CONTROLLED ENVIRONMENT STRAWBERRY PLANT GROWING SYSTEM

Rohan Tekade, Vaishnavi Kasturkar, Gargee Londhe and Prof S.B.Dhonde

Department of Electronics and Telecommunication
Engineering University of Pune, India

Abstract: In order to help farmer's grow fruits which require a specific climate which is different from the surrounding climate in which they are currently living, it is essential to create a system which maintains a controlled environment sustainable for growing strawberry plants. Even though a controlled environment system is already created, it has been observed that they only monitor the surrounding temperature and display it. So, this project focuses on creating a system which monitors as well as controls the parameters of the environment in this system so that there is minimum to almost no human interference required. The humidity sensor will detect the surrounding humidity and will control the DC fan accordingly to maintain the desired humidity inside the system. Temperature sensor will be used to monitor and control temperature using a DC fan. The LDR we detect the surrounding light and control it by using a Bulb. The moisture sensor will detect the soil moisture and control the DC pump to maintain the desired soil moisture. All these parameters will be sent to an application using the Bluetooth module.

Keywords— Moisture sensor, Dc pump, Controlled environment, LDR, Temperature sensor.

I. INTRODUCTION

Farmers in India have difficulty in cultivating different fruits and vegetables in a specific environment that require very precise temperature and soil conditions to grow. In order to do that, it requires controlling the different parameters like temperature, soil moisture, light, etc. using various technologies. With the help of modern agricultural methods and advanced irrigation systems, it is easy to yield any crop during any season i.e. throughout the year. Strawberry is one such specific plant that requires utmost care and is only seen to be cultivated in parts of our country where the temperature is around 20^0 to 29^0 C and most likely to bear fruit only during October-November and April-May.

With the help of this system, it is possible to grow strawberries anytime and anywhere without actually degrading the quality of the fruit. The various sensors used in this system help to track the specific changes of the plant and the DC motor, pump, bulb will operate and make the desired changes. All this will be monitored using the app that is created and thus reducing human interference and requiring much less manual work. The further sections will each describe in brief the various elements of this project based on a controlled environment plant growing system.

Section 2 contains the literature survey, followed by Section 3 that includes the methodology. Section 4 provides the expected outcome of this advance system and Section 5 delivers the conclusion

II. LITERATURE SURVEY

1. Temperature of air and condition of light are the two vital environmental factors for growth of the plants. Light and air temperature are related and it is a known fact that one cannot be optimized while neglecting the other. Productivity and lycopene value are not only affected by the microclimate parameters and cultural experience, but also with the Photosynthetic Photon Flux Density (PPFD). Combination of air temperature, humidity, and light optimally will result in maximum yield (assuming that other factors such as CO2, soil pH, and nutrient are not restrictive). So, an efficient greenhouse requires environment controlled for air quality, disease reduction, pest control, and nutrient and water uptake.

2. Recent studies have shown data acquisition platforms can be used including web-based, cloud-based, IoT communication and control, wireless sensor network to monitor the health. IOT is a 3-layer architecture: Perception layer, Network layer and Application layer Perception Layer: It is used for identification of objects and collecting information. It is coupled with hardware devices like GPS, sensor, RFID tags, and sensor network and then linked to any intelligent system. Network Layer: It is a network management centre where it fetches information from the perception layer which has been treated and transferred to various networks via wired or wireless channels. Application Layer: This layer gives the data/information received from network layer to the application which then runs on the application designed.

3. Fuzzy controllers (Temperature Control System, Irrigation Control System, and Light Control System) are effective in numerous control issues. These controllers manage the whole process, to ensure best performance and stability for the control system. The controllers are designed and programmed in a single microcontroller, and are executed sequentially and while passing the required information for each fuzzy controller. Temperature Control System manages the temperature of soil Irrigation control system stabilizes the humidity of the soil efficiently. Light control system targets the brightness in a particular range, which helps the plants in photosynthesis. The hardware managed by the fuzzy controller consists of two inputs. In order to operate the Motor (Pump) in to push water the fuzzy controller needs to produce value greater than 150 V as Pulse Width Modulation (PWM).

Strawberry has been cultivated commercially in different parts of the world and the demand for the fruit has been increasing rapidly in both domestic and export markets. The usual planting time ranges from late October to the first fortnight of November, and harvesting from the second fortnight of April to late May in open conditions. It is a temperate fruit crop and thus temperature is an important factor for floral initiation. The best temperature for short day floral initiation is 15-18°C. On the other hand, strawberries require an optimum daytime temperature of 22°C and night time temperature of 13°C for maximum growth and yield. It requires 6hrs of sunlight and good protection from wind. Growing strawberries under controlled environment significantly decreases the dependency of fruit quality on soil and climate conditions.

III. METHODOLOGY

This paper presents a controlled environment system for growing a strawberry plant.

A. Overall Design

The solution that has been propose to overcome the limitations of growing only certain fruits and plants in any environmental condition is used to design a system which creates a controlled environment which monitors four parameters: humidity, soil moisture, temperature and light. The temperature sensor will continuously monitor and monitor the surrounding temperature in the system and whenever the temperature rises or falls below the desired temperature, the DC fan will be turned on until the desired temperature is maintained. Similarly, the LDR moisture sensor and humidity sensor where continuously monitor its parameters and control these parameters using a bulb DC pump and DC fan respectively. The sensors will send their respective signal to the controller. We used ATmega328p which is a AVR controller. It is a low-power CMOS 8-bit microcontroller based on enhanced RISC architecture. With the help of the program that is been fed to the controller the controller will send respective signals to the controlling devices. This will ensure a desired environment is maintained in the system sustainable for growing strawberry plants.

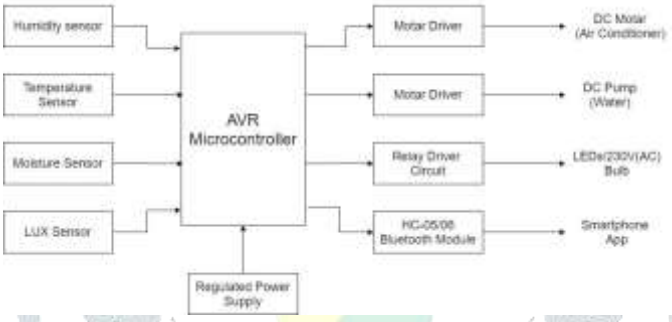

Fig.1.Architecture of Controlled environment strawberry plant growing system

B. Implementation Algorithm

The algorithm given below shows all possible circumstances acknowledged by different sensors and devices and the decision to be made by the controller in each of the circumstances. Initially the LDR sensor, the active sensor and the moisture sensor check the light intensity surrounding temperature and soil moisture respectively. In case the temperature drops below the desired temperature the dht11 sensor with send a signal to the microcontroller and output will be given to the l298 DC motor driver which will turn on the DC motor and the surrounding area will be maintained at the desired temperature. Similarly, if the parameters required for strawberry plant differ from the parameters sensed by rest of the sensors, microcontroller sends a signal to the controlling devices which include DC pump, DC fan, bulb to maintain the desired parameter required for growing a strawberry plant.

C. Hardware Platform

In this section, description of the hardware design of controlled environment strawberry plant growing system is to be seen. The hardware component consists of a humidity and temperature sensor which is a DHT11 sensor lux sensor and a soil moisture sensor. Use of a l298d motor driver which controls the DC motor and dc pump along with a relay driver that controls the 230v AC LEDs are being used. HC 0506 Bluetooth module is included to send the data to an app which that has already been created. Soil moisture sensor that has been included consists of two electrodes which are dipped in soil. Soil moisture is detected when the resistance between the two electrodes fluctuates because of presence of soil moisture. The DHT11 humidity and temperature sensor consists of two electrodes and between those electrodes there is a moisture holding substrate. moisture dependent resistor sensors the humidity. The moisture holding substrate holds the moisture which changes the conductance and resistance between the electrodes with change in humidity and temperature. There is a motor driver to control the DC motor.

1. ATmega328/p microcontroller

The high-performance 8-bit RISC-based microcontroller has 23 general purpose I/O lines, 32 general purpose working registers, three flexible timer/counters with compare modes, internal and external interrupts, serial programmable USART & 10-bit analog to digital converter. The controller operates between 1.8-5.5 volts.

2. Electronic power supply circuit

In order to provide adequate voltage supply to each circuit part, a linear power supply circuit is designed. It is possible to check the use to protect the circuit from overvoltage. The circuit converts the AC voltage to DC voltage. The ATmega328p works between 1.8-5.5 V so power supply circuit provide adequate supply for efficient working of the controller

3. DC Motor Driving

The circuit works on low current and the motor requires a high amount of current so the motor driver converts low current signals into high current signals. The motor driver works on H bridge principle. It consists of four switch mechanisms out of which only two switches conduct at a time. And accordingly, the conducting switches the direction of the motor. This is shown in the figure below.

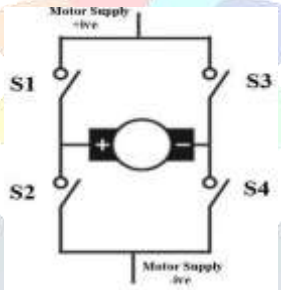

Fig. 2 DC Motor Driving using H Bridge

D. Design and Implementation

The overall functioning of the system is divided into two parts. The first part is sensing temperature and humidity using DHT11 sensor, soil moisture is sensed using soil moisture sensor and amount of light by using a LDR. The second part is to control all these parameters using controlling devices so as to get the desired environment required for growing a strawberry plant. In order to summarize the following steps have been taken in direction of making the project. Initially all the sensors and devices were tested on the breadboard to test the sensors in different conditions. Once the breadboard testing was finished, we designed the circuit diagram for the project on Easy EDA online platform. This platform also has PCB designing tools.

The designed PCB layout was printed on a PCB and the itching process was performed to get the final PCB tracks. All the components were fitted on the PCB and initial working was monitored. The PCB will be fitted on a box enclosure in which the strawberry plant will be kept. The sensors and controlling devices are attached to the enclosure. The front of the enclosure is sealed with a thick transparent plastic to make sure the system works efficiently.

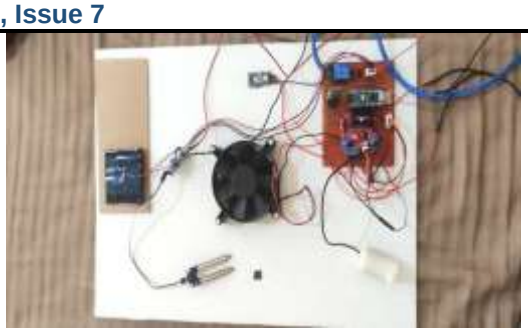

Fig. 4. Initial Testing

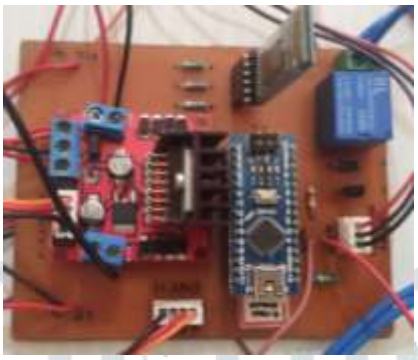

Fig. 5. Components fitted on the PCB

IV. EXPECTED OUTCOME

Whenever the temperature inside the enclosure goes above 22°C during day time a system turns on the DC fan, which has a small desert cooler attached to it, and cools the air inside the enclosure until it reaches 22°C and then turns off the fan.

The strawberry plant requires good protection from wind which is provided by the enclosure. The light source is turned on for 6 hrs daily as it is a requirement of strawberry. The soil is kept moist with the water pumped through DC pump whenever the soil becomes dry and the moisture sensor senses it. The strawberry seed was planted in a container and it has grown into a small sapling when kept for 38 days inside the controlled environment system. The expected outcome is that the sensors accurately detect four parameters i.e. temperature, soil moisture, humidity and light intensity and control it using the controlling devices such as DC motor, DC pump, LED lights to maintain a sustainable microclimate inside the system.

Fig.6.The enclosure of system

Fig.7.The PCB fitted on right side of enclosure

IV. CONCLUSION

We have effectively assembled and tested the plan outline to the paper. The objective is to create an efficient method for making a controlled environment system for strawberry plant growing has been presented. The system design is easy to understand and simple to use so that it can be easily used by farmers. The project would increase the efficiency of growing strawberry plants in controlled environment system with minimal human interference. The seed was planted and it germinated after one week. The sapling started growing as the system continually monitored the parameters to make sure the desired climate was maintained inside the controlled environment system. This project intends to ease the problem faced by farmers while growing strawberry plants in a locality which does not have the sustainable climate for growing the plant. This system will help maintain the environment for different stages of growing a strawberry plant. Finally we can state that this project is self-explanatory and we are free to allude to and forward the work in order to welcome further advancements on this project.

V. FUTURE SCOPE

The project presented an overview of modern greenhouses, controlled environment agriculture and their derivatives and highlighted some of the advances in environmental monitoring, control and optimization. Urbanization and living in multi-storied buildings request a redefinition of agricultural awareness for securing food supply. Proper placement of sensors can help in reducing the number of false alarms which can improve the accuracy by 70%. This could provide an effective response to the actual problem and can benefit the whole process. The costly sensors can now be replaced by simply designed Nitrogen measurement meters which costs almost 10 times cheaper than the conventional sensors.

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