Faculty of Electrical and Electronic Engineering Technology

DEVELOPMENT OF AUTOMATED HYDROPONIC SYSTEM MONITORING USING IOT MESH NETWORK BASED ON ESP8266

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Bachelor of Electronics Engineering Technology (Telecommunications) with Honours

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in partial fulfillment of the requirements for the degree of
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ABSTRACT

Hydroponic agriculture is a type of modern agriculture that allows for the production of healthy plants and vegetables. The majority of individuals nowadays want a garden in their homes. On the other hand, most individuals have trouble growing plants in their homes. It's due to a lack of available planting space at their home. Aside from that, they struggle to determine how much water the plants require and the existence of variable weather, which can cause the plants to wilt. An automated hydroponics system based on an IoT mesh network employing an esp8266 microcontroller was developed to address these issues. The IoT mesh now network, powered by an esp8266 microcontroller, will aid in collecting data collected by sensors, allowing for analysis. The hydroponics grower will have complete wireless management of the grow room atmospheric conditions, with user-inputted sensor thresholds that, if exceeded, will warn or take action as needed. Through the approaches adopted, integrated farming with an IoT mesh now network will be efficient for the automated hydroponic system.

ABSTRAK

Pertanian hidroponik adalah sejenis pertanian moden yang membolehkan pengeluaran tumbuhan dan sayur-sayuran yang sihat. Majoriti individu pada masa kini mahukan taman di rumah mereka. Sebaliknya, kebanyakan individu menghadapi masalah menanam tumbuhan di rumah mereka. Ini disebabkan kekurangan ruang penanaman di rumah mereka. Selain itu, mereka bergelut untuk menentukan jumlah air yang diperlukan oleh tumbuhan dan kewujudan cuaca yang berubah-ubah, yang boleh menyebabkan tumbuhan menjadi layu. Sistem hidroponik automatik berdasarkan rangkaian jaringan IoT yang menggunakan mikropengawal esp8266 telah dibangunkan untuk menangani isu ini. Rangkaian rangkaian IoT kini, dikuasakan oleh mikropengawal esp8266, akan membantu dalam mengumpul data yang dikumpul oleh penderia, membolehkan analisis. Penanam hidroponik akan mempunyai pengurusan wayarles lengkap keadaan atmosfera bilik tumbuh, dengan ambang penderia yang dimasukkan pengguna yang, jika melebihi, akan memberi amaran atau mengambil tindakan mengikut keperluan. Melalui pendekatan yang diterima pakai, perladangan bersepadu dengan rangkaian IoT kini akan menjadi cekap untuk sistem hidroponik automatik.

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

TABLE **PAGE**

CHAPTER 1

INTRODUCTION

1.1 Background

In a well-managed hydroponic system, plants can be produced twice as quickly as in soil. Furthermore, because hydroponic farming takes place indoors in a climate-controlled environment, farms can be established in areas where the weather and soil conditions are unfavorable. Hydroponics is a plant production technique that does not use soil and makes use of water and nutrient solutions only to grow plants. The deep flow technique and nutrient film technique are commercially used hydroponic systems to grow leafy vegetables. [2]. Most plant factories make use of hydroponics because of their added advantage of automated control of fertilization and irrigation which also saves labor. [3]. Indoor or greenhouse growing conditions keep the environment clean and control pests anddiseases. [4]. The booming internet of things(IoT) is becoming an area of interest for researchers and industrialists. Increased plant yield and reduced maintenance cost can be observed in hydroponics employing IoT. [5]. The Internet of Things (IoT) is used in this project to create an automated hydroponic system. Sensors such as temperature and humidity sensors, water level sensors, and soil moisture sensors are used in IoT to monitor plants. The use of IoT has enabled the user to keep track of the hydroponic culture. The temperature sensor installed in the hydroponics system can detect temperature loss. It can measure the moisture content of the plant, which is crucial for its growth. It also includes a water level sensor that can check by the user if the water level falls below a certain level.

The user can check about the plant's condition if IoT is used in this project. As a result, the goal of this project is to create an IoT-based monitoring hydroponic system. This project will allow the user to keep track of plant health in real-time.

1.2 Problem Statement

One of the issues that might harm plants is unpredictably changing weather. Sea-level rise, extreme events, health, energy use, and water supply are the five key climate hazards that cities face. Extreme events and water scarcity are two of the five threats that pose the greatest threat to traditional farming systems. Droughts, heatwaves, windstorms, and floods make outdoor farming tough to grow.

Furthermore, the difficulty in monitoring the level of water when planting plants is an issue. Planting that did not self-water required daily attention to detect soil moisture and water as needed. Under and overwatering are also regular occurrences if the plants are not inspected frequently enough to determine if there is too much water. Watering the plant without knowing the volume of water is common. If the plant receives too much or too little water, it may wilt. It can also impact the plant's humidity.

Lastly, the main problem of this project is the difficulty in monitoring the plant’s need and sand conditions from all over the area. The major challenge is to receive data fromall the nodes to one access point. People who stay far away from their farming land are facing more difficulty in notifying the plant’s conditions every day.

1.3 Project Objective

This project aims to develop an Automated hydroponic system monitoring using an IoT mesh network to help people with indoor planting. The following objectives must be met in order to attain the goal.

a) To design a web-based interface for status monitoring of indoor garden complete wirelessly with user-inputted sensor.
b) To develop an IoT monitoring system based on several nodes connected to a mesh now network and deliver all the information collected by the sensors to hydroponic growers.
c) Evaluate the functionality of an IoT monitoring system for hydroponics.

1.4 Scope of Project

The goal of this study is to grow plants using an Internet of Things mesh network to monitor an automated hydroponic system. The goal of this initiative is to assist those who are interested in indoor gardening at home. Several project scopes have been identified in order to achieve project objectives.

a) This project allows for autonomous hydroponics environment monitoring using a variety of sensors such as temperature and humidity sensors, water level sensors, and soil moisture sensors. Users may watch their plants in real-time over the web.

b) The system control unit is embedded with a Wi-Fi module and all the nodes will perform in a mesh now network to display the condition of the plant from different areas.

c) The system is analyzed and investigated the functionality of the IoT monitoring system.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter looks at what has been achieved based on previous research. The automated hydroponic system, related work with this project, and development techniques to be used to design the mesh network hydroponic system will be described as subtopics. This chapter is jam-packed with information and research culled from the internet, books, and journal papers.

2.2 Automated hydroponic system

An automated hydroponic system will help to solve the problem stated in Chapter 1, which is that there is a limited area for planting, especially for those who live in a city zone, unpredictable weather, and it is difficult to check the amount of water. People will be able to monitor their plants using smart technology in automated hydroponics that uses additional nodes in a mesh network, such as temperature and humidity sensors, soil moisture sensors, and water level sensors. [1]

Overall health and quality of life, physical strength, fitness flexibility, cognitive ability, and socialization are all advantages of automated hydroponics. Environmental studies have shown that interacting with plants improves our mental health and productivity and may even improve our empathy and compassion.

Furthermore, monitoring a hydroponics system using multiple nodes in a mesh network can offer reliable data. Finally, stress reduction is the only benefit of an automated hydroponic monitoring system using an IoT mesh network when people are in a room with a few containerized indoor plants.

2.3 Type of Mesh Network Nodes

A mesh network is a network in which devices (or nodes) are linked together and branch off one another. These networks are designed to transport data efficiently between devices and clients. They assist organizations in maintaining a continuous connection across a physical place.

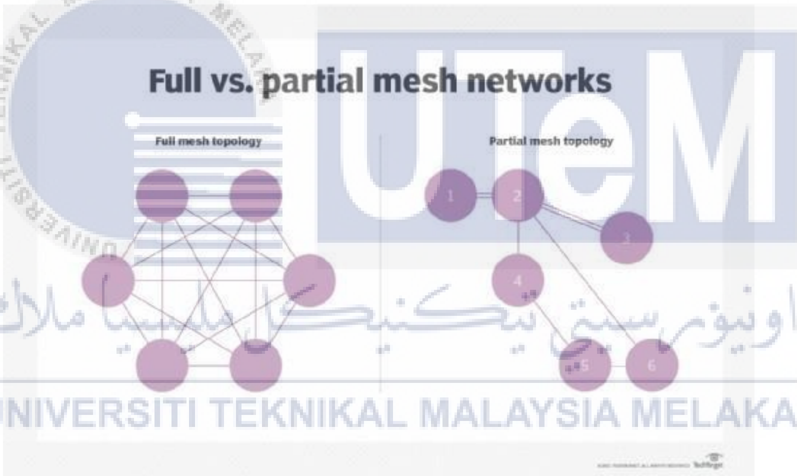

Figure 2.1 The Type of Mesh Network

Full mesh and partial mesh topologies are the two types of mesh topologies. When every node in a network has a circuit connecting it to every other node, it is known as full mesh topology. Full mesh provides the most redundancy, as network traffic can be routed to any of the other nodes if one fails. Backbone networks almost always use full mesh. Some nodes in a partial mesh network are structured in a full-mesh design, while others are only connected to one or two other nodes in the network. In peripheral networks coupled to a full mesh backbone, partial mesh topology is typical. Partial mesh topology is less expensive to implement than full mesh topology, but it provides less redundancy.

2.4 Related Work

The sensors, light-emitting diode lamps, water spray, and pump may effectively reduce CO2 levels and temperature while dramatically increasing water levels. [2] Hydroponic farming can also be better regulated in a greenhouse or indoor farming environment because of the surrounding conditions, according to the report. Hydroponic farming can also be better regulated in a greenhouse or indoor farming environment because of the surrounding conditions, according to the report. The unit area parameters are mechanically managed by ensuring that the plant receives all nutrients from the water solution. Furthermore, by utilizing IOT software, the cultivator can understand the conditions of plant growth and regulate the parameters remotely. This project used an Arduino microcontroller with three detector types: temperature sensor, pH detector, and LDR for each plant 1 and plant 2. A relay is utilized to automatically turn on and off the water supply to the pumping motor, and an ESP8266wifii module is used to communicate with the server via the internet of things.

The proposed project is about hydroponic farming, which is a method of growing plants without the use of soil or sunlight. [3] It is vital to building a farming system that is low-cost and easy to maintain and control critical variables such as light, water level, temperature, and humidity throughout the year. As illustrated in Figure 2.2, this project has been implemented as a NodeMCU microcontroller kit that can connect to the Wireless Sensor Network through the internet and measure humidity, temperature, and water level. The smart hydroponic farm's real-time data is collected using the sensors and other peripherals listed below. Blynk and ThingSpeak, two IoT-related platforms, were used in this project. API-based architecture is used to control and track the smart hydroponic farm.

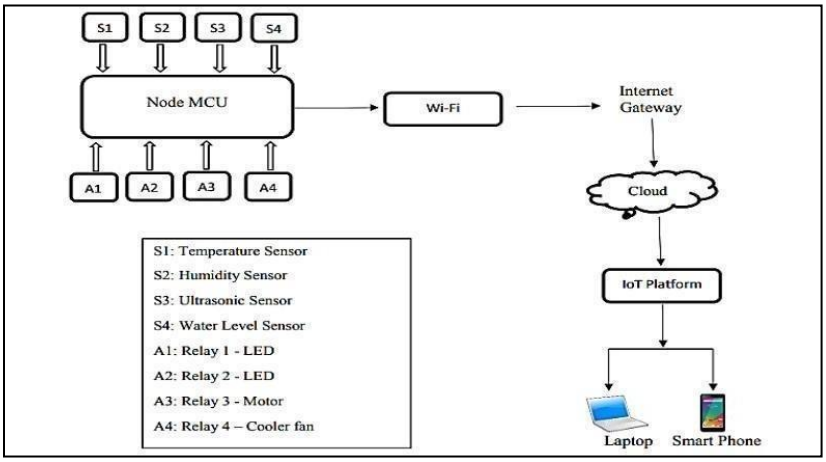

Figure 2.2 Proposed Architecture

PlantTalk is a smart hydroponic plant factory system based on the Internet of Things. [4] PlantTalk, according to the business, can use a smartphone to configure connections for a variety of plant sensors and actuators. This project simplified the process of developing Python applications for plant-care intelligence on smartphones. The plant-care intelligence includes automatic LED illumination, water spray, and a water pump. The gardener may monitor sensor data in real-time via smartphone, but in this experiment, the user had to manually regulate the actuators. Figure2.3 shows the PlantTalk functional block diagram, which is connected to the control board through a few sensors and actuators. For agricultural surveillance, the sensors were critical. A temperature sensor, pH sensor, humidity sensor, CO2 sensor, O2 sensor, water level sensor, and timer are now included on the control board. This project also allowed them to integrate a camera into their smartphone apps, allowing them to remotely monitor the plants that the sensors and actuators were looking after. Using any smartphone's browser, the web based PlantTalk GUI may be used to link all plant IoT devices. The data is delivered from the control board to the PlantTalk server over Ethernet or Wi-Fi.

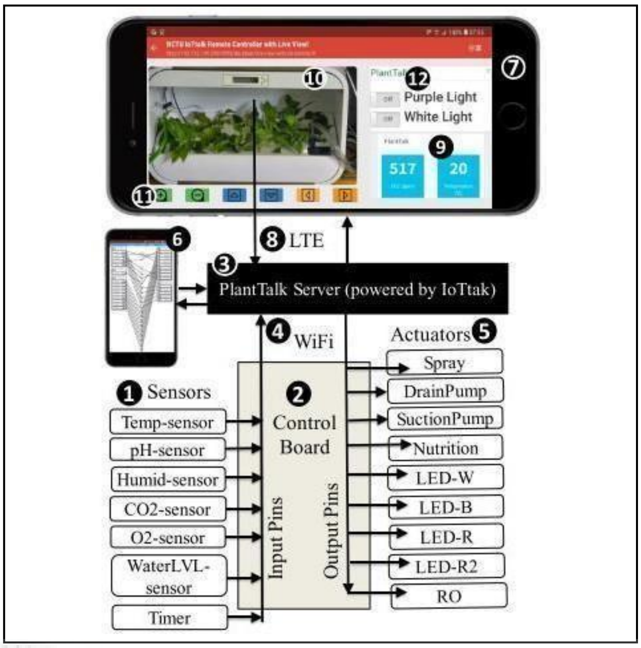

Figure 2.3 PlantTalk functional block diagram

The pH, water level, ambient temperature, and relative humidity are all constantly monitored in this project to give the ideal environment for plants to flourish in. [5] Irrigation is controlled by water and nutrient input. Sensor-collected data and cloud-based technologies serve as the backend, allowing users to store, manage, apply, and share information through the internet. This project used the Raspberry Pi to collect data from the server and relay data from the temperature and humidity sensor, pH level sensor, and water level sensor. To monitor system nutritional conditions, a water pump was used to control machine water inflow, as well as temperature and humidity sensors. Data from hardware control systems is received by Firebase in two modes: real-time and batch time. Following that, data from the Firebase cloud service is gathered and displayed on a website app. The software was designed to be user-friendly on both desktop and mobile platforms. In a nutshell, a command acquired from Google Firebase, a cloud service that enables real-time sensor logging, is used to monitor components in the hydroponics system using the Raspberry Pi.

Their project explains how hydroponic farmers and the Cyber-Physical Social System collaborate (CPSS). [6] A CPSS is a collection of physical and social systems that are broadcast through the internet or over a network. To combine all sensors, the Raspberry Pi must be utilized doing the introduction of the CPSS hypothesis, hydroponic farmers were able to collaborate. A light sensor, a temperature sensor, a moisture sensor, and a nutrition sensor are among the sensors used. Furthermore, the Telegram conversation was used as a social media platform for interactions between farmers and between farmers and Bots. A Bot is a Python-based telegram bot that communicates between sensors and farmers.

A model gardening system with soil moisture, temperature, water sensor, growing light, and Android is included in IoT Planting for the Elderly. [7] This design used the Arduino Uno Wi-Fi, which has an inbuilt Wi-Fi module, as seen in Figure 2.4. The sensors are connected to the Arduino via the DHT22 soil moisture and water detector. Temperature and humidity have been measured using the DHT22. The water sensor was also employed to monitor the water level, and soil moisture was used to determine volumetric water content at the root level of the soil stack. The grow light and water pump with power supply are shown in Figure 2.4, which provide light for the photosynthesis cycle and water to the plant, respectively. To save data, this project used cloud technologies and PHP MySQL.

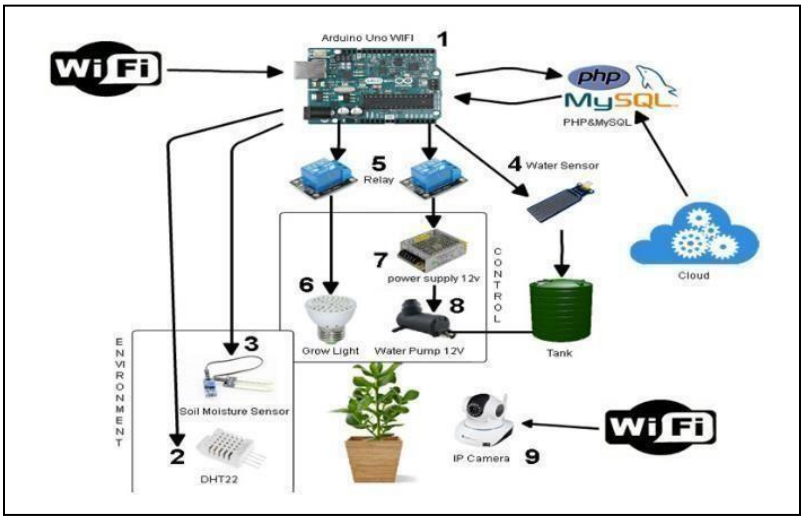

Figure 2.4 IoT Planting Components

Table 2.1 Comparison of previous work

Title	Author	Category	Focus Area	Control Board	Type of Sensor
Automating and Analysing Greenhouse Hydroponic Farms using IoT	(Keerthana, S. Devika, K.Sathiyadevi ,S. Priyanka, 2018)	Hydroponic	-	Arduino	• Temperature • pH • LDR
A Novel Approach forSmart Hydroponic Farming Using IoT	(Rajkumar et al., 2018)	Hydroponic	Home	NodeMCU	• Humidity • Temperature • Water Sensor

PlantTalk: ASmartphone-Based Intelligent Hydroponic Plant Box	(L.-D. Van et al., n.d.)	Hydroponic	Home	Arduino ESP8266 ESP-12F	• Temperature • pH • Humidity • CO2 • O2 • Water Level
NOT Hydroponics Management System	(Aliac & Maravillas, 2019)	Hydroponic	-	Raspberry Pi	• Temperature • Humidity • pH • Water Sensor
IoT Planting: Watering System Using Mobile Application for the Elderly	(Lekjaroen et al., 2016)	Non-hydroponic	-	Arduino Uno	• Temperature • Humidity • Soil moisture • Water sensor

Several scientists are also working on hydroponic and non-hydroponic plants. Arduino, NodeMCU, and Raspberry Pi all employ a variety of control boards in their designs, even though they are two different sorts. The microcontroller is a crucial component in the project's development. A sensor will be built into the microcontroller. We also make use of a range of sensors that might help the plant flourish. Sensors for temperature, humidity, pH level CO2 level, O2 level, water level sensor, and LDR are some of the sensors used in the facility. The data from the sensor will be transmitted to the cloud, where it will be analyzed.