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Automated Monitoring and Controlling of Polyhouse Environment

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***Abstract*— Greenhouse is a methodology used to grow plant under controlled environment for increasing yield and quality of the crops. The development and growth of crop depends on internal environment of polyhouse such as temperature, humidity, air movement. The controlling and monitoring of polyhouse parameters play vital role in overall development of plant. In greenhouse, for proper plant growth soil nutrient parameters are equally important. Nutrient related parameters give the ability to correct issue before they become problems like plant losses and poor crop quality. For nutrient testing, pH of growing substrate measures the availability of micronutrient and EC monitoring salt concentration in media. pH and EC depends on various factors such as fertilizers, growing substrate, irrigation, plant species, water quality and whole data provides valuable clues if problem arises. Irrigation is also one of the most important inputs for increasing yield of crop and quality. In this paper irrigation system is controlled and monitored as per soil moisture data. Polyhouse maintain necessary environment through web technologies instead of any kind of human interaction.**

***Index Terms*— Polyhouse, Irrigation System, Monitoring, Control, Automation, pH, Soil Moisture, Electric Conductivity.**

I. INTRODUCTION

In human activity, telecommunication and internet play very important role in day to day life. In modern society, no other technology has made such impact on communication. Web browser services form one of the core foundations of a successful information technology. Internet is information sharing technology. It not only sell product but also improves design engineering system, manufacture and test final product. Thus, to improve overall quality the balanced and justified usage of internet facilities is very important for reduction of design cycles. [1] Last few decade, growth of mobile technology and internet increased exponentially. India is the large developing country. Here, internet services have been proven to be one of the most efficient systems to couple with mobile telephony. Mechanization and modernization of agriculture make considerable impact to infuse these two technologies. In India two-third of population is depend on agriculture. Agriculture uses 85% of available fresh water resources worldwide. Because of population growth and increased food demand, this percentage will continue to be dominant in water consumption. In last decade, ground water level has been decreasing day by day due to unplanned use of water and lack of rains. Irrigation system improves the yield and quality of crops. Also, saves huge amount of water. In present micro irrigation system such as drip and Sprinkler irrigation, water being provided directly to root zone of plants and this results in water saving and labor work savings. [2]

Indian farmers face several challenges such as availability of water, small land holding, poor yield due improper methods of farming, natural phenomena such as rainfall and lack of knowledge of modern methods of agriculture.

Recently, for low cost production new intelligent systems are being developed in agricultural. To growing multiple crops and for making efficient use of land and resources, plant factory provide high yield of crop in agriculture. Main source for Plant growth is that surrounding climates such as humidity, temperature, CO2 and light intensity and these factors are very important to be monitored and maintained to increase yield of crop. The wireless sensors networks (WSN) perform a specific task to defined as the collection of sensor nodes that and they are representing one of the technological solutions to automates and improve the management of crops.

To solve environment related problem and high yield of crops, polyhouse farming is an alternative technique in agriculture. It reduces dependency on rainfall; we can take any crop at any time and at any season, makes the optimum use of land and water. Polyhouse can grow multiple crops every year at any season and help farmers in generating maximum income. This also helps them to spread their risks. Polyhouse farming can give maximum yield with quality on specific days (e.g. rose on Valentine's Day) to control and monitor whole climate to enable cultivation of crops. Polyhouse enables cultivation of regular crops in off season with best quality and thus, fetching farmer a higher price (e.g. cucumber, tomato, chilly, capsicum, cabbage).[3]

Polyhouse farming of entails construction is covered by polythene to collect the light and convert it into heat. In conventional greenhouse, to control environment using structured building have different covering materials such as plastic or glass walls and roof. Soil related parameters such as soil moisture, soil nutrients and soil temperature in the polyhouse are controlled to minimize crop disease and increase crop quality. Typical polyhouses are from 500

square meters to 10,000 square meters, [4] Farmer makes them suitable to take higher yield with small land holding.

Polyhouse farming protects the agricultural plants from sudden change in weather and regulates the internal environment inside the Polyhouse using different actuators. To monitor and control internal environment farmer helps to grow the crops without any external obstruction and thus, it form core element of a polyhouse. Internal thermal environment can be controlled by managing several elements like fans, air movement, ventilation window, heaters, air conditioning systems, sunroof, etc. The complete Polyhouse system refers sensors and controllers to control the system. Polyhouse detect environmental changes then take necessary action against predefined set of normal values.

II. Literature Review

E. D. Lund has designed commercialized sensing system which combines mapping of soil electrical conductivity and pH .To increase measurement density soil pH direct measurement has allowed. pH and conductivity is important nutrient for plant growth. [5]
Pranay Gopal Umate designed autonomous robots for nutrient management. This system tests nutrient deficiency to perform some soil test and judge water requirement. Depending on nutrient testing it provide fertilizer and water to crop. It can also alter farmer to give fertilizer.[6]

Gayatri Londhe developed well known drip irrigation system which is fully monitored and controlled by using ARM9 processor. Here, Soil moisture sensor is used to monitor moisture content of soil and depending on that result solenoid valve gets turned ON/OFF automatically. Sensors detect pH and nitrogen which is important micronutrient in the soil for proper plant growth. [7]
In agriculture environment a normal way to individuals manually taking dimensions and inspecting them at different times. The system uses agriculture monitoring application in which wireless mechanism used for sending data to central server which stores data and also perform analysis on it for displaying on client mobile.

Anuj Kumar has researched on necessity of a green house plant for optimum growth and improved yield of crop. For growth of plant using different mechanism and this work an attempt has been made to devise a DSP processor based on EMS to control environment condition in polyhouse. The developed system is simple, cost effective and easily installable. [8]

An automated irrigation system was developed for water saving purpose in agriculture. The system measure moisture and temperature of soil by connecting sensor directly root zone of the plant. In addition, a gateway unit handles data from soil moisture, temperature sensor, actuators, and transmits all information to a web application. An algorithm was developed programmed with controller to set threshold value of temperature and soil moisture to control water. The system was powered by photovoltaic panels and had a data inspection and irrigation scheduling to be programmed through web page based on duplex communication link. [9]

In the Indian context, awareness has increased about implementing technology in the agriculture industry. Manual collection of desired farm environment data required for analysis can be sporadic leading to incorrect measurements and findings. This can cause difficulty in controlling various important factors. Wireless distinct sensor nodes can reduce time and effort required for monitoring an environment. The graphical representation of PC data allows simplified diagnosis and analysis. To better quality control monitoring systems can ensure quicker response times to adverse factors and low labor cost.

III. Importance of Soil Nutrient

Nutritional problem affect to crop quality and plant losses in greenhouse. To solve nutritional problem soil pH is one of the important parameter. It is also detected and measured, which will affect the plant growth and quality. pH is the measurement of acidity. pH is a measurement of hydrogen ion concentration of solution. Normally pH range is from 0 to 14 (more acidic to most basic). Soil can affect the proper plant growth and it depends on pH. Farmer can give suggestion to add various fertilizers to measure nutrient of soil. pH of growing substrate affects the availability of nutrient, especially micronutrients like Magnesium, Zinc, Nitrogen, Potassium, Iron, Boron.[10]

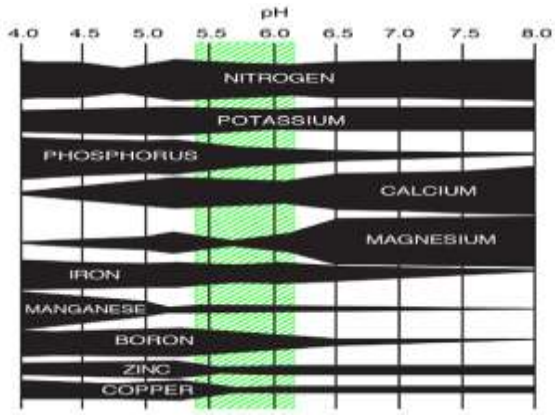

Fig 1: The pH of soilless substrates affects the amount of nutrients available to plants.

At high pH, some micronutrient (iron, manganese, zinc, boron) are unavailable for good plant growth and iron deficiency symptoms will start growing. Iron deficiency is a common problem that occurs when PH is very higher than optimal. Iron deficiency
Symptom is yellowing leaves. It normally occurs in younger leaves of the plant. Almost all crops prefer slightly acidic pH between 5.4 and 6.0.

At low pH manganese, zinc and boron are highly soluble. If pH is too low, micronutrient becomes very soluble and iron toxicity symptoms which appear as leaf bronzing. For correcting high pH, switching from high nitrate to high

ammonium fertilizer is needed. The quick method to decrease pH is to apply one time phosphoric acid drench and sulfuric acid. When we have to raise pH then stop acidifying water if acid being injected and apply potassium bicarbonate drench.

Electric conductivity is measure of total amount of salt in growing medium. In growing substrate EC as an indicator of the presence of micronutrient, but it gives no more information about the micronutrient. When conductivity of soil is higher than desired, it can be reduced by decreasing the frequency of fertilization. When EC is too high of growing substrate then leaching method is used to quickly decrease EC and prevent crop from damage. We can prevent problem of high EC by applying needed amount of fertilizer.

IV. EFFECT OF PH ON SOIL NUTRIENT

Soil nutrient parameters are very important for growth of the plant. pH effect on plant growth as well as physical, chemical and biological properties of soil. When pH is low or high then nutrient growth and yield of crops minimizes or maximizes.

Table I: Relative yield of selected crop grown in a corn, small grain at different pH level

CROP				PH		
	4.7	5.0	5.7	6.0	6.8	7.5
	Relative average yield					
Corn	34	73		83	100	85
Wheat	68	78		89	100	99
Oats	77	93		99	98	100
Barley	0	23		80	93	100
Soyabean	65	79		80	100	93
Timothy	31	47		66	100	95

V. METHODOLOGY

In polyhouse, condition and growth of the plant is influenced by the relevant conditions. Internal environment can be monitored and controlled by different mechanism. The cultivation of crops in the greenhouse is very complex issue and this issue can be simplified by checking level of water, temperature, humidity, fertilizer etc. The sensor data can be encompassed through data storage, data transmission to multiple users logged on to web-browsers. Polyhouse process parameters can control through pumps, ventilators, and accessories.

VI. BLOCK DIAGRAM

In greenhouse, for proper plant growth environmental parameters are monitored and controlled through accessories. Temperature, humidity and gas sensor is used to monitor internal environment. Temperature sensor senses surrounding atmosphere and keep a constant check on the temperature. For temperature control (see table II) if temperature exceeds the limit then exhaust fan will be automatically switched ON to reduce the temperature. When it reaches the desired temperature then fan will be switched OFF automatically. Humidity sensor measures the humidity of the air in the greenhouse in terms of percentage Relative Humidity. If the humidity increases beyond the limit set then an exhaust fan will be switched ON to maintain the suitable environment for plants.

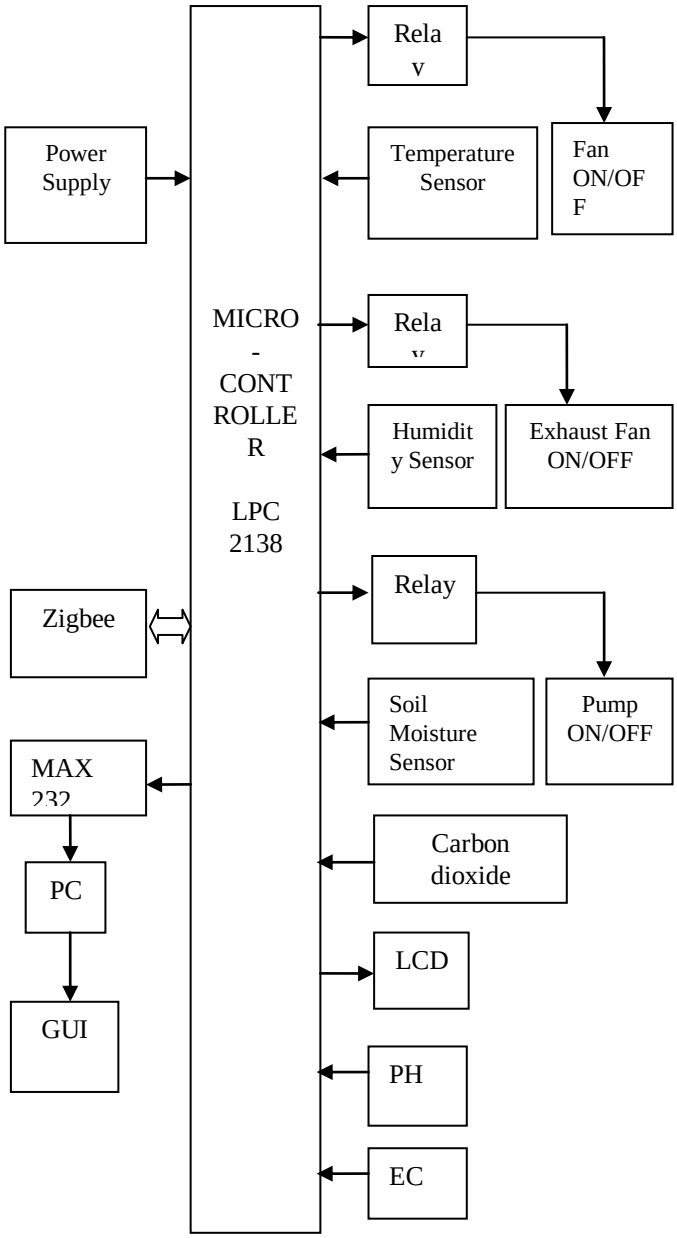

Fig 2.Block diagram of polyhouse automation

Another important part is a carbon dioxide. For proper plant growth, carbon dioxide is an important part of photosynthesis process. When carbon dioxide level is too low in polyhouse, ventilation window gets automatically opened and when sufficient carbon dioxide level is maintained in polyhouse then ventilation window will be closed. Soil moisture sensor is a key parameter of irrigation system. Soil moisture sensor checks the presence of water in the soil. Soil moisture measure in % moisture content (%MC). If there is

no adequate water present in soil then it starts water-pump automatically from water tank and when sensor sense threshold value of water in soil, then water pump will be automatically off. But, if soil moisture is dry and water level is low then pump will be off. All sensors data is collected in database and monitored on PC as well as web browser.

Table II: Parameters value and there action

Parameters	**Threshold value**	**Action**
Temperature	Above 50°C	Cooling fan ON
Humidity	Above 65 %	Exhaust fan ON

Table III: Soil moisture Control

Soil Moisture Value (in % MC)	Water Pump(For drip irrigation)
Below 70	ON
75 to 85	OFF
Above 85	OFF

VII. HARDWARE DETAILS

A. LPC2138 microcontroller

This is the heart of the system. It's based on 32/16 bit ARM7TDMI-S CPU with Real-time emulation. In the system the microcontroller have an embedded high speed flash memory ranging from 32 kB to 512 kB. Microcontroller is suitable for industrial control and medical application because of 32-bit timers, single or dual 10- bit ADC(s), 10-bit DAC, PWM channels and 45 fast GPIO pins. All sensor are directly connected to the microcontroller and data stored in a database. The Microcontroller performs action as per the data by using different controlling mechanism.

B. Temperature Sensor

The LM35 temperature sensor is used in the system whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. This temperature sensor can give reading more accurately than that of the thermistor. The operating temperature range is from -55°C to 150°C.When temperature sensor gives high output then fan will be on to control the temperature.

Fig 3: Temperature sensor

C. Humidity sensor

Here, SY-HS 220 Humidity sensor is used that gives analog output. This output feed to ADC and converted into digital form. Once output is converted into analog form, the microcontroller can process the digital humidity signal as per the application. This sensors value change in the atmosphere as per the application. When humidity is greater than threshold level then exhaust fan is on.

Fig 4: Humidity sensor

D. RELAY

A relay is an electromechanical switch to ON/OFF position according to the requirement. All sensor gives data to microcontroller then microcontroller perform action through relay.

E. LCD

The LCD display is used to provide all sensor value to the user in digital form. Sensor data display on LCD after every few millisecond. In LCD initialization you have to send command bytes to LCD.

F. Soil moisture sensor

Soil Moisture sensor is used to test moisture of soil. When moisture is dry, the sensor output is at high level else output is at low level. As per sensor output water pump will be ON/OFF. When soil moisture is dry then pump gets ON.

Fig 5: Soil Moisture sensor

G. *Water level sensor*

Water level sensor used as a fuel sensor to measure availability of water in tank and calibrate water consumption. Water level sensor checks level of water within specified range and determine amount of substances in certain place.

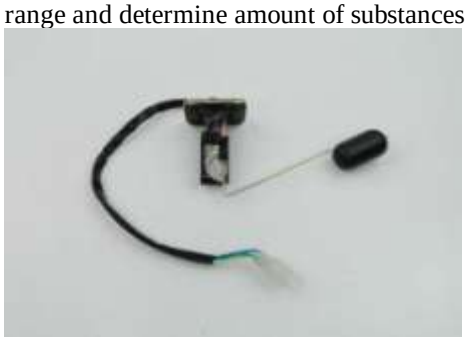

Fig 6: level sensor

H. *ZigBee Modules*

ZigBee (over IEEE 802.15.4) technology is used in short range WSN because of its low cost, low power consumption and greater range in comparison with other wireless technologies such as Bluetooth Wi-Fi (over IEEE 802.11), (over IEEE 802.15.1) and UWB (over IEEE 802.15.3), and it was selected for this battery-operated sensor network.

I. *PH sensor*

A pH electrode is a passive device that detects a current generated from hydrogen ion activity. This positive or negative current is very weak and cannot be detected with a multi-meter, or an analog to digital converter. Care should be taken to only use proper connectors and cables because this weak electrical signal can easily be disrupted.

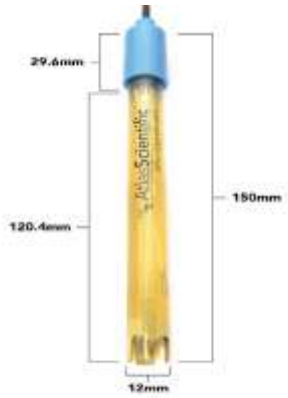

Fig 7: pH sensor

J. *Electric conductivity sensor*

The conductivity is a measurement of the ion concentration in a solution and it can be used to determine the amount of nutrients, the quality, salts or impurities in water or aqueous solutions. There is a temperature sensor on the device which allows temperature measurement and compensation and is placed directly in the measurement area to improve accuracy. conductivity sensors can be developed and produced with customer specific requirements based on thin- or thick-film technology, To direct manufacturing the sensor with custom housing and specific connections it can enhance application integration.

VIII. RESULT

The prototype of greenhouse monitoring using wireless sensor network consists of ARM7 controller, Temperature, humidity, pH, EC, Soil moisture sensor. All components are monitored and controlled using ARM processor. All sensor values that are collected from the greenhouse were displayed on the LCD screen as well as mobile phone via a Wi-Fi or internet.

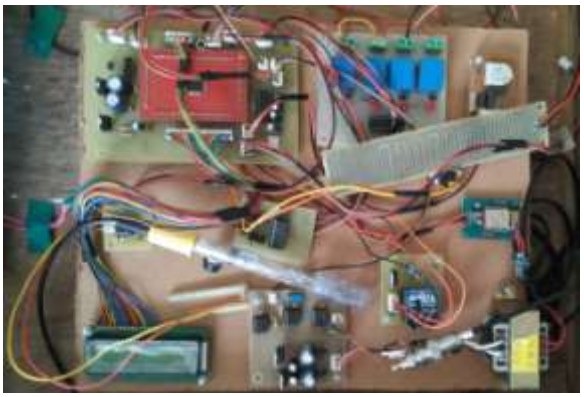

Fig 8: Complete hardware of polyhouse automation

In software design, KEIL3 software is used to design the connection and all the interface process. The data collected was sent to the microcontroller in analog form and the data was converted into digital form and sent to pc through RS232. All sensors data was collected in database and monitored on web page through WI-FI.

IX. CONCLUSION

This system collects and automatically controls the condition of greenhouse environment by using different sensors. The existing control system monitors the temperature, humidity, water level and soil nutrient parameters in the greenhouse to solve the problem of plant disease. Regular monitoring of soil nutrient give an indication of the availability of micronutrient and detection of possible problem they affect to plant growth and quality. The system gives efficient information regarding the soil pH and EC to improve production and profit.

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