GREENTECH
A step ahead in Greenhouse farming

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Abstract

Climate is fundamental to crop growth. Crops are dependent on light, temperature, moisture and carbon dioxide (CO_2) concentration for their optimal growth. Therefore, crop management is also about managing the climatic parameters according to the requirements. Climate management also impacts on the spread of weeds, pests and diseases which in turn affects crop yields, harvests and producers costs and returns. However the levels of these climate inputs particularly rainfall vary between locations and years, due to climate variability. A state like Jammu & Kashmir which has witnessed a swift climatic transition over the last few years, the winters are so harsh that communication with the entire world is cut off for months and which is dependent on its neighboring states for a variety of food supplies, automation in agriculture is much needed. One such setup is Greenhouse which is the heart of farming in winters and therefore the central focus of this automation. The proposed system is basically a Smart Greenhouse Monitoring and Control System which is called Project Greentech.

Index Terms- Greenhouse, Climate, Farming, Raspberry Pi, Arduino Mega.

INTRODUCTION

Climate plays a major role in crop growth. A changed climate will significantly affect agriculture. Higher levels of carbon dioxide, changing rain patterns, higher temperatures and greater occurrence of extreme weather events will all modify crop production [**1**]**.** Green house is a way of providing all these environmental parameters as required by the plant for its better growth. Throughout the world there is a lot of focus on Greenhouse crop breeding .Many agricultural institutions in J&K are in dire need of it as well. Most of them are already in the field searching ways to realize it. The horticulture and floriculture sectors in J&K can implement this to maximize smart farming. This project is not only economical but also provides a low maintenance solution for most of the problems we are facing in agriculture. For the optimal growth of a crop, all the imperative requirements should be known beforehand and met in due course. This can be achieved by the proposed system in an automated manner. The system is capable of taking as input the name of the crop to be grown, searching the internet for all the pre-requisites and finally providing the required environment inside the Greenhouse for the optimal growth of the crop. For this purpose we are using a mini computer- raspberry pi b+, Arduino and actuators.

The basic parameters which affect the crop growth are briefly illustrated below.

Temperature: Temperature influences all plant growth processes such as photosynthesis, respiration, transpiration, breaking of seed, dormancy, seed germination, protein synthesis and translocation. Favorable or optimal day and night temperature enhances plant growth and results in maximum yield **[2].** For this purpose, we are using an LM 35 temperature sensor that senses the temperature and sends it to the brain (Arduino) of the system.

Light: Light is essential in the production of chlorophyll and in photosynthesis. Other plant processes that are enhanced or inhibited by this climatic factor include stomatal movement, phototropism, photomorphogenisis, translocation, mineral absorption and abscission **[3].** We are using LDR to detect the intensity of light in this system.

Relative Humidity: Relative Humidity affects the opening and closing of the stomata, which regulates loss of water from the plant through transpiration as well as photosynthesis **[4].** The sensor used to detect relative humidity in our system is HIH-4030.

Wind: This climatic factor serves as a vector of pollen from one flower to another, thus aiding in the process of pollination. It is therefore, essential in the development of food and seed from wind pollinated flowers **[5].**

However strong winds can cause excessive water loss through transpiration as well as lodging or toppling of plants **[6].** The sensor used for this purpose is SPD005G.

Gases: Oxygen and carbon dioxide in the air are of particular importance to the physiology of plants. Carbon dioxide is a raw material in photosynthesis while as oxygen is essential in respiration for the production of energy **[7].** The sensor used for Carbon dioxide detection is MG811.

Rainfall and water: Rainfall is the most common form of precipitation. Other forms of precipitation are freezing rain, sleet or ice pellets, snowfall and hail **[8][9].**Rainfall is directly responsible for the moisture content of the soil. The soil Moisture sensor that we are using gives the amount of moisture in the soil.

pH: Soil pH is considered a master variable in soils as it affects many chemical processes. It specifically affects plant nutrient availability by controlling the chemical forms of different nutrients and by influencing the chemical reactions they undergo **[10].** The optimum pH range for most plants is between 5.5 and 7.5 **[11].** Every plant prefers a different level of acidity, so in order to maintain the same the proposed system notifies the user every time the acidity or basicity of the soil crosses the desired threshold.

Hardware Composition

Raspberry pi, Arduino, Keypad, Camera, Mosfet, Servo motors, Sensors, Fan, Buzzer, Water pump.

SOFTWARE AND PROGRAMMING USED

Linux
Python
Arduino IDE
Embedded C/C++

METHODOLOGY

The designed system works in fully autonomous mode. The process starts when the user provides the name of the crop to be cultivated as the input through a keypad to the raspberry pi. Subsequent to this input, the raspberry pi searches the internet for the specific requirements of the particular crop provided by the user and sets the threshold within the greenhouse environment so that the desired conditions are met. On the other hand, the sensors for sensing all the parameters are connected to the Arduino through analog or digital pins. Appropriate actions are performed by the Arduino when any of the levels cross the threshold mark to maintain the optimum conditions for crop growth.

I. Raspberry Pi b+

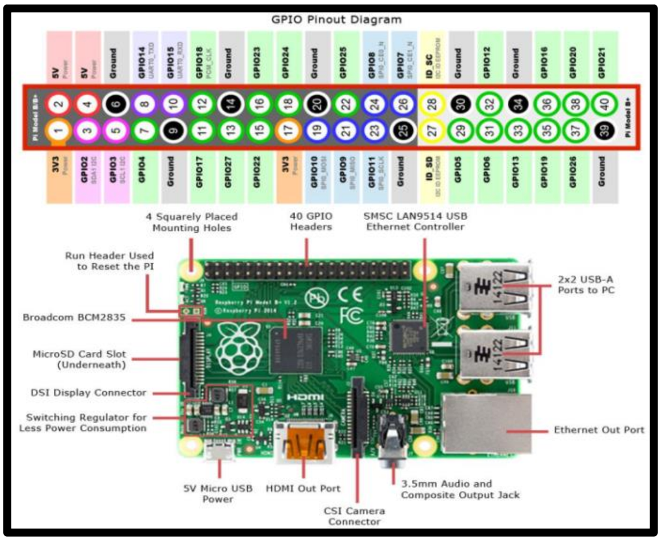
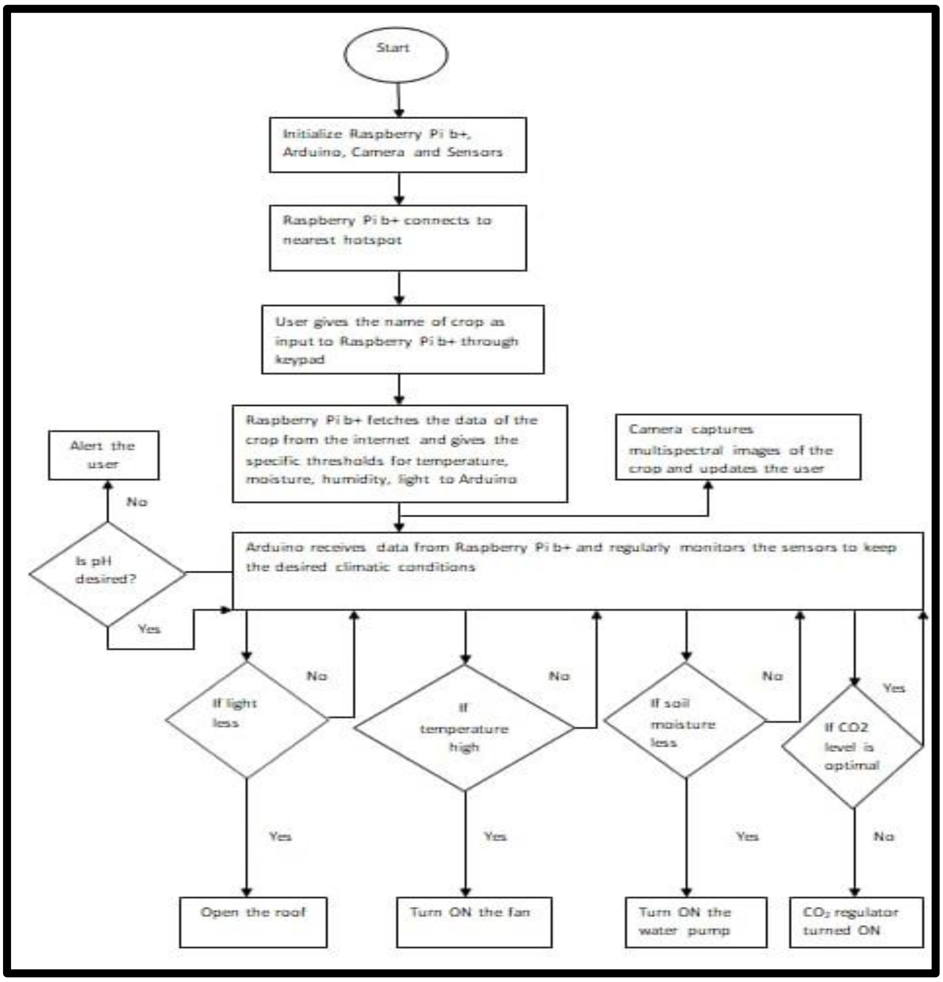


FIGURE I: Raspberry Pi b+

The Raspberry Pi 3 model b+ is the third generation Raspberry Pi. This powerful credit card sized single board computer can be used for many applications. It has wireless LAN and Bluetooth connectivity making it the ideal solution for powerful connected designs. Raspberry Pi 3 model b has an inbuilt Wi-Fi **[12].** The specificity of Raspberry Pi in this system is that it gathers all the required data about the crop fed by the user to the system by connecting to the internet through the inbuilt Wi-Fi which gets connected to the nearest hotspot. The Raspberry Pi then sets a threshold for all the parameters to be controlled. The camera connected to the Raspberry Pi captures real time images of the surroundings and send it to the user over the Wi-Fi. Thus the Raspberry Pi is the heart of the system which constantly monitors and controls the Greenhouse environment 24*7.



II. Camera

The camera used in this setup is PlantEye F500. It combines an overlay 3D and multi- spectral information to give details on plant height, 3D leaf area, projected leaf area, digital biomass, leaf inclination, leaf area index, light penetration depth and leaf coverage. This is done by capturing the plants in 3D and combining it on the fly with a 4 channel multispectral camera in the range between 400 to 900nm. This unique concept allows us to deliver spectral information for each data point of the plant in x, y and z direction. In addition PlantEye F500 can measure a spectral reflectance for each point of the plant. Each wavelength can be statistically analyzed individually to calculate greenness, chlorophyll levels or to detect senescence.

III. Arduino

The Arduino Mega 2560 is a microcontroller board based on the ATmega2560. It has 54 digital input/output pins (of which 15 can be used as PWM outputs), 16 analog inputs, four UARTs (hardware serial ports), a 16MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller, simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

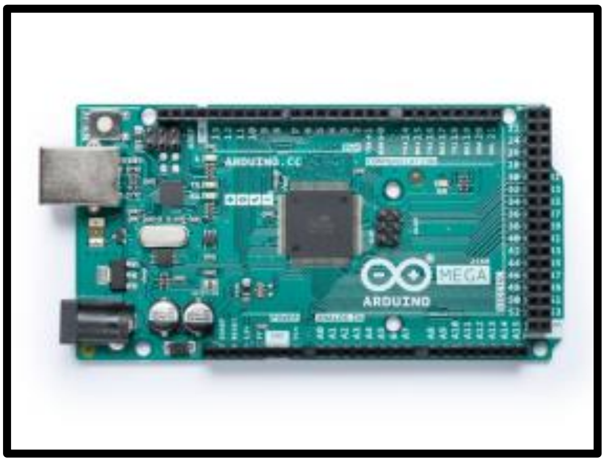


FIGURE II: Arduino Mega 2650

In our project all the motors, water pump, fan, heater, soil moisture sensor, light sensor, relative humidity and temperature sensor, pH sensor, air pressure sensor, fire sensor and buzzer for fire alarm all are connected to the Arduino Mega. It collects the data from all the sensors and performs the necessary actions to bring back the environment under control, for example, when the light intensity inside the Greenhouse is below the set threshold, the roof is lifted upwards with the help of the motor connected to it. When the water level of the soil goes below a set threshold, the soil is irrigated by the water pump controlled by the servo motor. In the same way temperature and humidity are controlled with the help of a heater and fan respectively. Thus Arduino Mega is responsible for the continuous control of the whole system.

IV. Temperature Sensor

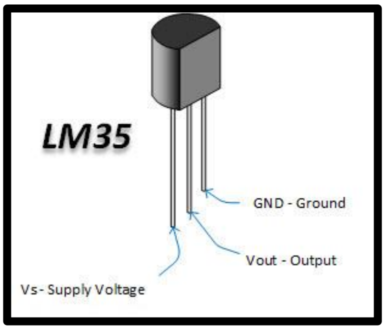


FIGURE III: L35 Sensor

The LM35 is a kind of temperature sensor that is used to measure temperature with an electrical output comparative to the temperature in degree C. It has an output voltage that is proportional to the Celsius temperature. The scale factor is .01V per degree C. This sensor maintains an exactness of +/- 0.4 degree C at room temperature and +/- 0.8 degree Celsius over arrange of 0 degree Celsius to + 100 degree Celsius and draws just 60 mA from its supply **[13].** In our project the temperature sensor is connected to one of the analog pins of the Arduino. When the temperature within the Greenhouse falls below or exceeds the given threshold, heater and fan are operated upon respectively, thus maintaining the optimal temperature within the Greenhouse.

V. Relative Humidity Sensor

HIH-4030 sensor measures the relative humidity (% RH) and delivers it as an analog output voltage. The output of the sensor can be connected directly to an ADC on the microcontroller. Voltage applied to the supply pins should be within 4-5.8 VDC and optimally at 5V. The sensor typically consumes about 200 microamperes. In the proposed system, the HIH-4030 is connected to one of the analog pins of the Arduino. If the humidity in the system exceeds the given threshold, the fan connected to the Arduino through the Mosfet is turned ON which stabilizes the humidity level within the Greenhouse environment.

FIGURE IV: HIH-4030 Sensor

VI. Gas Detection Sensor

FIGURE V: MG811

The MG811 is highly sensitive to CO_2 levels and is best used in air quality control. The output voltage of the sensor in clean air (typically 400ppm CO_2) is in the range of 200mV to 600mv. The output voltage of the module falls as the concentration of CO_2 increases. This sensor provides both analog and digital output and has signal conditioning and heating circuit onboard. This is because the amplitude of the signal is so low and the output impedance is so high that a signal conditioning circuit is required between the sensor and the microcontroller's ADC input. The operating temperature of the sensor is -20 to 50 degree C. In the proposed system, this sensor is connected to one of the analog pins of the Arduino. When the level of CO_2 inside the Greenhouse premises fall below the threshold set by the Arduino, the CO_2 regulator connected to it is automatically turned ON and CO_2 is dispensed.

VII. Soil Moisture Sensor

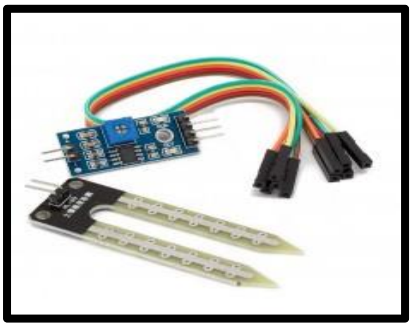


FIGURE VI: Soil Moisture Sensor

It is a transistor based circuitry which is used to check the moisture level of soil. The required action is performed by the microcontroller on the basis of the input to this sensor. It's two copper leads act as sensor probes. They are immersed into the specimen soil whose moisture content is under test. In our system, the soil moisture sensor on detecting the water levels of the soil below the threshold sends the data to Arduino which afterwards irrigates the land with the help of the water pump and motor.

VIII. Fire Sensor and Buzzer

FIGURE VII: Buzzer

Fire sensors sense one or more of the products or phenomena resulting from fire such as smoke, heat, infrared and ultraviolet light radiations or gas. When the fire sensor senses any of these conditions within the Greenhouse, it sends a signal to the Arduino which then activates the buzzer connected to it.

IX. Light Sensor

FIGURE VIII: Light Sensor

A light sensor is a passive device that converts light energy whether visible or infrared into electrical signal output. The light sensor used in our system is an LDR sensor. LDR has a variable resistance that changes with the light intensity that falls upon it. The resistance of an LDR typically have the value 5000 ohm for daylight and 20000000 ohm for dark. When the light intensity within the Greenhouse is below the set threshold the vent in the roof is automatically slided to maintain the optimal level of light in the environment.

FIGURE VIII: Prototype of GreenTech

CONCLUSION

1. Crops which could not be grown earlier due to specific needs can now be cultivated easily in the greenhouse as the required conditions are maintained in an optimal and cost effective way.
2. Manpower can be reduced significantly as all the objectives are achieved automatically including the knowledge of the crop to be cultivated.
3. Considering the dependency of J&K on agriculture in terms of economy and weather, automation in the said field is the need of the hour. Also most of the institutions are already in the field searching ways to realize it.
4. This project provides an economical and low maintenance solution for most of the problems in agriculture today and smart farming can be maximized.

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