



## Control of Environmental Parameters in A Greenhouse

Surinder Kaur, Diksha Kumari, Vandana Kumari \*

Information Technology Bharati Vidyapeeth's College of Engineering, New Delhi, INDIA.

Emails : [kaur.surinder@bharativedyapeeth.edu](mailto:kaur.surinder@bharativedyapeeth.edu); [diksha\\_k@yahoo.com](mailto:diksha_k@yahoo.com); [vandana3493@gmail.com](mailto:vandana3493@gmail.com)

\* Correspondence: [kaur.surinder@bharativedyapeeth.edu](mailto:kaur.surinder@bharativedyapeeth.edu)

### Abstract

This paper concentrates on the sustainable use of energy, water, and raw materials to increase production to meet the demand of a high population with available areas. This work describes a kind of automatically controlled greenhouse system of single-chip microcomputer based on sensors. This paper presents the system's hardware structure, working principle and process, and a large number of experiments on the effect of the control system. Five control parameters are chosen to increase the yield of the greenhouse, which can be used in indoor breeding and planting. Control actions are performed based on the fusion of different parameters. For the actuation system, the greenhouse is controlled by relays. The proposed control framework permits sparing costs related to wear minimization and delaying the actuator's life, yet continuing promising execution comes out. Methods of simulation results derive results and conclusions.

**Keywords:** Greenhouse; controlled farming; sustainable growth; microcontroller

### 1.Introduction

Agriculture is an important source for the survival of people. Every living being is dependent on crops directly or indirectly. Hence to sustain this life, crops play an important role. Therefore, necessary measurements and precautions should be taken to enhance the growth of crops with sufficient or least usage of natural resources like water, air, etc. [1]. Due to big climate change, increasing risk of the low cultivable area, and year-round production, farmers and multidisciplinary researchers bring their attention toward controlled environment farming like a greenhouse, hydroponics, aquaponics, and roof farming. These controlled environments provide food and agriculture throughout the year regardless of season; protect cash crops against severe weather conditions.

The growth of these crops depends on various factors like temperature, humidity, soil moisture, light intensity, pH of the soil, etc. Therefore, it is necessary to consider the factors affecting the growth of crops.

After a lot of research, we have come to a decision to work on the Agricultural sector, where we will consider how to grow healthy crops while considering different parameters with the minimum usage of natural resources and hence named it as control of environmental parameter [2-4].

## 2. The environment in the greenhouse

### A. Significance of greenhouse

The greenhouse is a man-made structure of transparent material like glass, which is used to artificially create regulated climatic conditions for the growth of crops and plants. The greenhouse has a variety of applications, as it can be used to grow off-seasoned crops. The greenhouse can stay warm even during winters as the heat cannot escape from the greenhouse. It provides a means to grow certain types of crops that cannot grow in areas [5-6],[9].

### B. Working on greenhouse

A greenhouse creates an artificial environment where heat is trapped by solar radiation. It helps in keeping the plant's environment constant without worrying about the atmosphere around or outside it. Heat plays a vital role in the growth of plants and keeps the expenses low.

## 3. Modeling of Greenhouse

Figure 1 shows the block diagram of the greenhouse system. Likewise, other parameters are used to control the different factors affecting the growth and nutrition of crops. This project will monitor and control the necessary factors affecting the greenhouse by constantly updating the system after a limited time, thus saving resources and diminishing human efforts to an ideal degree. Figure 2 shows the PCB model of the proposed system.

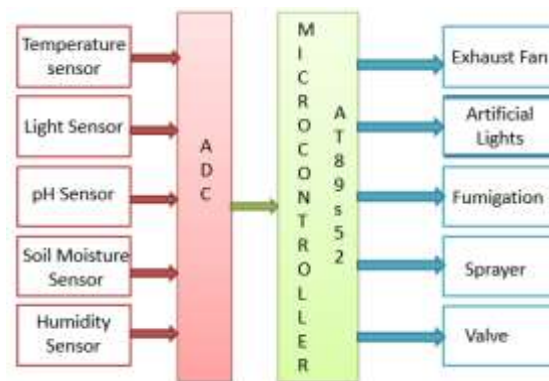
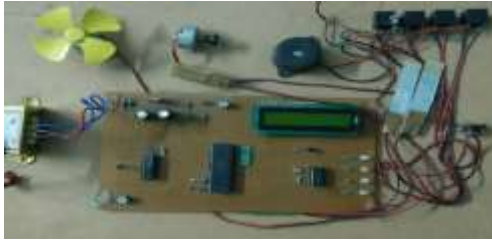


Figure 1: Block diagram of greenhouse

### A. Framework Model

1. Sensors
  - a) Temperature sensor
  - b) Light sensor
  - c) pH sensor
  - d) soil moisture
  - e) humidity
2. Analog to digital convertor (0804)
3. Microcontroller (89s52)
4. Drivers
5. Controllers
  - a) Cooler (recreated as exhaust fans)
  - b) Artificial Lights (recreated as LED)

- c) Fumigation (recreated as a buzzer)
- d) Water pump (recreated as sprayer)
- e) Vents (recreated as valves)
6. Power Supply
7. Liquid Crystal Displays(LCD)
8. Transducers



F Figure 2: PCB model of the proposed



Figure 3: relay device

#### B. System description

- Several sensors were used, such as soil moisture and pH the soil; to check the optimum growth of crops. The better the moisture, the healthier they would crop grow, resulting in increased profitability.

With the parameters mentioned above, there are some additional parameters too, which are used in the greenhouse and are explained in detail.

1. Temperature is displayed using an LCD panel with the help of a temperature sensor, i.e., LM35. When the threshold value set in the microcontroller is crossed, exhaust fans are turned on to control the temperature.
2. Soil Moisture checks the growth of crops; soil retains moisture (water) to feed crops with nutrients absorbed by the water.
3. PH of soil measures the acidity and alkalinity of soil in which the crops grow.
4. Photosynthesis is an important process in plants; therefore, a light sensor is used to provide appropriate sunlight and intensity.

- Relay: Relays are switches that open and close circuits automatically; they are operated in a separate circuit. Electromagnet present in the relay helps to actuate, and hence, another circuit's opening and closing are influenced. Figure 3 shows the relay.

- ADC: ADC forms an essential part of this project as sensors interfaced with microcontrollers give value to analog. So to measure the value of these sensors, external ADC is used. Moreover, after processing, the data is received in digital form, which can be used for reference. Figure 4 shows the ADC 0804 used in our proposed model.



Figure 4: ADC



Figure 5: MPC AT89s52



Figure 6: LCD panel

- Microcontroller: Microcontroller is the heart of our project. The MPC which we are using belongs to the member of the 8051 families, namely 89s52. Figure 5 shows the MPC used in our proposed system. It is used for: -
  1. Reading the analog values received from temperature sensor LM35.
  2. Sending the measured value to the LCD panel for keeping track of variation occurring in temperature. Figure 6 shows the LCD panel.
  3. Interfacing with other sensors like light intensity, soil moisture, etc.

#### C. Temperature

Since heat plays an important role in a greenhouse, therefore, to maintain the heating within a greenhouse, temperature also plays an important factor. Crops can sustain up to the desired amount of temperature for their futile growth. Above or below that range can affect its growth.

Therefore, to maintain a sustainable environment, the temperature must be kept within limits, and to do so, ventilation is done using exhaust fans to release the heat and cool down the temperature in a greenhouse.

#### D. Light intensity

Improper or lack of light can result in hindrance to crop growth, development, and productivity. As light is associated with very important factors of plants that are., photosynthesis, by which.  $CO_2$  and  $H_2O$  are converted into carbohydrates using light. So in cold climatic locations, supplementary lighting is required.

#### E. pH of soil

pH checks the alkalinity and acidity in soils. To grow healthy and nutritious crops, the maintenance of pH is necessary. The value in which crops adopt good health lives in-between the range 5.5 to 7.0. Most of the crops are grown in-between 6.0 to 7.0.

#### F. Soil moisture

The crop growth rate and its yield are affected due to the modifications of crop climate at higher moisture content. Improving the moisture content result in appropriate growth required while taking into consideration not wastewater and improving irrigation systems to reduce water.

#### G. Humidity

Humidity is a major factor and is difficult to control. If it is not kept under certain levels, it can lead to serious problems like influencing pests and causing diseases to crops. To avoid this situation, one should give water to the roots directly instead of the leaves.

### 4. Strategy

In this strategy, we have chosen Five parameters to say temperature, pH of the soil, humidity, etc. The temperature sensor uses threshold values to detect, and relays are set to control automatically by turning the exhaust fans ON. Light intensity when it goes below or above the desired percentage (%) triggers the artificial lights ON or OFF, respectively. The pH of the soil, when it is not in-between the set values, activate the buzzer ON as an indication.

Soil Moisture, when senses the soil is dry or moist, activates or deactivates the water pump, respectively. Humidity, when it reaches below or above the values, valves are opened for sprinklers to spray water.

## 5. Results

Henceforth presenting the experimental results using the above model. Evaluated values are tabulated in Table I. And the required action in monitoring the pH of the soil is mentioned in Table II. Other readings are taken at room temperature of 24 °C. These readings are the values taken after the experimental setup on different types of crops, and the readings are presented in Table III, with Graph 1 displaying the variations in the requirements of resources. This is also clear from Fig 7.

Table 1: Observation Table

Weather conditions		Control Values	Deductions
Temperature	Minimum	18 °C	As soon as the temp exceeds 33 °C, relays set exhaust fan on
	Maximum	33 °C	
Light Intensity	Minimum	55%	Light intensity below or after, set artificial lights On or Off, respectively.
	Maximum	80%	
pH of soil	Minimum	5.5	When pH reaches below or above threshold values, the buzzer is turned ON.
	Maximum	7.2	
Soil Moisture	Minimum	60%	Below or above the value, set the pump On and OFF, respectively.
	Maximum	78%	
Humidity	Minimum	50%	Valves are opened or closed, below or above the threshold value.
	Maximum	75%	

Finally, after long last advancement of the microcontroller-based framework for estimation and controlling of the five fundamental parameters for plant development, i.e., temperature, moisture, soil moisture, pH of the soil, and light power, has been taken care. The outcomes obtained from the estimation have demonstrated that the framework execution is very dependable and exact. The principal part is the controller, which does different undertakings like accumulation, information stockpiling, and information preparation. In this manner, the proposed framework gives continuous application and is advantageous for agriculturists of many creating nations.

Table 2: Action Required In Ph Monitoring

Denomination	pH range	Status	Required Action
Very strongly alkaline	> 9.0	Decrease the pH	ADD phosphorus, iron, manganese,
Moderately alkaline	7.9–8.4	Decrease the pH	ADD ammonium sulfate, ammonium nitrate, and urea

Very strongly acidic	4.5–5.0	Increase the pH	ADD wood ash
Neutral	6.6–7.3	Normal	None

Table 3: Experimental Values Taken In A GreenHouse

	Light Intensity	Soil Moisture	Humidity	Temperature	pH Range
8:00 AM	40	90	68	21	7.2
9:00 AM	60	88	59	24	7.2
10:00 AM	66	88	52	26	7.2
11:00 AM	76	85	48	28	7.2
12:00 PM	80	79	44	29	7.2
1:00 PM	82	78	39	30	7.2
2:00 PM	82	80	37	30	7.1
3:00 PM	81	80	35	30	7.1
4:00 PM	80	82	36	30	7.2
5:00 PM	70	86	38	28	7.2
6:00 PM	40	85	40	27	7.2
7:00 PM	38	85	45	26	7.2
8:00 PM	20	85	51	24	7.2

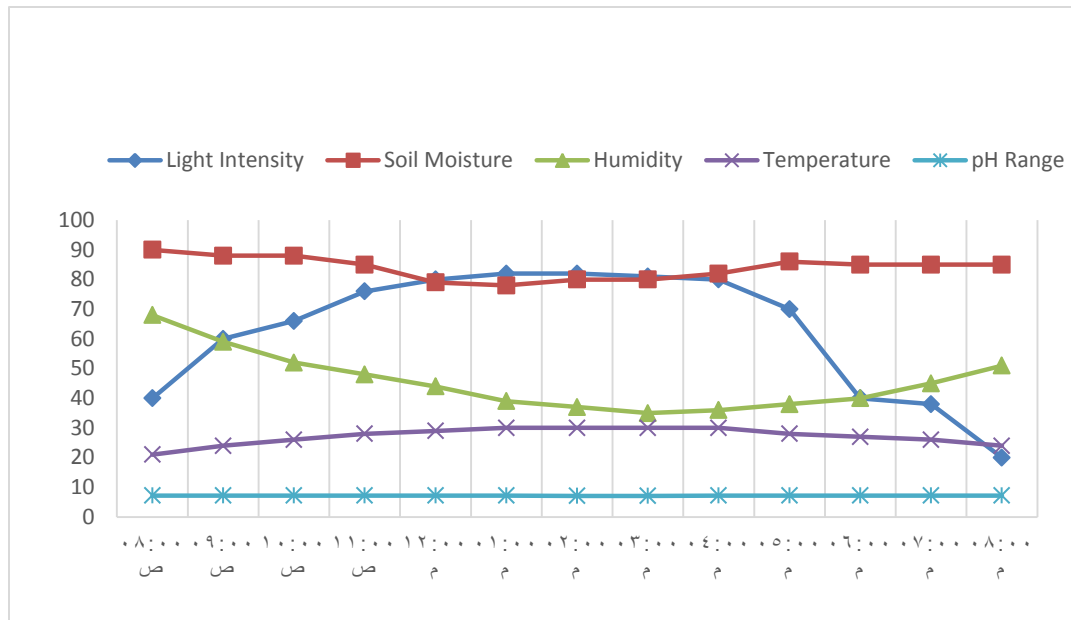


Figure 7: The behavior of greenhouse parameters in 12 hour

## 6. Conclusions

This paper has shown an automatically controlled greenhouse system of single-chip microcomputers based on sensors. This paper presented the system's hardware structure, working principle and process, and a large number of experiments on the effect of the control system. Five control parameters were shown to increase the yield of the greenhouse, which can be used in indoor breeding and planting. Control actions were performed on the basis of the fusion of different parameters. The proposed control framework permits sparing costs related to wear minimization and delaying the actuator's life, yet continuing promising execution comes out.

## References

- [1] Stipanicev, D., & Marasovic, J. (2003, June). *Networked embedded greenhouse monitoring and control*. In Proceedings of 2003 IEEE Conference on Control Applications, 2003. CCA 2003. (Vol. 2, pp. 1350-1355). IEEE.
- [2] Turnell, D. J., de Fatima, Q. V., Turnell, M., Deep, G. S., & Freire, R. C. S. (1998, October). *FarmWeb-an integrated, modular farm automation system*. In SMC'98 Conference Proceedings. 1998 IEEE International Conference on Systems, Man, and Cybernetics (Cat. No. 98CH36218) (Vol. 2, pp. 1184-1189). IEEE.
- [3] Mazidi, M. A., Mazidi, J. G., & McKinlay, R. D. (2006). *The 8051 microcontroller and embedded systems: using Assembly and C* (Vol. 626). Pearson/Prentice Hall.
- [4] Nelson, P. V. (1991). *Greenhouse operation and management* (No. Ed. 4). Prentice Hall.
- [5] Mastalerz, J. W. *The greenhouse environment: the effect of environmental factors on the growth and development of flower crops*. 1977.
- [6] Datasheet, LM35. "LM35 Precision centigrade temperature sensors." Retrieved Sept. 13th, no November (2017).
- [7] Stipanicev, D., & Marasovic, J. (2003, June). *Networked embedded greenhouse monitoring and control*. In Proceedings of 2003 IEEE Conference on Control Applications, 2003. CCA 2003. (Vol. 2, pp. 1350-1355). IEEE.
- [8] Kenneth, J. A. (1996). *The 8051 microcontroller architecture, programming, and applications*.

[9] Runkle, E. S., & Heins, R. D. (2005, June). Manipulating the light environment to control flowering and morphogenesis of herbaceous plants. In *V International Symposium on Artificial Lighting in Horticulture 711* (pp. 51-60).