ESP-IJCEET
ESP International Journal of Communication Engineering & Electronics Technology
ISSN: 2583-9217 / Volume 1 Issue 2 July 2023 / Page No: 6-10
Paper Id: IJCEET-V1I2P102 / Doi: **10.56472/25839217/ IJCEET-V1I2P102**

Original Article

Environmental Factors Independent System for Plants' Growth

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Received Date: 25 June 2023 Revised Date: 16 July 2023 Accepted Date: 27 July 2023

Abstract: *Due to incessant increase in global population and unpredictable nature of environmental conditions, food availability to meet population demand has become a threat. This menace to human populace will continue until serious efforts are shifted to controlled environmental agriculture (CEA) and ensure there is urgent change of food production systems. Conventional greenhouses have not been able to combat this menace effectively because its result still depends on weather conditions which vary constantly. Since predictions of weather conditions are not usually 100% accurate, it is difficult to plan ahead all the time. This model is proposed to adopt Wireless Sensors Network (WSN) with its nodes deployed to sense and gather available plants' growth factors as data (temperature, humidity, light intensity, moisture and carbon dioxide) per time. These data are fed into microcontroller which had been programmed to correspondingly control actuators which are readily at work to change to plants' needed growth factors per time according to preset data in the microcontroller.*

Keywords: *Microcontroller, Wireless Sensors Network, Greenhouse*

I. INTRODUCTION

A. Background

A Greenhouse is a building with glass walls and roof for the cultivation and exhibition of plants under controlled conditions. Apart from the fact that it provides controlled environment, it also provides protection for plants. For a greenhouse to be optimally acceptable, it must comply with economic and environmental requirements. An automated hydroponic greenhouse is that type of greenhouse whereby its plants are grown in sand (and not in soil) and all necessary conditions as may be required by the plants are automatedly supplied.

B. Aims and Objectives

Aim: The aim of this project is to develop a wireless sensor networked greenhouse in order to establish a controlled environment for plants production.

C. Objectives:

The followings are the major objectives of this research work:

- Set up sensors to take different readings (which are conditions for plants growth).
- Put in place necessary actuators that will be used to give wanted conditions to the plants.
- Develop an application through which the user can communicate with the sensors and actuators.
- Record the readings in a database and display them to user.

D. Significance

Natural environment is very unpredictable and so planting crops and reaping commensurate harvest is very unpredictable. With the help of this system, a controlled environment will be created for plants. This means requirement of each plant (which has been predetermined) will be monitored and adequately provided. The overall effect is increased food production and thus, hunger and starvation become a thing of the past.

E. Problem Statement

Due to inordinate weather conditions, crop farmers have long been identified with working like elephants but eating like ants; they dissipate a lot of energy but at the end record little result. No commensurate results to show forth.

Several technologies have been applied in previous times to tackle this menace. One of the technologies is greenhouse which is used to give adequate weather condition as required by any crop purposed for the greenhouse. However, this requires constant monitoring and care.

To give constant monitoring and care may be hard to come by. As a result, this project looks into adopting the use of WSN to provide needed monitoring and consequently, provides required care/need needed by plant as the case may be.

II. ARCHITECTURE OF THE PROPOSED AUTOMATED GREENHOUSE

The general overview of how the system components parts link together is given here.

A. Data Flow

The main components to be used in this project work are linked together as shown in figure 1 below. The main components are: the hub, sensors, actuators, CD Screen and wireless system (to communicate with the entire system)

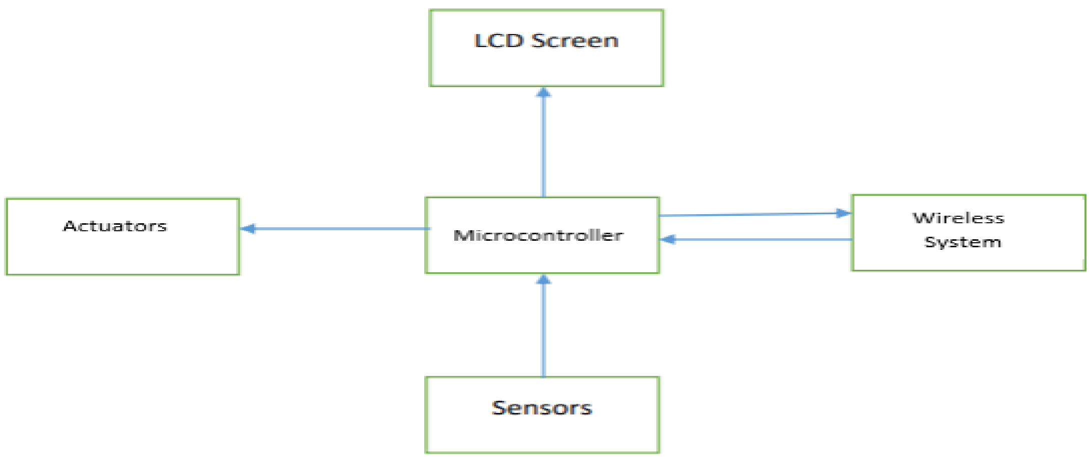

Figure 1: System Data Flow

B. Typical Pictorial diagrams of Greenhouses Already in Existence

Different types of greenhouse have been in existence with different technologies. Figure 2.2 below gives a snapshot of typical modern greenhouses already in existence.

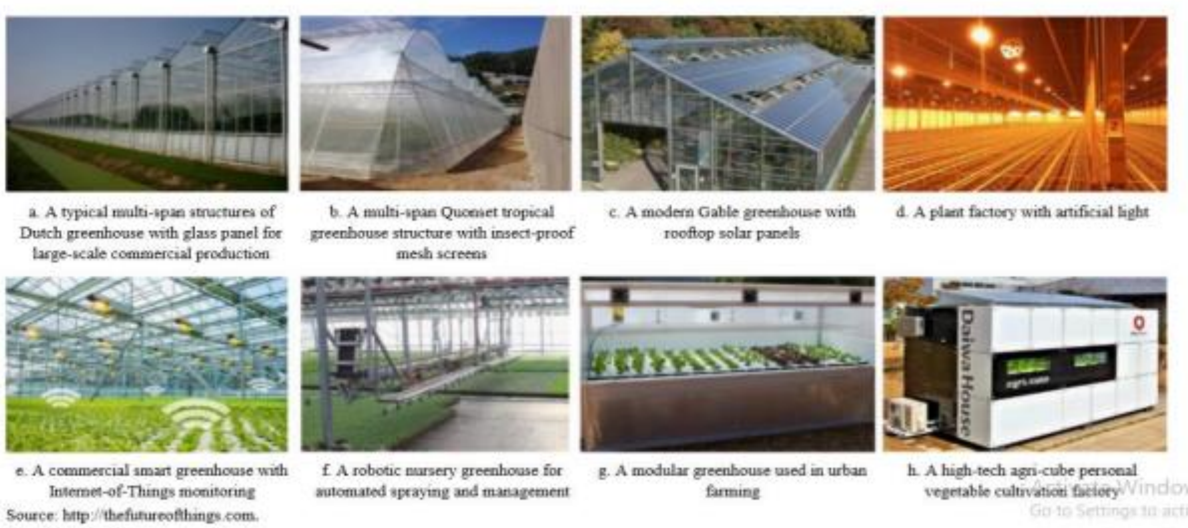

Figure 2: Snapshot Views of Some of the Popular Modern Greenhouses

III. RESEARCH APPROACH

The approaches considered below are to be adopted:

- Collection of Growth Data for a Particular Plant (e.g. Maize) from a Research Institute.
- Planting of a certain quantity of plant outside the greenhouse in the best planting period of the crop.
- Planting of the same quantity of plant seed within the greenhouse.
- Deployment of sensors to monitor plant conditions and application of actuators to provide required condition for the plant per time in accordance with how microcontroller is programmed which strictly follows the growth data of the plant.
- Comparison of the plant proceeds (both quantity and quality) from within and within the greenhouse.

A. Sensors

To achieve the aim of monitoring the conditions of plants in the greenhouse, sensors are deployed to read different conditions of each plant. The various plant conditions to be read by sensors are as shown below:

- Moisture sensor
- Illumination intensity sensor
- Temperature and Humidity sensor
- pH level sensor
- EC level sensor
- Oxygen and CO2 concentration sensor

Some of the sensors to be adopted are as detailed in the sections below:

B. Moisture sensor HL-69 is a Soil Moisture sensor [8]

It is an analogue sensor whose value ranges between 0 – 1023. When the sand is wet, a low value is received as output by the sensor and vice versa.

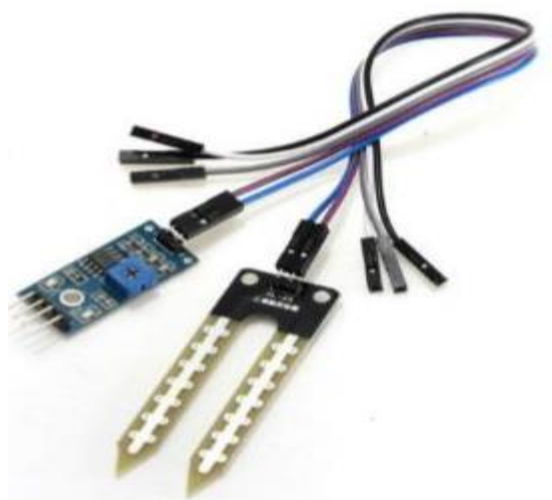

Figure 3: HL- 69

C. Illumination intensity sensor

Excessive light intensity could burn the plants and when light intensity is too low, plants will under develop. To monitor the light intensity, photoresistor could be adopted. With photoresistor, when light intensity changes, its resistance changes and consequently generates an analog signal which is sent to the microcontroller for appropriate use. Figure 3.2 below shows the picture of photoresistor.

Figure 4: Photoresistor

D. Temperature and Humidity

Both temperature and humidity can be measured with a sensor RHT03 (also known as DHT22). Figure 3.3 below is the picture of DHT22. DHT22 is an analogue device that produces a voltage output that is linearly proportional to the temperature in Celsius [1].

Figure 5: RHT03 / DHT22

IV. ACTUATORS

In order to adjust to required conditions as needed by each plant/group of plants, the following are some of the actuators to be employed:

A. Pump System

Apart from water that is a key factor to be monitored in the growth of a given plant, diverse nutrients, are as well, are needed to be monitored. The pump system is responsible for these tasks. Each pump, after receiving signal(s) from the microcontroller, sends water or nutrients as required by each plant of group of plants.

B. LED

Different light intensities can be achieved for different plants by putting ON/OFF of a number of LEDs in an array/bar of LEDs. The number of LEDs that will be ON/OFF per time and for each plant/group of plants will depend on signal received from microcontroller.

C. CO2 Generator

Co-generator or combined heat and power (CHP/Micro-CHP) is an example of CO2 generator. When it burns natural gas (or propane) it emits CO2 into the atmosphere. It also generates heat and electricity at the same time. This can be used to supply CO2

D. Dehumidifier

An industrial dehumidifier will be adopted to reduce and maintain the levels of humidity in the greenhouse.

E. Air-Conditioner

Air condition of the whole system is controlled by a combination of absorption refrigerator and CHP. CHP will burn the fuel to heat up the system while absorption refrigerator will cool the air [7].

V. MICRO-ENVIRONMENT MONITORING AND PERCEPTION

For efficient monitoring of pants micro-environment, attention will be shifted from offline systems to wireless and cloud-based data collection architectures. A wireless technique to be adopted for the micro-environment is Wireless Sensors Network (WSN) or IoT communication and control. Figure 5.1 below gives an illustration of likely components and instrumentation that will be adopted in the proposed greenhouse.

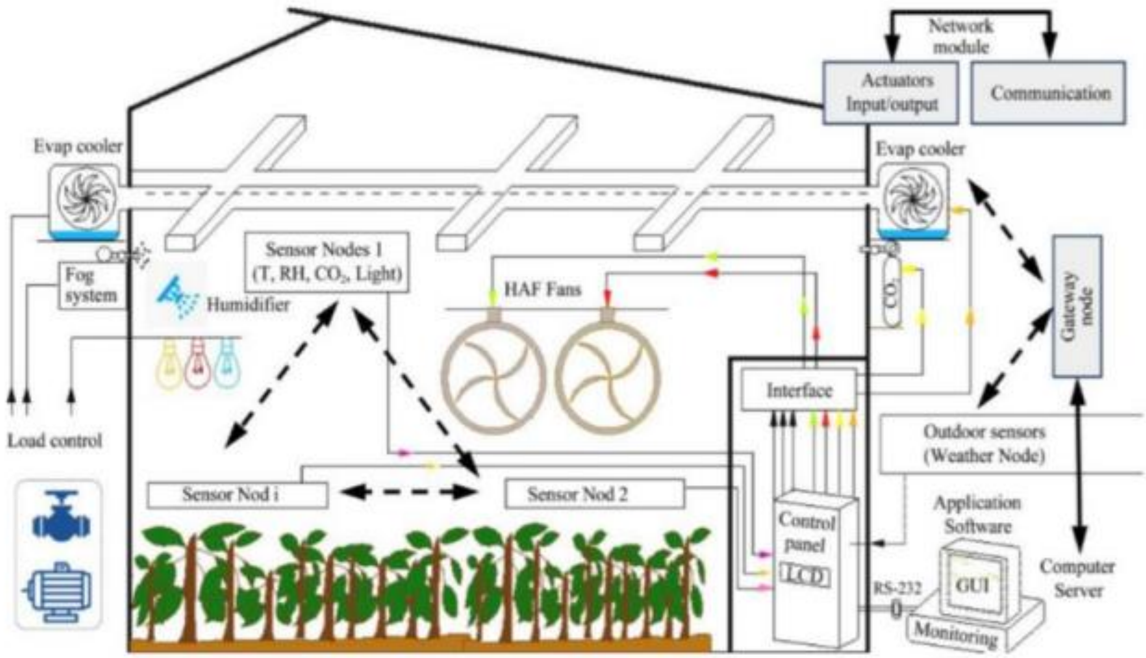

Figure 6: General Components and Instrumentations in a Typical Greenhouse
Source: www.AdaptiveAgroTech.com

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