NEW INNOVATIONS IN GREENHOUSE CONTROL SYSTEMS & TECHNOLOGY

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Abstract. In the modern world, the demand for human food products is increasing due to the increasing population of the earth. One of the new ways to meet this demand is to build modern smart greenhouses. In this article, a project based on the principle of remote control of greenhouses has been developed. In this way, the population is provided with high-quality, clean food products.

Keywords: IOT (internet of things), Android operating system, LED module, step motor, server, microcontroller, Arduino, HSM 20G humidity sensor module, PIC18F452 microcontroller, Tarang F4 module, relay.

Introduction. Various greenhouse automation equipment like computer software and sensors are connected and used to collect data in the greenhouse environment to boost crop yields. This new innovative technology (***IoT or the Internet of Things***) makes use of numerous sensors linked to a central _greenhouse environment climate control computer_. The greenhouse sensor system have elements that monitor and control temperature, humidity, electrical conductivity, pH, carbon dioxide (c02), fogging, shading and read external weather conditions via a weather station.

The gathered information helps to control not only specific elements within the internal growing environment, but also saves time, energy costs and labour. We even include in our software an irrigation schedule to control up to 5 different feed formulas and expandable zones. Growers today are

investing in greenhouse technology & controls to ensure that their crop will produce healthy yields and run a more productive operation which in turn means, better financial performance for the company.

Climate Controlled Greenhouses For Quality Control. Climate controlled greenhouses can help any grower get better at quality control or enhance crop yields, with advanced computer technology. You probably have heard of the importance of using greenhouse automation for your operation, but what does that mean? What systems will really help to reduce labour costs and give you a better return on your plants.

While it is possible to control the temperature of the greenhouse manually, the best thing to do is to install a climate control greenhouse computer to maintain the ideal climate, everyday for your crops.

Controlled & Monitored Greenhouse Climate for Optimal Growing:

Climate control of greenhouses is precisely what it sounds like. It refers to the regulation of the temperature and humidity inside the greenhouse in all growing climates to ensure that the crops can thrive and even live past their "season". *But one question, how do you control the greenhouse with a computer?*

Grower set points are created within the greenhouse automation software and are triggered when things hit a certain level. During high-temperature climates, you can mist or spray water inside the greenhouse to bring down the temperature inside the greenhouse with automation. You can also take the help of a fogging or misting system to move warm air with the help of water evaporation using a fine spray.

When there is a temperature drop during winter months, you may use simple manual methods to heat the greenhouse. You can place a container with hot water inside the greenhouse or insulate the greenhouse with the help of something as simple as a bubble wrap. You can even use polythene to screen off only a part of the greenhouse.

There are other manual methods, but farmers who want to make the best of modern technology prefer to integrate the climate control system. This will help

seasonal crops to grow throughout the year. A climate control system automates the greenhouse to reach the desired temperature as required by your crops' growing process. The system monitors and handles humidity, shading, fogging, and much more. This is accomplished by the way of real time sensors, that communicate wirelessly in the greenhouse, via mesh WiFi.

Greenhouse Sensor System Principles. A sensor is any tool that measures some chemical or physical characteristics and alters the results into an electrical signal collected by the main automation computer and then this data can be easily read and interpreted by the grower. Automation can make growing easier with lots of instrumentation to be a more precise grower and get all elements feed to a crop that it is looking for.

However, user input is always required by you the grower to set limits, create schedules and create your own feed formulas, the automated software helps with controlling all the things you use to have to do manually, opening a vent for instance and keeping a close eye on all data values. If the pH of the water gets too high for instance, our software will trigger an alarm, before you would have to test for pH your self or by some other semi-automated sensor. With our Climate Manager™ all data and controls become centralized to make things like monitoring and user input easier for you the grower.

Control More with Greenhouse Automation Equipment.

Outside Weather Station

Ok, so we can't control the weather outdoors, would be nice though wouldn't it? But having some instrumentation on top of the greenhouse in the way of a professional weather station it great to read all outside weather

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conditions like temperature, solar, temperature, wind and rain conditions. These all effect the greenhouse and how you should make adjustments to the inside of the greenhouse, again all of these signals can be read, then trigger a control in the greenhouse, if the solar level gets to high, trigger all vents to open for instance.

Temperature and Humidity conditions in all greenhouse compartments

Greenhouse temperatures rise under intense sunlight. This rise in temperature is referred to as "solar gain" . To enter the greenhouse, light has to travel through the greenhouse glass or plastic, in doing so the light loses some of its energy which is converted to heat . Without a cooling system, the temperature and humidity within the greenhouse can rise to over + 45 °C . To successfully optimize the environment within the greenhouse means countering the adverse effects of the external environment with the proper greenhouse controls and automation to ensure temperature and humidity levels stay optimal for crop health and growth.

CONCLUSION. The prototype of the system is successfully built and run in reality based on Technology Acceptance Modeling that shows in Table 2. The

output for the given analog input values are visualized in android application system. The analog value given by the sensor changes it into a digital value.

The android software is already working properly and appropriate with the purpose in the beginning, that is to get humidity value from green house and give input to control components in green house.

After development is finished, test for sensor's work is done and device is working properly.

The testing that has done shows that condition in datasheet of sensor and in system is appropriate. The test result shows in temperature 30°C to 70°C, humidity is still in normal range area. If temperature gets higher and more, relative humidity will be decrease and goes near to zero.

Looking into the Table 2 about Technology Acceptance Modeling, it can be conclude that the whole system, which are software and hardware is working fine.

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