Faculty of Electrical and Electronic Engineering Technology

DEVELOPMENT OF SMART PLANTS WATERING SYSTEM USING IOT

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Bachelor of Computer Engineering Technology (Computer Systems) with Honours

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DEDICATION

This Dissertation is dedicated to my parents

Yaakob Bin Amir Hamzah

And

Noor Madiah Binti Ismail

who given me invaluable educational opportunities

I also dedicate this dissertation to my friends who have supported me throughout the process. I will always appreciate all they have done.

I dedicate this work and give special thanks to my best friend

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ABSTRACT

The Smart Plant Watering System Using IoT is a project that provides smart garden devices for indoor gardening systems. The systems implemented into the smart plant watering system used gardening basic concept involving elements that are important for plants to grow and thrive. This system used NodeMCU ESP8266 as the controller for the whole system. As for the control element, this system uses a water pump and LED grow light. The water pump is connected to the soil moisture sensor and DHT22 sensor as the sensors are used to measure specific parameters information. Soil moisture sensors are used to detect moisture level in soil whether the soil is dry or moist which then send signal to the microcontroller for analyzation. DHT22 sensor is used to detect and measure temperature and humidity of surrounding air. LED grow light is used to maintain and control light intensity sufficiently for the plant. Information regarding the condition of soil, light, temperature, and humidity will be displayed on Mobile Apps for easy monitoring and control. In conclusion, the system is designed and developed using Arduino IDE software that links to the NodeMCU ESP8266 board used as microcontroller of the system. Mobile applications connected to the system are developed using Android Studio and Firebase Realtime Database.

ABSTRAK

Sistem Penyiraman Tumbuhan Pintar Menggunakan IoT ialah projek yang menyediakan peranti dan alatan taman pintar untuk sistem berkebun bertutup. Sistem yang dilaksanakan ke dalam sistem penyiraman tanaman pintar ini menggunakan konsep asas berkebun yang melibatkan unsur-unsur yang penting bagi tumbuhan untuk tumbuh dengan sihat dan berkembang. Sistem ini menggunakan NodeMCU ESP8266 sebagai pengawal untuk keseluruhan sistem. Bagi elemen kawalan pula, sistem ini menggunakan pam air dan LED tumbuh cahaya. Pam air disambungkan kepada sensor kelembapan tanah dan sensor model DHT22 kerana sensor-sensor ini digunakan untuk mengukur parameter-parameter yang tertentu. Sensor kelembapan tanah digunakan untuk mengesan tahap lembapan di dalam tanah sama ada tanah kering ataupun lembap, yang kemudiannya menghantar isyarat kepada mikropengawal untuk dianalisis. Penderia DHT22 digunakan untuk mengesan dan mengukur suhu dan kelembapan udara sekeliling. LED tumbuh cahaya digunakan untuk mengekalkan dan mengawal keamatan cahaya secukupnya untuk tumbesaran tumbuhan. Maklumat mengenai keadaan tanah, cahaya, suhu, dan kelembapan akan dipaparkan pada Aplikasi Mudah Alih untuk pemantauan dan kawalan yang mudah. Kesimpulannya, sistem ini direka bentuk dan dibangunkan menggunakan perisian Arduino IDE yang menghubungkan kepada papan NodeMCU ESP8266 yang digunakan sebagai mikropengawal sistem. Aplikasi mudah alih yang disambungkan ke sistem dibangunkan menggunakan Android Studio dan Pangkalan Firebase Realtime Database.

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LIST OF SYMBOLS AND ABBREVIATIONS

IoT	-	Internet of Things
LED	-	Light Emitting Diode
RH	-	Relative Humidity
X	-	Weight of Wet Soil
Y	-	Weight of Dry Soil
M	-	Moisture Content Based on Wright

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

This chapter will discuss the background of the project, problem statement, objectives,scope of the project and summary.

1.1 Project background

Gardening activities usually consume plenty of time before the plants can grow and thrive successfully. The owner faced varieties of problems during this period such as watering the plants in their fixed schedule and since they are sometimes busy with other works, they tend to skip the watering routine. This will result in low-quality plants. Thus requires an automated system that can water the plants automatically following the specific watering schedule that are set for those various types of plants. The purpose of this project is to create and develop a Smart Gardening system with the use of the Internet of Things (IoT). The system can monitor the environmental conditions around the plants about the soil humidity and temperature (Al Rasyid, Hasan and Najaa, 2020). The system can provide accurate information such as humidity level and temperature of the garden by using sensors that can detect these variables and then carry out specific actions to satisfy the detected variables (Mohammad Sa'at, 2015). This automation system also can help reduce electricity usage, reduce waste products and manpower as well as conserve money spent (Nikhil, Anisha and Kumar, 2020). In simple terms, the smart system will be built using sensors that can read selected variables which are then signaled to the programmed system and then carry out specific actions performed by the output receptor (Habibi *et al*., 2021). The block diagram of the smart gardening system is illustrated in figure 1.1 below.

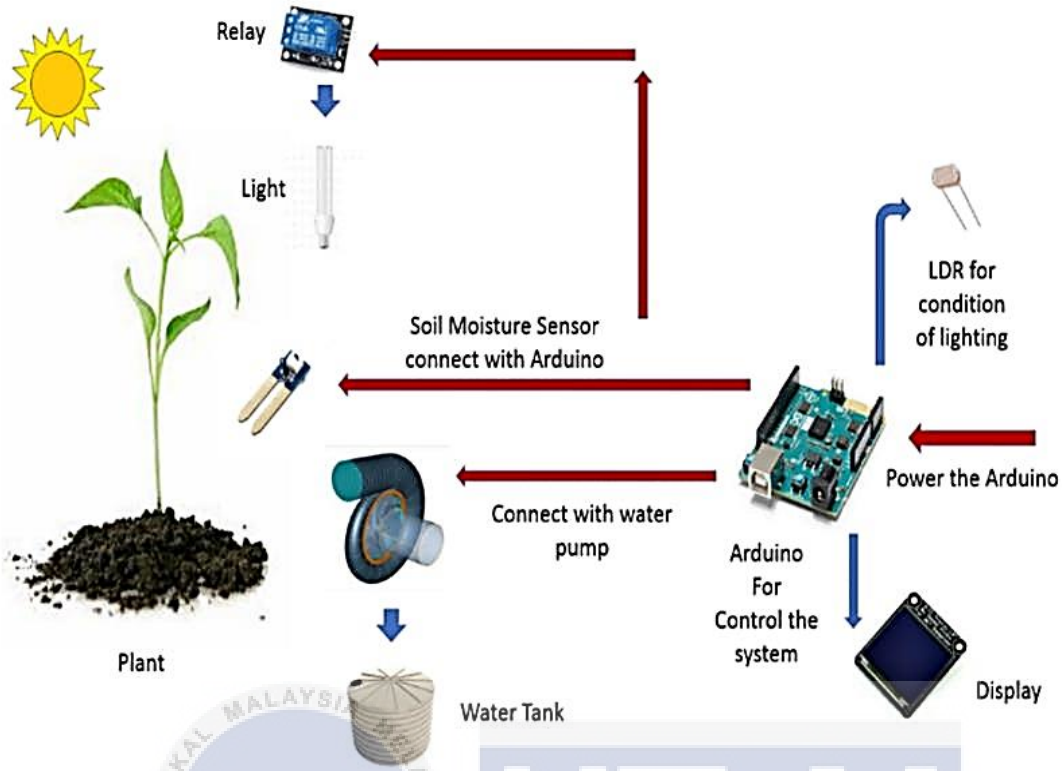

Figure 1.1: Block diagram of smart gardening system (Zaki et al., 2021)

1.2 Problem Statement

The common problem encountered by a gardener in plant gardening is the quality of plants. Since different types of plants require different amounts of water, it is important to avoid drowning the plant by watering too much water to the plants. This problem can be tackled by using the system to water the plants automatically when it is needed.

Other than water, controlling the humidity of the soil is hard to maintain for the gardener. To maximize the quality of the plants, a certain range of humidity levels for each plant needs to be maintained. It is also aware that sufficient lighting and surrounding temperature cannot be manipulated. Hence needing the project to be able to control these aspects with good technology is crucial to make the system be able to provide optimum conditions for the plants.

1.3 Objective

To complete this project, there are several objectives that need to be achieved to determine the success of the project. Several objectives need to achieve in this project:

a) To design a Smart Watering System with the implementation of IoT for easy monitoring.
b) To be able to detect soil humidity and the surrounding temperature of the plant.
c) To maintain the soil's moisture level in the optimum moisture range needed by the plant.
d) To supply light for plants growing in indoor environment.

1.4 Scope of Project

i. The scope of the project is to design a system and build hardware for indoor gardening which can provide optimum conditions needed for plant growth.

ii. The system will be designed using NodeMCU, which acts as the controller to control the Smart Plant Watering System.

iii. A water pump will be used that acts as irrigation system for the plant and an LED grow light used as the indicator of lighting needed by the plant.

iv. There are three types of sensors used in the system which are soil moisture sensors to detect moisture level in the soil. A temperature and humidity sensor are used to detect the surrounding temperature and humidity level experienced by the plant. Lastly, light intensity sensor to detect light sensor.

v. Information and data detected from the sensors will be displayed on the mobile application design using Android Studio, Firebase and Arduino IDE.

1.5 Thesis Outline

Chapter 1:

The first chapter provides a quick overview of the project. This chapter covers the history of the project. It concentrated on the project overview, defining the objectives, problem description, and scope of the project.

Chapter 2:

The second chapter discusses the technique concept, theory, and some characteristics of hardware components employed in this project. This chapter also defines terms used in this project and describes the research concept and how it relates to the theory.

Chapter 3:

This is the methodology chapter. The methodology chapter is a timetable or tasks that must be completed, as well as full summaries of studies done to attain the goal. This chapter describes the steps taken to complete the project. It contains the project's detailed development.

Chapter 4:

This chapter four discusses the results and discussions that we obtained using the methods that we applied. All simulations, data gathering, and analysis results were well discussed. The outcomes were compared to the objectives given to form some hypothesis and conclusions.

Chapter 5:

The conclusion and future work are discussed in this chapter. In this section, we will conclude what we have done and followed by some recommendation on how to improve the performance of the system based on the desired results.

CHAPTER 2

LITERATURE REVIEW

This chapter will discuss the background study of Indoor Gardening, Factors Affecting Indoor Gardening, The Type of Sensors, the Internet of Things (IoT), and the Arduino System.

2.1 Indoor Gardening

Gardening activity refers to activity in an outdoor garden where ones taking care of and cultivates plants involving several processes for the plants to grow. It can be done as a hobby or recreational activity for different age layers which benefits improve mental and physical health (Abd Rahim, Zaki, and Noor, 2020). Indoor gardening refers to growing plants inside houses and done on smaller scales compared to a standard garden. This type of gardening mainly involves growing small, beautifully coloured, and easy-to-care plants such as roses, orchids, or tiny cacti.

Indoor gardening has many benefits as it is commonly known to increase health and quality of life, especially removing toxins from the air, and decreasing the risk of having respiratory diseases (Min and Park, 2017). Researchers also studied those environmental activities involving humans and plants have greatly improved human mental health along with levels of empathy and compassion (Min and Park, 2017). However, it is complicated to garden in the house due to various challenges that are encountered to grow a healthy plant (Raka, 2021).

2.2 Factor Affecting Indoor Gardening

To successfully grow a plant indoors, there are many factors to be considered as indoor surroundings have limited resources required by the plant to thrive. Prime examples of these factors are lighting, soil moisture and surrounding humidity level (Min and Park, 2017). The availability of water resources is essential to be controlled perfectly to support the continuity of the plant's health growth (Al Rasyid, Ahsan and Najaa, 2020). Water wastage can be reduced and avoided as an accurate amount of water is used during the watering process conducted by the system. Hence results in more fertile soil due to a uniform amount of moisture in the soil (Maniraj *et al*., 2018). Temperature and humidity effects on plants widely vary as they control the photosynthesis process (Min and Park, 2017). Regulating the temperature and the humidity greatly affected the survival of the plant.

2.2.1 Soil Moisture for Plant

Soil moisture is the quantity of water the soil contains. This factor also affects the humidity of the soil and the surroundings of the plants. The optimum amount of moisture in the soil is enough to provide sufficient nutrients such as salt for plants to thrive and grow brilliantly. Flooded soil with excess water can greatly reduce the amount of nutrients present in soil, hence inhibiting healthy growth of a plant. Another importance of soil moisture to plants is how it regulates the temperature of the soil and helps in chemical and biological activities in the soil (Van Walt News, 2022).

There are several methods that are popular to estimate and calculate the moisture of the soil. Time Domain Reflectometry (TDR) is a technique used by many researchers to estimate the amount of moisture in the soil and give a highly accurate result. According to Tomar and Patidar (2020), the TDR technique focused on measuring the time difference of a high frequency transverse electromagnetic wave signal which propagates between a pair of parallel probes of a device placed into the soil, which will be used to calculate the wave velocity with known waveguide and cable length. The wave velocity is inversely proportional to the dielectric constant which is directly related to the soil moisture.

Another practical technique used is called the gravimetric method. This technique is used to determine the soil moisture by calculating the weight of the soil before and after the soil being heated at 100 °C for 24 hours. The formula used to perform the calculation is as followed.

$$M(\%) = \frac{X - Y}{Y} \times 100$$

2.2.2 Importance of Light for Plant

Light is one of many important factors essential for growing plants as it induces photosynthesis, a process converting light energy, oxygen and water into energy that is used by the plants to grow. Indoor plants require high maintenance care due to the lack of sunlight are exposed to them, thus artificial and aided lighting technology are dependent. However, the amount of light intensity needed for growth differs for each plant and can be categorized as low-light, medium-light, and high-light plants such as *Dracaena trifasciata* (snake plant), ferns and orchids respectively. The lack of sunlight can be overcome by implementing light sources such as light bulbs or LED with various intensities. Practically, Light Dependent Resistor (LDR) is embedded into the smart system to detect changes in light intensity surrounding plants and send

the signal to the controller, which then commands LED or bulbs to light up, providing light energy to the plants. Aside from the intensity alone, distance from the light source, duration exposed to light source and quality of light can affect the growth (Lighting for indoor plants and starting seeds, 2022).

The Research has been conducted on the growth of lettuce, spinach, komatsuna (also known as Japanese mustard spinach), and radish in the presence of a combination of blue and red light (Mackowiak et al., 2001). It is possible to say that the proportion of LEDs red and blue used to supply an indoor plant is between 7:3 and 16:2, which is suitable for the growth of plants without the assistance of sunlight (Cruz et al., 2020). The LED specifications used for indoor plants are shown in Table 2.1 below.

Table 2.2.2.1: Photoelectric parameter of LED source (Cruz et al., 2020)

LED	Peak wavelength (nm)	Ratio	LED Power (W)	Divergence angle
Red	660	4	40	120°
Blue	460	16	160	120°