DESIGN AND CHARACTERIZATION OF LED LIGHT ON HYDROPONIC PLANT'S GROWTH STIMULATION

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This report is submitted in partial fulfilment of the requirements for the degree of Bachelor of Electronic Engineering with Honours

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I would like to dedicate this project to my family especially my parents who has raised me to who I am today. I would not be here without my parents help and support. Besides that, I would also like to dedicate this project to my friends and seniors who have helped me to complete this project.

ABSTRACT

Human population is increasing day by day, so as the demand for food. Thus, by using hydroponic technique, food like vegetables and fruits can grow at a faster speed. Hydroponic plants are grown in indoor thus artificial light is needed for the plant to create its food. This project aims to develop a system of light capable of changing its color and brightness via Wi-Fi by using smartphone application as most of the hydroponic light today lack of a control system and emit fixed spectrum of light and brightness. At the end of this research, the developed system will be able to produce accurate spectrum of red light, which falls in the range of 600 to 650nm, and blue light in between 450 to 500nm. The emitted light from the project was able to stimulate the growth of plants, showing longer and stronger stems and greener leaves.

ABSTRAK

Populasi manusia yang meningkat setiap hari telah menyebabkan permintaan terhadap makanan meningkat secara drastic sehingga tidak mampu menampung kebuluran kita. Salah satu cara pneyelesaian adalah dengan menghasilkan makanan seperti sayur and buah-buahan dengan menggunakan teknik hidroponik. Tumbuh-tumbuhan hidroponik ditanam dalam suasana yang tertutup di mana tiada cahaya yang boleh sampai ke mereka. Oleh sebab itu, projek ini bertujuan untuk menghasilkan sebuah system lampu yang mampu menukar warna dan kecerahannya dengan mengawal aplikasi telefon bimbit menerusi Wi-Fi kerana kebanyakan lampu hidroponik tidak boleh dikawal untuk menukar warna dan kecerahan. Pada akhir project ini, sistem yang dihasilkan mampu menghasilkan spektrum lampu yang tepat di mana cahaya merah mempunyai kepanjangan gelombang di antara 600 hingga 650nm dan cahaya biru mempunyai kepanjangan gelombang di antara 450 hingga 500nm. Lampu yang dihasilkan telah berjaya merangsangkan pertumbuhan tanam-tanaman. Tanam-tanaman tersebut menunjukkan pertumbuhan batang dan akar yang lebih panjang serta daun yang lebih berwana hijau.

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF SYMBOLS AND ABBREVIATIONS

LED	:	Light Emitting Diodes
Wi-Fi	:	Wireless Fidelity
RGB	:	Red, Green, Blue
ATP	:	Adenosine Triphosphate
SPAD	:	Soil Plant Analysis Development
PIR	:	Passive Infrared Detector
S/R	:	Shoot/Root
IoT	:	Internet of Things
IR	:	Infrared
RF	:	Radio Frequency
UHF	:	Ultra High Frequency
IC	:	Integrated Circuit
MCU	:	Microcontroller Unit

CHAPTER 1

INTRODUCTION

1.1 Overview

Hydroponic is a method of growing plants with controlled environment and nutrient supplied water as the soil of the plant. Hydroponic has been practiced by many civilizations throughout history due to its ability to grow food on areas which cannot support crops in the soil at all. Besides that, the yield of plants and food by using hydroponic techniques has been proven by numerous research and projects to have higher than soil-based agriculture. In addition, hydroponic technique can reduce and even eliminate the risk of plants getting destroyed by pests. This results in avoiding the use of pesticide on food which ultimately make the air, soil and the food that we consume everyday cleaner.

Plants or food can grow at a rapid pace under controlled situations such as its surrounding temperature and humidity, light source and soil. Hydroponic technique

allows its user to provide and control the needs of the plant according to each stage of the growth of the plant. Plant reacts differently to different wavelength of light especially light of wavelength 400nm to 700nm which contains large portion of red color. Plants which are exposed to red color light grow longer and taller compared to those exposed to white light. Farmers or growers uses fluorescent grow lights for their hydroponic plant as light source. The light source however is only sufficient to provide the most basic needs for the plant and cannot change in color.

LED is proposed as another alternative to replace typical and conventional grow lights which is the fluorescent light. Color LED is made up of three LEDs or red, blue and yellow, each of which can be controlled by a microcontroller. The microcontroller is able to turn on or off any of the color LED to give different colors. Turning off and on the red, blue and yellow color LEDs would give a combination of new colors.

1.2 Problem Statement

Light is the most fundamental and also the most important element for a plant to grow. Hydroponic plants are grown in enclosed facility where the plant is not exposed to sunlight. Artificial light is needed to act as the light source for the plant to grow. The problems of the current artificial light are listed as below:

- Most of the artificial light has limited wavelength in the spectrum.

  Artificial light like fluorescent, high-pressure sodium light, and LED tube mimic the spectrum of the sunlight which consist lights of wavelength ranges from 300 to 800nm.
- Most of the artificial light is not controllable.

The artificial light available in the market cannot be controlled in terms of color and intensity. Most of the artificial lights are sold in tubes with fixed color of light emission and brightness.

- There is no control system to control the artificial lights.

  Growers need to transfer the plant or change the artificial lights in order for plants to grow under different color of light. This requires manpower and labor cost. A control system shall enable the light to be controlled at anywhere and anytime.

1.3 Objectives

i. To characterize a combination of LED with various area coverage for their different wavelength and intensity.
ii. To construct a wireless system to control LED light intensity and color, which consists of hardware and software.
iii. To investigate the wavelength and intensity produce by the wireless LED control system on plants.

1.4 Scope of Work

The LED that will be used in this project is a type of LED strip of model WS2812B. The LED strip comprises of 60 RGB LEDs with each RGB LED containing one tiny IC in one meter which enable them to be addressable thus every RGB LED's color and brightness to produce new combination of colors which are suitable for the plant's growth stimulation.

Microcontroller Arduino Uno will be used as processor for the wireless control system. Arduino Uno control the LEDs in the WS2812B LED strip. ESP8266 is chosen for this project as it is a Wi-Fi module that is able to establish a connection to

the internet and at the same time providing signal to the Arduino Uno to control WS2812B LED strip. It is important to have an internet connection in the smartphone. The phone application that will be used to control the LED via internet is Blynk. Blynk is a platform with iOS and Android apps to control Arduino over the internet. It is a digital dashboard where we can build a graphic interface for the project.

However, there is certain limitation to his project. The wireless LED control system cannot be used in open air. It has to be used in an enclosed area where sunlight cannot penetrate. The total number of LEDs that will be used in this project is 30 and the light produce from the LED is in the visible light spectrum with wavelength of 300 to 700 nanometer. The type of plants that will be used to verify the effect of light spectrum emitted from the project light on plants is bean sprout. Bean sprout is able to grow in a short period of 4 to 6 days. Three containers will be prepared with the same amount of green beans that is 40, to verify the experiments in three different situations. One container will be grown under red and blue light of 10 to 1 ratio, the second container will be grown under room condition with indirect sunlight and the last container will be grown in a dark box.

1.5 Report Outline

This report consists of five chapters: Introduction, Literature Review, Methodology, Result and Discussion, and Conclusion.

Chapter one discuss the background of the project, problem statements, objectives, scope of work and report outline are discussed and presented. Chapter two discuss the background study of related research and previous research of hydroponic system and LED light are reviewed and critically compared to other lighting alternatives. Chapter three discuss the proposed method of designing a LED lighting system for hydroponic plant's growth stimulation are discussed in this chapter. Moreover, several experimental lab test including measuring the spectrum of LED light and planting of bean sprouts are also discussed in this section.

The effect and the function of the LED light system is discussed in chapter four. Furthermore, the light spectrum of several light profiles for plant's growth stimulation is also discussed here. The last chapter, chapter five discuss the summary of the project and future research of high potential are discussed in this final chapter.

CHAPTER 2

BACKGROUND STUDY

This chapter discusses the hydroponics techniques of previous research and the effect of different wavelength of light on the growth of the plant grown under hydroponic technique. Besides that, the impact of different intensity of light on plants is discussed here. Types of artificial light are also discussed here. The technology of Internet of Things and other control system mechanism is also being discussed in this chapter.

2.1 Hydroponics Technique

Hydroponics is a technique of growing plants without soil and is used widely and frequently. Hydroponics plants are grown under controlled environment where their basic needs like nutrients, sunlight, surrounding temperature and humidity are provided artificially. Hydroponic is an agriculture without soil that has been utilized since hundreds of years ago in the civilization of the Chinese, the Egyptian and other cultures (EI-Kazzaz, 2017). Sooner in the mid-16th century, Robert Boyle, and Irish scientist has conducted and published his work on growing plants with their roots submerged in water.

During the 1700s, a few scientist and researches experimented on the growth of plant under a variety types of mixtures of soil and water to find out what really help plants to grow under hydroponic technique (Jones, 1982). As the research goes on, scientist and researches have more understanding on the plant's growth and development. One of the achieved milestone includes the preparation and management of nutrient solution to replace nutrient rich water.

Mamta D. Sadare (., 2013), in his work stated that with the drastic change and improvement of the civilization and technology, agriculture based on soil or open field is facing major challenges. The rapid pace in urbanization, construction and industrialization has vastly decreased arable land for agriculture, which in turn affect the production of edible food. Besides that, not to mention that global warming also plays a big part in decreasing arable land. Hydroponic growing which highly effective in conservation of food and sustainability is one of the salvation to this insufficient food supply due to decrease in arable land according to Patil et al (Patil and Bhandia, 2016). Hydroponics is now the fastest growing sector of agriculture, and it could even

dominate the food market and production in the future. As Earth's population keep on increasing drastically where by 2050, it is estimated that the population figure will hit 9.2 billion, while arable land for agriculture and food production will greatly decrease. Hydroponic by then shall begin replacing traditional agriculture.

2.1.1 Advantages of Hydroponic Technique

Hydroponics is one of the established branch of agronomical science. The progress has been faster than ever and the obtained results in various countries have proved to be practical and to have more benefit compared to conventional methods of agriculture or horticulture. Listed below are the main advantages of hydroponics. The listed advantages are also supported by R, Pandey and Jain (Pandey and Jain, 2009) :

- Lesser area of land is required to produce the same amount of plant compared to plants grown in the field.
- Faster growing of plants. The growth of the plant is much faster and there is no mechanical impediment to the roots and all the nutrients for the plant are provided. In addition, artificial lighting such as metal halide or high pressure sodium lamps are used and at longer hours to promote plant's growth.
- Cost saving. The nutrients and water can be recycled for the plants. The nutrient in closed system of hydroponics is always recycling, thus preventing any loss of nutrient elements and soil pollution. Large amounts of water that are not used can be recycled by the plant after being aerated and eliminating anoxic conditions.