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MONITORING CONTROL SYSTEM FOR GREEN HOUSE USING WIRELESS SENSOR NETWORK

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ABSTRACT

There are many techniques available for the precision agriculture to monitor and control, environment for the growth of many crops. Due to unequal distribution of rain water, it is very difficult to requirement needed farmer to manage the water equally to all the crops in whole farm it requires some irrigation method that suitable for any weather condition, soil types and variety of crops. Green House is the best solution to control and mange all this problem It is more important to search a method that gives perfect analyzation and controlling to develop proper environment. Large areas covered by sensor network this can establish greenhouse with precision environment required for different crops. This environment builds up by using two technologies it. a Wireless Sensor Network (WSN) established embedded system and arrangements with the implementation of Zig Bee network for remote controlling of the Greenhouse parameters. It also establishes the real time monitoring of limitations such as temperature, humidity, as well as the total power consumption of the system. In current greenhouses, a number of quantity points are required to suggestion down the local climate parameters in different parts of the big greenhouse to make the greenhouse automation system work properly. Cabling would make the measurement system expensive, unsafe and unprotected. Moreover, the cabled measurement points are difficult to relocate once they are installed. Thus, a Wireless Sensor Network (WSN) consisting of small-size wireless sensor node. Wireless sensor nodes well-appointed with radio and one or several sensors is an pretty and cost efficient opportunity to build the required measurement system. This paper reveals an initiative of environmental monitoring and greenhouse control using a sensor networks.

Keywords – WSN; Greenhouse; XBee s2; ZigBee Technology; LDR;soil Sensor ;Temperature Sensor; Light Senor; and Humidity Sensor.

1. INTRODUCTION

The most important factors for ssthe quality and productivity of plant growth are temperature, humidity, light and the soil moisture sensor. Endless monitoring of these environmental variables elasticity information to the farmer to better understand, how each factor affects growth and how to manage maximal crop productiveness. The optimal greenhouse climate alteration can permit us to improve productivity and to achieve extraordinary energy savings - especially during the winter in northern countries. In the ancient generation greenhouses it was an adequate amount of to have one cabled measurement point in the middle to make available the data to the greenhouse automation system. The system this one was recurrently simple without chances to control nearby central heating, lights, air

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circulation or some other activity, which was affecting the greenhouse interior climate. This all has changed in the modern greenhouses. The typical size of the greenhouse itself is much bigger what it was before, and the greenhouse facilities provide several options to make local adjustments to the lights, ventilation, heating and other greenhouse support systems. However, more measurement data is also needed to make this kind of automation system work properly. Increased number of measurement points should not dramatically increase the automation system cost. It should also be possible to easily change the location of the measurement points according to the particular needs, which depend on the specific plant, on the possible changes in the external weather or greenhouse structure and on the plant placement in the greenhouse. Wireless sensor network (WSN) can form a useful part of the automation system architecture in modern greenhouses. Wireless communication can be recycled to gather the measurements and to communicate between the consolidated control and the actuators located to the different parts of the greenhouse. In advanced WSN solutions, some parts of the control system itself can also be implemented in a distributed manner to the network such that local control loops can be formed. Compared to the cabled systems, the connection of WSN is fast, low-priced and relaxed. If the greenhouse flora is high and dense, the small and light weight nodes can even be hanged up to the plants' branches. WSN maintenance is also relatively cheap and easy. Batteries and the batteries need to be charged or replaced, but the lifespan of the battery can be several years if an efficient power saving algorithm is applied technology.

2. SYSTEM ASPECTS AND DESIGN DETAILS

2.1. THE GREENHOUSE ENVIRONMENT

system A greenhouse is a building with walls and roof complete chiefly of transparent measureable, such as glass, in which plant life needful measured weather surroundings are developed. These structures range in size from lesser sheds to industrial-sized buildings as a result, quantities of measurement points are also wanted. This group of area is difficult both for the sensor node electronics and designed for the short-range IEEE 802.15.4 wireless network, in which communication choice is greatly longer in open environments.

2.2. GREEN HOUSE

A greenhouse is a pattern covering the ground frequently used for growth and progress of plants that will revisit the owner's risk, time and resources. This exhibit is mounted with the purpose of caring and keep safe of the crop and allowing a better environment to its advancement. This cover is enough to guarantee a higher quality reaches late up to the plants. This ultimately affects the plant growth. Also there are many such problems associated with it. To overawe from this problem, we can usage an automatic micro controller based system. For automatic monitor and controller we are developing an embedded system which will record the temperature, moisture and further parameters that will control the environmental conditions in the plant field. Moreover for effective control, an android application is used along with embedded system these components, incorporating the applicable criteria that follow.

2. 3. PRECISION AGRICULTURE

In spatial data collection, a mobile field data acquisition system is available to collect useful data for crop management . The system is consisted of, a data gather instrument, a manager vehicle, data collection and control systems on farm machines. This system can handle local field survey and collects data of soil water availability, biomass yield, soil compaction, soil fertility, leaf area index, leaf temperature, leaf chlorophyll content, local climate data, insect-disease-weed infestation, plant water status, and yield of grain etc.

The data from farm machines is retrieved by the data collection instrument through local network. Then it can be stored, analysed and transmitted to the manager vehicle via wireless radio. Based on this information the manager vehicle monitor and control the performances of the farm machines. The silage yield mapping system is consist of a moisture sensor, a GPS module, load cells and Bluetooth wireless communication module for yield mapping. The system with infrared sensors, programmable logic controllers and low power radio transceivers is used to collect and transmit the data to a remote receiver

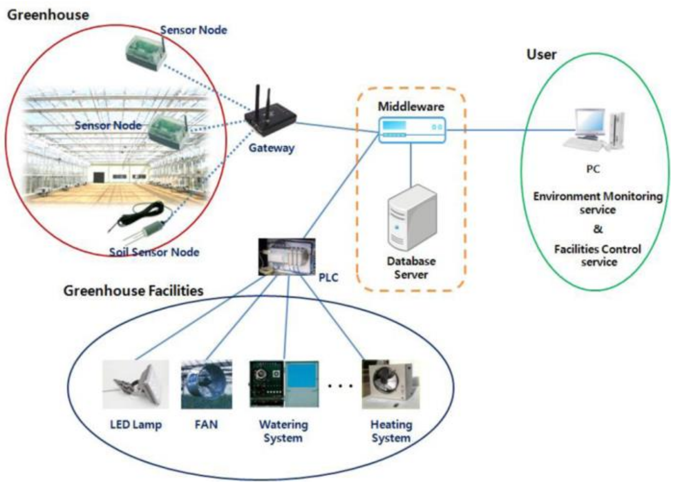

Fig.2.3.architecture diagram

2.4. RELATED WORK

Our designed system is implemented with ZigBee protocol. The detailed information regarding establishment of ZigBee network in Star topology as well as in Mesh Topology, inside the Greenhouse is illustrated. It also establishes the real time monitoring of parameters such as temperature, humidity, as healthy as the total power consumption of the system,. It mainly consists of two systems viz. Portable Controller Node (PCN) system and the Sensor and actuator Node (SAN) system. Portable Controller Node (PCN) system PCN system mainly consists of user laptop/PC and ZigBee transceiver module interfaced with PC via UART (Universal Asynchronous Receiver/Transmitter) port. Module of XBee Series2 of Digi Inc. is used which is configured as PAN coordinator API.It transmits user control commands serving as Controller node. The XBee modules are programmed using X-CTU software in Application Programming Interface (API) mode which helps to construct a real wireless network.

3. SYSTEM OPERATION

In this greenhouse system in which there are four sensors. These sensors act as input to microcontroller system. The input provided to microcontroller is in the form of analog data. This data is converted by the controller into digital formate. Once the parameter values are monitored they can be control by the embedded system which is built with coding. This is automating controlling.

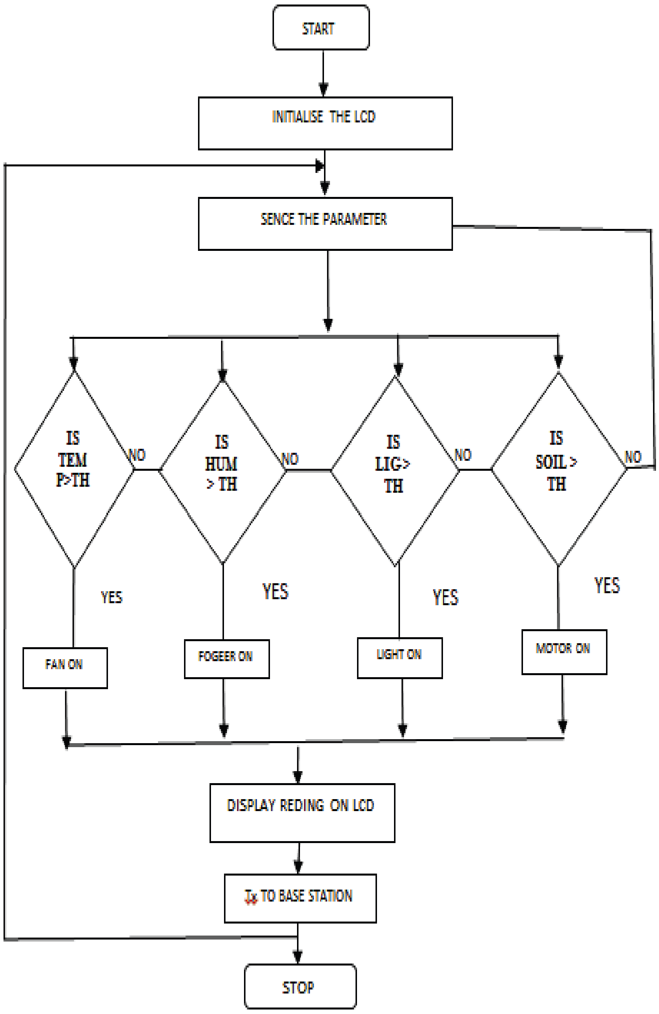

Fig 3.1.data flow diagram

Compare the collected data with threshold data: Depending upon predefined sensor condition the variations from the collected sense data can be cosssmpare for serving the next operation.

If any parameter varies take a required action to control a climate condition: The variations with in the field parameters can be served by using control actions.

visually display real-time data in terms of total time taken by controlling output: To display the collected data by means of quantified representation of parameters.

Send current status data to the base station: Here we have to send the collected data by sensor station to base station by using transmitting technology (ZigBee).

3.2. HUMIDITY SENSOR

Presence of water in air is called Humidity. Water vapor in the air can effect human comfort and also manufacturing processes in industries. Water vapor in air also influences various physical, chemical, and biological processes. affects the health, safety of workers and also effects on cost of product. Therefore humidity sensor is presented, in the monitoring and control systems

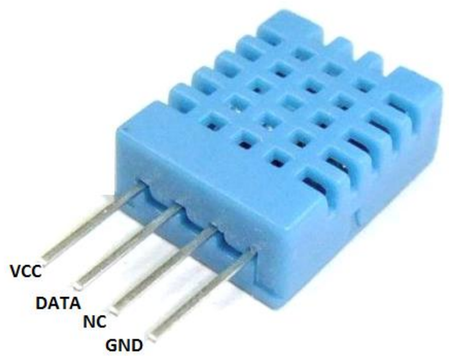

Fig 3.2 : Humidity Sensor

In industrial & domestic applications controlling and monitoring the humidity is very important. Humidity sensors also plays an important role in Semiconductor Industries, Chemical Industries, Medical applications, Soil moisture monitoring, and some other applications.

3.3. TEMPERATURE SENSOR

Temperature sensors use a solid-state technique to determine the temperature. They don't use mercury , bimetallic strips, and thermistors. Instead, whenever temperature increases, the voltage across a diode also increases at a known rate. By precisely amplifying the voltage interchange, generating the analog signal is easy, that is directly proportional to temperature.

Since there are no moving parts in this sensor, they work under many environmental conditions, and are consistent between readings and sensors. The major advantage is inexpensive and easy to use.

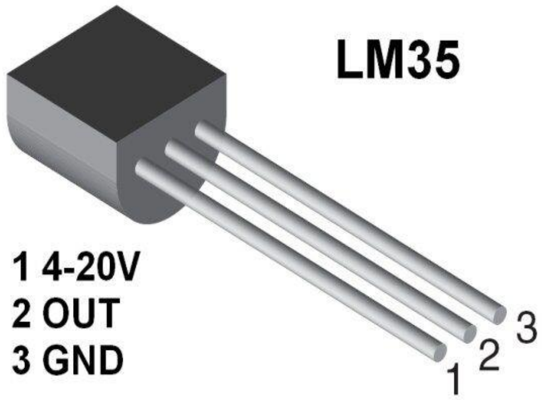

Fig.3.3. temperature sensor

3.4.WATER PUMP MOTOR

The water pump, a ampule made of aluminum or iron, is part of the freezing system. It contains an impeller (looks like a fan) that circulates water and coolant throughout the cooling system, keeping the engine from overheating. Jet pumps produce suction in a slightly novel way. The pump is powered by an electric motor that drives an impeller, or centrifugal pump. The impeller moves water, called drive water, from the well through a narrow orifice, or jet, mounted in the housing in front of the impeller.

Fig.3.4.Water pump motor

As the name implies, water pumps pump water. Whether that be in a vehicle, at a business, in the home-based, or in a well, purchasers can possibly find a water pump to fit their vehicle or to help them draw water from the ground in a self-dug well to be used in pressure tanks within the location. Vehicle water pumps help standardize the flow of water over and done with a vehicle's cooling system; when the seal on these go bad, the whole pump must be replaced. Located within the home or business, pressure water pumps regulate the water pressure year round, controlling water flow to different areas of the location.

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3.5. LDR

Light Dependent Resistor as know as called Photo resistor is a device whose resistivity is a function of the incident electromagnetic radiation. LDR is also known as photo cells, photoconductors. It is a type of semiconductor and LDR conductivity changes with proportional change in the intensity of light. Principles of LDR are as follows:

LDR works on principle of photoconductivity. When photons incident on the device , a photon is absorbed and electrons in the valence band of the semiconductor material into conduction band. To make electrons exit from valence band to conduction band, photons that incident on the device must have greater energy than the band gap of semiconductor material. The result of this process is current starts flowing through the device.

3.5. SOIL MOISTURE SENS0R

Functional description of Soil moisture sensor:

The copper plate act as the sensor probes. They are absorbed into the sampling soil whose moisture content is under test. The soil is examined under three conditions:
Low (Dry) condition- The probes are placed in the soil under dry conditions and are inserted up to a fair depth of the soil. As there is no transference path between the two copper leads the sensor circuit remainders open. The output in this case ranges from 0 to 30%.
Case#2: Medium (Optimum) condition- When water is added to the soil, it percolates through the successive layers of it and spreads across the layers of soil due to capillary force. This water increases the moisture content of the soil. This leads to an increase in its conductivity which forms a conductive path between the two sensor probes leading to a close path for the current flowing from the supply to the sensor probes. The output of the circuit in the case ranges from 31% to 60% approximately.
Case#3: High(Excess water) condition - With the increase in water content beyond the optimum level, the conductivity of the soil increases drastically and a steady conduction path is established between the two sensor leads and the voltage output from the sensor increases no further beyond a certaisn limit..

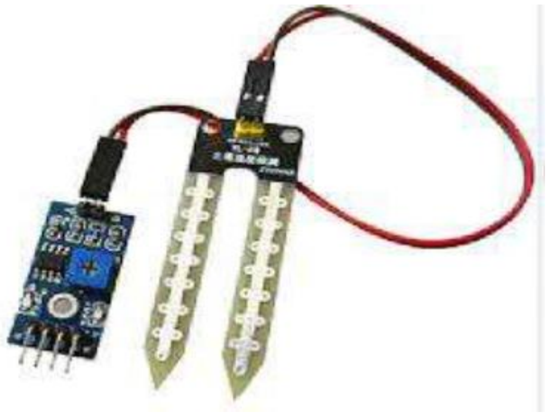

Fig.3.5.soil moisture sensor

3.6 ZIGBEE

Zig Bee is a wireless technology developed as an open global standard to address the unique needs of low-cost, low-power wireless M2M networks. The Zig Bee regular activates on the IEEE 802.15.4 physical radio specification and controls in unlicensed bands including 2.4 GHz, 900 MHz and 868 MHz

Fig.3.6.zig bee

Zig Bee is an IEEE 802.15.4-based specification for a suite of high-level communication protocols used for wireless networking. It is a wireless technology developed as an open global standard to address the unique needs of low-cost, low-power wireless M2M networks. ZigBee (CC2500) is a low price true sole chip 2.4 GHz transceiver considered for very small power wireless applications. The RF transceiver is integrated with a highly configurable baseband modem.

3.6. PIC CCS

Code Composer Studio (CCStudio or CCS) is an combined development environment (IDE) to advance applications for Texas Instruments (TI) embedded processors.

4. MODULES & DESCRIPTION:

- Sensor Nodes
- Sensors
- Node Deployment and Network Architecture

4. 1.Sensor Nodes:

The wireless sensor nodule we charity be present Sensinode's Micro.2420 U100 .It worked as a basic measuring node with a CC2420 802.15.4 RF-transceiver and a MSP430 Microcontroller. It operated as a bas ice measuring node with a CC2420 802.15.4 RF-transceiver and a MSP430 Microcontroller. The gateway node was a combination of U100 node and USB serial adapter board (Micro.USB U600). Sensors were soldered to a board equipped with the needed components (resistors, capacitors and operation amplifier). Then the sensor board (see Figure 4 on the left) was plugged in to the U100 node through its I/O pins. The node and two 1,5V AA-batteries acting as a power source were sheltered by a plastic box (80*55*33mm) to prevent them from the humidity. Sensor board was placed on the top of the box and were protected from the moisture by a plastic coating spray. Finally, the whole board was enveloped by ESD plastic sachet leaving only the heads of the sensors outside.

Which enables transmission of compressed Internet Protocol version 6 (IPv6) packets over IEEE 802.15.4 networks. Sensinode's Nana stack protocol provides the use of 6LoWPAN and a standard Socket API for accessing the network. It works in 2,4GHz ISM band and offers 250 kbps data rate.

4.2. Sensor:

Fast response time, low power depletion and tolerance against moisture climate prepared SHT75 qualified humidity and temperature sensor a complete solution for the greenhouse environment**.** Fast response time, low power consumption against moisture climate made SHT75 relative humidity and temperature sensor [10] a perfect solution for the greenhouse environment. Temperature accuracy of the sensor is ±0.3 °C and the accuracy of the relative humidity under ±2 %. Communication between SHT75 sensor and node is parallel to IIC boundary developed by Philips. Data and clock line are the same in both cases, but SHT75 has only one pull-up resistor between data and power supply line. Luminosity was measured by TAOS TSL262R, which converts light intensity to voltage. Unstable output signal is handled by low-pass filter to get correct luminosity values. We mounted irradiance, temperature and humidity sensors into four nodes, but Carbon dioxide sensor was tricky because it sets special requirements for the input voltage and the response time. Figaro's TGS4161 carbon dioxide sensor (see Figure 4 on the right) was the alternative, which was the most compatible with low voltage sensor node. read from the output voltage. Operation amplifier raises the voltage level of otherwise weak signal from the sensor. We end up to left the TGS4161 to be implemented in its own node which can also act as a router node in a multi hop network, which will be part of the future work.

4.3. Node Deployment and Network Architecture:

where four nodes with temperature, luminosity and humidity sensors measured climate variables and communicated directly with the nectars gateway node. The gateway node acted as a coordinator and received the measured data from the sensor nodes we applied a simple star topology, where four nodes with temperature, luminosity and humidity sensors measured climate variables and communicated directly with the gateway node. The gateway node acted as a coordinator and received the measured data from the sensor nodes. It was placed in the greenhouse entering hall because the humidity present-day was 20-30% lower than inside the greenhouse. A laptop computer was connected to the gateway node by USB-cable. Marten's greenhouse was divided into vertical blocks and the nodes monitored one block at a time. Figure 5 illustrates how the sensor nodes were deployed to the greenhouse block. The idea of the vertical deployment was to get a better understanding of the microclimate layers which typically exist in

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the greenhouse, and to figure out what kind of differences occur in the climate between lower and upper flora.

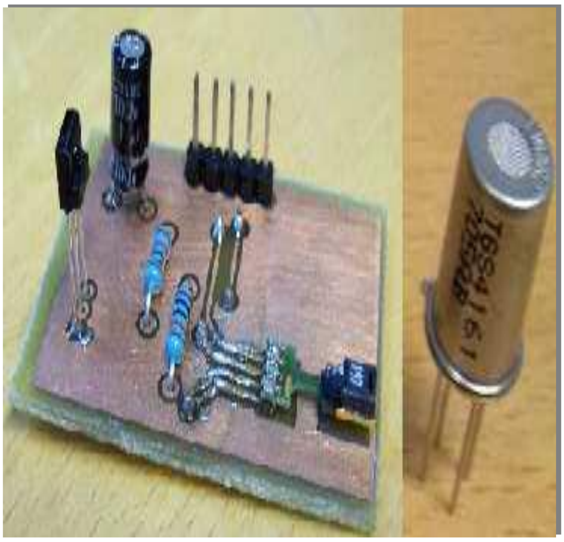

Fig. 4.3. Sensor board (equipped with luminosity and temperature/humidity sensors) and carbon dioxide sensor.

5. ADVANTAGES AND DISADVANTAGES Advantages:-

- Market oriented results.
- Greater saving in the natural resources.
- Low cost setup with maximum automation.
- Less expenditure and low labor cost.
- System can be easily modified for adding the new features.
- Single defective part will not affect the whole system.
- Sensors used have high sensitivity.
- Complete setup is easy to operate.
- Income flow is increased.

Disadvantages

requires uninterrupted power supply.

Proper installation of setup is required.

Connection is for limited range.

6. CONCLUSION AND FUTURE WORK

This paper describes the design of a greenhouse monitoring and controlling system based on wireless sensor network. Agriculture projects even in urban areas are on a rise in recent times, in unique forms. Technological progress makes the agricultural sector grow high, that is made by the Android Application. This control and monitoring system use different parameters to provide the current values of temperature, humidity, water level and light. The system can be proved it is well profitable and it also optimize the resources in the greenhouse. The complete module is of low cost, low power operation. Hence, easily available to everyone.

In green house tools, more number of the limitations is to be control because, the varieties of the crop are big. They are increasing day by day because of the development in agriculture technology. In this situation, the wireless sensor network with additional hardware and software is an efficient solution for green house control this paper describes the design of a greenhouse monitoring and controlling system based on wireless sensor network. Agriculture projects even in urban areas are on a rise in recent times, in unique forms. Technological progress makes the agricultural sector grow high, that is made by the Android Application. This control and monitoring system use different parameters to provide the current values of temperature, humidity, water level and light. The system can be proved it is well profitable and it also optimize the resources in the greenhouse. The complete module is of low cost, low power operation. Hence, easily available to everyone.

In this work, we integrated three commercial sensors with Sensinode's sensor platform to measure four environmental key variables in greenhouse control. The system feasibility was verified in a simple star topology setup in a tomato greenhouse. We achieved up to 10 meter communication range with tolerable 5% packet loss. Because of the high humidity and dense tomato growth, the reliable communication range was reduced to one third of the respective communication range in open space. The sizes also indicated that the system is able to detect the local differences in the greenhouse environment, such as different climate layers which exist from greenhouse bottom to the top.

High moisture forced to consider the possible damages and to protect sensitive boards carefully. When running the experiments, another board damaging factor was noticed. The pollen from the tomato flowers colored one of the black plastic boxes yellow. Small particles of the pollen could also block the measuring component of the sensors, affecting the measuring results. Applied 15 minutes wake periods between 4 min 15 s sleep periods fulfilled the requirements of the energy- efficient wireless sensor network architecture. Each sensor node was receiving and sending packets in its own turn according to the polling of the coordinator node. The sleep time of the node was 93.75%, which could be increased over 97.50% by shortening the operation time from 15s to five seconds. Sensors were turned on all the time. Both, SHT75 humidity/temperature sensor and TSL262R light irradiance sensor are suitable for nodes powered by batteries.

Irradiance sensor does not have the sleep mode at all, and to save energy it have to be turned off most of the time. In the nearby future, we will develop a multi-hop network to cover the entire greenhouse. We will also attach probes to the nodes so that the wireless nodes can be used to measure soil moisture and possibly other parameters from the flower pots, but still be flexibly moved with the pots or from one pot to another. We are also considering the option to implement the CO_2 sensor to the network by connecting it to the plug-in router node. In addition to networking in data collecting purposes, we will develop the control part and close the wireless control loop. The control commands will be counted in a centralized or locally centralized manner, and then transmitted wirelessly to the actuators located to the different parts of the greenhouse. Required local control implementations suggest us to use DSP-units with some of the wireless sensor nodes.

For future developments it can be enhanced by developing this system for large acres of land. Also the system can be integrated to check the quality of the soil and the growth of crop in each soil. The sensors and microcontroller are successfully interfaced and wireless communication is completed between several nodes. All observations and experimental tests prove that this project is a complete solution to field activities and irrigation problems. Implementation of such a system in the field can definitely help to improve the yield of the crops and overall production.

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