DIGITAL FARMING USING AEROPONICS FOR SMART CITIES

Project Reference No.: 42S_BE_1485

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Introduction :
Climatic change has generated shifting weather patterns and extreme weather events that makes it more difficult for farmers to cultivate. Modern farming methods impacts soil by the use of nitrogen fertilizers; this erodes the soil ability to hold the nutrients. Thus the agricultural land becomes unproductive. Today’s agricultural practices majorly rely on irrigation rather than rainfall, which in turn depletes groundwater reserves and these have huge impact on the soil. Rapid urbanization and industrialization leads to loss of agricultural land, population growth, these trends will cause massive food shortage in the future. So these problems can be overcome by adopting soilless indoor farming, of which aeroponics is one of the technique. Aeroponics is a process of growing plants in an air or mist environment without the use of soil. The word aeroponics is derived from Greek meanings of aer (“air”) and ponos (“labour”). NASA’s research on aeroponics have proven that this technique can reduce water usage by 98%, the usage of fertilizer by 60% and pesticide usage by 100% while increasing crop yields. The main focus of this project is on constructing an automated system that regulates and monitors the aeroponic system. This will be accomplished by the use of mist makers, pH sensor, temperature, humidity and intensity regulator and a single board computer. While a mobile app or a web interface will be employed to allow the user to monitor and interact with the system in ease. The user will also be warned in case of any malfunction so that necessary action could be taken.

Objective :
The goal of this project is to create a fully automated aeroponic and greenhouse system that will reduce the need for human interference to the maximum possible extent. Two different chambers will be developed one for the shoot system and the other for the root system. This is done to ensure that the climatic conditions of root system and shoot system are completely independent of each other.

The shoot chamber will host a light and a temperature sensor, gas sensor with exhaust fan to regulate the air pressure and temperature in the chamber and microphone to monitor nozzles.

An array of LED lights will be fixed to the zenith of the chamber and the brightness of these lights will be controlled according to the optimum light intensity required by different plants for photosynthesis.

Temperature and humidity regulation is done using exhaust fan and sensors. The exhaust fan will reduce the temperature and humidity of the chamber if it increases above the optimum value.

The gas sensor will regulate the amount of oxygen and Carbon dioxide present within the shoot chamber.
Methodology:

Shoot chamber:

The shoot chamber will host a light sensor, temperature sensor, gas sensor with exhaust fan to regulate the air pressure and temperature in the chamber.

An array of LED lights will be fixed to the zenith of the chamber and the brightness of these lights will be controlled according to the optimum light intensity required by different plants for photosynthesis.

Temperature and humidity regulation is done using exhaust fan and sensors. The exhaust fan will reduce the temperature and humidity of the chamber if it increases above the optimum value.
The gas sensor will regulate the amount of oxygen and Carbon dioxide present within the shoot chamber.

A microphone is placed beside the net pots to ensure the proper working of high pressure nozzles by picking up the intensity of the sound signals.

**Root chamber:**

The root chamber will have its own sensors to regulate the temperature and humidity of the chamber. The nutrient reservoir will be constructed which comprises of nutrient solution, pH up and pH down solutions. These solutions will be supplied through solenoid valves. A couple of mixers in the reservoir will ensure that the composition of the nutrient solution within the reservoir stays consistent.

A pH sensor and an EC sensor will monitor the pH and EC level of the solution respectively according to the needs of the plant. Water level sensor monitors the water level of the reservoir and it will replenish the reservoir if the solution drops below the given level.

In summary, the developed system consists of the following parts to accomplish the project objectives.

1. Temperature monitoring and regulating system
2. Humidity monitoring and regulating system
3. Light intensity monitoring and regulating system
4. Air composition monitoring and regulatory system
5. Shoot growth monitoring system
6. Nutrient composition and regulatory system
7. Water level monitoring and regulatory system
8. Mist maker (high pressure nozzles) and feedback system
9. In the solution section, each solution bottle is integrated with an ultrasonic sensor to indicate the quantity of solutions left.

This system will be fully enclosed and completely detached from the outer environment. Thus this aeroponic system can be completely monitored and regulated which can greatly reduce the practical problems associated making it a commercially viable solution.

**Advantages:**

1. Minimum water usage.
2. Gives the cultivators effective control over the environment
3. Fungal disease can be significantly reduced through controlled humidity.
4. Root zone aerations and temperature are maintained as ideal to ensure good growth of the plant
5. Yields are very predictable and also consistent throughout the year

**Applications:**

1. This system can be used in every household for the cultivation of produce for daily consumption.
2. This system can also be integrated for large scale production.