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Optimum performance parameters for monitoring and controlling of greenhouse eco-system

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Abstract
Agriculture is the backbone of our country. Our agriculture depends on monsoon. Hence agriculture production is very less. In case the monsoons were good, production rate is good and vice versa. Therefore there is a need for the healthy growth of cultivating agricultural crops. It is possible by the implementation of monitoring and controlling of greenhouse system. We developed a greenhouse environment which could grow these seasonal plants for the whole year by controlling several climatic conditions like light, temperature, humidity and soil moisture. The main of objective of our research is to create GSM based system that reacts and controls the weather inside a greenhouse. Working on a response system which changes with the change in climatic condition on four parameters Humidity, Soil Moisture, Light and Temperature. In this research, the parameters are controlled by using microcontroller which is connected to Wi-Fi module. By the use of Wi-Fi module, data can transferred to wide range of distances at high data rates compared to other modules. If any variations occurs in these four parameters which reaches above the threshold level, accordingly it can be controlled by using sprayer, pump, bulb and fan.

Keywords: crop monitoring, IoT, parameters

1. Introduction

Our country is mostly dependent on agriculture. About seventy percent of our population depends on agriculture. India ranks second in the world in the production of rice, sugarcane, jute and oil seeds. Our agriculture depended on rains. As a result our agriculture produce was very small. Indian agricultural productivity is very less compared to world standards due to lack of advancement in farming technology. Most of the farming in India is monsoon dependent – if monsoons are good, the entire economy is upbeat and when the monsoon fails, it takes a hit to some extent. The problem here is of lack of proper water management. There are many natural calamities that causes impacts on agricultural growth like droughts, change in climatic conditions, deforestation etc. Therefore there is a need for the healthy growth of agricultural crops. The healthy growth of these agricultural crops is possible by the use of greenhouse.

There are many seasonal fruits and vegetables like apple, mango, strawberries, cauliflower, carrot etc. They are grown in a particular season like rainy, summer or winter season. Here in this research we are developing a greenhouse research which could grow these seasonal plants for the whole year by controlling several climatic conditions like light, temperature, humidity and soil moisture. In this research 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.

Greenhouse cultivation represents a very important role in modern agriculture. As the greenhouse usually equips with various high-tech equipment's, management tend to be very complex. A fully automated greenhouse control systems along with improved monitoring system brings obvious benefit such as labor saving, but far more importantly, it enables improved quality of production and information gathering that will make difference between earning a profit and suffering substantial losses. By developing this system there are many advantages like Increase fertility, Better productivity, Increase in quality of crop, Percentage of germination of seeds is high in green house.

Fig 1: Greenhouse Eco-system

Greenhouse structure of various types are used for crop production. Although there are advantages in each type for a particular application, in general there is no single type

greenhouse, which can be constituted as the best. Different types of greenhouses are designed to meet the specific needs. The different types of greenhouses based on shape, utility, material and construction are briefly given below

1. Greenhouse type based on shape: For the purpose of classification, the uniqueness of cross section of the greenhouses can be considered as a factor. The commonly followed types of greenhouses based on shape are: a) Lean to type greenhouse. b) Even span type greenhouse. c) Uneven span type greenhouse. d) Ridge and furrow type. e) Saw tooth type. f) Quonset greenhouse. g) Interlocking ridges and furrow type Quonset greenhouse. h) Ground to ground greenhouse.
2. Greenhouse type based on Utility: Classification can be made depending on the functions or utilities. Of the different utilities, artificial cooling and heating are more expensive and elaborate. Hence based on this, they are classified in to two types. a) Greenhouses for active heating. b) Greenhouses for active cooling.
3. Greenhouse type based on construction. This type of construction predominantly is influenced by structural material, though the covering material also influence the type. Higher the span, stronger should be the material and more structural members are used to make sturdy tissues. For smaller spans, simple designs like hoops can be followed. So based on construction, greenhouses can be classified as a) wooden framed structure. b) Pipe framed structure. c) Truss framed structure.
4. Greenhouse type based on covering material: Covering materials are the important component of the greenhouse structure. They have direct influence on greenhouse effect, inside the structure and they alter the air temperature inside. The types of frames and method of fixing also varies with covering material. Hence based on the type of covering material they may be classified as a) Glass glazing b) Fiber glass reinforced plastic (FRP) glazing 1.Plain sheet 2.Corrugated sheet. c) Plastic film d) based on the cost of construction involved. The structural requirements and the cost per unit area for different models of low cost green houses for cultivation of vegetables are detailed below with diagrams to enable an interested entrepreneur to construct a low cost green house on his own accord. However, the local weather conditions and the individual's necessity play a major role in the selection of the model.

2. Materials and methods

About seventy percent of our population depends on agriculture. Our agriculture depended on rains. As a result our agriculture produce was very small. On comparing with amount of area cultivated and production, Indian agricultural productivity is very less compared to world standards. Most of the farming in India is monsoon dependent. If monsoons are good, the entire economy is upbeat and when the monsoon fails, it takes a hit to some extent.There are many natural calamities that causes impacts on agricultural growth like droughts, change in climatic conditions, deforestation etc. The problem here is of lack of due to lack of advancement in farming technology. Therefore to overcome this problem an intelligent farming technology is necessary for the efficient growth of crops.

Small and fragmented land-holdings

The seemingly abundance of net sown area of 141.2 million hectares and total cropped area of 189.7 million hectares (1999-2000) pales into insignificance when we see that it is divided into economically unviable small and scattered holdings. The average size of holdings was 2.28 hectares in 1970-71 which was reduced to 1.82 hectares in 1980-81 and 1.50 hectares in 1995-96. The size of the holdings will further decrease with the infinite Sub-division of the land holdings. This problems can be solved using electricity. Though farmers have small land they can grow on that land.

Ex: One Farmer have 1 hectar land. If he constructs building of 10 floor. He can grow few rows in one floor 10 floor *3 rows = 30 times 1 hectare or 30 hectares

Seeds

Seed is a critical and basic input for attaining higher crop yields and sustained growth in agricultural production. Distribution of assured quality seed is as critical as the production of such seeds. Unfortunately, good quality seeds are out of reach of the majority of farmers, especially small and marginal farmers mainly because of exorbitant prices of better seeds.

Manures, Fertilizers and Biocides

Indian soils have been used for growing crops over thousands of years without caring much for replenishing. This has led to depletion and exhaustion of soils resulting in their low productivity. The average yields of almost all the crops are among t e lowest in the world. This is a serious problem which can be solved by using more manures and fertilizers.

Irrigation

Although India is the second largest irrigated country of the world after China, only one-third of the cropped area is under irrigation. Irrigation is the most important agricultural input in a tropical monsoon country like India where rainfall is uncertain, unreliable and erratic India cannot achieve sustained progress in agriculture unless and until more than half of the cropped area is brought under assured irrigation.

Lack of mechanisation

In spite of the large scale mechanisation of agriculture in some parts of the country, most of the agricultural operations in larger parts are carried on by human hand using simple and conventional tools and implements like wooden plough, sickle, etc.

Soil erosion

Large tracts of fertile land suffer from soil erosion by wind and water. This area must be properly treated and restored to its original fertility.

Agricultural Marketing

Agricultural marketing still continues to be in a bad shape in rural India. In the absence of sound marketing facilities, the farmers have to depend upon local traders and middlemen for the disposal of their farm produce which is sold at throw-away price.

Scarcity of capital

Agriculture is an important industry and like all other industries it also requires capital. The role of capital input is becoming more and more important with the advancement of farm technology. Since the agriculturists' capital is locked up in his lands and stocks, he is obliged to borrow money for stimulating the tempo of agricultural production.

Experimental Results

The set of field observations of temperature, humidity, soil moisture, light intensity were recorded at green house. In India one of the most cultivated crop is Tomato. The required optimum range of greenhouse parameters for this crop is also taken in to consideration. It is found that temperature and humidity are intensively responsible environmental factors for successive growth of crops. Hence the optimum temperature and humidity value for this crop has been set separately. Tomatoes are a warm season vegetable crop. They grow best under conditions of high light and warm temperatures (summer conditions). Production rate greatly reduces, due to the low light in winter season. For this reason, it is difficult to recommend that a greenhouse operator should grow and harvest fruit from December 15 to February 15.

Humidity is the measure of the quantity of water vapor in air. In green house humidity is very important because air humidity affects the rate of plants transpiration. Transpiration is process by which plants are drawing water and nutrients from root to leaves where water then evaporates from leaf pores in to air. Due to evaporation of water plants are cooled down. As there is no one level of humidity that is good for all crops, it is necessary to establish preferred humidity level of crops in green house for best growing condition.

During summer season, air is too dry which makes humidity level low and hence plants will transpire more rapidly, often losing a great amount of moisture which is not suitable for growth plants. These unbalance conditions are prevented by creating humid atmosphere in green house by using humidification technique like misters, fogging and roof sprinklers. Very high humidity level of plants can be controlled by using automatic spray system. In small greenhouse spray can be sprayed by hands. By installing our equipment in a Greenhouse, we have analyzed the four parameters: temperature, light, humidity and soil moisture of the plants in greenhouse for the whole day. Meanwhile, if these parameters reaches above optimum values accordingly controlling is done.

Table 1: Data Analysis

Time	8 am	9 am	10 am	11am	12 pm	1pm	2 pm	3 pm	4 pm	5 pm	6pm	7 pm
Temperature (˚C)	23	24	25	26	27	28	27	27	26	25	24	24
Light (%)	100	100	100	100	100	100	100	100	100	95	90	20
Soil moisture (%)	100	100	100	100	100	98	95	90	88	85	80	100
Humidity (%)	83	82	81	80	87	87	85	81	82	85	84	83

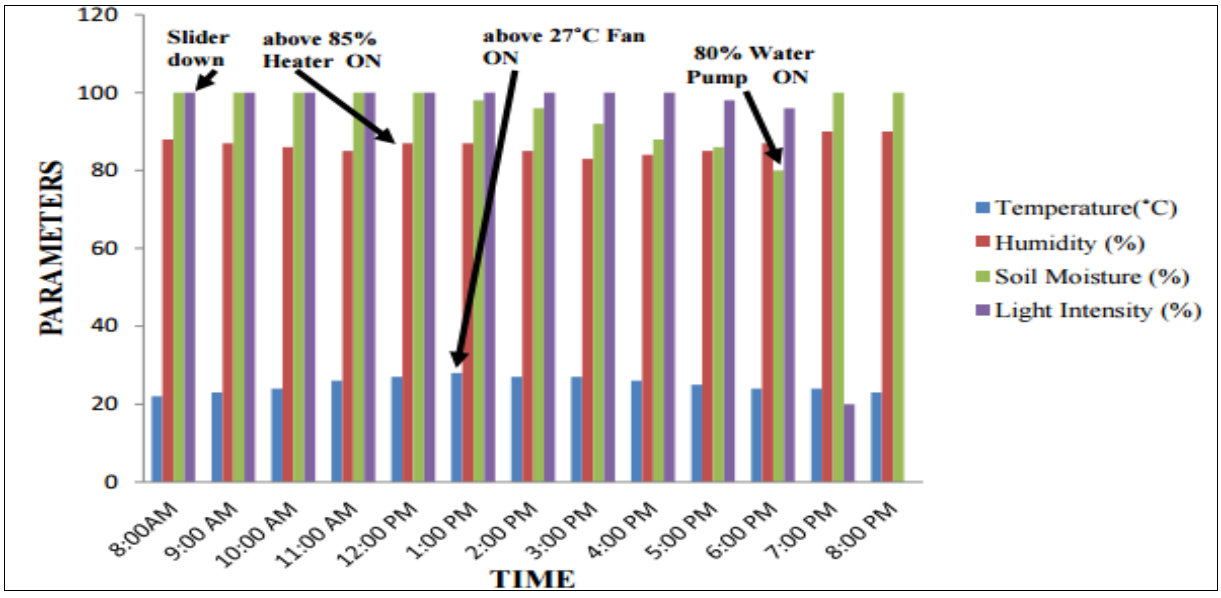

Fig 2: Graphical Comparison of Parameters

This numerical data is plotted on a graph. By setting a certain threshold value for these four parameters if they reached above the limit, controlling is done accordingly.

Growing conditions

Tomatoes prefer warm temperatures with full sun exposure. Below 8–10 °C the plants stop growing, and night temperatures of 13–14 °C encourage fruit set. Temperatures above 40 °C cause floral abortion and poor fruit setting. There are two major types of tomato plants: determinate (seasonal production) and indeterminate (continuous production of floral branches). In the first type, plants can be left to grow as bushes by leaving 3–4 main branches and removing all the auxiliary suckers to divert nutrients to fruits. Both determinate

and indeterminate varieties should be grown with a single stem (double in case of high plant vigor) by removing all the auxiliary suckers. However, in determinate varieties, the apical tip of the single stem has to be cut as soon as the plant reaches 7–8 floral branches in order to get fruiting. Tomato rely on supports that can be either made of stakes (bush plants) or bound to vertical plastic/nylon strings that are attached to iron wires pulled horizontally above the plant units. By using an app named telnet mobile is connected to Wi-Fi module. Based on the AT command received from the mobile the Wi-Fi module send the data to microcontroller through RS232.The microcontroller control the whole circuit based on the program.

Table 3: Optimum Performance of a Parameter Value

Name Of Vegetable Crop	Optimum Temperature (˚C)		Optimum Relative Humidity (%)	Light exposure	PH	Plant spacing	Germination time
	Night	Day					
Tomatoes	13-16	22-26	50-60	full sun	5.5-6.5	40-60 cm 3-5 plants/m2	4-6 days

Monitoring of greenhouse is done by using four sensors namely
Temperature sensor
Light Sensor
Humidity sensor
0Soil Moisture Probes
If the values of the sensors reached above threshold values then immediate controlling of these parameters is done accordingly
Temperature Sensor: Fan is switched ON
Light Sensor: Bulb is switched ON
Humidity Sensor: Sprayer is switched ON
Soil Moisture Probes: Water pump is switched ON

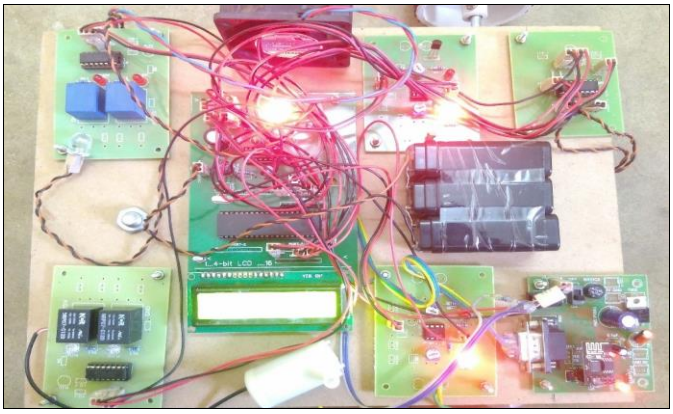

Fig 4: Prototype model

3. Conclusion

A step-by-step approach in designing the microcontroller based system for measurement and control of the four essential parameters for plant growth, 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 continuously decreasing costs of hardware and software, the wider acceptance of electronic systems. During summer season, air is too dry which makes humidity level low and hence plants will transpire more rapidly. Tomatoes prefer warm temperatures with full sun exposure. Below 8–10 °C the plants stop growing, and night temperature of 13–14 °C encourage fruit set. Temperatures above 40 °C cause floral abortion and poor fruit setting. These unbalance conditions are prevented by creating humid atmosphere in green house by using humidification technique like misters, fogging and roof sprinklers.

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