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Remote Monitoring and control of Green House Using ZigBee Wireless Sensor Network

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Abstract - *As advancement in technology, the world around us keeps on changing every day. The manual procedures are being replaced by these automated systems which are more energy efficient as well as takes less labor work and also saves time. This paper proposes the advantages of having Wireless Sensor Network technology along with the proper environment provided by green house in Indian agricultural sector, which shows the path to the farmers to replace some of their manual traditional techniques. Here, multiple environmental data such as Temperature, Humidity, Soil moisture, Soil pH etc. are collected by a set of wireless sensor nodes for particular application and applied as input to the microcontroller (PIC). The data is continuously fed and checked by PIC controller as defined in it by programming and a set of control actions like Irrigation, temperature and Soil fertility check etc. are made if they exceed threshold level. After every activity, an evidence message is sent through SMS via ZigBee to the farmer. The module by module design and implementation of the system are given. The system overcomes the limitations of traditional manual old agricultural procedures by providing proper temperature, water utilizing efficiently and also reduces labor cost along with time. The requirement of energy alternatives has increased tremendously. This has led to the development of renewable energy sources and their different usage in the daily applications. Building integrated PV is one such concept used where installation of transparent solar PV in building design is done. This not only reduces the cost of manufacturing but also allow to harness the solar energy for meeting the energy demand. With the increase in population, there is a lot of increase in food demand. So there is a need of regular supply of food items for meeting this demand. Greenhouses are developed all over the world for growing plants. There is a lot of advancement done in the greenhouse design which help in proper growth of plants in the greenhouse. The greenhouse is nowadays automated to carry out the activities inside it. The automated greenhouse requires a power source for the operation to carry out inside the greenhouse. Sometimes the greenhouse is grid connected or provided electricity from renewable sources or an integrated supply of both renewable and grids. The concept of Building Integrated PV was used in the greenhouse design to harness the solar energy by solar PV for stimulating the greenhouse environment. The photovoltaic panel is placed on the rooftop of the greenhouse to harness the solar energy. The greenhouse requires the sunlight intensity inside for the plants to grow. The use of transparent PV is done to avoid any shadow region within the greenhouse. There are various parameters inside the greenhouse which need to be controlled for proper growth of plants. The parameters include temperature, relative humidity, light radiation and the soil moisture. The sensors and microcontroller for proper monitoring and control of the parameters inside greenhouse. The various sensors used are soil sensor, humidity sensor, PAR sensor and temperature sensor. They check the working environment of the greenhouse and accordingly signals the microcontroller to simulate the environment by the proper circulation of air and water.*

Key Words: ZigBee, humidity sensors, temperature sensors, Soil pH, precise agriculture.

1. INTRODUCTION

A greenhouse is a complex glasshouse is a building or house in which plants are grown. These structures varies in range in size from small sheds to industrial-sized buildings depending upon the requirements ass per user. A miniature greenhouse or mini greenhouse is known as a cold frame Greenhouses allow for greater control over the growing environment of plants because of its smaller size it allow user to modify or use it for small scale research work . Depending up on the technical specification of a greenhouse, key factors which may be controlled include temperature, levels of light and shade i.e. intensity, irrigation, fertilizer application, and atmospheric humidity and soil moisture. Greenhouses is useful to overcome shortcomings or lesser yield in the growing qualities of a piece of land, such as a short growing season or poor light levels, and they can thereby improve food production in marginal environments as well as saves time. With the advancement of the Greenhouse industries, the greenhouse control technology is of higher requirements because of how to obtain accurate, precise and reliable measurable information output, as

described by. In some of the countries, most of existing greenhouse control systems used wired communication, which faces with wiring problem also time to time replacement of wire, it also includes high cost, installation and maintenance difficulties and that broken node is likely to cause the entire system out of work. By using wireless communication we can overcome these kinds of problems and can be controlled remotely. The wireless communication does not require wiring (but transmitter and receiver at both ends), it's low cost and easy to maintain and fetch data or information and you can also increase or decrease the measurement node arbitrarily. Through literature survey, it is found that some research scholars utilized wireless sensor network technology in while some of the scholars used controllers with RF technology and multi-sensor technology to design greenhouse monitoring sensor nodes, as in and some of the scholars utilized online or Intranet way to achieve remote monitoring in presented there were also some scholars who used ZigBee technology combined with wireless sensor network technology to design greenhouse environment monitoring system for better results. These projects are relatively good in designs and working, but their hardware designs are complex and also high cost, especially in small scale greenhouse monitoring applications, the cost performance is not high. ZigBee technology constitutes a regional environmental information monitoring network, realizes the monitoring and controlling of small greenhouse environment successfully.

2. ZIGBEE TECHNOLOGY

There are various wireless control and monitoring technologies for smaller and bigger areas which needs lower data rates, longer battery life, lower complexity and better range then the existing standards. Particularly for this wireless applications, a new standard has been set by IEEE which is called IEEE 802.15.4 and this new standard is also named as ZigBee. However, to fulfil the demand of consuming low power and low speed in wireless communication devices, a new wireless technology ZigBee comes as a handy application easy to install and monitor. ZigBee name come from erratic zigzagging patterns of bees between flowers which shows communication between nodes in a mesh network. Network components of ZigBee are similar to queen bee, drones and worker bees. Engineers are trying to come up with this protocol (The ZigBee Principle) a bunch of simple and separate organisms that join together to tackle complex tasks. [8]
ZigBee/IEEE 802.15.4 is a universally accepted hardware and software standard designed for WSN requiring high reliability, low cost, low power consumption, scalability, and low data rate.

3. SYSTEM DESIGN

Hardware	Software
PIC Controller	Micro_C version
ZigBee modem	PIC kit2
pH sensors	
Temperature Sensor	
Humidity Sensor	

Table -1: System design

3.1 Hardware Requirement

PIC Controller:

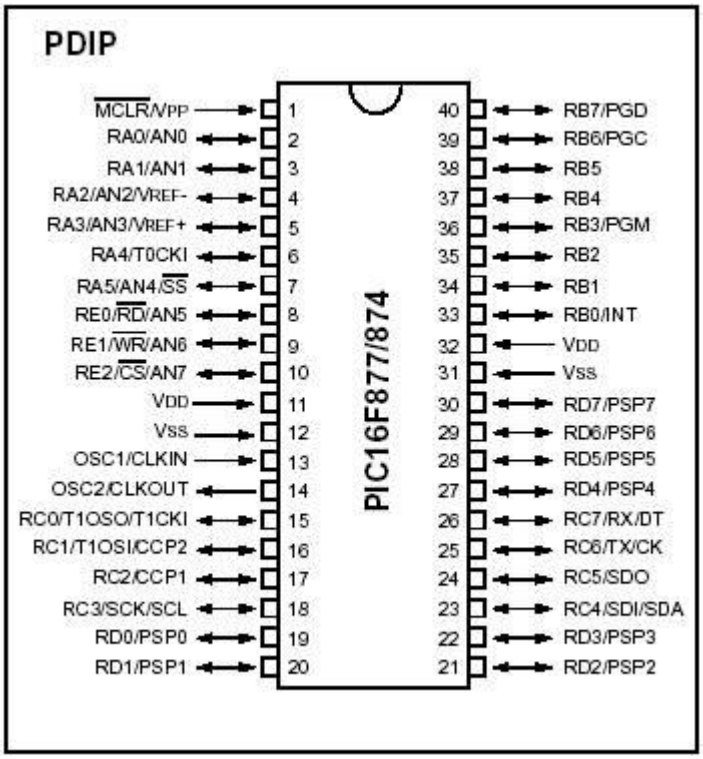


Fig1. PIC 16F877A microcontroller

Peripheral Interface Controller (PIC), microcontroller which act as a CPU (central processing unit) of our project which controls all the execution and functioning of greenhouse. We are going to use microcontroller of 8051 family (PIC16F877A) and the functions are:
I. Receive and reads the digital input from ADC which is derived from Temperature, Light and humidity sensors.

II. Sending this data to LCD of that person, operating this greenhouse should get the values of temperature, light and humidity.
III. Controlling the parameters like Temperature, light and humidity, switching On/Off the respective relays according to its use and requirements.
IV. Sending the values of temperature, light and humidity to the computer or memory card for storage using serial port.

Humidity Sensor:

Humidity is known as the amount of water vapor present in the air. Water vapor is the gaseous state also not visible to naked eyes. The indication of humidity is in the form of precipitation, dew, or fog. The effective rate of evaporation of moisture from the soil is directly proportional to the humidity. So, irrigation to the crop has to be made based on humidity level in atmosphere of agriculture land as well as moisture content in the agriculture soil.
Humidity **sensor** is used to check the moisture level in air because optimum level is useful for the growth plants but excess or scarcity is harmful for plant growth. We have used humidity sensor HS1101 to measure the humidity content in the air. It is capacitive in nature, so another circuit is used to convert the capacitance of humidity sensor into frequency and frequency is calculated with the aid of microcontroller as data afore given in the microcontroller by programming. Measured frequency is transform back into humidity using an algorithm in microcontroller programming.

Moisture Sensor:

The moisture sensor is useful to calculate the water content in the soil. Soil moisture measuring is very important part in agriculture which assist farmers to manage their irrigation systems more fruitfully. Not only they are able to use water more efficiently, but also able to increase yields and quality of the crop. Moisture sensor is used to measure water level present in the soil. A wire strip is used to measure moisture (water content) of soil. Wire strip has a distinct resistance at distinct moisture, but when moisture increases, the resistance of wire strip starts decreasing and akin when moisture decreases, defiance become higher. PIC16F877A gets the data of moisture level and according to that it turn on and off water pump with the help of relay.

PH Sensor:

A pH sensor is an electronic device accustomed for calculating the pH value of the soil, which is either the concentration of Hydrogen ions in an aqueous result or solution. If the solution is acidic, then its range is below 7 or basic, then its range is above 7 (pH ranges from 0 to 14). In agriculture, pH sensor is useful to detect the usage of fertilizers to the crop depending upon the requirement. For ideal pH range of soil for optimum production should be between 6.5 to 8 for all crops.

TEMPERATURE SENSOR:

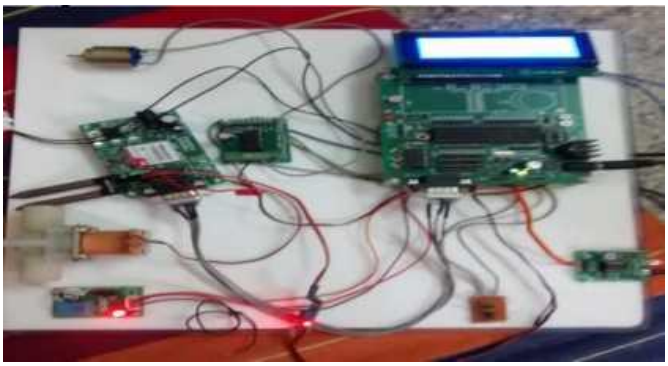
The temperature sensor senses the change in temperature and accordingly triggers the exhaust fan to remove the hot air inside greenhouse. When temperature becomes exceeds 25 degree, respective relay become energize to operate the DC fan and when temperature gets lower than 20-degree relay nauseate the fan by getting control signals from microcontroller as the threshold values are already fed to it by programming.PIC16F877A microcontroller analog to digital converter module is used to read temperature value and to run relay which amble operate the fan.

3.2. Software Requirements

Micro_C Version 2.5.6.1: It is the software used to scribble embedded C code, anthologize and implement them.

PICkit2: It is software accustomed to burn the code into Peripheral Interface Controller.
With the help of all these components, the overall proposed system implementation can be shown as follows.

Fig 2. Overall view of proposed system



For water pump motor we are using a 5V motor and also 5V solenoid valve is used for irrigation purpose. The soil pH 6.5 to 8.0 is ideal for almost all crops, so, threshold for soil pH is set as 6.5 to 8.0. If soil moisture value above 100, then we predict that the soil is dry and ready to irrigate unless humidity value

4. THE PROPOSED WORK

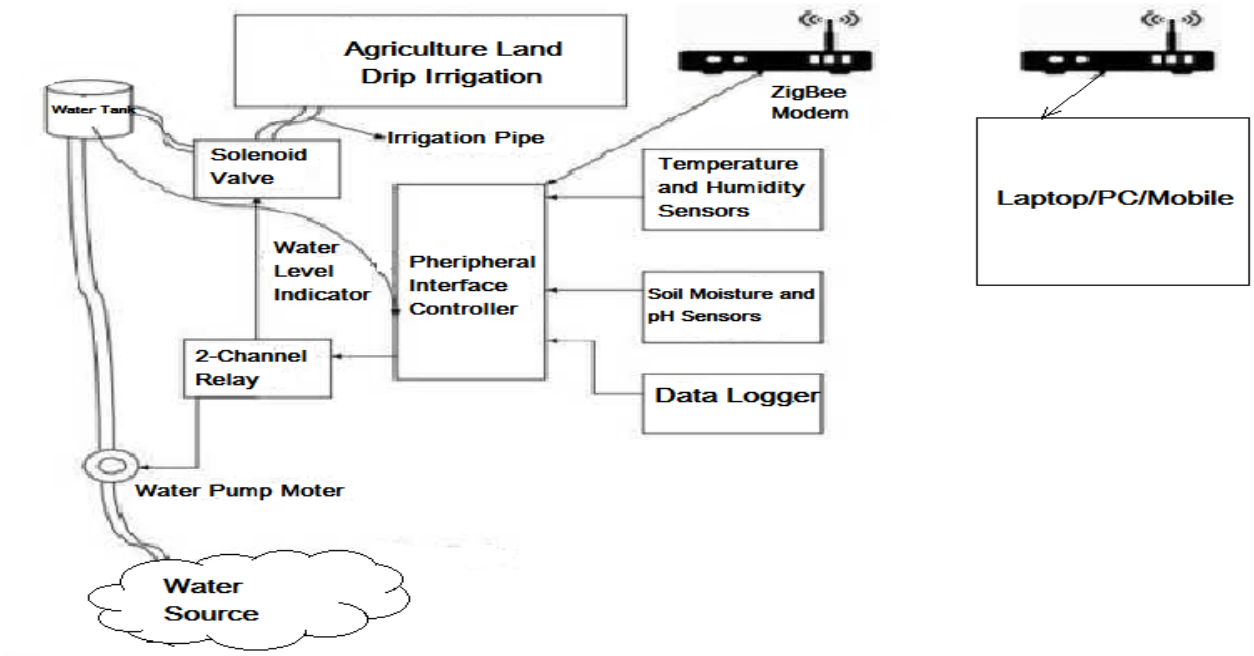


Fig 3. Complete architecture of proposed work

The picture above shows the architecture of the proposed system. First, the soil moisture sensor values are analyzed by the PIC controller. Soil Moisture and humidity are less than the limit, the PIC controller will understand that the soil is dry and has time to irrigate the land. So, solenoid valve procedure takes place with the help of irrigation. Secondly, the water level indicator on and off the water pump motor will be responsible. Soil health, soil pH can be monitored by sensors with the help of the PIC controller. PH value exceeds the limit, then an indication message will be sent to the farmer. Finally, in the field of intrusion detection, the IR sensor, will be posted after every detection alarm will be generated. Farmers sign a message will be sent via SMS through ZigBee modem.

4.1. AUTOMATIC IRRIGATION SYSTEM

If the soil moisture and humidity less than threshold over limit, so there might be a chance of rain caused by excess moisture. Therefore, irrigation stopped, if both soil moisture and humidity are less than threshold, then irrigation will take place by opening the solenoid valve.

4.2 SOIL HEALTH MONITORING

Here, check the soil fertility is built on soil pH value. Most of the crops: ideal soil pH range of 6.8 to 7.2 as shown above effectively grow. An alert message via ZigBee modem via SMS will be sent to the farmer, when the pH value exceeds the range limit. This will help farmers reduce fertilizer than crops or crops by the addition of starvation found out about additional fertilizer.

CONCLUSION:

Precision agriculture farmers harvest more efficiently than conventional processes inputs provides the ability to implement. Without harming the environment, it provides greater quality crops, as well as saves time and money". This is a low-cost prototype model where the ZigBee modem using real-time environmental data is transmitted to the remote area. Farmers get to control the movements of the region can use data.

FUTURE WORK:

The other issue farmers are confronting is the demolition of crops by wild creatures. So the future work incorporates the design of the system which is capable of monitoring the agricultural field by introducing serial cameras and installing sensors at the boundaries. The camera module may take a depiction once the sensor identifies the passage of animals and transmit the real time pictures by coordinating with other data.

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