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Design & Implementation of Wireless Transceiver for Data Acquisition in Wireless Sensor Network

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Abstract:The aim of this paper is to design a multi-parameter monitoring system which is based on low-power ZigBee wireless communication technology for system automation and monitoring. Real time data is collected by wireless sensor nodes and transmitted to base station using ZigBee. Data is received, saved and displayed at base station to achieve soil temperature, soil moisture and humidity monitoring. The data is continuously monitored at base station and if it exceeds the desired limit, a message is sent to farmer on mobile through GSM network for controlling actions. The implementation of system software and hardware are given, including the design of wireless node and the implementation principle of data transmission and communication modules. This system overcomes the limitations of wired sensor networks and has the advantage of flexible networking for monitoring equipment, convenient installation and low cost and reliable nodes and high capacity.

Keyword: AVR Microcontroller, GSM, LCD, remote monitoring, Sensors, ZigBee.

I. Introduction

Wireless technology for an intelligent irrigation system has become a popular research with the greenhouse effect. People are utilizing the merits of embedded system into monitoring and control system for intelligent irrigation system. Monitoring parameters of temperature and humidity is an important means for obtaining high-quality environment. Remote monitoring is an effective method in order to avoid interference environment and improve efficiency. Today, Ethernet network, RF module and ZigBee wireless network are used to transmit data in remote Monitoring System. This paper gives a review of remote control and monitoring systems based on existing technologies and a GSM-ZigBee based remote control and monitoring system with automatic irrigation system is proposed. The design presented has the advantage of both GSM and ZigBee technology.

Wireless Sensor Networks

A WSN is a system comprised of radio frequency (RF) transceivers, sensors, microcontrollers and power sources. Recent advances in wireless sensor networking technology have led to the development of low cost, low power, multifunctional sensor nodes. Sensor nodes enable environment sensing together with data processing. Instrumented with a variety of sensors, such as temperature, humidity and volatile compound detection, allow monitoring of different environments. They are able to network with other sensor systems and exchange data with external users. Sensor networks are used for a variety of applications, including wireless data acquisition, machine monitoring and maintenance, smart buildings and highways, environmental monitoring, site security, automated on-site tracking of expensive materials, safety management, and in many other areas. A general WSN protocol consists of the application layer, transport layer, network layer, data link layer, physical layer, power management plane, mobility management plane and the task management plane. Currently two there standard technologies are available for WSN: ZigBee and Bluetooth. Both operate within the Industrial Scientific and Medical (ISM) band of 2.4 GHz, which provides license free operations, huge spectrum allocation and worldwide compatibility. In general, as frequency increases, bandwidth increases allowing for higher data rates but power requirements are also higher and transmission distance is considerably shorter. Multi-hop communication over the ISM band might well be possible in WSN since it consumes less power than traditional single hop communication. It is also possible to create a WSN using Wi-Fi (IEEE 802.11), but this protocol is usually utilized in PC-based systems because it was developed to extend or substitute for a wired LAN [29]. Its power consumption is rather high, and the short autonomy of a battery power supply still remains an important disadvantage.

ZigBee

The ZigBee standard is built on top of the IEEE 802.15.4 standard. The IEEE 802.15.4 standard defines the physical and MAC (Medium Access Control) layers for low-rate wireless personal area networks . The physical layer supports three frequency bands with different gross data rates:2,450 MHz (250 kbs-1), 915 MHz (40 kbs-1) and 868 MHz (20 kbs-1) It also supports functionalities for channel selection, link quality estimation, energy measurement and clear channel assessment. ZigBee standardizes both the network and the application layer. The network layer is in charge of organizing and providing routing over a multi-hop network, specifying different network topologies: star, tree, peer-to-peer and

mesh. The application layer provides a framework for distributed application development and communication. Aside from the agriculture and food industry, it is widely used in home building control, automation, security, consumer electronics, personal computer peripherals, medical monitoring and toys. These applications require a technology that offers long battery life, reliability, automatic or semiautomatic installation, the ability to easily add or remove network nodes, signals that can pass through walls and ceilings and a low system cost.

II. System Architecture

The hardware of this system includes 16 bit AVR, Bluetooth and GSM module, Temperature, humidity and soil moisture sensors, LCD. The system should be designed in such a way that even illiterate villagers can operate it. They themselves can check different parameters of the soil like salinity, acidity, moisture etc. from time to time. During irrigation period they have to monitor their distant pump house throughout the night as the electricity supply is not consistent. The system can be installed at the pump house located remotely from the village, it is interfaced with the pump starter & sensors are plugged at different location in the field for data acquisition. Using this system they can switch on their pump from their home whenever they want. All they have to do is to make a call/miss call/SMS to the GSM module & pump gets ON. System design and its unit

Figure.1 Temp Sensor

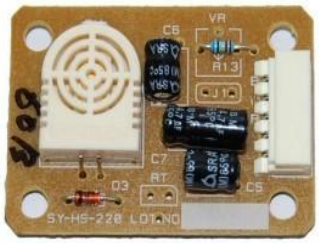

Figure.2 Humidity Sensor

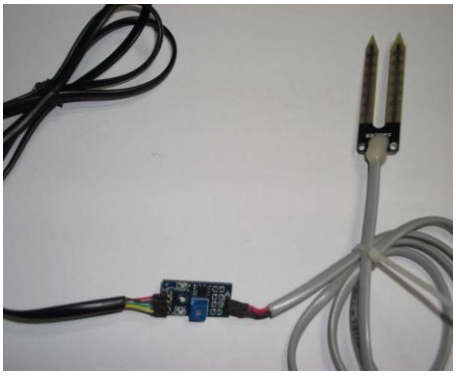

Figure.3 Soil Moisture Sensor

Temperature sensor

The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. It is low cost and small size sensor. Its temperature range is -55° to +150°C.

Humidity sensor

Humidity measurement instruments usually rely on measurements of some other quantity such as temperature, pressure, mass or a mechanical or electrical change in a substance as moisture is absorbed. By calibration and calculation, these measured quantities can lead to a Measurement of humidity.

Soil moisture sensor

The soil moisture sensor used is capacitive type. The sensor gives analog output of zero volt when there is 100% moisture and 5V for 0% moisture.

III. Circuit Diagram

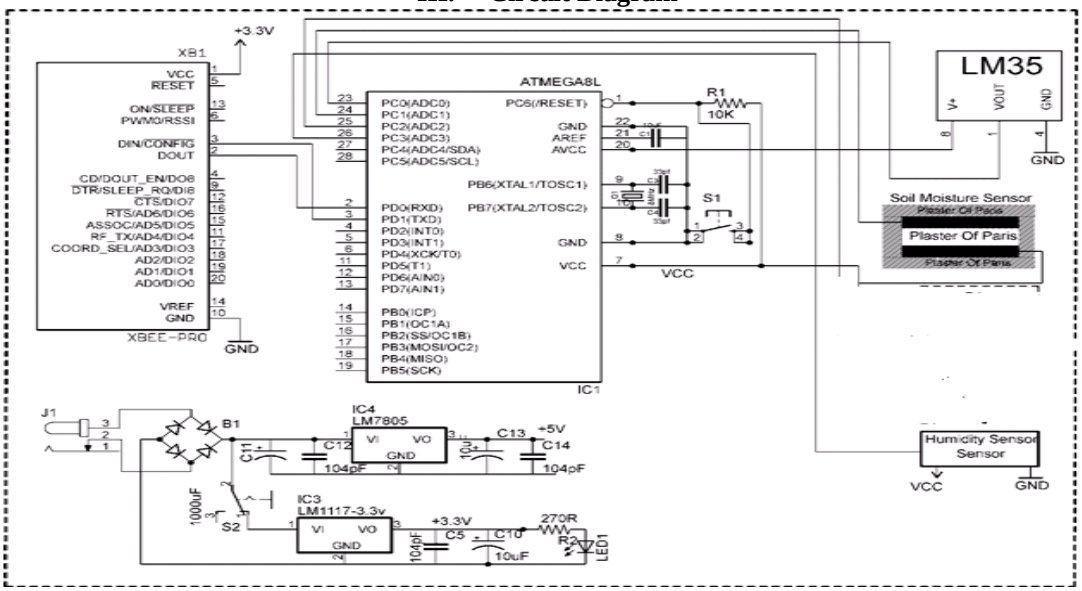

Figure.4 Circuit Diagram of Transmitter

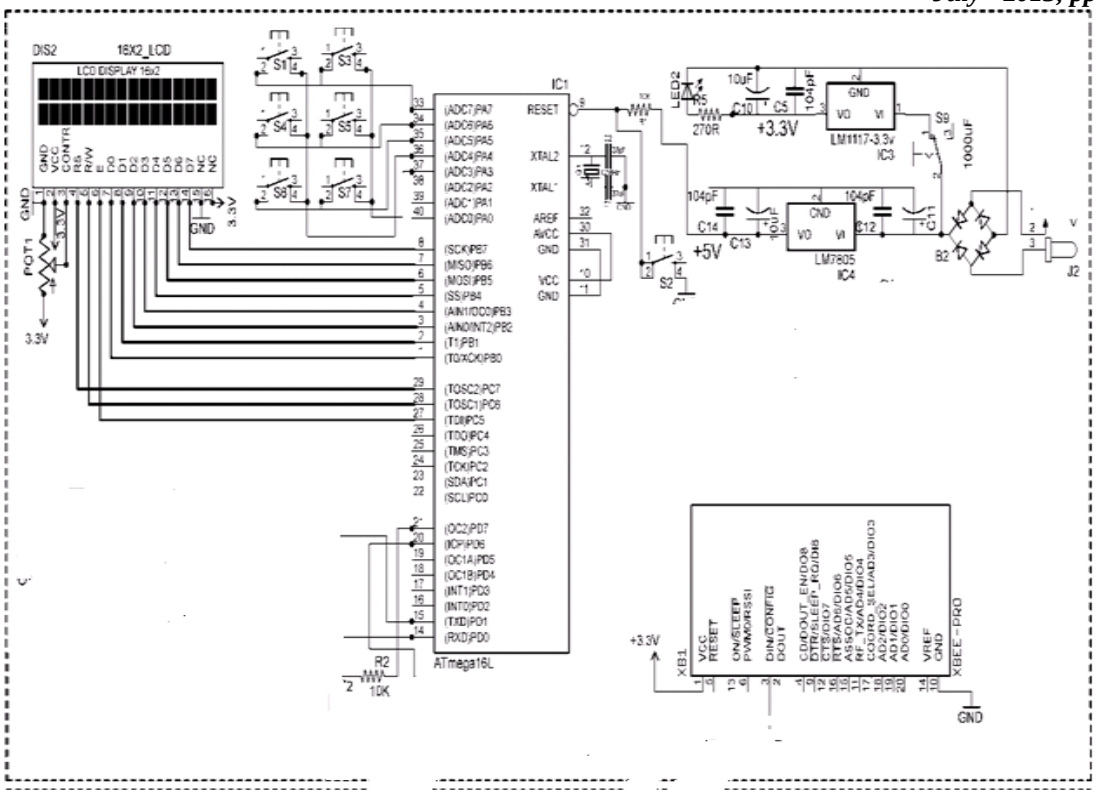

Figure.5 Circuit Diagram of Receiver

IV. Working

System works in two parts
1) Transmitter 2) Receiver

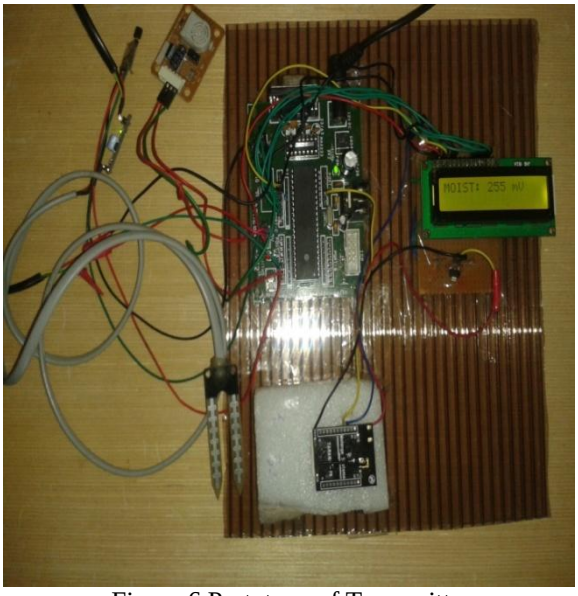

Figure.6 Prototype of Transmitter

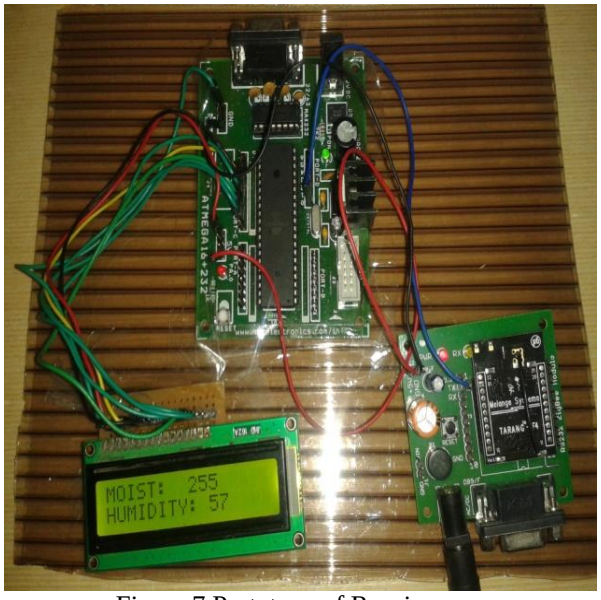

Figure.7 Prototype of Receiver

Transmitter

Initially power is on. After this system is reset. Signals are read by different sensors and its output is given to microcontroller. Output to microcontroller from sensor is taken through 8 channel ADC pins. The output from microcontroller is given to Bluetooth through Rx and Tx pins. In the fault condition such as in empty tank, signal is given to GSM.

Receiver :

At receiver side both GSM and Bluetooth come into picture. There is only one Tx and Rx pins so we are using a relay. Relay will switch one by one. Signal is send to microcontroller and parameters like temperature, soil moisture and humidity are monitored. The actuators can be controlled using microcontroller data. This is how total working takes place of automation irrigation system. Different sensors like moisture and temperature sensor senses the moisture content and temperature required. Thus it helps to provide a proper environment to grow crops easily. A different technique of

irrigation has been used to irrigate the field. First water is stored in tanks trough pipes then different sources like sprinklers and drip irrigation can been used as both are suitable to irrigate crops.

Advantages of the system

In crop field we have to irrigate the land fully. We have to irrigate depending upon the soil, ups and downs of the land and where it needs.

i) We have designed ZigBee wireless sensor network for monitoring the crop field area by deploying moisture sensors in the land to detect the places where the water level is low. From those results we can irrigate to that particular place only. So we can conserve water and minimize the problem of water logging in the land.

ii) We used humidity sensor to sense the weather. By this the farmer can get idea about the climate. If there is any chance for rainfall, the farmer need not irrigate the crop field. Due to this we can conserve water and also power since we dint turn on motors.

iii) Nowadays in the crops the fertilizer level is increasing, which affects people. By using pH sensors we get the information about the soil and analyze the acid level of the soil. By which we can apply fertilizer to the place where it needs, also we can avoid over fertilization of the crops. Temperature is a randomly varying quantity in the environment of paddy field. Temperature reading gives information to the farmer. By using temperature sensors we can detect the temperature

V. Results

The results are plotted using MATLAB

```
%To plot the graph of moisture vs equivalent output Voltage
x = 0:50:250;
y = [100,78,65,41,22,05];
plot(x,y);
ylabel('% Moisture');
xlabel('Voltage in mV');
Title('Moisture Vs Volatge');
grid on
```

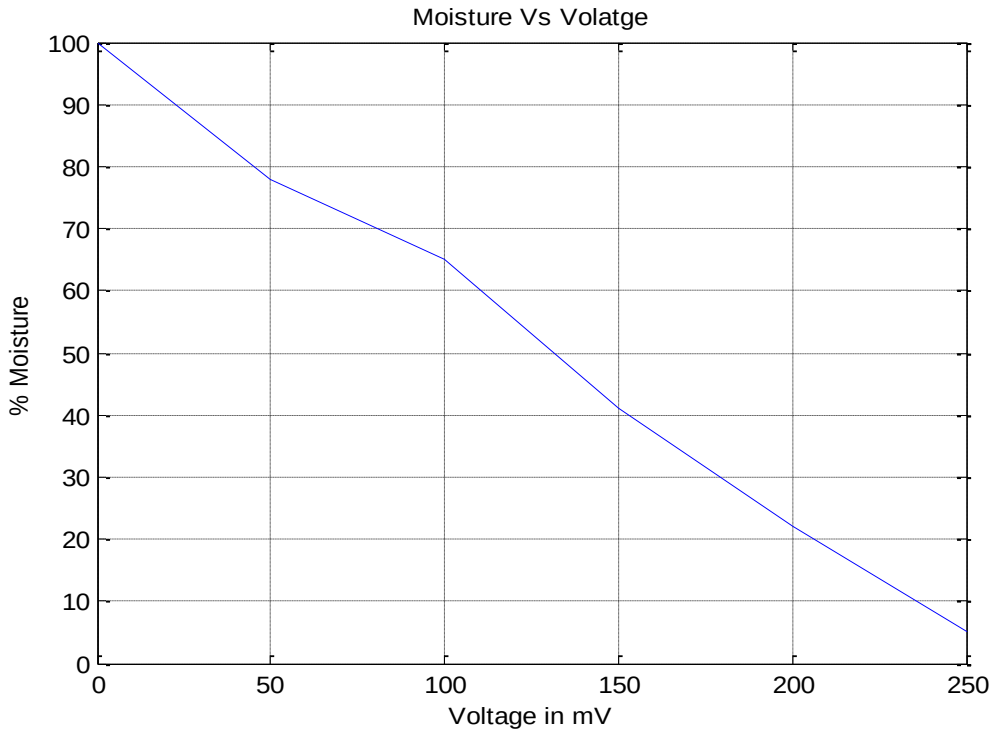

Figure.8 Response of moisture sensor

```
%To plot the graph of Humidity vs equivalent output Voltage
x = 30:10:90;
y = [1000,1300,1650,2000,2300,2600,3000];
plot(x,y );
xlabel('relative Humidity in %Rh');
ylabel('Voltage in mV');
title('Humidity Vs Volatge');
grid on
```


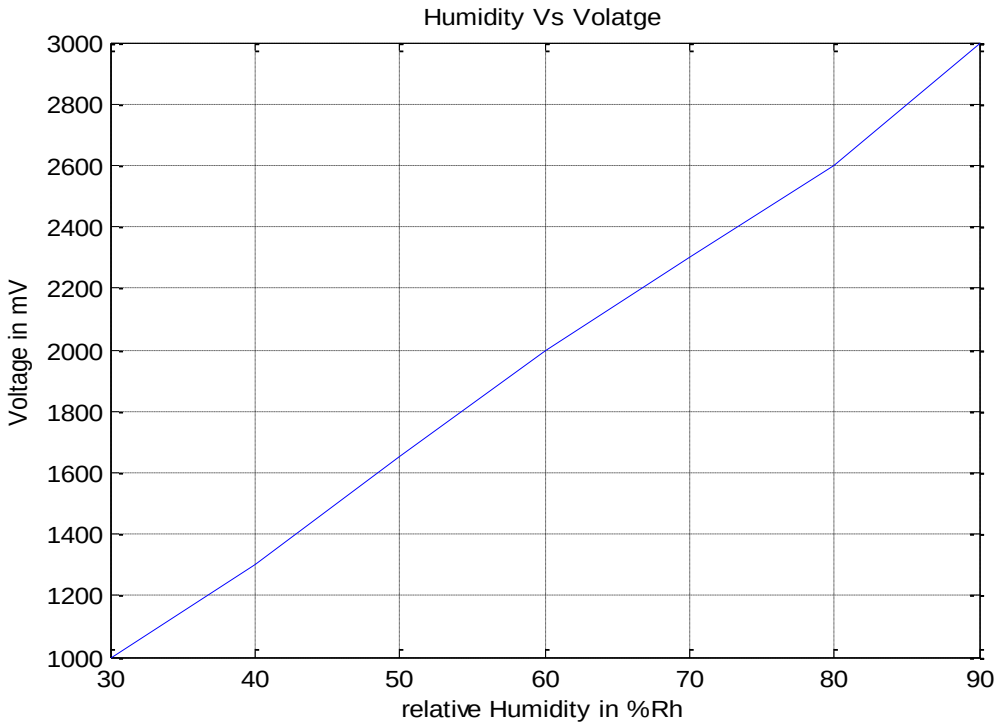

Figure.9 Response of humidity sensor

```
%To plot the graph of Temparature  vs equivalent output Voltage
x = 20:5:50;
y = [3.10,3.20,3.25,3.30,3.35,3.37,3.40];
plot(x,y );
xlabel('Temparature in degree celcius');
ylabel('Voltage in volts');
title('Temparature Vs Volatge');
grid on
```

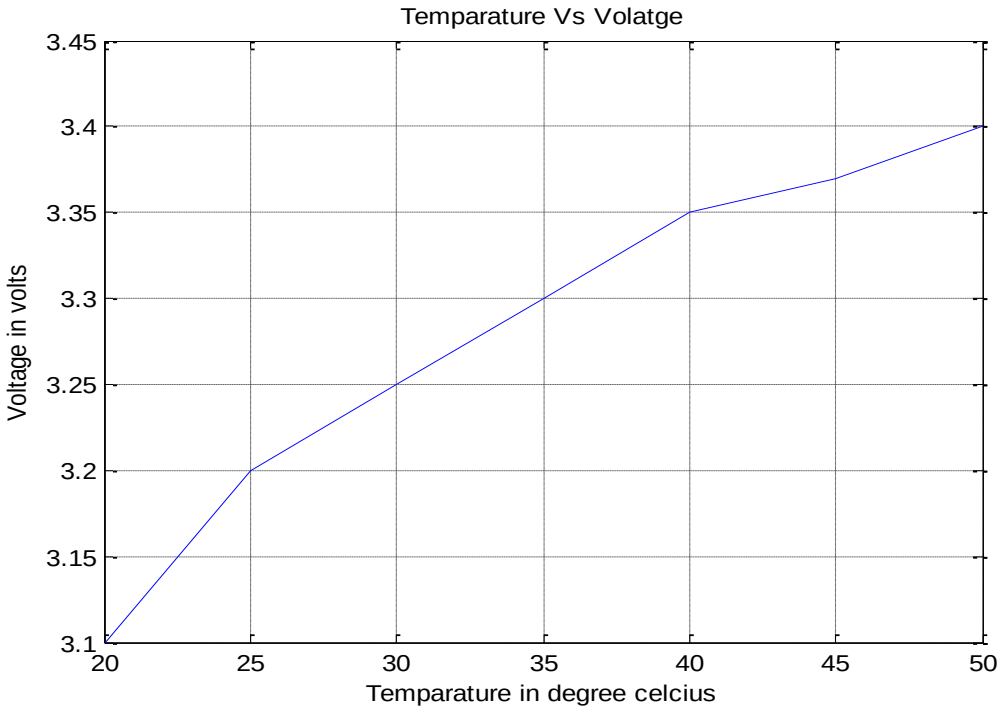

Figure.10 Response of Temperature sensor

When RS-232 port is interfaced with computer, sensors data can be monitored continuously. The snapshot of screen is shown

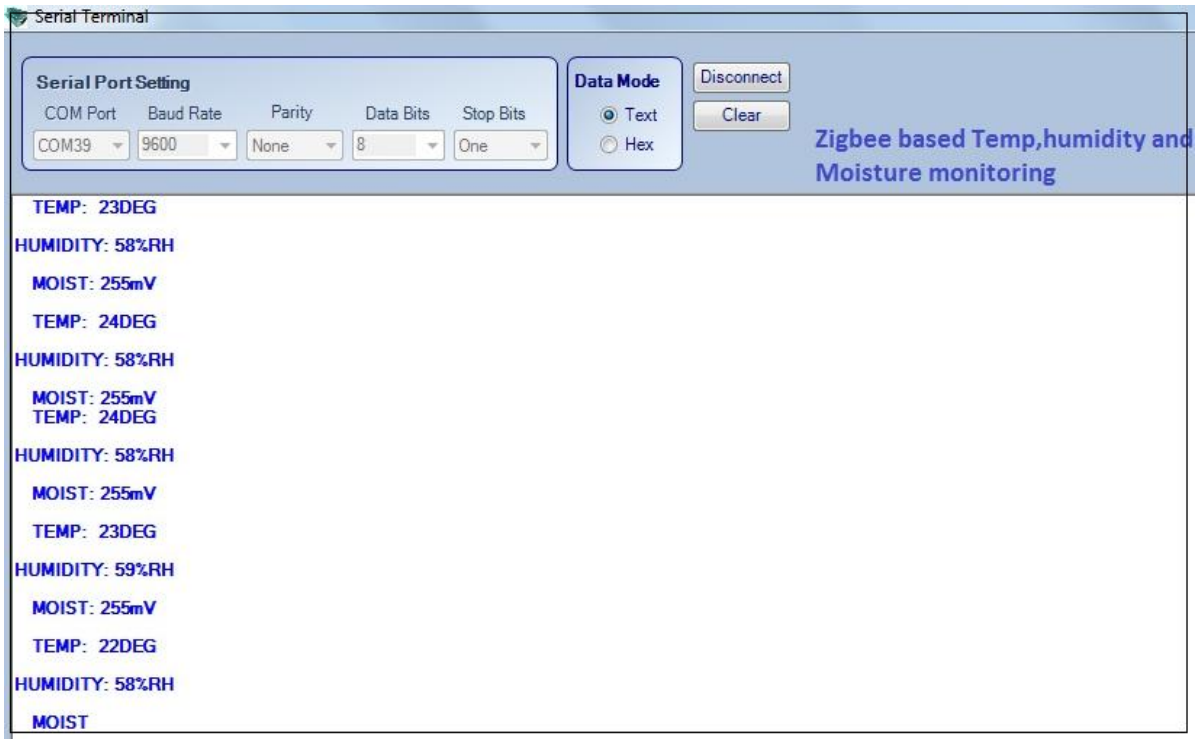

Figure.11 All parameter monitoring on computer using serial port

VI. Conclusion And Future Scope

The design of a GSM-ZigBee based remote monitoring and control system with Automatic irrigation system is designed. This system has an advantage of using both GSM and ZigBee technology which thereby eliminates the cost of network usage to a great extent by using ZigBee when in the range of few meters with the devices.. Thus by going through all the problems and project is practically implemented and it is feasible. It brings into focus the future direction of water management. The principles of irrigation are fairly well developed, understood, and modelled. Most research and development efforts are aimed at refining and expanding engineering, soil and plant science, and economic knowledge of individual processes and interactions that are already well defined. The weakness therefore in irrigation science and application lies primarily in the management of the irrigation system as a whole and not the design and operation of the irrigation system's individual components (fields, farms, canals and watercourses, reservoirs, dams and headworks, etc.). The hydraulics of surface irrigation, for example, continues to receive research attention even though the fundamental relationships have been established long since.

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