International Journal of Advances in Engineering and Management (IJAEM)
Volume 3, Issue 7 July 2021, pp: 2192-2196www.ijaem.net ISSN: 2395-5252

Automated Plant Growth System

Shubhangi Kumar, Vikas Singh Yadav, Pankaj Kumar
Department Of Computer Science And Engineering,Shri Ramswaroop Memorial Group Of Professional Colleges, Lucknow.

Submitted: 01-07-2021 Revised: 13-07-2021 Accepted: 16-07-2021

ABSTRACT-Due to rapid urbanization and industrialization cultivable land is decreasing at a very fast rate.Use of continuous fertilizer over the past many years has decreased soil fertility to a great extent and this is the main reason for decreased productivity. Besides, poor soil fertility, melting of icebergs, water pollution, frequent drought conditions, unpredictable climate change, temperature rise, decrease in the level of underground water is also threatening open field that is, soil-based agriculture. If the same condition persists, then that day is not far when feeding the whole population would be impossible [1]. Also, growing plants in remote areas such as deserts, the north pole, and the south pole is a very challenging task due to unfavourable conditions. To avoid all these difficulties, soil-less agriculture came into the picture. In soil-less agriculture, plants can be grown without soil. Therefore, growing plants under artificial conditions will be proved very beneficial for increasing productivity.

Keywords:urbanization, industrialization, soil-less agriculture, unfavourable conditions, artificial conditions.

I. INTRODUCTION

Soil is the foundation of our ecosystem. It helps in regulating earth's temperature and also greenhouse gases. It is very important medium for the growth of the plant. Soil supports plant growth by providing them oxygen which allows plants to grow. Roots grow downwards therefore the process of stabilizing plant is done by roots. Soil supplies important nutrients such as Nitrogen, Sulphur, Phosphorus, etc, and hold the essential fertilizers useful in plant growth. Water that is essential for plant growth is supplied to them by soil via their roots. But sometimes this beneficial soil also poses difficulties in the growth of the plant. Like, presence of disease-causing microbes in soil, soil quality degradation due to erosion, unfavourable soil compaction, poor drainage, etc. can be some reasons behind this [1][2]. In addition to this conventional crop growing in soil that is, Open Field Architecture, requires large land for cultivation, good amount of water and large labour [1][2]. It is a very difficult to get large land for cultivation nowadays in metropolitan cities and in some areas, we find scarcity of fertile soil due to unfavourable geographical conditions [1][2].

Not only this, growing certain plants and vegetables in remote areas such as deserts, south pole, north pole can be can be a very difficult task because of extreme outsideweather [3][4]. Very few species can grow and thrive in such conditions and those are not considered as food source [3][4]. In this study, we created a system with the help of which we can grow plants without depending on outside climate. We achieved this by a technique called Hydroponics.Hydroponics is a type of agriculturetechnique in which plants are grown without soil by using the mineral nutrient solution in an aqueous solvent [5]. In addition to this root of plants can also be kept in some inert medium like perlite, gravel, or other such substrates [5]. The purpose of this research is to expand and improve the use of hydroponics and to create a system for indoor plant growth [1]. In this research, we monitored and controlled the moisture contained in the soil, the temperature of the surroundings, the amount of light received by the plant, and the growth of the plant. Here, we replaced soil with cocoa powder as it is easy to control the moisture and nutrients content of cocoa powder easily when compared to normal soil.

II. RELATED WORK

In 1627, a book name Sylva Sylvarum was written by Francis Bacon which described growing terrestrial plants without soil. After that, water culture became very popular among researchers. John Woodward found that plants in less pure water grew better and faster than plants in distilled water. So, he published his water culture experiments with spearmint. A list of nine elements essential for the growth of the plant was compiled by 1842, and the discoveries of German botanists Julius von Sachs and Wilhelm Knop, in the years

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1859-1875, resulted in the development of the technique of hydroponics that is soilless cultivation [6]. Solution Culture is defined as the growth of terrestrial plants without soil in mineral nutrients solution [7]. Solution culture is a type of hydroponics where an inert medium is used [5].

In 1929, William Frederick Gericke of the University of California at Berkeley began publicly promoting that for agriculture crop production solution culture can be used.[8][9] Gericke created history by growing tomatoesin a nutrient solution without soil using hydroponics. [10] Gericke and his Reports claim that hydroponics would revolutionize plant agriculture [4].

Hydroponics was implemented in Wake Island, a rocky atoll in the Pacific Ocean used as a refueling stop for Pan Americans flights. Hydroponics was used there in the 1930s to grow vegetables for the passengers. There was a requirement of hydroponics in Wake Island as there was no soil and it was very expensive to airlift fresh vegetables [11].

A nutrient film technique was developed by Allen Cooper of England in the 1960s [12]. Avariety of hydroponics techniques are featured inthe land Pavilion at Walt Disney World's EPCOT Center opened in 1982[4][5].

NASA has also done extensive research in hydroponics in the last decades for its Controlled Ecological Life Support System (CELS). It has also planned to do hydroponics on mars using LED lighting to grow in a different color spectrum with much less heat. Hydroponics is very useful to grow plants that were not traditionally grown in a particular climate. NASA has decided to utilize hydroponics in its upcoming space program [4][5].

Ray Wheeler, a plant physiologist at Kennedy Space Center's Space Life Science Lab, believes that hydroponics has the power to create many advances within space travel. [13]

III. IMPLEMENTATION

Our system is fully automated and the decision of what to do when will be automatically taken by the computer. And the decision which will be taken will be communicated to the concerned devices andthey will operate accordingly.

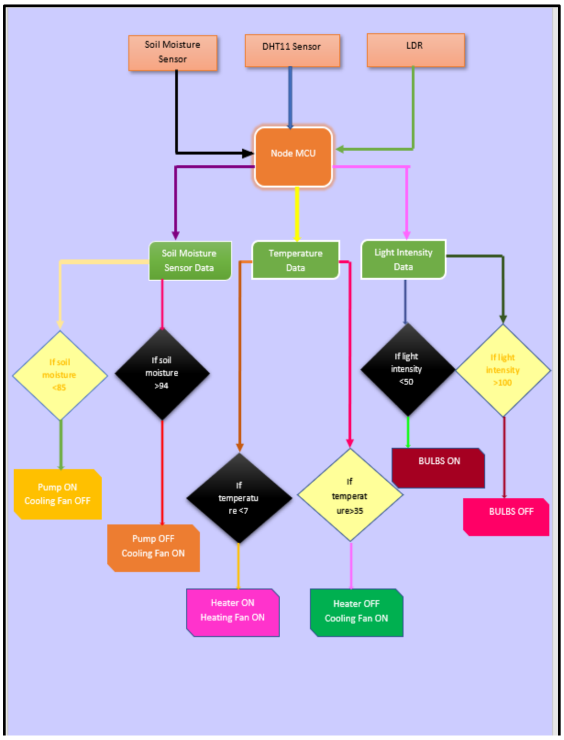

Fig.1 Block Diagram of Automated PlantGrowth

Fig.1, clearly shows the block diagram of the system. Soil moisture sensor, Dht11 sensor, and LDR are connected to NodeMCU ESP8266. The **Moisture** Sensor is used for detecting the moisture of the soil. The **DHT11** is a basic, ultra-low-cost digital temperature and humidity sensor. It uses a capacitive humidity **sensor** and a thermistor to measure the surrounding air and spits out a digital signal on the data pin (no analog input pins needed). It's fairly simple to use, but requires careful timing to grab data [14]. **Light-dependent resistor (LDR)** are photoresistors. Photoresistors are used to simply detect whether a light is on or off and compare relative light levels throughout a day. We have used Python programming language in this system to connect all the sensors to the NodeMCU ESP8266. Cocoa powder is used in place of the soil. As we can control the moisture and nutrients content of the cocoa powder easily concerning normal soil. A 100W incandescent light bulb is used as a heater in addition to the heating fan to raise the temperature of the surroundings of the plant if the temperature falls below 7^0 C. And a cooling fan is used to cool the surroundings if the temperature rises above 35^0 C. A mini water pump is used to manage the water requirement of the plant. Two bulbs: red and blue are used to fulfill the requirement of photons by the plant. The relay module is used to switch the devices ON and OFF based on the conditions. It is

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a digital normally-open switch. Through it, we can control the circuit of high voltage with low voltage, say 5V on the controller. There is an indicator LED on the board, which will light up when the terminals get closed.

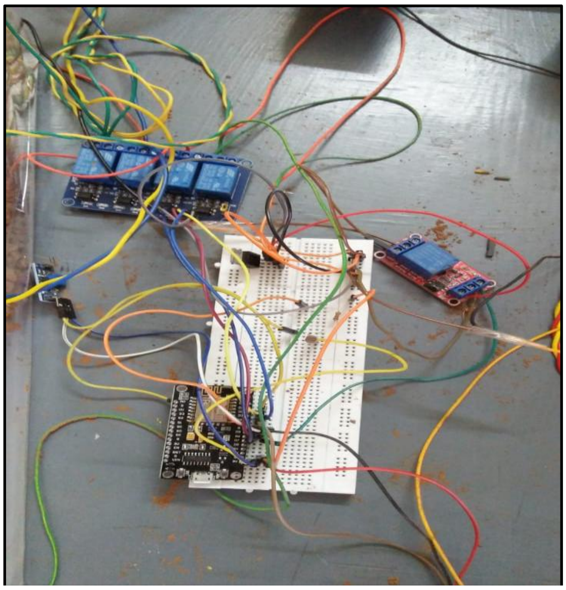

Fig. 2 Connections made with Node MCU

Fig. 2 depicts the connections that we have made between the sensors, NodeMCU ESP8266, and the different devices.

IV. RESULT

In this paper, the model is built using NodeMCU ESP8266. The prototype of the working model is shown below:

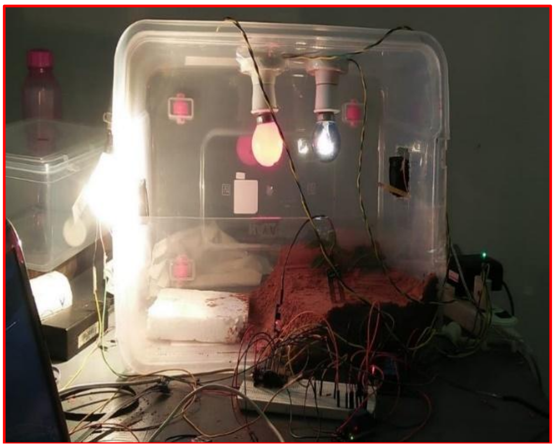

Fig. 3 Prototype of Working model

We have grown the Hoya Brevialata plant as shown below:

Fig. 4 Hoya Brevialata plant

It is also widely known as 'Porcelain Plant' and 'Wax Plant'. Hoya Brevialata showcases waxy oval-round green leaves.

V. CONCLUSION

From above study it is clear that it is possible to grow plants without soil and in artificial conditions. The plants grown by hydroponics are healthy and of good quality. Hydroponics also helps in increased plant yields. Automated plant growth system will provide optimum growing conditions for the plant. Plants will be supplied with appropriate nutrient amounts when needed. Automating a plant growth system will enable us to do remote monitoring through a standard Wi-Fi connection. Sensors will detect any changes andwill send alerts to the computer control system. This system also makes it easy to collect valuable data such as plant cycles, climate control reports, soil data and nutrient intake. This data will help undergo analysis and make important decisions regarding healthy plant growth. And also, system can contribute to eco-friendly as no use of pesticides are there.
Thus, the future of heathy farming depends on hydroponics.

ACKNOWLEDGEMENT

We gratefully acknowledge the Department of Computer Science and Engineering, Shri Ramswaroop Memorial Group Of Professional Colleges for providing us the required facilities and support.

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