Agrogenic – IoT Based Modern Automated Greenhouse System

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ABSTRACT

World population growth has created a number of problems, the most serious of which is the threat of famine. In the Sri Lankan context, there is an urgent need to increase the production of crops and other crops due to the rapidly growing population of Sri Lanka. There we considered two effects. The composition of phosphorus, potassium, and nitrogen levels in the soil plays an important role. Here we have introduced a new mechanism to identify nitrogen, potassium, and phosphorous levels, which are the main factors that stimulate plant growth inside the soil. There is a required level of nitrogen, potassium, and phosphorus for a certain plant that is grown inside a greenhouse. When the line chart identifies that there is not enough nitrogen, potassium, and phosphorus in the soil, it will generate an alert through the mobile app. At the same time, arrangements have been made to supply fertilizer that contains nitrogen, potassium, and phosphorus. After the recommended life span of a plant, the productivity of the organically fertilized plant group and the group of chemically fertilized plants are compared separately. Another thing to consider is, Plant and genetic researchers have found that different wavelength factors directly contribute to plant growth. A small amount of research has been done in these areas and some research is still ongoing. Research has shown that light wavelengths affect plant growth. In this case, we have made greater use of the technical side to stimulate plant growth by controlling such wavelength factors well. Then the mobile app user can control the decoders through the mobile app and set the required amounts of light intensity. In this proposed system, Users can put the new plant species inside the greenhouse and control the light beam wavelength through the mobile app.

***Keywords*--** IoT, Automation System, Greenhouse, Arduino, N, P, K Indicator, Organic Fertilizer, In-Organic Fertilizer, Light Emitting Diodes, Chlorophyll Fluorescent, Basil, Greenhouse

I. INTRODUCTION

Agriculture is the backbone of our Sri Lankan nation.But the main problem that is emerging at the moment is that the Sri Lankan youth community is not interested in agricultural activities and is resorting to earn income in foreign countries outside the motherland. Why does all Sri Lankan youth run into these IT-related jobs? Because their work requires a white- collar job and system. So, by turning manual farming into automated farming no one wants to go down to the field for farming and no need to scratch their shirt, everything will be done automatically by machine, we have to take care of control. Whether the work of the computer is done at the correct stage. The improvement in the agricultural sector through automation methods directly and indirectly causes the young generation to turn to this sector. Here we automated the irrigation and fertilizer supply process with the help of sensors and processors.

During the project, we came up with the idea of automating and integrating fertilizer supply processes with improvements in mind. Lighting is a major factor influencing plant growth and development. Since light is an important factor in the formation of food or photosynthesis in chlorophyll plants, this sensor uses energy to convert carbon dioxide and water into carbohydrates and exposes oxygen to other factors that affect plant growth, including wavelength, light intensity, and duration of light [1].A greenhouse is a reference to the intensity of light, and if it is exposed to too much or too little light, plant photosynthesis is reduced. Exposure to high- intensity light and cultivation in the open garden should be covered to minimize light. Since light quality and quantity directly affect plant growth and chemical composition, it can be used as an easy and highly modifiable factor to obtain an herbal substance with a composition suitable for specific applications. Since chlorophyll pigments are mainly absorbed in the red and blue light regions, these wavelengths are major factors influencing plant growth. Phytochrome receptors feel the red light of plants.

e-ISSN: 2250-0758 | p-ISSN: 2394-6962
Volume-12, Issue-6, (December 2022)
https://doi.org/10.31033/ijemr.12.6.19

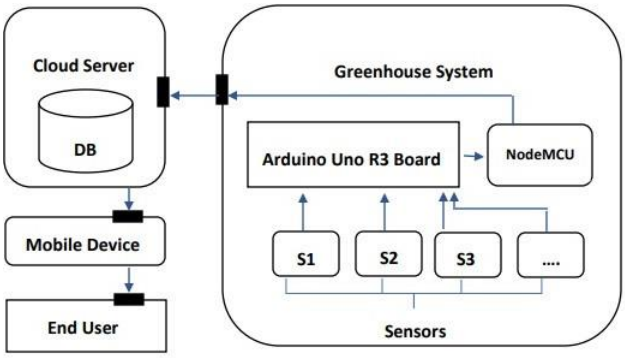

Figure 1: High level Architecture of the System

The rest of the paper is organized as follows. We begin by presenting the relevant work in Section II. We describe the motivational application of the modern automated greenhouse system in several route planning problems, Methodology Section III. In Part IV, we have the Simulation results and discussion points and test based on field data. We finally conclude with a discussion of future work and conclusion in Section V.

II. RELATED WORK

A. Effect of colors on light

The photosynthesis equipment of higher plants is optimized for sunlight harvesting and consists of large light-harvesting complexes that connect to the reaction centers that convert the absorbed light energy into redox energy. In plants, the nuclei of light-harvesting complexes consist of two types of photovoltaic voltages that activate the linear electron transport process. Here the process that takes place inside the plant electromagnetically has been studied.

Understanding the effect of monochromatic light on a photo- synthesis and secondary metabolic biosynthesis is a challenge for botanists as well as for applied research focusing on indoor lighting development. In fact, in nature, plants describe the use of light information to adjust their morphological and physical characteristics and to modify the genetic expression to better suit circulating lighting conditions. In basil microglia, the effect of red-light supplementation on light quality research [2], total phenolic content, and antioxidant activity is con- sidered; Red, blue and crimson supplements on antioxidant activity Ultraviolet A growth, phenolic, anthocyanin, ascor- bate and tocopherol synthesis, and a blue light dose growth, ascorbate, complete phenolic, anthocyanin-2, anthocyanin, 2 1-picrylhydrazyl antioxidant activity [3].

B. Effect of organic and chemical fertilizers

Modern agriculture needs to be more productive, sustain- able, and environmentally friendly. Nitrogen , Phosphorus , Potassium , and Sulfur supplied by mineral fertilizers are essential for macronutrient production and micro-organisms beneficial to agriculture can also directly contribute to increase crops and fertilizer efficiency. The biological formula based on microorganisms that increase plant activity are in great demand, especially those that exhibit complementary and as- sociated effects with mineral fertilizers. Such an integrated soil fertility management strategy has been demonstrated through several controlled and uncontrolled experiments, but more effort should be made to better understand the multifunctional activities of microorganisms and their interactions with plants and minerals within the soil microbial community[4].

Global food demand is growing rapidly in developing countries where lands and resources do not contribute to the efficient production of crops needed to meet such emergency food demand. There is a need to intensify sustainable agricultural production through the use of efficient agro-ecosystems, taking into account the biochemical diversity of the entire agro-ecosystem and low soil fertility, potential for reducing inorganic stress, pathogenic and adverse effects of pesticides. L.Renaldi and Alinursafa Research under the heading Performance Analysis of Soil Moisture Monitoring Based on LORA Communications on the Internet. A method has been developed to measure nitrogen, phosphorus, and potassium elemental levels in the soil to increase crop yields [5].

In the traditional farming, farmer add the fertilizer with his own wisdom, as a result the farmer did not get a sufficient crop harvest. Introduction Determining the amount of mineral present in the soil during the process and applying only the required amount of fertilizer gives an optimally high yield [6].

III. METHODOLOGY

The control of the LEDs is carried out experimentally in a closed dark cover, such as a real base greenhouse concept, which is activated several hours a day. Growth of Basil plant in two laboratories under artificial light, super-bright LEDs in red and blue were tested, while fluorescent red to blue LEDs was used, and the test is expected to be developed by growing a normal plant while maintaining a constant amount of light. Previous studies have shown that with the use of LEDs, the intensity of light is lower than that of natural light at deep temperatures. The test plant grows a plant using natural lighting and artificial LEDs and will finally introduce the best color and range considering their maximum crop productivity. Considering the field of fertilizers, Based on testing of soil nutrient measurement equipment for basil plants in Sri Lanka. The NPK sensor measures the nutrients in the soil for planting basil, the

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Volume-12, Issue-6, (December 2022)
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NPK sensor uses the Node MCU to store the results on the fire database platform, and the AGROGENIC mobile application presents a data preview to facilitate farmers' cultivation of basil. For this, the amount of fertilizer for the cultivated lands can be measured.

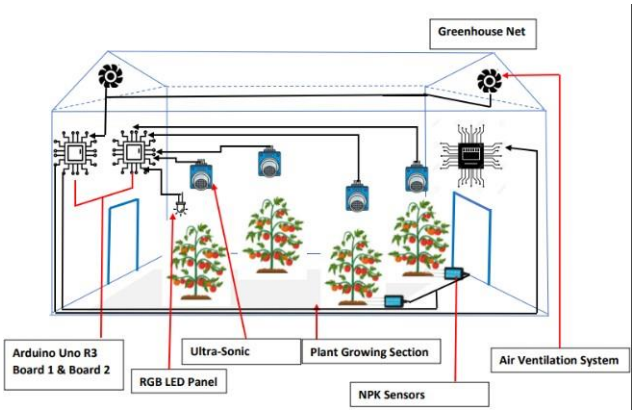

Figure 2: Overall Greenhouse Architecture

A. Problem Definition

Different types of growth nutrients and fertilizers are needed to stimulate plant growth and productivity, and their composition plays an important role in the composition of phosphorus, potassium, and nitrogen levels in the soil. There has been a major crisis over the use of organic and chemical fertilizers, and we have introduced a new mechanism to identify the levels of nitrogen, potassium, and phosphorus, the main factors affecting plant growth in the soil. Using our built method, we can come to a scientific conclusion as to what is the best type of fertilizer for greenhouses. Excessive use of chemical fertilizers can contribute to soil acidity and soil crustation, reducing the content of organic matter, humus content, beneficial species, inhibiting plant growth, altering soil pH, promoting the growth of pests, and even releasing greenhouse gases [7]. Furthermore, nutrient depletion, loss of organic matter, erosion, and condensation lead to deterioration of soil quality and reduced agricultural productivity. Excessive use of fertilizers and misuse and disposal of animal wastes have led to a number of soil and water pollution problems.

The other thing is that those scientific factors are not done through any automatic method and usually depend on the intervention of the person. The selected plant is grown separately in two sub-chambers in the greenhouse system and the one chamber is made to grow using wavelength factors and the other chamber is made to be exposed to normal light. Arrangements are made to provide a clear output report on the advantages and disadvantages of cultivating using wavelength factors at the end of the life of each plant and without wavelength factors. There are also plant species for which the wavelength factors required to stimulate growth have not yet been researched. Furthermore, this proposed system is designed to use an ultrasonic sensor to automatically measure plant height. Technological arrangements have been made to find the wavelength factors required to stimulate the growth rate of such new plant species [8].

B. SDLC - Software Development Life Cycle

The software development life cycle methodology is to be used as the system development process is the prototype methodology. The prototyping method is a very different form of methodology than the agile methodology which used by most project practitioners. In the prototype model a system builds, tests, and rebuilds as needed until the final product is acquired. When the project is carried out through the prototype methodology, the complete project is not planned in any way at the beginning and changes are made according to the need while the work is being carried out.

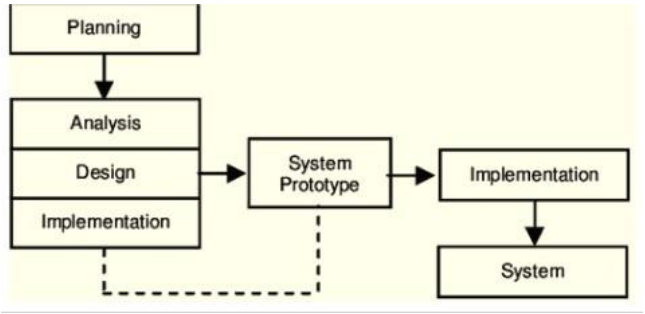

Figure 3: Methodology Overview

C. Work Flow

- Divide the planting chamber inside the greenhouse in to two chambers and plant Basil plant in both chambers.
- Place, the soil moisture sensor in the soil.
- Implement a mechanism to supply chemical fertilizer to one chamber and organic fertilizer to the other chamber.
- Develop mechanism to detect nitrogen, phosphorus, and potassium levels in soil.
- Set up a mechanism to generate alerts when the expected nutrients are not available in the soil.
- Setup automation mechanism to supply chemical as well as organic fertilizers with nutrients after a warning.
- Once the nutrient level reaches a constant level, set up an automation mechanism to stop the fertilizer supply.
- Analyze the comparative records between chemically and organically fertilized plant chambers.
- The mobile application controls the wavelength sensor and the decoder.
- There are also plant species for which the wavelength

e-ISSN: 2250-0758 | p-ISSN: 2394-6962
Volume-12, Issue-6, (December 2022)
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factors needed to stimulate growth have not yet been researched.

- Basil plant is used to grow in the separate chambers.
- One plant is grown under wavelength factors and the other plant is grown without wavelength factors.
- Ultrasonic sensor is used to automatically measure plant height.
- To stimulate the growth rate of such new plant species, technological arrangements have been made to find the wavelength factors required.

The plant we used for this test is basil, which has a recommended growing period of six weeks. Therefore, within a period of six weeks, a new basil plant was planted in the greenhouse system. Also, after completing the test, recording the very accurate results is also a very important feature. This project is designed to target ordinary farmers and it is important to conduct tests on this system by involving a few selected farmers. Because the last system was able to be used by any type of farmers. In those tests, it is our responsibility to reconsider if any procedure is not acceptable to their knowledge level.

Figure 4: Basil Plant Growth Chambers Under Changing Light Waves

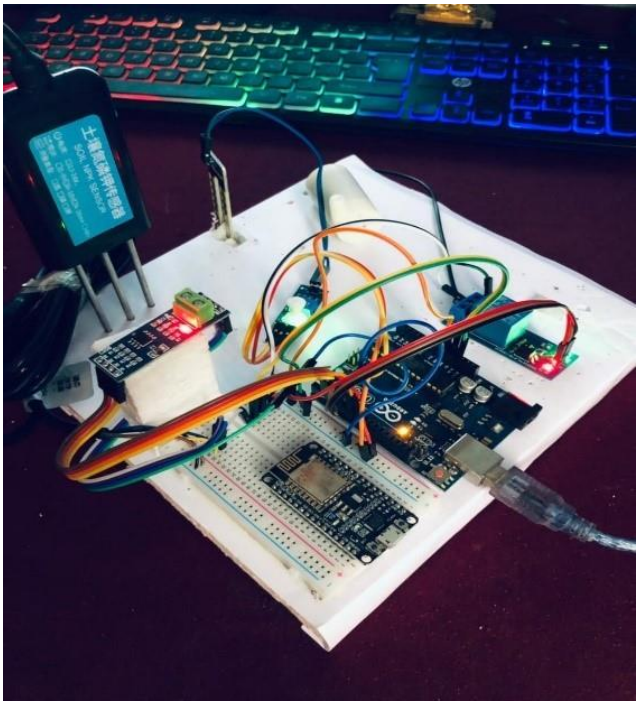

Figure 5: Fertilizer Supply System of Greenhouse System

Figure 6: Mobile App UI of Fertilizer Supply system

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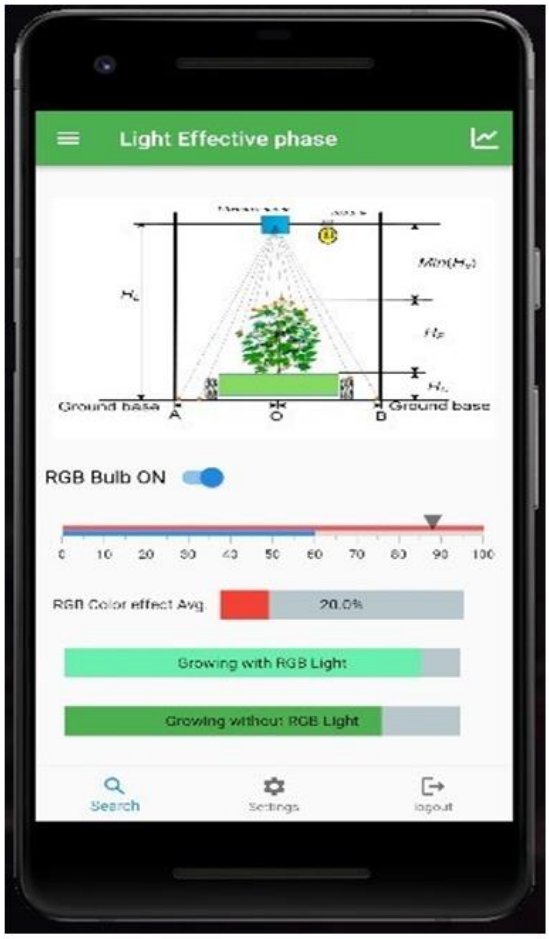

Figure 7: Mobile App UI of the Light Wave Changing system

The mobile app allows the user to easily change the sensing ranges of the sensors and the data retrieval by the Agrogenic mobile application. ”LED” lights are used to get a better yield, the wavelengths of light we need for that purpose. In this case, we choose the light wavelengths 430-460nm and 630-660nm, which are more suitable for photosynthesis in plants due to the wavelength of light and also help the growth of other trees as well as its growth.

The fertilizer management system basically uses a soil NPK sensor to detect NPK values and send data to Uno R3. The specific nutrient concentration is calculated as one million parts. It also activates the moisture sensor for moisture in the cultivation area through clean water. The system functions primarily as balancing inorganic values. Plant growth is measured using an ultrasonic sensor and all data is stored on an online platform. (Firebase)

IV. RESULTS AND DISCUSSION

Different types of sensors have been used to take the results of the fertilizer management process. The pre data sets were collected from an agricultural laboratory study of all data reported over a two-week period. A well-seasoned basil plant is 10-12 inches tall and takes about six weeks under normal environmental conditions. We conducted the test considering the two components of time and height as two variables in this test, and the results were obtained in such ways that a conclusion can be drawn through a graphical analysis. As mentioned earlier, the system was made to receive organic and inorganic fertilizers into two parts, separately to those parts under an automation process. The software has arranged to store the change in the height of the basil plant over the course of 6 weeks. The results obtained for the time and height components related to the growth of the basil plant within the recommended period of six weeks are as follows. The final results of the basil plant grown using organic fertilizers and the basil plant grown using inorganic fertilizers are as follows.

Time (Weeks)	Plant Height (inches)
Week-1	2.1 inches
Week-2	4.6 inches
Week-3	5.2 inches
Week-4	6.7 inches
Week-5	8.0 inches
Week-6	9.7 inches

Table 1: The Results obtained at the end of the recommended period of the basil plant under organic fertilization

Time (Weeks)	Plant Height (inches)
Week-1	2.4 inches
Week-2	4.0 inches
Week-3	5.0 inches
Week-4	6.6 inches
Week-5	8.9 inches
Week-6	11.2 inches

Table 2: The Results obtained at the end of the recommended period of basil the plant under in-organic fertilization

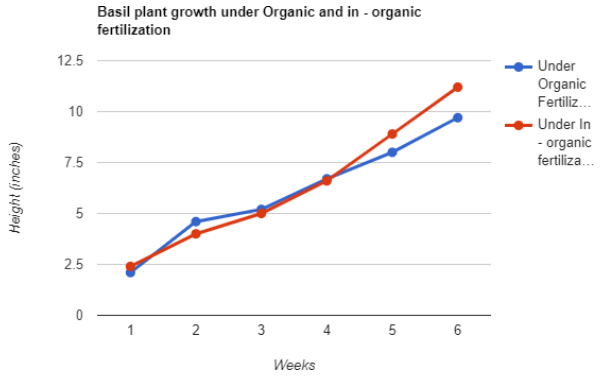

Figure 8: Line Chart Generated According To Final Result

e-ISSN: 2250-0758 | p-ISSN: 2394-6962
Volume-12, Issue-6, (December 2022)
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Data from the sun planted in two different phases show that both test samples grow at different rates. Our target is to represent the plants grown in greenhouses covered with a "LED" light grow faster than plants in natural light. The Basil plant exposed to artificial light and the plant exposed to the natural sunlight, shows a significant growth difference within 6 weeks. The plants which exposed to red and blue lights the highest productivity. The ultra-sonic sensor generates 40 kHz sound waves when it triggered. Speed of sound is 340ms¯1 at normal temperature and distance is calculated as D.

d =
Distance t
= Duration

$$d = \frac{t(0.034)}{2}.$$

Distance from the ultrasonic sensor to the base is a constant value. And it represents by(H).The height of the pot is a constant(L). Ultrasonic sensor will measure the distance to the plant surface as "d". The actual plant height(h) is measured as follows.

$$h = H - (L + d).$$

The final equation will be
h = Height of the plant
H = Distance from the ultrasonic sensor to soil L = Height of the pot
d = Distance calculated by the previous equation

$$h = H - L + \frac{[t(0.034)]}{2}.$$

The results of the basil plant grown using sunlight and the basil plant grown using RGB LED are as follows.

Time (Weeks)	Plant Height (inches)
Week-1	1.5 inches
Week-2	4.6 inches
Week-3	5.2 inches
Week-4	6.7 inches
Week-5	8.0 inches
Week-6	9.7 inches

Table 3: The results obtained at the end of the recommended period of the basil plant under Sunlight

Time (Weeks)	Plant Height (inches)
Week-1	2.4 inches
Week-2	4.2 inches
Week-3	5.1 inches
Week-4	6.6 inches
Week-5	8.4 inches
Week-6	10.8 inches

Table 4: The results obtained at the end of the recommended period of the basil plant under RGB LED light panel

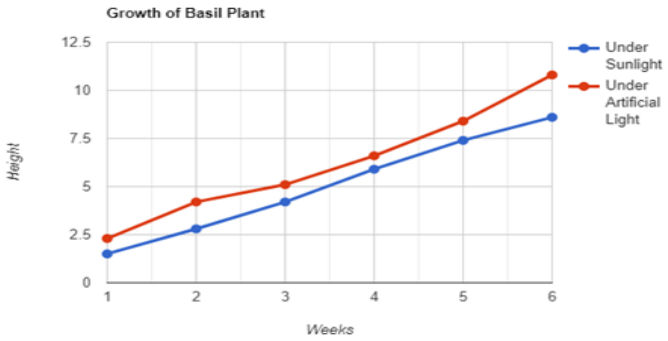

Figure 9: Line Chart Generated According to the final Results of the RGB tables

V. CONCLUSION & FUTURE WORK

IoT-based automated fertilizer supply system reduces farmers' effort to transport fertilizer samples to the greenhouse. Compared to manual fertilization, this project reduces the time it takes to manual involvement. Weather forecasting systems can be added in the future for better cultivation. There can include security aid mechanisms such as an invasion detection system in the future.

Plants require a wavelength of (400-520)nm and a wave- length of (610-720)nm for blue light and red-light wavelength. The study examined the use of LEDs for the plant lighting instead of natural light. The result was that the light from the LEDs could help the plant grow. In this study, using a mixture of LED red and blue light bulbs in a 3: 1 ratio, the color is reddish purple. The result of experimenting with the basil plant in an enclosed environment for 10 hours a day for 2 weeks is the gradual growth of plants with LED light. During the test, the LEDs can control the light and temperature at a constant level. Basil plant grows best in light and warm natural sunlight.

An automated fertilizer unit is found to be a

decisive factor in the field of precision agriculture. But It is successful in its operation, can improve the field of accuracy. The main scope of the project is to use it on a large scale in large- scale agricultural fields other than small farms. It could be too Activated for different soil types and their related crops. Differences with respect to climatic factors such as Temperature and humidity can also be incorporated into the system, resulting in better accuracy Soil characteristics obtained. In addition to the developed system, the system can be upgraded by a large number of bulbs. Then the efficiency will be higher than the collection of low bulbs. Furthermore, the use of artificial intelligence has the potential to increase productivity when considering the color changes that occur in leaves according to light.

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