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Monitor and Control of Environment for Greenhouse Using Sensor Networks

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Abstract- **Almost people live in a world where everything can be controlled and operated automatically, but there are still a few important sectors in our country where automation has not been adopted or not been put to a full-fledged use, perhaps because of several reasons one such reason is cost. One such field is that of agriculture. Agriculture has been one of the primary occupations of human being since early civilizations and even today manual interventions in farming are inevitable. Greenhouse plays an important part of the agriculture and horticulture sectors in our country as they can be used to grow plants under controlled climatic conditions for optimum produce. The proposed system is an embedded system which constantly monitors the digitized parameters of the various sensors and verifies them with the predefined threshold values and checks if any corrective action is to be taken by controlling the parameters inside the greenhouse by actuating a cooler, fogger, dripper and light respectively in accordance with the necessary conditions for the plants.**

Keywords-Arduino Mega 2560 ,Climatic Parameters, Microcontroller and Sensors

I.INTRODUCTION

Greenhouse plays an important part of the agriculture and horticulture sectors in our country as they can be used to grow plants under controlled climatic conditions for optimum produce. Day, advances in sensors ,actuators and microprocessor technology,both on hardware and software level,have enabled distributed implementation of sensors and control actions over sensor/actuators networks. Appropriate environmental conditions are necessary for optimum plant growth, improved crop yields and efficient use of water and other resources.Automating the data acquisition process of the soil conditions and various climatic parameters that governed plant growth allows information to the collector at high frequency with less labor requirements.The existing systems employed PC or SMS based systems for keeping the users continuously informed of the conditions inside the green house; but are unaffordable,bulky,difficult to maintain and less accepted by the technologically unskilled workers. Every land has its own soil quantities such as moisture absorption content,water maintain capacity,composition of various materials,rocks,dead and decaying particles,organic and inorganic materials,so its moisture retaining capacity depends upon these factors. So a proper irrigation facility can be provided,by checking the soil moisture level content at various instants and water irrigation can be provided, by implementing this methods. Modern agriculture is subjected to regulations in terms of quality and environmental impact and thus it is a field where the application of automatic control techniques is increasing a lot during the last years. In modern precision agriculture,green houses play an increasingly important role to meet the demand-driven economic. The primary issue of green house is to manage the green house environment optimally in order to compete with the economic and environmental requirements. The objective of this work is to design a simple,easy to install,microcontroller-based circuit to monitor and record the values of temperature,humidity,soil moisture and sunlight of the natural environment it continuously modified and control inorder to optimize them to achieve maximum plant growth and yield.The design is quite flexible as the software can be changed at any time.It can does be tailor-made to the specific requirements of the user.These makes the proposed system to be an economical, portable and low maintenance solution for green house applications,especially in rural areas and for small scale agriculturist.

II.LITERATURE SURVEY

There are more than 50 countries now in the world where cultivation of crops is undertaken on a commercial scale under cover. United States of America has a total area of about 4000 ha under greenhouses mostly used for floriculture with a turnover of more than 2.8 billion US $ per annum and the area under greenhouses is expected to go up considerably, if the cost of transportation of vegetables from neighboring countriescontinues to rise. The area under greenhouses in Spain has been estimated to be around 25.000 ha and Italy 18,500 ha used mostly for growing vegetable crops like watermelon, capsicum, strawberries, beans, cucumbers and tomatoes. In Spain simple tunnel type greenhouses are generally used without any elaborate environmental control equipment's mostly using UV stabilized polyethylene film as cladding material. In Canada the greenhouse industry caters both to the flower and off-season vegetable markets. The main vegetable crops grown in Canadian greenhouses are tomato, cucumbers and capsicum. Hydroponically grown greenhouse vegetables in Canada find greater preference with the consumers and could be priced as much as twice the regulargreenhouse produce.The Netherlands is the traditional exporter of greenhouse grown flowers and vegetables all over the world. With about 89,600 ha under cover, the Dutch greenhouse industry is probably the most advanced in the world. Dutch greenhouse industry however relies heavily on glass framed greenhouses, in order to cope up with very cloudy conditions prevalent all the year round. A very strong research and development component has keptthe Dutch industry in the forefront. The development of greenhouses in Gulf countries is primarily due to the extremity in the prevailing climatic conditions. Israel is the largest exporter of cut flowers and has wide range of crops under greenhouses (15,000 ha) and Turkey has an area of 10,000 ha under cover for cultivation of cut flowers and vegetables. In Saudi Arabia cucumbers and tomatoes are the most important crops contributing more than 94% of the total production. The most common cooling method employed in these areas is evaporative cooling. Egypt has about 1000 ha greenhouses consisting mainly of plastic covered tunnel type structures. Arrangements for natural ventilation are made for regulation of temperature and humidity conditions. The main crops grown in these greenhouses are tomatoes, cucumbers, peppers, melons and nursery plant material.In Asia, China and Japan are the largest users of greenhouses. The development of greenhouse technology in China has been faster than in any other country in the world. With a modest beginning in late seventies, the area under greenhouses in China has increased to 48,000 ha in recent years. Out of this 11,000 ha is under fruits like grapes, cherry, Japanese persimmon, lemon and mango. The majority of greenhouses use local materials for the frame and flexible plastic films for glazing.

III.PROPOSED WORK

The proposed system is an embedded system which will closely monitor and control the microclimatic parameters of a greenhouse on a regular basis round the clock for cultivation of crops or specific plant species which could maximize their production over the whole crop growth season and to eliminate the difficulties involved in the system by reducing human intervention to the best possible extent. The system comprises of sensors, Analog to Digital Converter, microcontroller and actuators. When any of the climatic parameters cross a safety threshold which has to be maintained to protect the crops, the sensors sense the change and the microcontroller reads this from the data at its input ports after being converted to a digital form by the ADC. The microcontroller then performs the needed actions by employing relays until the strayed-out parameter has been brought back to its optimum level. Since a microcontroller is used as the heart of the system, it makes the set-up low-cost and effective nevertheless. As the system also employs an LCD display for continuously alerting the user about the condition inside the greenhouse, the entire set-up becomes user friendly. The knobs present set the reference value for the ADC which decides the status of the climatic parameters (temperature, humidity, moisture, light intensity). Relay switches the water pump, exhaust fans, humidifier and LED's based on the instruction given by the microcontroller. Thus, this system eliminates the drawbacks of the existing set-ups mentioned in the previous section and is designed as a flexible method which gives a low cost solution than the existing system. This system is easy to install and portable. Fig. 3.1 shows the system model of a Greenhouse.

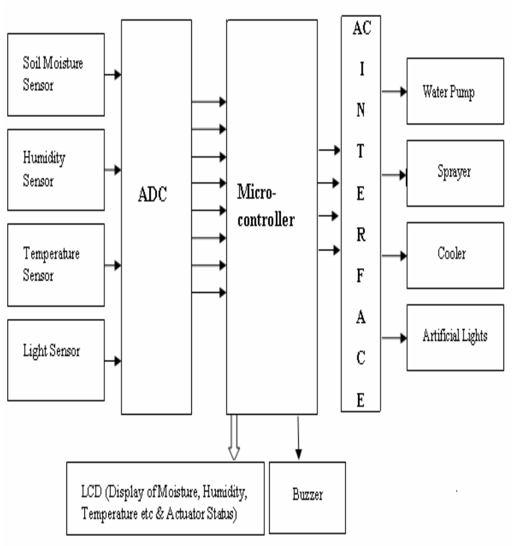

Fig. 1: Structure of system model of Greenhouse

A) Steps Followed In Designing The System

Three general steps can be followed to appropriately select the control system:

Step 1: Identify measurable variables important to production It is very important to correctly identify the parameters that are going to be measured by the controller's data acquisition interface, and how they are to be measured. The set of variables typically used in greenhouse control is shown below table

Sl.No	Variables To Be Monitored	Its Importance
1	Temperature	Affects all plant metabolic functions
2	Humidity	Affects transpiration rate and the plant's Thermal control mechanisms
3	Soil moisture	Affects salinity and pH of irrigation water
4	Solar Radiation	Affects photosynthetic rateresponsible for most thermal loading during warm periods

Table1 Importance of various parameters

Step 2: Identify the control strategies an important element in considering a control system is the control strategy that is to be followed. The simplest strategy is to use threshold sensors that directly affect actuation of devices. For example, the temperature inside a greenhouse can be affected by controlling heaters, fans, or window openings, once it exceeds the maximum allowable limit. The light intensity can be controlled using four threshold levels. As the light intensity decreases one light may be turned on. With a further decrease in its intensity a second light would be powered, and so on; thus ensuring that the plants are not deprived of adequate sunlight even during the winter season or a cloudy day

Step 3: Identify the software and the hardware to be used. It is very important that control system functions are specified before deciding what software and hardware system to purchase. The model chosen must have the ability .To expand the number of measured variables (input subsystem) and controlled devices (output subsystem) so that growth and changing needs of the production operation can be satisfied in the future. To provide a flexible and easy to use interface. To ensure high precision measurement and must have the ability resist noise.

B) Hardware Description

i) Transducers

A transducer is a device which measures a physical quantity and converts it into a signal which can be read by an observer or by an instrument. Monitoring and controlling of a greenhouse environment involves sensing the changes occurring inside it which can influence the rate of growth in plants. The sensors used in this system are:

1. Soil Moisture Sensor
2. Light Sensor (LDR)
3. Humidity and Temperature Sensor (DTH 11)

ii) Arduino Mega 2560

The arduino mega 2560 is a microcontroller board based on the Atmega 2560. It has 54 digital input/output pins (of which 15 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), and a reset button. It contains everything needed to support the microcontroller, simply connect it to a computer with USB cable or power it with a Ac to Dc adapter or battery get started. The mega is compatible with most shields designed for arduino Duemilanove or Diecimila.

Fig. 2 Arduino mega 2560

IV.RESULTS AND DISCUSSION

Soil moisture sensor senses the moisture content of the soil, depending upon the moisture level in the soil an analog voltage is given as output. This analog voltage is compared with reference value in 1m324. Table 2 shows the soil moisture sensor readings which have been taken under room temperature

Sl.No	Soil Condition	Transducer Optimum Range
1	Soil is dry	0V
2	Optimum level of soil moisture	1.9-3.5 V
3	Slurry soil	>3.5V

Table2 Soil moisture sensor readings

Light sensor senses the light intensity of the atmosphere, depending upon the light intensity of the atmosphere an analog voltage is given as output. This analog voltage is compared with reference value in 1m324. Table 4.2 shows the light sensor readings which have been taken under room temperature

Sl.No	Illumination Status	Transducer Optimum Range
1	Optimum illumination	0-0.69V
2	Dim light	0.7-2.5V
3	Dark	2.5-3V
4	Night	3-3.47V

Table3 Light sensor readings

The hardware output pertaining to the crop is shown below in Figure 3. Three selection knobs are provided in order to set the threshold levels which can be varied to use different crops. Knobs are used to change the reference value for 1m324 which compares this value with analog output of sensor. The knobs are movable in clockwise direction based on which three sort of micro climate margin (LOW, OPTI, HIGH) is fixed. This variation can be done for all four climatic parameters (temperature, humidity, soil moisture and light intensity). LCD prints the status of the micro climatic parameters in each layer of vertical farming.

Fig. 3 setup with Knobs and LCD

Figure 4 shows the status of the all micro climatic parameter (temperature, moisture and light intensity, humidity) inside the greenhouse. Depending upon the value given via knobs the status of the climatic parameter varies.

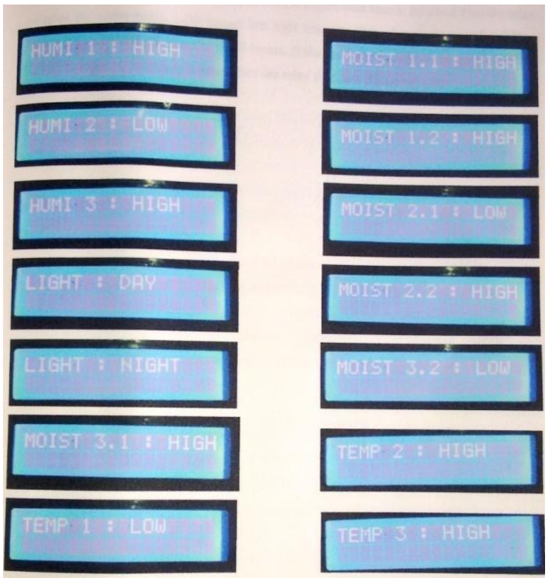

Fig. 4 Climatic parameter status in LCD

V.CONCLUSION AND FUTURE SCOPE

A step-by-step approach in designing the microcontroller basedsystem for measurement and control of the four essential parameters for plantgrowth, i.e. temperature, humidity, soil moisture, and light intensity, has been followed. The results obtained from the measurement have shown that the system performance is quite reliable and accurate. The system has successfully overcome quite a few shortcomings of the existing systems by reducing the power consumption, maintenance and complexity, at the same time providing a flexible and precise form of maintaining the environment.The performance of the system can be further improved in terms of the operating speed, memory capacity, and instruction cycle period of the microcontroller by using other controllers such as AVRs and PICs. The number of channels can be increased to interface more number of sensors which is possible by using advanced versions Microcontrollers

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