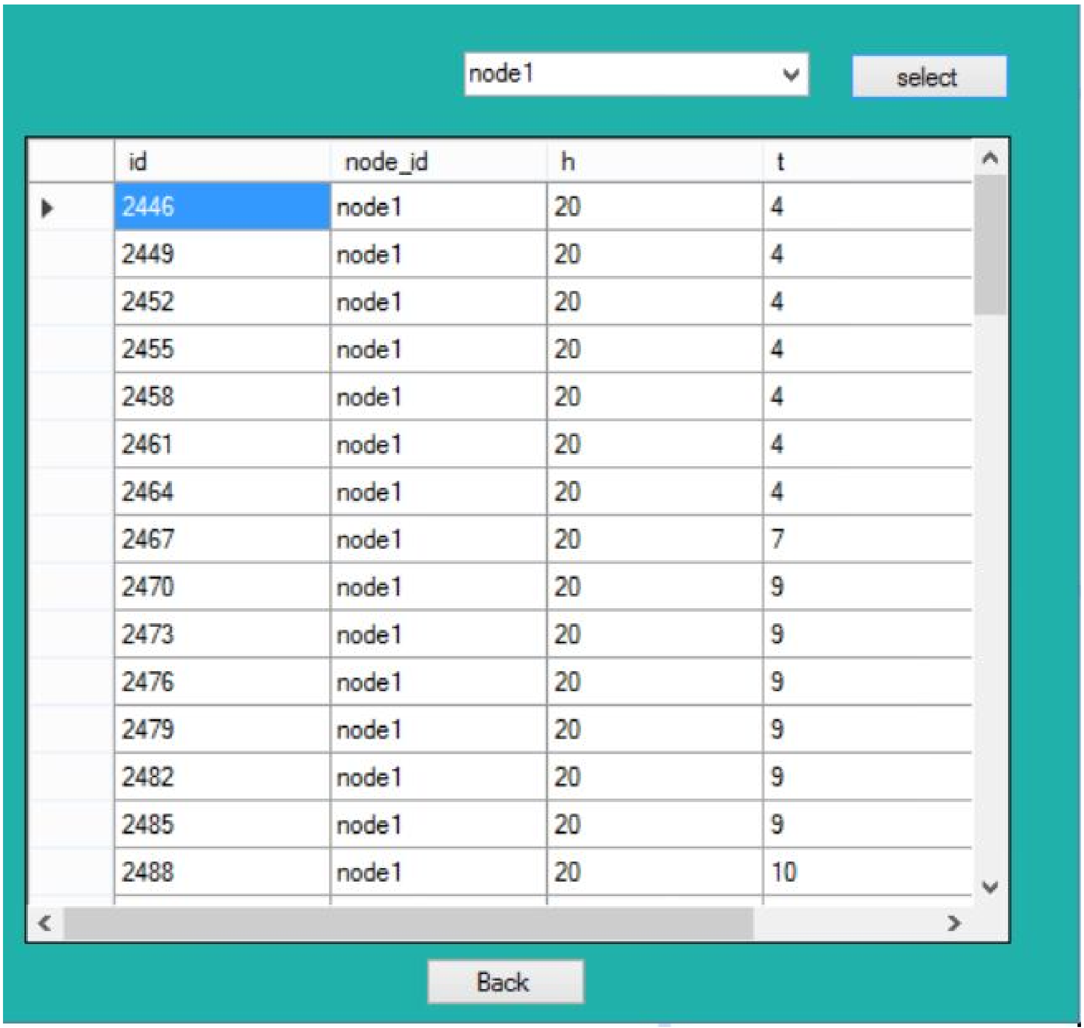



Fig (6.10) chooses node to generate report about.




| id | node_id | h | t |
|---|---|---|---|
| 2446 | node1 | 20 | 4 |
| 2449 | node1 | 20 | 4 |
| 2452 | node1 | 20 | 4 |
| 2455 | node1 | 20 | 4 |
| 2458 | node1 | 20 | 4 |
| 2461 | node1 | 20 | 4 |
| 2464 | node1 | 20 | 4 |
| 2467 | node1 | 20 | 7 |
| 2470 | node1 | 20 | 9 |
| 2473 | node1 | 20 | 9 |
| 2476 | node1 | 20 | 9 |
| 2479 | node1 | 20 | 9 |
| 2482 | node1 | 20 | 9 |
| 2485 | node1 | 20 | 9 |
| 2488 | node1 | 20 | 10 |

Fig (6.11) report is generated for the chosen node.

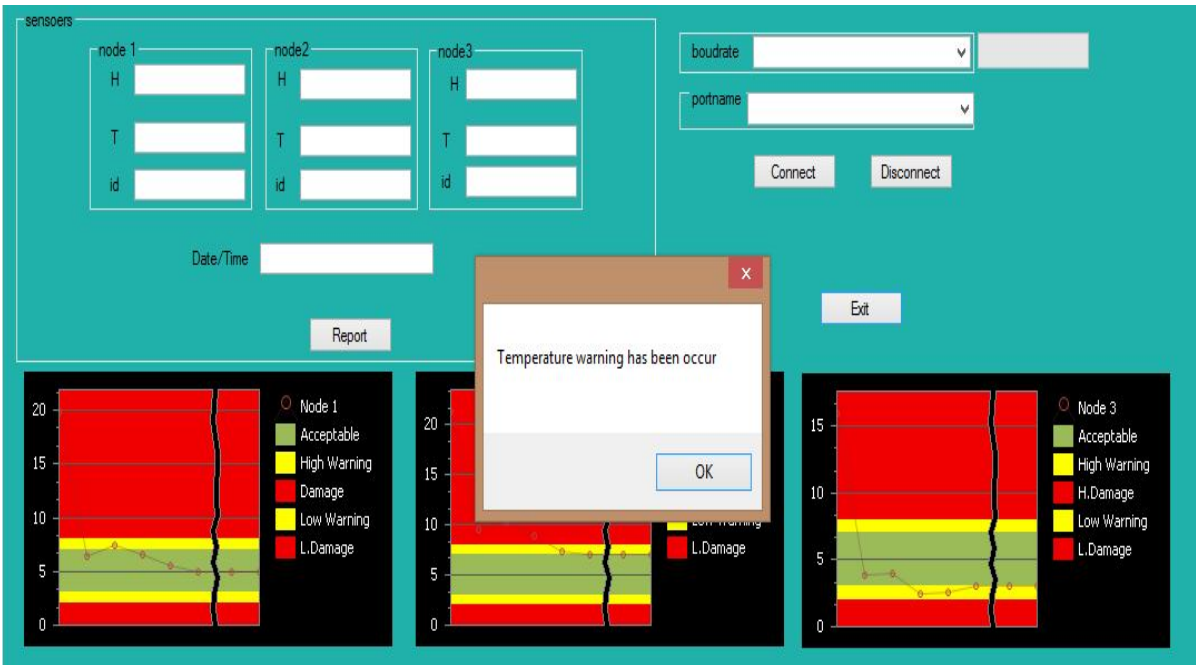



Fig (6.12) generate alert when the monitored parameters exceed the warning range.

## 6.2.2 Mobile application

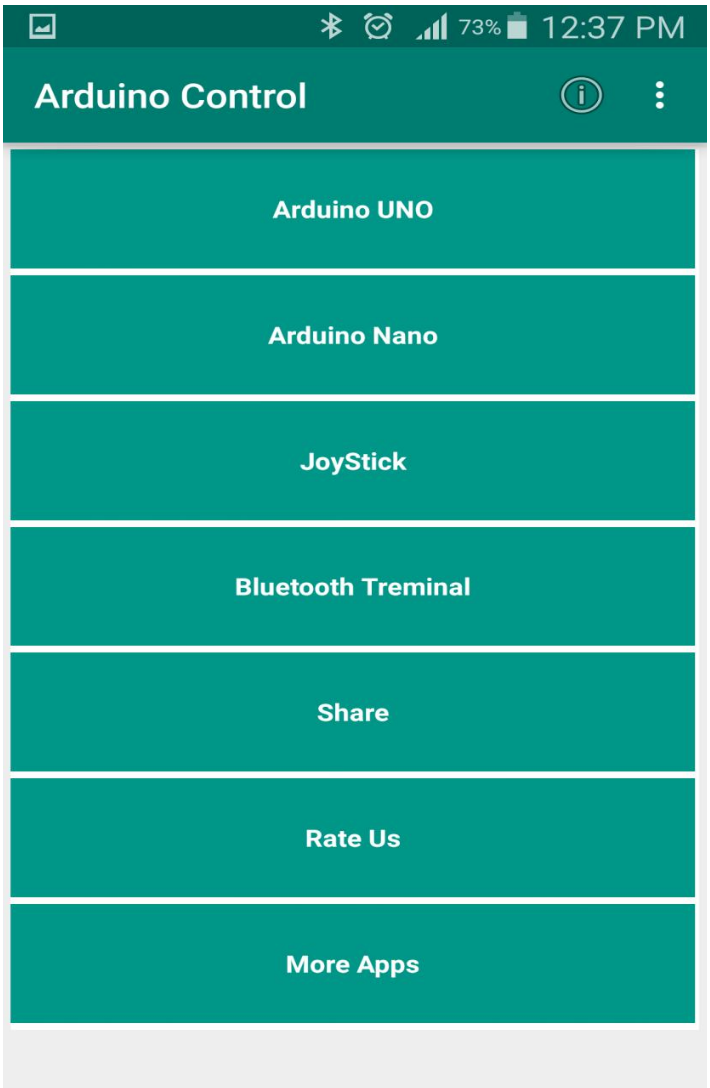



Fig (6.13) chooses the microcontroller used to control WSN nodes.

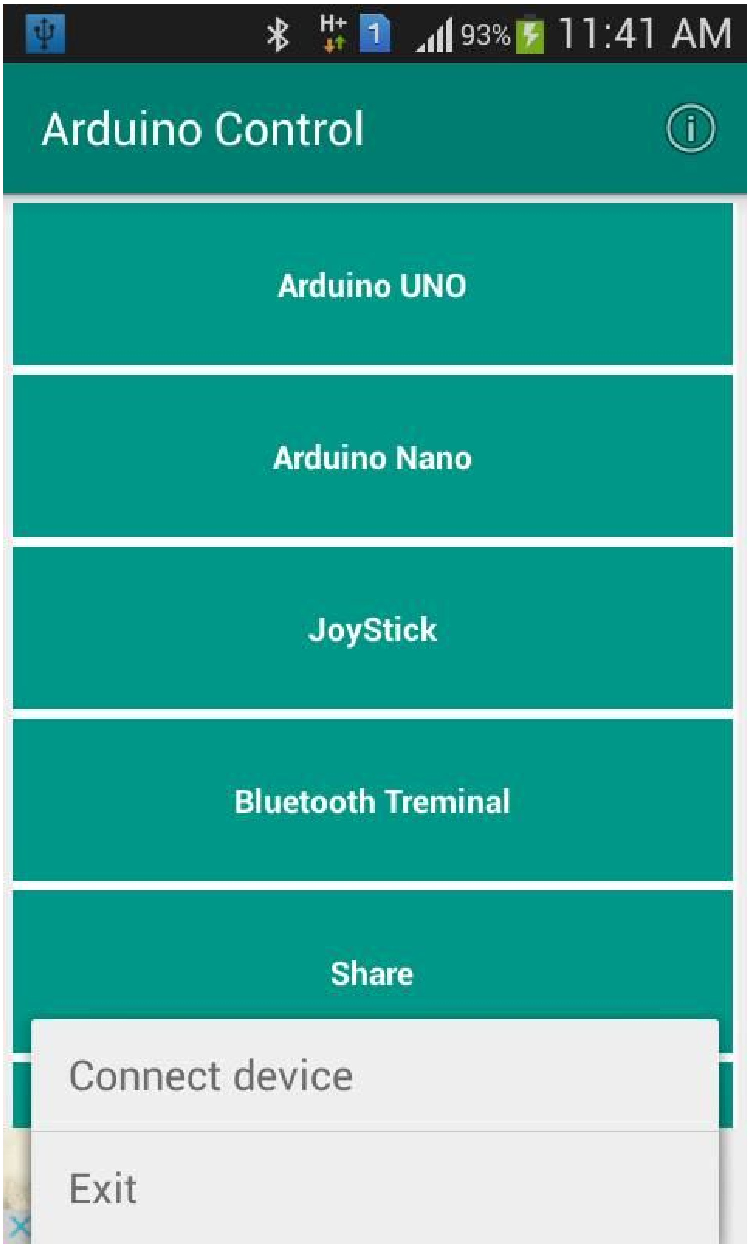



Fig (6.14) pairing process with Bluetooth module.


Fig (6.15) Bluetooth terminal receives the incoming data from the sensor.

# 6.2Summary

This chapter explained the result of using Wireless Sensor Network in monitoring Insulin.

# CHAPTER 7

# Conclusion and Recommendations

# 7.1 Conclusions

In this research we have identified the main use of the Arduino microcontroller, sensors and wireless modules in order to developed a desktop application and mobile application.in this project we developed a system to monitor insulin status by sensing  and storing information about humidity and temperature in a database for future use.

The application, monitors insulin using a Wireless Sensors Network which enables the administrator to monitor insulin status remotely for quick and correct decision making.

# 7.2 Recommendations

A lot of researches has been devoted to various Wireless Sensor Network monitoring applications. Still , more work is require to improve systems in this area.

We recommend the following:

- Develop a mobile application with alert and  option to take an action.
- Testing the application with actual required equipment.

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[13]https://teaching.ncl.ac.uk/bms/wiki/index.php/Insulin access at 9/22/2016 1:03 pm

[14]https://github.com/mysql/mysql-serveraccess at 9/18/2016 10:45 am

[15]https://www.sparkfun.com/pages/xbee_guide access at 9/18/2016 11:30 am

[16] http://www.tutorialspoint.com/uml/uml_tutorial.pdfaccess at 9/18/2016 11:37 am

[17]http://robotics.eecs.berkeley.edu/~pister/publications/2008/TSMP%20DSN08.pdf9/18/2016 12:58 pm

[18]http://engineering-softwares.blogspot.com/2013/02/labcenter-electronics-isis-proteus.htmlhttp://9/18/2016 12:58 pm

[19]http://www.umass.edu/landeco/teaching/ecodata/schedule/environmental.data.pdf 7/12/2016 12:55 pm