Faculty of Electronics & Computer Technology and Engineering

DEVELOPMENT OF COCONUT OIL CONCENTRATION LEVEL SENSOR VIA GREEN LED DETECTION

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Bachelor of Computer Engineering Technology (Computer Systems) with Honours

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A project report submitted in partial fulfillment of the requirements for the degree of Bachelor of Computer Engineering Technology (Computer Systems) with Honours

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DEDICATION

To my loved ones ,

Your unwavering presence and support have been my strength and solace.

This is dedicated to each of you,

for being there when I needed you the most

ABSTRACT

There are several problems and worries associated with the concentration level of coconut oil. Because solvent-based chemical extraction methods have the potential to leave residues and endanger both human health and the environment, they could be problematic. The production of RBD coconut oil serves as an example of how nutrients and antioxidants found in unrefined varieties may be lost during the refining process. Since there has been adulteration in the industry, purity and quality are essential. Waste disposal is one example of an environmental effect that needs to be carefully considered. In addition, the need for sustainable methods and consumer preferences for virgin coconut oil highlight the importance of ethical sourcing and processing. In the coconut oil industry, label transparency, avoiding misleading claims, and maintaining the nutritional value and oxidative stability of concentrated products are all necessary to meet consumer expectations. Thus, the goal of the project is to create a level sensor for coconut oil concentration level using green LED detection.The purpose of this project is to develop an LDR oil concentration level sensor, analyse its performance using green LED power transfer, and optimise its performance based on results related to sensitivity, linearity, and stability.An Arduino UNO processor is used to measure the coconut oil concentration level and controls the system's inputs and outputs. It controls the green LED's functionality, including turning it on and off. To enable observation, the Arduino UNO transmits data to the LCD regarding the amount of light reflected from the oil samples. The sensor that measured light intensity as it passed through the oil is called an LDR.Consequently, three types of graphs demonstrating linearity, repeatability, and stability have been created along with a sensitivity value. It demonstrates that light emitted from oil decreases with increasing salt concentration level.With little expense and user effort, this invention offers a better understanding of coconut oil in the food industries.

ABSTRAK

Terdapat beberapa masalah dan kebimbangan yang berkaitan dengan penumpuan minyak kelapa. Kerana kaedah ekstraksi kimia berasaskan pelarut boleh meninggalkan residu dan mengancam kesihatan manusia serta alam sekitar, ia boleh menjadi masalah. Pengeluaran minyak kelapa RBD adalah contoh bagaimana nutrien dan antioksidan yang terdapat dalam varieti yang tidak dimurnikan mungkin hilang semasa proses pemurnian. Memandangkan terdapat pemalsuan dalam industri ini, keaslian dan kualiti adalah penting. Pembuangan sisa merupakan contoh kesan alam sekitar yang perlu dipertimbangkan dengan teliti. Selain itu, keperluan untuk kaedah yang mampan dan pilihan pengguna untuk minyak kelapa virgin menonjolkan kepentingan sumber dan pemprosesan yang beretika. Dalam industri minyak kelapa, ketelusan label, mengelakkan tuntutan yang menyesatkan, dan mengekalkan nilai pemakanan serta kestabilan oksidatif produk yang ditumpukan adalah semua keperluan untuk memenuhi harapan pengguna. Oleh itu, tujuan projek ini adalah untuk mencipta sensor aras untuk penumpuan minyak kelapa dengan menggunakan pengesanan LED hijau. Tujuan projek ini adalah untuk membangunkan sensor minyak LDR, menganalisis prestasinya menggunakan pemindahan kuasa LED hijau, dan mengoptimumkan prestasinya berdasarkan keputusan berkaitan dengan kepekaan, lineariti, dan kestabilan. Pemproses Arduino UNO digunakan untuk mengukur penumpuan minyak kelapa dan mengawal input dan output sistem. Ia mengawal fungsi LED hijau, termasuk menyalakannya dan mematikannya. Untuk membolehkan pemerhatian, Arduino UNO menghantar data ke LCD mengenai jumlah cahaya yang dipantulkan dari sampel minyak. Sensor yang mengukur keamatan cahaya ketika melalui minyak dipanggil sebagai LDR. Oleh itu, tiga jenis graf yang menunjukkan lineariti, kebolehulangan, dan kestabilan telah dihasilkan bersama dengan nilai kepekaan. Ini menunjukkan bahawa cahaya yang dipancarkan dari air berkurangan dengan peningkatan kepekatan garam. Dengan kos yang sedikit dan usaha pengguna yang rendah, penemuan ini menawarkan pemahaman yang lebih baik tentang minyak kelapa dalam industri makanan.

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I would also like to extend my heartfelt appreciation to the graduate program at Universiti Teknikal Malaysia Melaka. My gratitude is particularly directed towards the funding provided by the Bachelor Degree Project (BDP) I and II programs, without which the completion of this project would have been infeasible.

My deepest thanks go to my mother, Hasnah Omar, my father, Abdul Aziz Bin Mahmud, and all my friends who have offered unwavering support and encouragement throughout this endeavor. As I reach the conclusion of my BDP, I take this opportunity to express my profound appreciation to everyone who has played a role in assisting, encouraging, advising, and supporting me on this transformative journey.

In closing, I express my sincere gratitude to the faculty and staff of Universiti Teknikal Malaysia Melaka for their positive feedback and encouragement throughout this semester. Your support has been invaluable, and I am truly thankful for the enriching experience.

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LIST OF SYMBOLS

m	-	Gradient
%	-	Percentage
c	-	Intercept
×	-	Multiple
√	-	Square Root
X^2	-	Power of 2
δ	-	Voltage angle
+	-	Addition

LIST OF ABBREVIATIONS

dBm	-	Power
LED	-	Light-Emitting Diode
LCD	-	Liquid Crystal Display
LDR	-	Light-Dependent Resistor
SDA	-	Serial Data Line.
SDC	-	Serial Data Clock

CHAPTER 1

INTRODUCTION

1.1 Introduction

The primary objective of this chapter is to establish the structure and offer a succinct introduction to the project. The text primarily provides a synopsis of the project, delineates the objectives, briefly addresses the problem statement and scope, and offers an overview of the anticipated outcomes. This chapter offers a comprehensive overview of the project's structure, allowing for a clear visualization and establishing a strong basis for further exploration and comprehension.

1.2 Background

Coconut oil concentration level plays a critical role in ensuring the production of high-quality, clean products that meet the discriminating needs of consumers. Due to its numerous uses, challenging extraction and refining processes, and popularity, coconut oil is utilised extensively across various industries. Evaluating the nutritional makeup, purity, and general quality of the final product depends heavily on the concentration level process. Customers are growing more conscious of the effects that the products they choose have on their health and the environment in today's market. Therefore, it is imperative to provide accurate information regarding the quality and purity of coconut oil. To provide accurate product information, allay consumer concerns, and satisfy the growing demand for transparency in the production of a highly desirable and versatile natural resource, this introduction looks at the significance of coconut oil concentration level.

There are several detrimental effects associated with the food industry's use of inaccurate and inferior coconut oil. Apart from the possible health risks associated with false nutritional information, substandard coconut oil can result in disagreeable tastes and smells that detract from the mouthfeel and visual appeal of food products. The performance of the cooking process may be adversely affected, thereby influencing the overall quality and texture of the food. In the commercial food production industry, where consistency is crucial, this is a serious concern. Unstable or rancid coconut oil can speed up food items' deterioration, lowering their freshness and shelf life. Moreover, using inferior oil can erode customer confidence over time, harming a brand's reputation and causing financial difficulties. Food safety and labelling regulations must be followed; otherwise, the risks increase and there may be product recalls and legal consequences. In the food industry, maintaining the accuracy and superior quality of coconut oil is essential for consumer satisfaction and well-being as well as for maintaining credibility and financial sustainability in a cutthroat market.

To address these issues, the development of a coconut oil concentration level level sensor that makes use of green LED detection offers a promising solution to ensure accurate and reliable concentration level process supervision. This sensor makes use of the concepts of green LED power transfer to increase the precision and efficacy of measuring coconut oil concentration level. Real-time data acquisition is made possible using an Arduino UNO microcontroller to measure and control the system's inputs and outputs, including the green LED's function. To precisely measure the amount of light that passes through the oil, the sensor makes use of a Light-Dependent Resistor (LDR). This allows for accurate concentration level measurements. This solution satisfies the need for transparency in the coconut oil production process by providing producers with an instrument to improve the concentration level process by leveraging stability, linearity, and sensitivity. An LCD gives producers the ability to visually display data, which enables them to closely monitor and modify the concentration level process to maintain a consistently high-quality coconut oil. The affordability and intuitive design of this sensor renders it an invaluable tool for augmenting the accuracy and efficiency of coconut oil concentration level level in the food sector.

Figure 1.1 Elevating Coconut Oil Quality with Green LED Tech

1.3 Problem Statement

Various challenges arise in the coconut oil industry regarding concerns about quality and purity. The presence of adulteration, which entails the blending of inferior or substitute vegetable oils with coconut oil, presents a substantial risk. Thus , to maintain consumer trust, it is crucial to meticulously uphold the concentration level process to preserve purity. Ensuring transparency in labelling is crucial, as deceptive assertions regarding concentration level or purity can mislead consumers, emphasising the need to comply with established standards. The longevity and resistance to oxidation are additional concerns, as the concentration level processes may potentially affect the freshness and excellence of coconut oil as time passes. Producers addressing these concerns should give priority to implementing sustainable and transparent practices, utilising safe extraction techniques, and offering precise and transparent product information to meet and surpass consumer expectations. Regrettably, the portable oil metres for measuring conductivity and concentration level are excessively expensive for individuals to independently assess the concentration level level. The high cost would create an unfair disadvantage for individuals with limited financial means, leading to an inequitable distribution of information regarding concentration level levels. Therefore, it is necessary to create and construct a coconut concentration level level sensor that utilises green LED detections to achieve precise measurements of concentration level levels. This project explored the utilisation of light refraction as a sensor for measuring the concentration level level oil level. The selection of the green light emitted by the LED is determined by the range of wavelengths that it can accept. The sensor is constructed by combining a green LED, a photodetector, and a power metre to serve as the data collector. The performance of sensing can be influenced by the wavelength of light due to the reflection and refraction field generated by transmitted spectral information.

1.4 Project Objective

The primary objective of this project is to create an accurate, quick, affordable, and user-friendly green LED-based sensor for measuring coconut oil concentration level in industries. The following are the goals:

i) To develop coconut oil concentration level sensor using LDR sensor.

iii) To analyze the sensor performance through green LED power transfer.

iv) To implement the sensor performance by sensitivity, linearity and stability results.

1.5 Scope of Project

Thoroughly documenting the project's scope ensures that it will be completed within the allocated budget. The functional scope will ensure the successful completion of the project. The coconut oil concentration level level sensor assesses the detectability of concentration level in different samples by utilizing green LED detections. This project utilizes LCD, LDR, green LED, and Arduino UNO. Project readiness is essential for determining the concentration level ratio of coconut oil. The current apparatus used to quantify the concentration level of coconut oil is either prohibitively expensive or impractical. Given the lab's restricted measuring apparatus, it was challenging to modify the concentration levels of coconut oil in each beaker.

The limited availability compelled us to explore alternative approaches to guarantee precise and diverse concentration levels for each sample. To address this discrepancy, develop a cost-effective and eco-friendly sensor utilizing LED technology that accurately measures concentration level levels through light refraction in a convenient manner. Each glass beaker used for containing coconut oil samples of varying concentration levels is an integral component of the experimental setup. Simultaneously completing the PSM I certification and creating the project structure proves to be challenging. This is due to the scarcity of glass beakers in most simulation programs.

1.6 Thesis Structure

Chapter 1:

The first chapter provides a concise explanation of the project's feasibility. This section will provide an overview of the background and circumstances surrounding the tasks.

The primary emphasis will be on presenting a comprehensive outline of the project, encompassing the goals, issue description, and extent.

Chapter 2:

The subsequent chapter will provide a more comprehensive analysis of the concept, hypothesis, and attributes of the equipment and components employed in this project. Additionally, it establishes the definitions of the terms employed in the project and delves into the research concept, with a particular focus on its connection to the hypothesis.

Chapter 3:

The upcoming chapter will thoroughly examine the methodology employed in the project. The methodology chapter delineates the necessary procedures to be adhered to and furnishes comprehensive accounts of the studies that must be conducted to accomplish the project's objectives. This chapter will offer an extensive overview of the project's progress and a detailed elucidation of the methodologies employed to accomplish it.

Chapter 4:

The fourth chapter will concentrate on the results and subsequent deliberations pertaining to the utilized methodology. A thorough examination and explanation of the methodology for collecting and analyzing data will be presented. This chapter presents a comprehensive explanation of the four distinct categories of graphs: stability, repeatability, linearity, and power versus sample.

Chapter 5:

This final chapter will present the conclusion derived from the results. This chapter will present a thorough overview of the research findings and project outcomes derived from the Bachelor Degree Project.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This part covered the entire project's literature review and the project development. Additional materials for this project, such as journals, articles, and books from prior works related to the project's topic, would serve as primary sources. This chapter will cover everything from the fundamentals to related research applications. This stage is necessary to grasp the concept of light sensors and how they work before moving on to the next step, which is to develop a coconut oil concentration level sensor via green led detection

2.2 Past Related Research

Educational research will primarily concentrate on the field of education. The selection of research materials is contingent upon the specific theories, equipment, and system employed. The selected sources must adhere to the specified format, such as scholarly books, academic journals, or research articles.

2.2.1 LED sensor detection

LED sensor detection is the use of light-emitting diodes (LEDs) as a sensing element in a variety of applications. When an electric current is passed through LEDs, they emit light, and their optical properties can be used to detect and measure various phenomena. LED sensor detection has several advantages, including low power consumption, small size, quick response time, and high sensitivity.

Based on the reflection or absorption of emitted light, LED sensors can be used to determine the proximity or distance to an object. This is commonly used in systems for object detection, position sensing, and gesture recognition. LEDs can emit specific wavelengths of light, making them ideal for colour and spectral analysis. LED sensors can identify and quantify the presence of specific colours or analyse the spectral composition of a sample by measuring the reflected or transmitted light. By monitoring changes in the reflected or interrupted light beam, LED sensors can detect the presence or movement of objects. Motion sensors, security systems, and automatic door opening and closing systems all make use of this. LEDs, in conjunction with appropriate sensors, can be used to detect and analyse liquids or gases. Light absorption or scattering by the target substance can reveal important information about its composition or concentration level. LED sensors can be used to measure environmental parameters like light levels, air quality, humidity, and temperature. These sensors enable real-time monitoring and data collection by measuring changes in light emitted or received.

2.2.2 Fibre optic sensor for the detection of adulterant traces in coconut oil

The design and development of a fibre optic evanescent wave refractometer to detect trace amounts of paraffin oil and palm oil in coconut oil is presented. Side-polished plastic optical fibers power this sensor. The fibre is polished, and the cladding removed at the sensing region. A bent mould perfectly fits the sensing region. This sensing region bending boosts sensitivity. The output intensity dropped sharply when the sensing region was filled with oil mixtures of different mix ratios. The intensity variation is linear, and the detection limit is 2% (by volume) paraffin oil/palm oil in coconut oil. Refractometric sensors have 10-3 resolution. This fibre optic sensor detects adulterants like paraffin oil and palm oil, which are miscible in coconut oil, which is widely consumed in south India.

This sensor is cheap and easy to install. The side-polished fibre's 7s response time and low analyte requirement are also appealing.

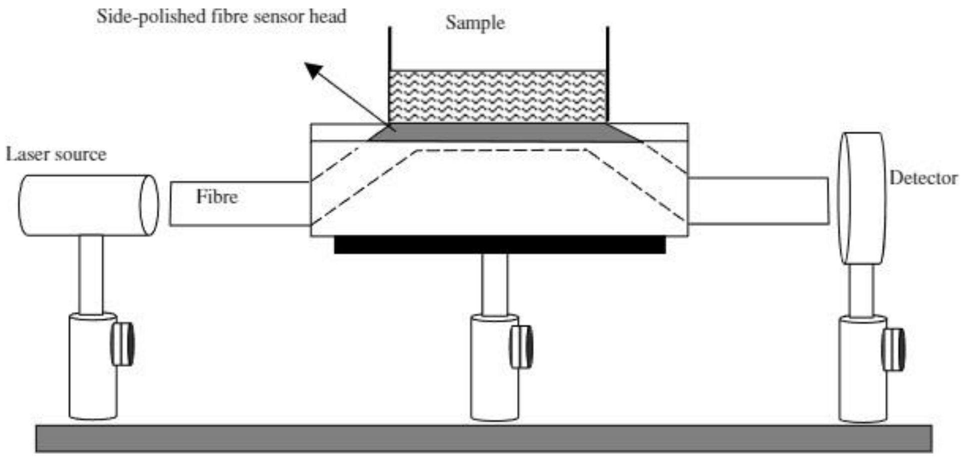

Figure 2.1 Polished fiber optic sensor to traces oil in coconut

2.2.3 Development of microfluidic LED sensor platform

The microfluidic light emitting diode (LED) sensor for methanol detection is discussed in this journal. The microfluidic device that generates linear gradients has two inlet microchannels and four outlet microchannels in total. Within the confines of the microfluidic platform, stable concentration level gradients of methanol were produced in a manner that was both temporally and spatially variable. The electrical conductivity of the methanol that was extracted from the microfluidic platforms was measured, and the results showed that the currents dropped as the methanol concentration level increased. LED sensor was also used to observe the presence of methanol within the microfluidic device. As a result, this microfluidic LED device has the potential to be an effective platform for applications involving methanol sensors.

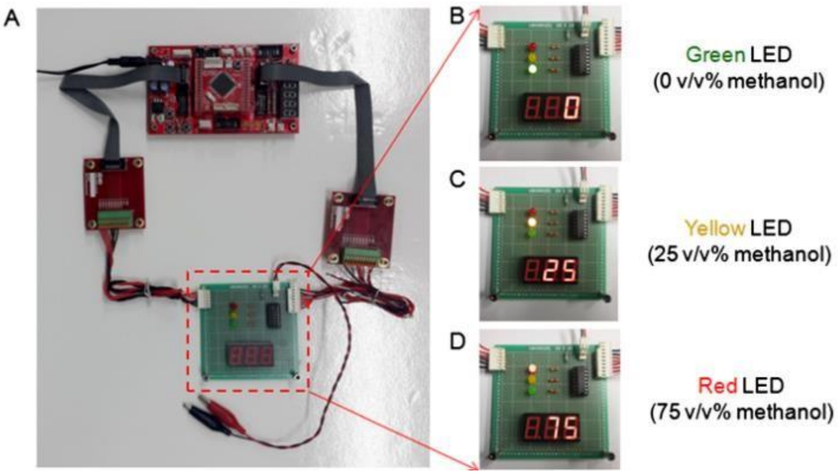

Figure 2.2 Sensor operation system containing three LED (green, yellow, red)

2.2.4 Low-Cost System Based on Optical Sensor to Monitor Discharge of Industrial Oil in Irrigation Ditches

Oils get into the irrigation system more often because of agricultural vehicles that dump waste without being watched. In this paper, we suggest a way to measure the amount of oil in irrigation ditches using an optical sensor. Our prototype is based on how light is taken in and spread out. We use white, yellow, blue, green, and red-Light Emitting Diodes (LEDs) as the light source and a photodetector as the sensor. To test how well the sensor works, we add diesel or gasoline engine oils with a concentration level between 0 and 0.20 mLoil/cm3. The experiment was done at different heights of the oil column, from 0 to 20 cm. Based on what we found, the sensor can tell if diesel engine oil is present or not by which LED is lit. For gasoline engine oil, the sensor uses the red-light source to measure its concentration level. Concentration levels of more than 0.1 mLoil/cm? cannot be told apart. For the worst case, 15 cm, the data collected with the red LED has an average absolute error of 0.003 mLoil/cm (a relative error of 15.8%). Lastly, depending on the type of oil, the blue LED sends different signals to the photodetector. We made an algorithm that uses the white LED to check for oil, the blue LED to tell if the oil is from a gasoline or diesel engine, and the red LED to check how much oil a gasoline engine is using.

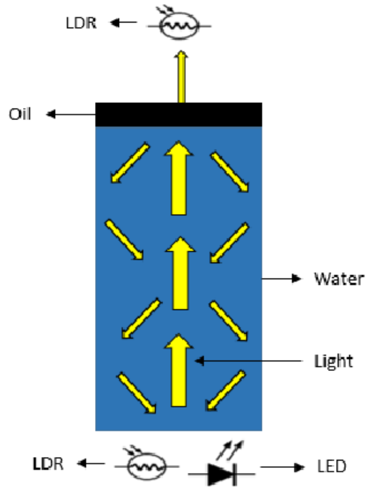

Figure 2.3 Sensor working diagram

2.2.5 Online Monitoring of the Oil Acidification Using a Chemical Sensor Measuring Corrosiveness by S. Sen

Chemical corrosiveness sensors based on capacitively coupled electrodes were used to determine the corrosiveness of lubricating. Acidification is a crucial parameter for evaluation of the conditioning of lubricating oils, it being driven by gaseous biofuels for instance in stationary engines. Now, acidification is considered as the main indicator for the oil change. So, this system has been created for online monitoring of the engine oil's acidification by a chemical corrosiveness sensor. The system also has try to use field trials to monitor the oil acidification in lubricating oil by using sensor and electrode. There is some barrier because the critical amount of the acidification initiated the accelerated corrosion of the sacrificial layer. However, the corrosiveness sensor is appropriate for the onlimonitoring which is it is low-cost system. It's also having pre-warming system for an oil change caused by a critical amount of acid content.

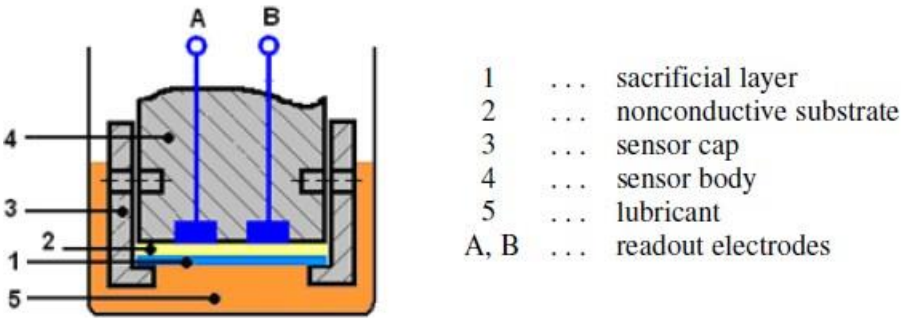

Figure 2.4 Schematic setup of the chemical sensor

2.2.6 Designing and modelling of Arduino based light sensor by Deepak Kumar

The designing model of Arduino based light sensor is about made an Arduino light sensor circuit which is if any light is incident on it, it will sense the light and gives the signal to the buzzer and the buzzer will blow. Light sensor is to detect the light that come from circuit to be produce for the buzzer. From the result, we can get that the light energy that we get, it will be covert to the electric signal. It also measures radiant energy present in the wide range of frequencies in the light spectrum. But the system needs to calibrate the light based on the condition.

2.2.7 Arduino Uno-Based oil turbidity meter using LDR and LED sensor by A.P.U. Siahaan

The Arduino uno-based oil is the system that study the attempts to make a simple drinking oil test kit using the Arduino uno to determine value of turbidity of oil in glass container. The system also uses LED as the light source to the system. The advantage to use the Arduino uno as the hardware is because Arduino uno as data processing. The data will be process after we get the results from the turbidity meter. LED as the light source will measure the oil turbidity and the amount of light scattered depends on concentration level and distribution of particle size. But the system is more focus on measure turbidity of oil only.

2.2.8 Designing and modelling of Arduino based light sensor by Deepak Kumar

The designing model of Arduino based light sensor is about made an Arduino light sensor circuit which is if any light is incident on it, it will sense the light and gives the signal to the buzzer and the buzzer will blow. Light sensor is to detect the light that come from circuit to be produce for the buzzer. From the result, we can get that the light energy that we get, it will be covert to the electric signal. It also measures radiant energy present in the wide range of frequencies in the light spectrum. But the system need to calibrate the light based on the condition.

2.2.9 Low-Cost Quality Sensor Based on Changes in Complex Permittivity by Angel Torres Perez

The system by Angel Torres Perez and Mark Hadfield have created the system to protect important industry assets by minimize downtime and reduce the maintenance cost. To reduce the maintaining process, it selects the most adequate oil replacement maintenance schedules and provide oil quality sensors an indication of the condition of oils by measuring different fluid characteristic such as viscosity, density and optical. This system is the real time oil quality monitoring technique system. It’s also can monitor the loses of the dielectric at high frequencies. By the results, an electronic design procedure is covered which in a low cost, effective and ruggedized sensor implementation suitable for use in harsh environments. While using this measurement technique, most common type of commercially process rheometer rely on resonators. Resonator measurement principles are based on changes in the resonant frequency and the damping or Q factor. If the mechanical structure of the resonator is brought into contact with a fluid or solid medium both resonance frequency and damping are changed depending on the viscosity and the elasticity of the fluid.

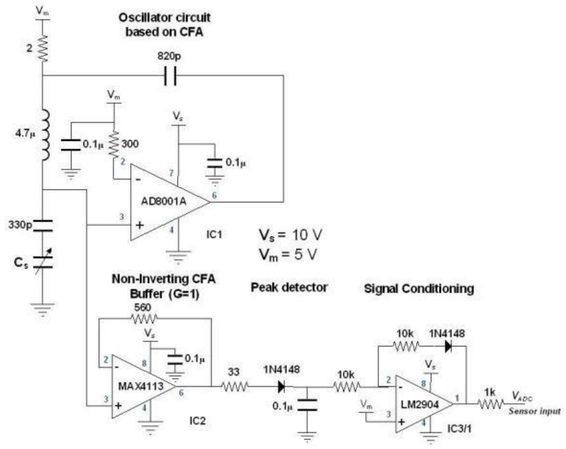

Figure 2.5 Hardware schematic (Analog part)

2.2.10 Engine Oil Condition Monitoring using IoT and Predictive Analysis by Mr.K. Madhana Mohan

Engine lubricant oil should be maintained properly so that the heat generated, and vibration produced from the engine is greatly reduced and hence the overall efficiency of the engine improves. So, the system assesses the condition of the engine oil using IoT technique to provide a detailed analysis of the same for assessing the condition of the oil conductivity sensor, PH sensor and turbidity sensor. To get the output of the results, those three values will be categorized by colored's LED to indicate oil condition. The digital monitoring can be used to produce a trend analysis of oil parameters like temperature, viscosity of the liquid, PH measurement and oil level indicator. The maintenance can be most efficiently scheduled for known downtimes before a failure occurs. The system will help the owner to change the engine oil when its condition degraded by employing sensor-based technology. The engine oil condition also can be monitored on a real time basis. The deterioration of oil condition can be analyzed based on the sensor's data. But the major problem is that the oil level is indicated high irrespective to the its viscosity consistency as when temperature increase, the viscosity of the oil will decrease. There is always a certain number of frictions, which results in wear and tear and as a result the presence of tiny particles in the lubrication oil.

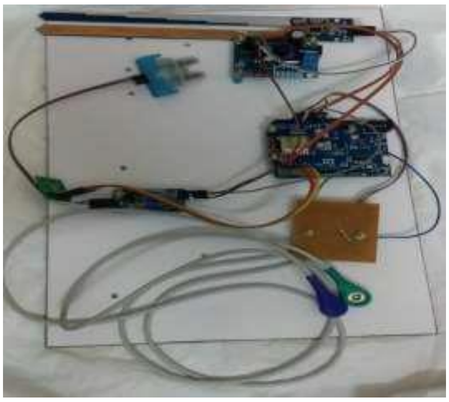

Figure 2.6 Experiment Setup

2.2.11 Development of a sensor for the continuous measurement oil concentration level

A precise sensor system is needed to continuously measure oil concentration level in a refrigeration system. Detailed procedure: Sensor option: Select an oil concentration level sensor technology. Ultrasonic, optical, capacitance, and conductivity sensors are available. Consider sensitivity, precision, response speed, and system compatibility.Use oil-concentrated reference samples to calibrate the sensor. Create a accuracy curve or mathematical model that links sensor output to oil concentration level. Sensor amalgamation: Create a sensor housing or mounting mechanism to position the sensor in the refrigeration system. Consider accessibility, visibility, and environmental preservation. Extract representative refrigeration system oil samples. This may require establishing a sampling port or continuous sampling. Mix and homogenize extracted samples before analysis. Signal conditioning and processing: Process and amplify sensor data with a signal conditioning circuit. This circuitry may include amplifiers, filters, or analog-to-digital converters. Algorithms or analysis can convert sensor output into oil concentration level measurements. Data collection and analysis: Create a sensor measuring system. Microcontrollers, data recorders, and other electronics may be used. Real-time oil concentration level data analysis and visualization methods.

2.2.12 Automatic Dual Axis Sun Tracking System using LDR sensor

The aim of this paper is to present a solar energy collection technology by a photovoltaic cell. To present this efficient solar distributed generation system, a dual-axis solar tracker is designed. The tracker actively tracks the sun and changes its position accordingly to maximize the power ourput. The designed tracking system consists of sensors, microcontroller operated control circuits to drive DC motors and gear- bearing arrangements with supports and mountings. Two geared de motors are used to move the solar panel so that sun's beam is able to remain aligned with the solar panel.

This dual axis tracking system uses LDR sensors. Light intensity lowers LDR resistance. Two 12-volt full-geared stepper motors rotate the solar panel in two axes. Four LDRs monitor light intensity in this dual axis. Dual axis tracking systems monitor the sun properly. The panel absorbs the most energy when facing the sun. This research focuses on accurate sun tracking to boost power gain. The daily motion makes the sun look east-west over the globe, but the annual motion tilts it 23.5 degrees while travelling east-west. Single axis tracking systems do not maximize solar panel efficiency. L293D converts binary data into mechanical data in this project.

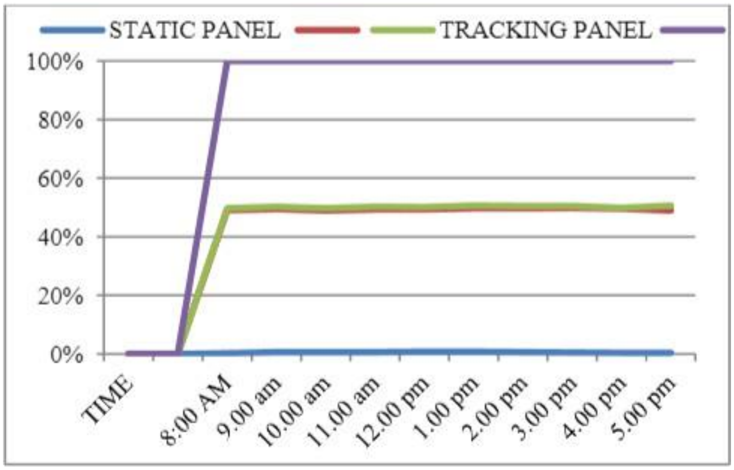

Figure 2.7 Graph plot of current and voltage

2.2.13 Coconut Oil and Virgin Coconut Oil: An Insight into its Oral and Overall, Health Benefits

Everyone should place a premium on maintaining good oral health. Oil's long history of use as a dental hygiene aid in India can be traced back to ancient Vedic texts. Kavala Gandoosha, or oil pulling therapy, is a traditional practice that involves rinsing or swishing the oil in the mouth to remove plaque. The oil is believed to have an anti-inflammatory and antimicrobial effect. Coconut oil has an antimicrobial effect against a wide range of microorganisms found within the body, making it a highly sought-after and widely available edible oil in India. As demand for Virgin Coconut Oil (VCO) continues to rise, scientists are exploring its potential beyond the realm of functional food oil. The current review's goals are to (1) recognize the use of traditional medicine as part of primary healthcare and (2) bring attention to the general benefits of coconut oil usage and the traditional concept of oil pulling with coconut oil as a supplementary oral hygiene aid.

2.2.14 A comprehensive Review on Health Benefits of Coconut Oil

Coconut oil is made from the kernel of ripe coconuts, which are harvested from the coconut tree. It is a common oil. Copra oil and virgin coconut oil are the two main types of coconut oil. They both have similar carboxylic acid profiles, but virgin coconut oil has more nutrients like vitamin E and bioactive compounds like polyphenols. In recent years, copra oil products have become more popular because of what people think are the health benefits of some medium-chain fatty acids. However, dodecanoic acid (C12:0), the first carboxylic acid found in copra oil, is thought to behave metabolically like both a medium-chain and a long-chain carboxylic acid. In this thorough review, the authors have put together a summary of the peer-reviewed research and mechanisms that are known about how copra oil products affect health. In the paper, some facts that have been proven are told. The topical use to prevent and treat atopic eczema, as well as "oil pulling" to prevent cavities, is backed by a small but consistent body of evidence. Products made with copra oil can also help protect hair from damage caused by protein loss during grooming and exposure to ultraviolet (UV) light. However, more research is needed to confirm this effect.

2.2.15 A Real Time Engine Oil Monitoring System for Diagnosis of Lubricant using IoT Network

Internet of Things (IoT) is a smart communicating approach and create an energetic impression in innovation. An IoT technology based a real time Engine Oil Monitoring (EOM) is a system for diagnosis of engine lubricant. So, the main objective for this system is to reduce the human effort and provide a smart sensing approach in automobile industry for maintaining real time oil condition. This is because lack of automatic monitoring system from the continuous use of engine that can cause problem to the engine. EOM have been designed with the help of Arduino Nano with sensor devices named as Light Dependent

Resistor (LDR). This sensor is for check the quality of the lubricant, check the temperature and Ultrasonic Sensor for oil level measurement in engine. These electronics sensor having better sensing capacity and helps to improve the interactive with the physical environment of developed IoT based EOM system. Other than that, oil quantity measurement is automatically and according to condition of lubricants. When the system will reduce the use of the labor, so the cost is low. However, the system is unable to decide whether oil quantity is degraded and failed to find out the exact depth of oil in the tank.

2.2.16 Arduino Uno-Based oil turbidity meter using LDR and LED sensor by A.P.U. Siahaan

The Arduino uno-based oil is the system that study the attempts to make a simple drinking oil test kit using the Arduino uno to determine value of turbidity of oil in glass container. The system also uses LED as the light source to the system. The advantage to use the Arduino uno as the hardware is because Arduino uno as data processing. The data will be process after we get the results from the turbidity meter. LED as the light source will measure the oil turbidity and the amount of light scattered depends on concentration level and distribution of particle size. But the system is more focused on measure turbidity of oil only.

2.2.17 Working Principle of Arduino and Using it as a Tool for Study and Research

This paper explores the functionality and possible applications of an Arduino board. In addition, it also investigates the potential use of Arduino as a tool for academic and research pursuits. The Arduino board is a highly effective tool for developing VLSI test benches, particularly for sensors. The primary advantages include a user-friendly interface and efficient processing speed. In the present era, technology is revolutionizing by simplifying and captivating intricate concepts through the widespread adoption of open-source hardware and software. This open-source software provides cost-effective and reliable technology that is available for free or at a low cost. This paper examines the various types of Arduino boards, their operational principles, software integration, and practical applications. Arduino can be referred to as an open-source microcontroller due to its rapidity, ease of programming, and ability to be erased and reprogrammed at any given moment. Initially, Arduino was developed for students, professionals, and hobbyists due to its user-friendly nature and affordable cost. Additionally, it can function as a minicomputer similar to other microcontrollers, by receiving inputs and managing outputs for various electronic devices. In addition, it has the ability to both receive and transmit data over the internet using Arduino shields [21]. The Arduino shields consist of three types: the Arduino Ethernet shield, the Arduino Wireless shield, and the Arduino Motor Driver shield. Each Arduino shield possesses its own distinct functionality. A sketch refers to the program code written for Arduino. The Arduino IDE is the designated software used for creating sketches. The Arduino IDE includes a feature that requires projects to be saved with a file name. Indeed, the functions of copying, pasting, cutting, and searching for specific words or replacing them with others can be performed by utilizing the Ctrl+F keyboard shortcut. This paper also presents three applications that can be utilized with Arduino.

Figure 2.8 Arduino Shields Ethernet

2.2.18 Sensing Using Light: A Key of Sensors

This paper presents a theoretical framework for sensing using light (SuL) that can be universally apply to any sensing method involving light sciences and technologies [22]. A rapid bottom-up approach employed to promptly introduce the fundamental specifications of a sensing system. By employing optical methodologies, one can gain a comprehensive understanding of a sensor and acquire knowledge about various aspects such as the diverse classifications and fundamental constituents of a sensor. Photonics is a comprehensive field that encompasses the various aspects of light signal generation, propagation, control, amplification, detection, storage, processing, and other applications. The advancement of science, technology, and various organizations is heavily dependent on the disciplines of electronics and photonics. These factors have significant impacts on both the economy and society. Photonics is a multidisciplinary field that encompasses various subfields, one of which is sensing based on light or photonics, which holds significant importance. The photonic sensor consists of three primary components: the optical transducer, the optical channel, and the optoelectronic unit. These components work together to generate precise and reliable electrical signals that represent the measurements taken. A sensing device is considered a Smart Photonic Sensor when it possesses the capability to provide actuation signals through its intelligence. Overall, this article presents a theoretical framework for the utilization of light as a comprehensive tool for incorporating various methods related to light sciences and technologies. Every single term, The paper article can encompass various concepts, methods, techniques, technologies, and sensing devices. Within the paper proposal, all light-based sensing methods will be promptly evaluated for inclusion in the photonic sensors.

2.2.19 Measurement of The Degree of Concentration level level of Oil with Fiber-Optic Sensor Using Light: A Key of Sensors

This paper suggests measuring oil concentration level level with refractive index sensors. This parameter is empirically linked to biological, environmental, and refractive index interest. Optical concentration level level measurements have advantages over conductivity measurements due to fiber-optic sensors' amazing properties and sensor system integration potential [23]. The sensor's physical foundation is surface plasmon excitation in a multilayer fiber structure, which attenuates power transmitted along a fiber. Experiments show that the transducer's response can be adjusted to produce linear behavior in the targeted area (refractive index near 1.33). An empirical algorithm calculated concentration level level. When an optical fiber is side-polished and a thin metallic layer is deposited on it, the guided mode's evanescent field excites surface plasmons. This reduces fiber power transmission, and the external medium's refractive index affects attenuation when it contacts a metallic layer. Thus, any index change is measurable. For an external medium whose refractive index matches the structure's effective index and the fiber-guided mode's effective propagation index, maximum coupling and minimum transmitted power are predicted [23]. To locate and sharpen the minimum using structure constraints. Finally, oil concentration level level measurement requires a surface plasmon excitation-based refractive index optical sensor. We achieve repeatability, accuracy, and linearity. Any combination of liquids with different refractive indices can be used, and the instrument can be quickly calibrated using any reference response.

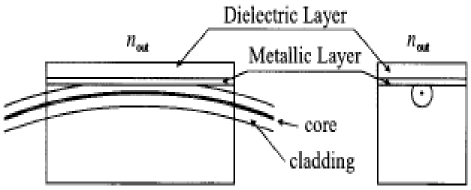

Figure 2.9 Sensor schematic

2.2.20 Measurement of The Degree of Concentration level level of Oil with Fiber-Optic Sensor Using Light: A Key of Sensors

LED technology has gained popularity in recent decades. There are numerous benefits that have rendered it a crucial element of contemporary lighting technology. The purpose of LED is to provide energy-efficient lighting that has a longer lifespan. LEDs excel in generating both light and heat. Regrettably, their performance in the latter is slightly superior to the former, and with the advancement of technology, a greater number of lumens are generated per unit of electrical energy. To keep the junction temperature of LEDs within acceptable limits, it is necessary to cool them, as they can generate heat in addition to photons [24]. As the temperature increases, the performance metrics of LEDs, such as efficiency, stability of hue, and lifetime, generally decline. It is optimal for them to function at the minimum attainable temperature. It is advisable to employ circuit boards with extremely low thermal resistance to facilitate the conduction cooling of LEDs between semiconductors. To summarize, the heat generated by LED technology has the potential to cook eggs. The generation of heat is a result of the conversion of electrical energy. The application of electricity to the bulb results in the generation of heat. Nevertheless, in comparison to an incandescent bulb, LEDs generate substantially less heat. A GLS incandescent bulb with a power rating of 100 watts consumes energy that is converted into different forms: 12% is emitted as heat, 83% as infrared radiation, and 5% as visible light. Conversely, the typical LED emits 15% of visible light and 85% of heat. Efficient thermal management is essential for dissipating heat, especially when dealing with high power LEDs.

2.3 Journal Comparison from Previous Work Related to the Project

Table 2.1 Comparison for previous research paper

NO	TITLE	AUTHOR	PLATFORM	COMPONENTS	PURPOSE	ADVANTAGE	DISADVANTAGE
1	LED Sensor Detection	Not specified	LEDs, Sensors	Detection in various applications such as proximity sensing, color analysis, and environmental monitoring.	Low power consumption, quick response time, high sensitivity	-Explanation about each LED colours. --green LED light has maximal penetration of up to 1mm.	-Focusing LEDs for face skin treatment.
2	Fibre Optic Sensor for Detection of Adulterant Traces in Coconut Oil	Not specified	Not specified	Fiber optic, LED, Photodetector	Detect trace amounts of paraffin oil and palm oil in coconut oil.	Cheap, easy to install, detects specific adulterants	Detection limit is 2%, focused on specific adulterants
3	Development of Microfluidic LED Sensor Platform	Not specified	Not specified	Microfluidic device, LED, Methanol	Detect methanol concentration level with a microfluidic device generating stable gradients.	Real-time data analysis, potential for effective methanol sensing	Specific to methanol detection, requires a microfluidic platform
4	Low-Cost System Based on Optical Sensor to Monitor Discharge of Industrial Oil in Irrigation Ditches	Not specified	Not specified	Optical sensor, LED	Monitor industrial oil discharge in irrigation ditches using LEDs and a photodetector.	Low-cost, uses optical sensors	Limitation in distinguishing oil concentration levels >0.1 mLoil/cm3

5	Online Monitoring of the Oil Acidification Using a Chemical Sensor Measuring Corrosiveness	S. Sen	Not specified	Chemical sensor, Capacitive electrodes	Online monitoring of lubricating oil acidification using capacitive chemical corrosiveness sensors.	Low-cost, real-time monitoring	Barrier due to accelerated corrosion, requires careful monitoring
6	Designing and Modelling of Arduino-Based Light Sensor	Deepak Kumar	Arduino	Arduino, Light sensor, Buzzer	Design an Arduino-based light sensor circuit to detect light and trigger a buzzer.	Measures radiant energy, wide frequency range	Requires accuracy based on conditions
7	Arduino Uno-Based Oil Turbidity Meter using LDR and LED Sensor	A.P.U. Siahaan	Arduino	Arduino Uno, LDR, LED	Measure oil turbidity using Arduino Uno, LDR, and LED sensors.	Utilizes Arduino for data processing	Focus on measuring oil turbidity only
8	Designing and Modelling of Arduino-Based Light Sensor	Deepak Kumar	Arduino	Arduino, Light sensor, Buzzer	Reiteration of the information from No. 2.2.6.	Measures radiant energy, wide frequency range	Requires accuracy based on conditions

9	Low-Cost Quality Sensor Based on Changes in Complex Permittivity	Angel Torres Perez	Not specified	Oil quality sensor	Real-time monitoring of oil quality in harsh environments using changes in complex permittivity.	Low-cost, effective, ruggedized sensor	Limited information on specific advantages
10	Engine Oil Condition Monitoring using IoT and Predictive Analysis	Mr. K. Madhana Mohan	Arduino Nano, IoT	Arduino Nano, Sensors	Monitor engine oil condition using IoT for real-time analysis and predictive maintenance.	Real-time monitoring, predictive analysis	Issue with oil level indication, potential errors due to viscosity changes
11	Development of a Sensor for the Continuous Measurement Oil Concentration level	Not specified	Not specified	Oil concentration level sensor	Continuous measurement of oil concentration level in a refrigeration system using various sensors.	Precise sensor system, continuous monitoring	Specific details on sensors and disadvantages not provided
12	Automatic Dual Axis Sun Tracking System using LDR Sensor	Not specified	Not specified	Dual-axis solar tracker	Design a dual-axis solar tracker using LDR sensors for efficient solar energy collection.	Actively tracks the sun for maximum power output	Specific disadvantages not provided
13	Coconut Oil and Virgin Coconut Oil: An Insight into its Oral and Overall Health Benefits	Not specified	Not specified	Not specified	Explore the traditional use of coconut oil in oral health and its antimicrobial properties.	Rich in antimicrobial properties	Specific disadvantages not provided

14	A Comprehensive Review on Health Benefits of Coconut Oil	Not specified	Not specified	Not specified	Review the health benefits of coconut oil, including its use in preventing cavities and protecting hair.	Summary of proven health benefits	More research needed for certain effects
15	A Real Time Engine Oil Monitoring System for Diagnosis of Lubricant using IoT Network	Mr. K. Madhana Mohan	Arduino Nano, IoT	Arduino Nano, Sensors	Real-time engine oil monitoring using IoT for oil quality, temperature, and level diagnosis.	Real-time monitoring, detailed analysis	Issues with oil level and viscosity indication
16	Arduino Uno-Based Water Turbidity Meter using LDR and LED Sensor	A.P.U. Siahaan	Arduino	Arduino Uno, LDR, LED	Reiteration of the information from No. 2.2.7.	Utilizes Arduino for data processing	Focus on measuring water turbidity only
17	Working Principle of Arduino and Using it as a tool for study and research.	Leo Louis	Microcontroller	Arduino	-Explores the working principle and applications of an Arduino board.	-Easily programmed decerased -reprogrammed at any instant of time -inexpensive	-limited memory storage
18	Sensing using light: A key of sensors	Jose Miguel Lopez- Higuera	Microcontroller	Photonic sensors	-Offers a Doctrinal Conception of sensing light as “umbrella” in which any sensing approach using Light Science and Technologies can be easily included.	-Returning object consequence of the interrogation light -Produced because of a pumping light	-Presence cut-off frequency. -Absent of lag time. -Can get radiation.

19	Measurement of the Degree of Salinity of Water with a Fiber-Optic Sensor	Oscar Esteban, Maria Cruz-Navarrete, Agustı´n Gonza´ lez-Cano, and Eusebio Bernabeu	microcontroller	Fiber-optic sensor	-In this paper we propose an application of these refractive-index sensors to determine the degree of salinity of water.	-high lev el accuracy -low cost -small size	-development the reliability of the sensor is not yet same as that conductivity meter mainly because of problems of repeatability associated with stability of source.
20	Alcohol Detection Sensor - An Apprise	Pranavan.S	Not specified	Alcohol sensor	Review an alcohol detection system using an MQ3 alcohol sensor.	saving cost Carbon dioxid e emissions reduction -Save energy	saving cost Carbon dioxide emissions reduction -Save energy

2.4 Summary

In summary, the concentration level of coconut oil can be determined by applying the laws of refraction. Light experiences refraction when it passes through a substance and is bent by another substance. The refractive index of the two media determines the degree of refraction. The angle of refraction is dependent on the coconut oil concentration level due to the fluctuation in the refractive index of oil caused by changes in oil concentration level. Various light sources, such as LEDs (Light Emitting Diodes) and lasers, can be employed for the project, each possessing distinct advantages and constraints. They produce a broader spectrum of light colors, which can be advantageous in certain situations. Lasers, in contrast, produce highly coherent and potent light. This signifies that the light waves are synchronized and there is a dense accumulation of light. This can result in more precise and accurate measurements of refraction. Lasers, as opposed to LEDs, tend to be pricier and have a shorter lifespan. LED and laser light will experience refraction when transitioning between different mediums. The coherence and intensity of the light have a significant impact on the reliability of the measurements. The selection of LED is based on its optimal alignment with the problem statement and project objectives.

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CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter will present a concise overview of the research methodology and the rationale for selecting the chosen approach. The project will begin by employing a particular methodology. Subsequently, a diverse array of tools and methodologies will be employed until the project attains its culmination. The chapter will also elucidate the process flow and design requirements imperative for the development of this project.

3.2 Flowchart

The success of this project is largely dependent on project planning, which is thought to be the most crucial component. To guarantee project development success and lessen roadblocks, proper organisation and stress management are essential. To ensure that the project is finished within the allotted time, a methodical flowchart with a defined goal must be created. The bachelor's degree project, which is broken up into two phases, Bachelor Degree Project I (BDP I) and Bachelor Degree Project II (BDP II), is depicted in the flowchart shown in figure 3.1 below. Finding and contacting a qualified supervisor who could provide guidance throughout the project was the first step. The entailed looking up and contacting possible supervisors with experience in the project area and study field. After we had the supervisor on board, we collaborated to choose a suitable project title. This required considering my interests, the supervisor's experience, and the topic's applicability to my line of work.

After deciding on a project title, the problem statement needed to be precisely defined. This necessitated defining the problem or obstacle that the research was intended to address. Additionally, it had to establish clear goals that outlined the intended outcomes for the project. Understanding the body of knowledge and research that has already been done that is pertinent to the project required doing an extensive literature review. This step required reading academic books and articles to become familiar with the current state of knowledge in the field. After gaining a thorough grasp of previous research, the project's methodology was developed. This involved figuring out the hardware design of the system, the coding flowchart, the project layout, and the approximate cost. The final stage of the BDP I process involved determining the project's anticipated outcomes and results.

The first step in BDP II was to design and construct the hardware system needed for the project. this involved choosing and putting together the required parts in accordance with the project's needs and guidelines. The next stage after setting up the hardware system was writing the software code that managed and communicated with the hardware parts. In order to create a cohesive working unit, the coding process also included integrating the software with the hardware system. It was imperative that the design be thoroughly tested after the coding was finished and the hardware was integrated. To verify the functionality, performance, and dependability of the project, several test scenarios and simulations had to be run. Testing was essential to identify and address any potential issues, bugs, or errors in the software and hardware components. After the design had successfully completed the testing phase, the next step was to gather and review the results. Data from experiments conducted as part of the project had to be collected in order to do this. After being collected, the data was properly analysed using statistical or analytical techniques. Making judgements and assessing the project's performance in light of its goals was the goal.

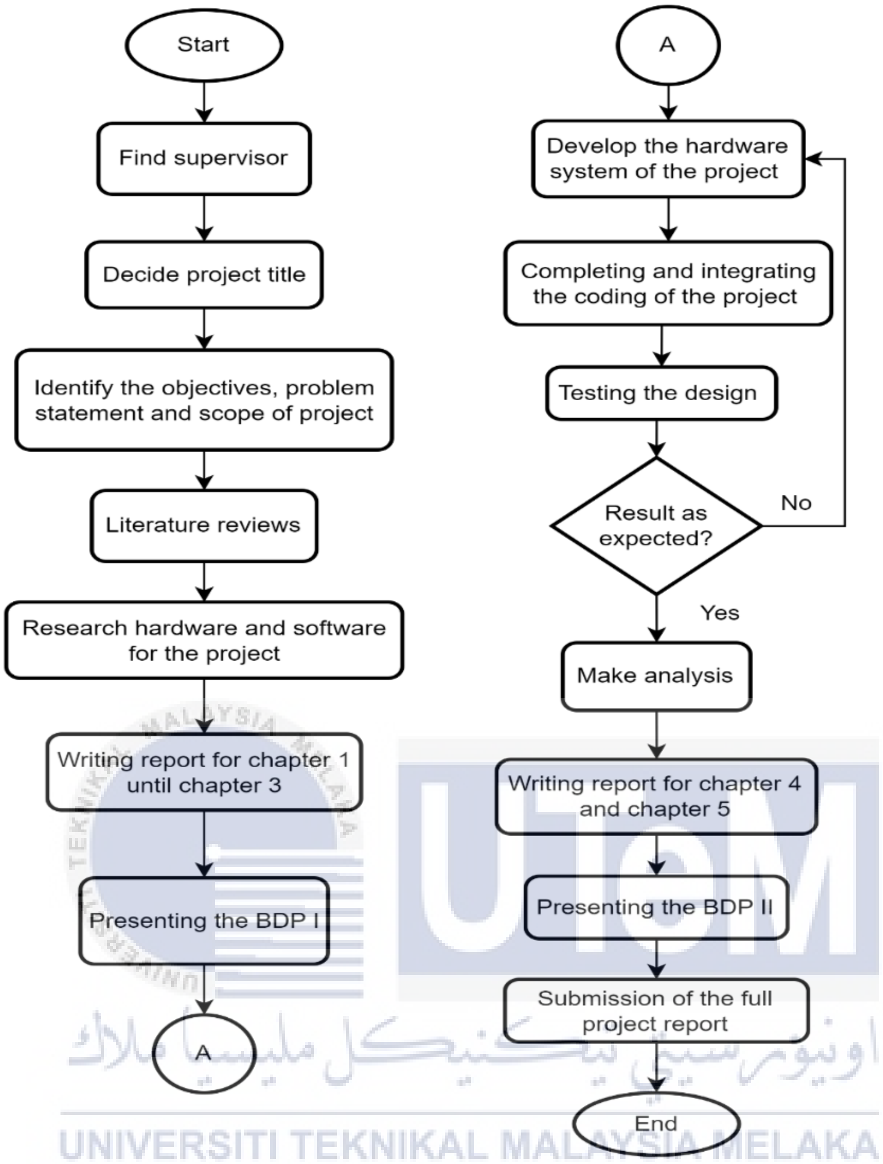

Figure 3.1 Flowchart of the program

Table 3.1 Gantt Chart for PSM 1

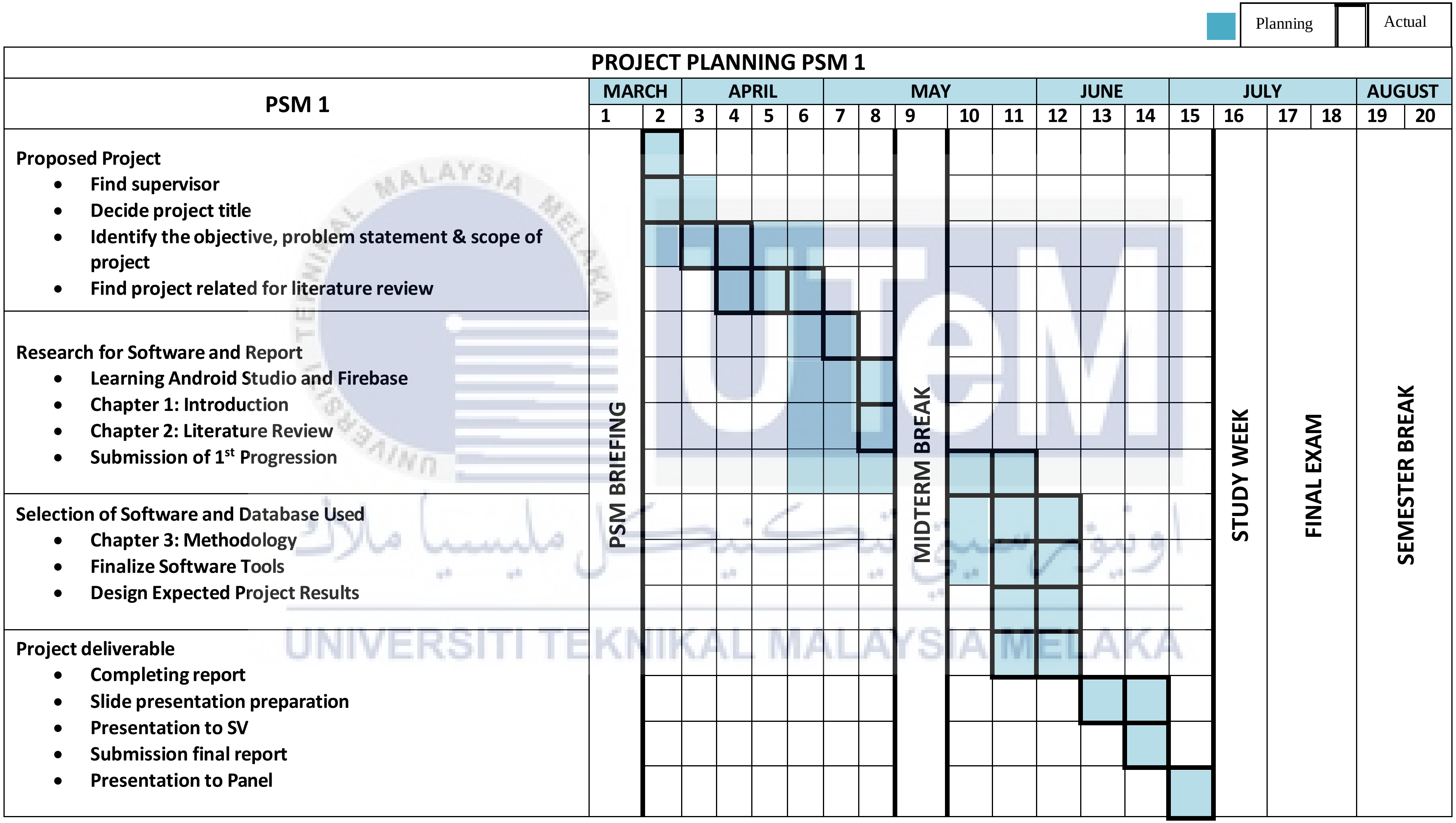

Table 3.2 Gantt Chart for PSM 2

Planning | Actual

PROJECT PLANNING PSM 2																				
PSM 2	SEPT		OCT				NOV					DEC			JAN				AUGUST	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Proposed Project • **Design hardware** • **Setup hardware and codding** • **Run the experiment** • **Collect data and plotting graph**	PSM BRIEFING								MIDTERM BREAK							STUDY WEEK	FINAL EXAM		SEMESTER BREAK	
Research for Software and Report • **Observe and Analyze graph** • **Chapter 4: Result and Dicussion** • **Chapter 2: Literature Review** • **Submission of 1st Progression**																				
Selection of Software and Database Used • **Chanpter 5: Conclusion and Future Work** • **Chapter 3: Methodology** • **Finalize Software and Hardware**																				
Project deliverable • **Completing report** • **Slide presentation preparation** • **Presentation to SV** • **Submission final report**																				

3.3 Milestone of BDP I & II

Project milestones are calendar events that mark a significant achievement or the completion of a major phase of the project. Project milestones are essential for effective project management and keeping the team on track.

Table 3.3 Milestone PSM I

No	Task Name	Start Date	End Date	Duration
1	Briefing	20/3/2023	26/3/2023	7 days
2	Weekly Meeting with SV	27/3/2023	2/4/2023	7 days
3	Chapter 2: Literature Review	3/4/2023	9/4/2023	7 days
4	Understanding Existing System	10/4/2023	16/4/2023	7 days
5	Chapter 1: Introduction	17/4/2023	23/4/2023	7 days
6	Understanding Existing System	24/4/2023	30/4/2023	7 days
7	Submission of 1st Progress	1/5/2023	7/5/2023	7 days
8	Discuss with SV about project	8/5/2023	14/5/2023	7 days
9	Submission of 2nd Progress	15/5/2023	21/5/2023	7 days
10	Chapter 3: Methodology	22/5/2023	28/5/2023	7 days
11	System Requirement	29/5/2023	4/6/2023	7 days
12	Design the Project	5/6/2023	11/6/2023	7 days
13	Submission of 3rd Progress	12/5/2023	18/6/2023	7 days
14	Preparation for Report and Slide Presentation	19/6/2023	25/6/2023	7 days
15	Presentation of PSM 1	26/6/2023	2/7/2023	7 days

Table 3.4 Milestone PSM 2

No	Task Name	Start Date	End Date	Duration
1	Briefing	2/10/2023	8/10/2023	7 days
2	Project Hardware Setup	9/10/2023	15/10/2023	7 days
3	Chapter 3: Methodology	16/10/2023	22/10/2023	7 days
4	Understanding Existing System	23/10/2023	29/10/2023	7 days
5	Chapter 4: Result	30/10/2023	5/11/2023	7 days
6	Understanding Existing System	6/11/2023	12/11/2023	7 days
7	Submission of 1st Progress	13/11/2023	19/11/2023	7 days
8	Discuss with SV about project	20/11/2023	26/11/2023	7 days
9	Submission of 2nd Progress	27/11/2023	3/12/2023	7 days
10	Chapter 5: Conclusion & Future Work	4/12/2023	10/12/2023	7 days
11	System Requirement	18/12/2023	24/12/2023	7 days
12	Design the Project	25/12/2023	31/12/2023	7 days
13	Submission of 3rd Progress	1/1/2024	7/1/2024	7 days
14	Preparation for Report and Slide Presentation	8/1/2024	14/1/2024	7 days
15	Presentation of PSM 2	15/1/2024	21/1/2024	7 days

3.4 Hardware and Software Development

The project methodology encompasses a collection of fundamental principles that succinctly outline the sequential progression of the project from its initiation to its completion. Below is a comprehensive inventory of the necessary tools needed to successfully carry out the procedure.

3.4.1 UNO R3 Board

Figure 3.2 UNO R3 Board

Figure 3.2 illustrates the widespread popularity of the Atmega328P-based UNO R3 board as a microcontroller board. The Arduino ecosystem relies heavily on this component for prototyping and developing electronic projects.

3.4.2 1602 Display

Figure 3.3 1602 Display

Figure 3.3 depicts a 1602 display, commonly known as a 16x2 character LCD (Liquid Crystal Display). This display module is frequently used to show alphanumeric characters and has a resolution of 16 columns by two rows. The device comprises of an LCD panel that is illuminated from behind and an integrated circuit (IC) that controls the display.

3.4.3 Arduino IIC I2C

Figure 3.4 Arduino IIC I2C

The 2x16 Character LCD is a commonly employed display module for compact controllers like Arduino. Nevertheless, it is important to mention that most of these LCDs employ a parallel interface. Usually, a total of 10 pins are necessary to control or display messages on it. The 8-pin connectors serve the purpose of transmitting data, whereas the Enable and Latch pins have the responsibility of controlling the signal. You will need a 6-pin interface at least to support the 4-bit mode. There is still a substantial reduction in the number of pins. Figure 3.4 depicts an Arduino IIC I2C module designed for LCD, which allows for the efficient utilisation of important pins. This module necessitates solely 2 GPIO pins, specifically I2C pins, for the purpose of transmitting messages to a Character LCD.

3.4.4 Green LED

Figure 3.5 Green LED

Light is released when an electric current passes through the green Light Emitting Diode (LED) shown in Figure 3.5. The color of a green LED is determined by its wavelength, which typically ranges in nanometers. For green LEDs, the wavelength range is typically around 520 to 570 nanometers.

3.4.5 Light Detector

Figure 3.6 LDR

A photoresistor, also known as a light-dependent resistor (LDR) as shown in Figure 3.6, is a resistor that becomes less resistant in the presence of light. As demonstrated by automated car porch lights, it is frequently used to detect whether it is day or night. Since the sensor is nonlinear, it has a resistance of up to 500K ohm when it is not in contact with light. However, when the light is off, the resistance normally falls between 10 and 20K ohm in a typical room. When the light is turned on, the resistance drops to one kiloohm or less.

3.4.6 Resistor 10k ohm

Figure 3.7 Resistor 10k ohm

An electrical component with two terminals that provides electrical resistance is called a resistor, and it is used as a passive circuit element. Resistors are used in electronic circuits for a variety of purposes, including reducing current flow, controlling signal levels, dividing voltages, biassing active components, and ending transmission lines. The BDP was implemented using 10k ohm.

3.4.7 Brown PCB

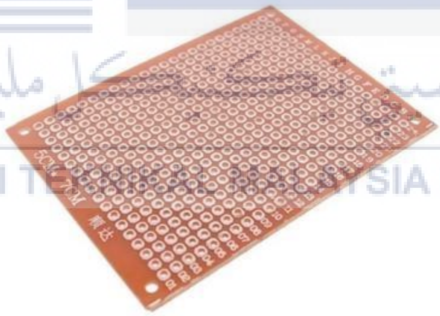

Figure 3.8 Brown PCB

These perforated prototyping boards, measuring 7 by 14.5 cm, are perfect for developing your circuit. On this board, soldering is permitted on both sides. This is a solderable printed circuit board (PCB) made of glass and epoxy, a premium material known as FR4.

3.4.8 Jumper Wires

Figure 3.9 Jumper

A jumper wire is seen in Figure 3.9. It is to connect electronic components on a breadboard or other prototyping platforms temporarily. It's widely used in electronic projects, circuit design, and prototyping.

3.4.9 Glass Beaker

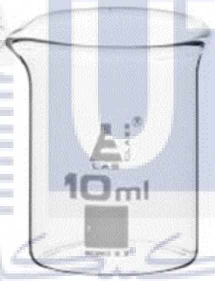

Figure 3.10 Jumper

A 10 ml glass beaker is shown in Figure 3.10. This glass lab jar has a capacity of up to ten millilitres (ml) of liquid. In scientific investigations and other laboratory processes, glass beakers are commonly utilised.

3.4.10 Battery

Figure 3.11 Battery

The 9V Battery Connector has a snap for the battery and a 2.1mm DC jack on the other end. This cable is convenient and ideal for powering your Arduino board with a 9V battery. Positive and negative terminals of the DC barrel plug are on the center pin and outer barrel, respectively. This setup works with Arduino's DC barrel jack. The connector securely holds the battery, which has 110mm cables for positioning without taking up too much enclosure space.

3.4.11 Custom Acrylic Box

Figure 3.12 Custom Acrylic Box

Based on Figure 3.12, a custom acrylic box that was designed for holding the hardware components of my project. The advantage of my project is its portability.

3.4.12 Arduino IDE version 2.1.0

Figure 3.13 Arduino IDE

The Arduino IDE is a software platform that streamlines the process of programming Arduino microcontrollers. The software offers a user-friendly interface for creating, compiling, and transferring code to Arduino boards. The IDE incorporates a code editor that features user-friendly syntax highlighting and error detection. Additionally, it provides a library manager for effortless installation and management of code libraries. The integrated board manager ensures compatibility with a wide range of Arduino boards. The serial monitor enables you to establish communication with the board, monitor sensor readings, and troubleshoot your code. Utilising the upload manager facilitates a straightforward process for uploading your code. The IDE encompasses an extensive repository of exemplary code snippets and instructional materials designed for the purpose of learning and referencing. Debugging tools, such as breakpoints and variable monitoring, facilitate the identification and resolution of code errors. The Arduino IDE, depicted in Figure 3.13, is accessible on various operating systems, is open-source, and caters to users of all skill levels, from beginners to experts.

3.5 Defining Arduino Pins

Table 3.5 Electronic component and Pin attached to Arduino UNO R3

Component	Pin in Arduino Code	Pin Number/Type
LCD I2C Module	0x27	I2C Address
LDR (Light Sensor)	7	Analog Pin
LED	13	Digital Pin

Based from the Table 3.5 above, an LCD I2C module is connected to the Arduino with an I2C address of 0x27. The light-dependent resistor (LDR) is connected to analog pin 7, serving as a sensor to measure light intensity. Additionally, a light-emitting diode (LED) is connected to digital pin 13, and the code includes commands to initialize and control these components. The LCD displays a welcome message and an initialization message upon startup, followed by a loop that continuously reads the analog value from the LDR, converts it to voltage, and then calculates the corresponding dBm value. The results are displayed on the LCD, with a delay of 4 seconds between readings.

3.6 Oil Sample Blending

The process of adjusting the oil concentration level involves a method known as "oil blending," wherein different oil compositions are combined to create specific blends. This technique is widely used in various industries, including manufacturing and pharmaceuticals, to achieve precise oil concentration levels for specific applications. The primary goal of oil blending is to create a homogeneous mixture with the desired properties, ensuring that the end result meets specified requirements. Due to the lack of laboratory equipment, this method is the simplest to implement. Borrowing equipment from other universities proved challenging due to numerous procedures and paperwork requirements.

The procedure involved blending coconut oil and palm oil in five different ratios. The first sample has a 10% concentration level and consists entirely of coconut oil. The second sample contains an 8:2 ratio of coconut oil to palm oil. The third sample uses a 6:4 ratio, with 6 parts coconut oil and 4 parts palm oil. The fourth solution follows a 4:6 ratio, with 4 parts coconut oil and 6 parts palm oil. Finally, the fifth sample follows a 2:8 ratio, with 2 parts coconut oil and 8 parts palm oil.

Based on figure 3.14, the ratios prepared during the oil blending process are meticulously measured on a digital scale to ensure precision. Each component of the ratio represents a specific weight in grams, maintaining a consistent measurement format across all samples. For example, in the 8:2 ratio, 8 parts are allocated to coconut oil and 2 parts to palm oil, resulting in 8 grams of coconut oil and 2 grams of palm oil, respectively. The use of a digital scale improves accuracy, allowing for the creation of desired oil blends at the specified concentration levels. This standardized measuring method is critical for quality control and reproducibility in the oil blending process, ensuring that each sample contains the intended composition and concentration level.

Through this procedure, the varying concentration levels of coconut oil in the oil blends can be visually differentiated by examining the color of the resulting mixture that can be seen on figure 3.15. Pure coconut oil often exhibits a discernible color, and the overall color of a blend may alter depending on the concentration level of coconut oil present. The color can be influenced by various factors, including the existence of additional oils, pigments, or impurities within the constituents. Generally, an increased concentration level of coconut oil can cause the blend to have a lighter or more transparent color, whereas a lower concentration level or the inclusion of other oils may lead to a deeper or darker shade. By analyzing the color of each sample, one can obtain information about the comparative concentration level of coconut oil in the oil blends, serving as a visual indicator of the composition of each mixture. This visual observation provides supplementary information about the properties of the blended oils, complementing the quantitative measurements obtained from ratio and percentage calculations.

Figure 3.14 Digital scale to measure the sample ratio

Figure 3.15 Five sample of different concentration level

3.7 Project Layout

Figure 3.16 shows the project simulation layout. The term "project layout" pertains to the arrangement and organisation of various elements and components within a simulation environment. This layout incorporates the spatial arrangement of objects, machinery, and other critical components, in addition to the physical and virtual aspects of the simulated project. The primary aim of the simulation layout is to mimic or simulate a real-world scenario or system that the project intends to model. This provides a spatial and visual representation of the project, enabling users to engage with and observe the simulated environment.

The simulation layout for the project is illustrated in Figure 3.16. The phenomenon of refraction was documented as the deflection of light as it traversed from one medium of one optical density to another. By examining the LDR readings on the LCD, we determined the concentration level of oil via refraction for this project. The green LED is utilised as a light source to illuminate the coconut oil. The green light-emitting diode (LED) supplied illumination for the various concentration levels of oil. A light dependent resistor (LDR) was employed to measure the light intensity that traversed the coconut oil. The light-dependent reflectometer (LDR) quantified the light's intensity in response to varying oil concentration levels. A 10ml glass beaker was utilised and positioned between the green LED and LDR in order to contain cococnut oil of varying concentration levels. As a microcontroller board, the Arduino Uno was utilised to manage the project. The data obtained from LDR was processed in order to ascertain the concentration level level. Licencing the concentration level readings was an LCD (Liquid Crystal Display).

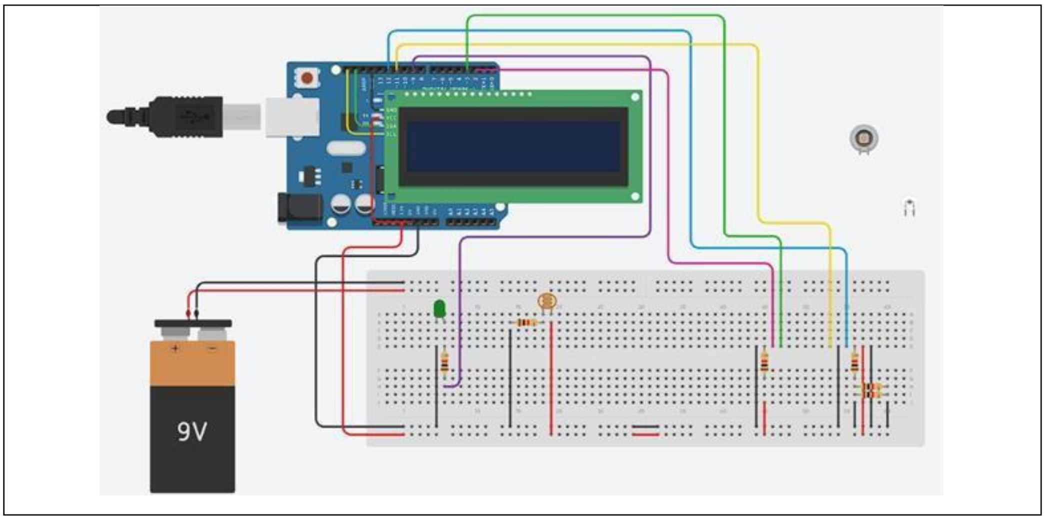

Figure 3.16 Project simulation layout

3.8 System hardware design

Hardware design is one of the planning that needs to be done before implementing the project. When doing this design, the overview of the project will be more understanding and give a clear view on what needs to be done to make sure this project is successful. In the early stage, by having the hardware design, the next step to Consider the following when designing the hardware for a coconut oil concentration level sensor with green LED detection:

System hardware design refers to the process of creating and organizing the physical framework and components of a computer system or electronic device. It entails activities like determining the hardware requirements, selecting the appropriate components, and designing the architecture of the system to achieve the desired functionality and performance goals. Figure 3.17 shows the project's block diagram, which includes the parts and their connections that will be discussed. LEDs were used to illuminate oil samples for analysis. Arduino Uno with an LED wired to a digital pin. LEDs can be turned on and off with the push of a button using an Arduino Uno. The LDR sensor measured the amount of light that penetrated the coconut oil. The Arduino Uno aided in the data analysis process by processing the LDR's analog values.

Project management and data processing were done with an Arduino Uno. The LDR's digital readings were converted to analogue. Arduino Uno processing power calculated the coconut oil concentration level in dBm. In addition, it dynamically controlled LED on/off. Arduino sent those readings to the LCD, which showed the oil sample light reflection. An LCD module displayed concentration level readings graphically. A pin needed to connect the LCD to Arduino Uno. Arduino Uno readings of oil sample light scattering were sent to the LCD display without error. Data was displayed graphically on an LCD.

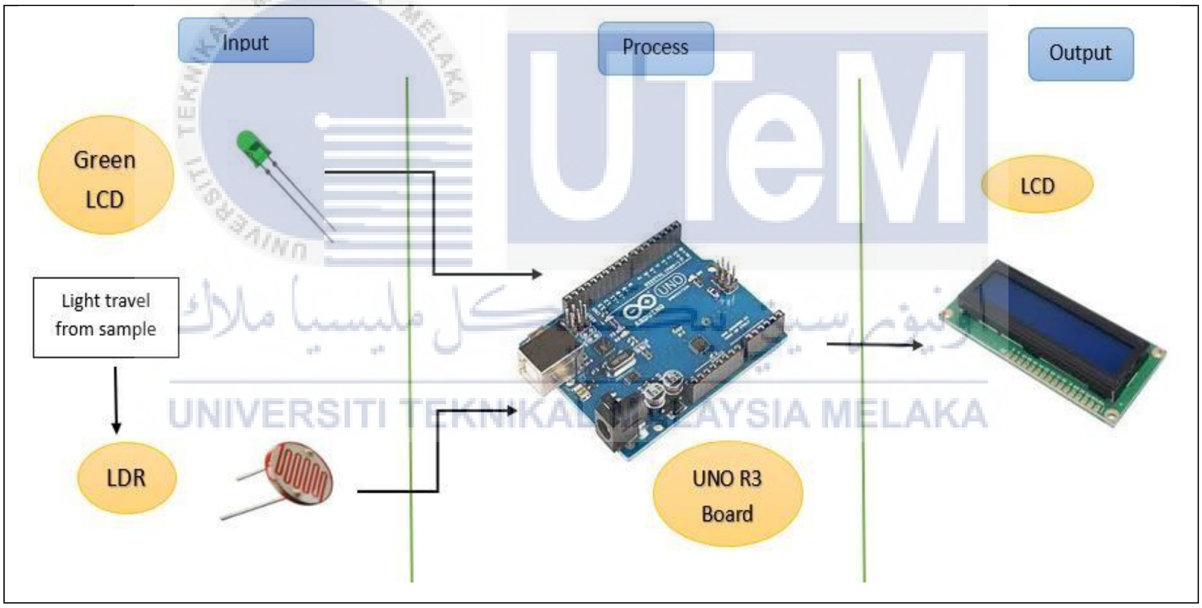

Figure 3.17 Block diagram of the Project

3.9 Flowchart of Coding

A flowchart is a graphical representation that illustrates the sequential steps and their corresponding importance in an algorithm or programme. Various symbols and connections are utilised to illustrate the progression of the code and the points at which decisions are made. Below is a detailed analysis of the flowchart depicted in figure 3.18, which illustrates the coding process. In order to initiate the coding process, it is necessary to specify all the sensors that are LED-based.

Connect the Light Dependent Resistor (LDR) and Liquid Crystal Display (LCD) to their respective pins and select the appropriate library for coding the project. Next, the LED and LDR are initialised to zero in order to prevent potential logical errors that may be difficult to debug at certain times. The green LED emits light towards a 10ml glass beaker containing oil with varying concentration levels. The LDR sensor detects the light emitted from a 10ml glass beaker. Finally, the LCD screen shows the measured value of light travel as detected by the LDR.

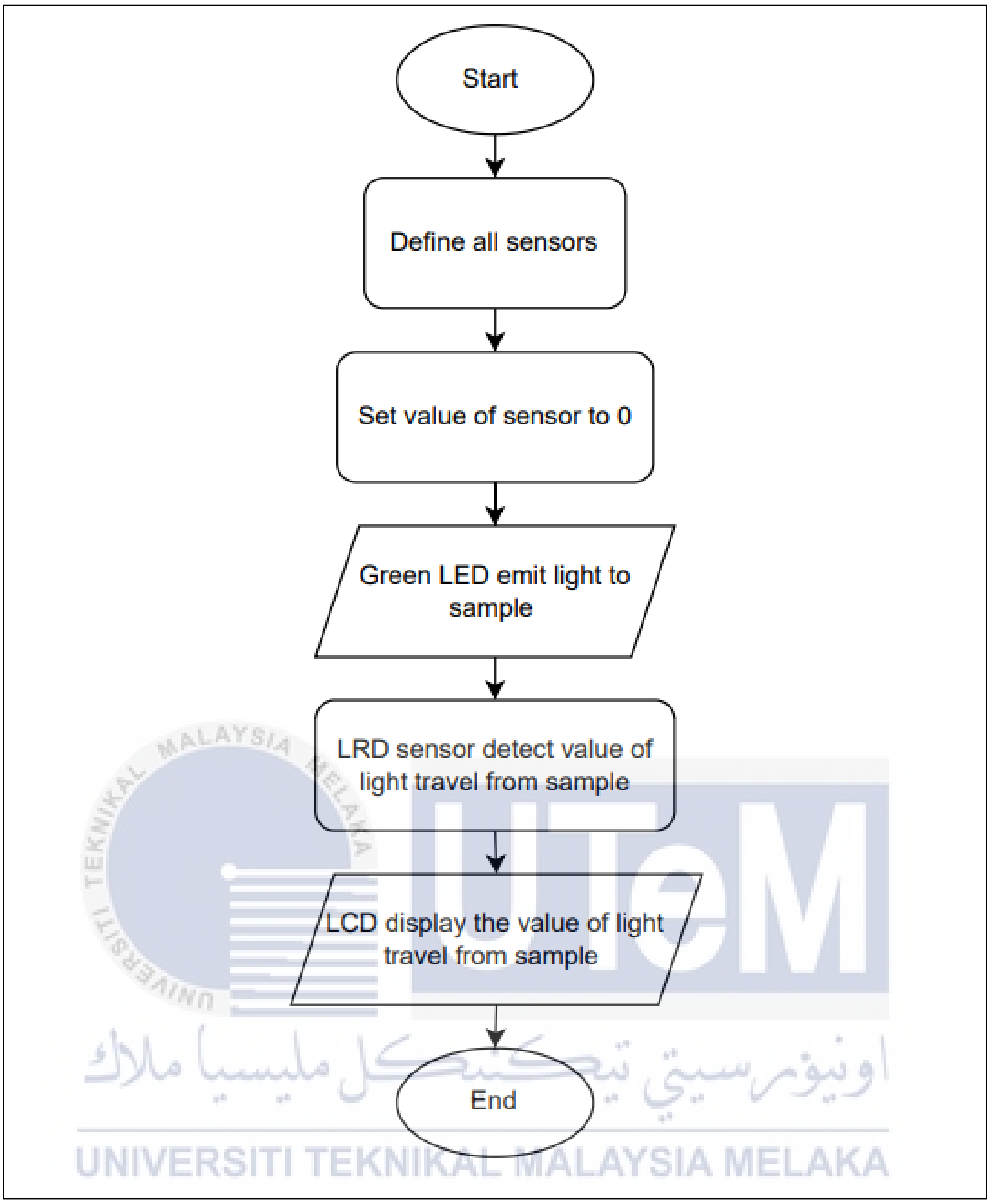

Figure 3.18 Flowchart of the coding

3.10 Project Flowchart

Figure 3.19 depicts a flowchart illustrating the project. Once receiving power, the Arduino UNO will activate the green LED, enabling it to emit light. The LDR will analyze the light sample by passing it through the sample. If a detection occurs, the LCD will exhibit the dBm value of the light that has traveled from the sample. Otherwise, the process will continuously repeat to emit the green LED light.

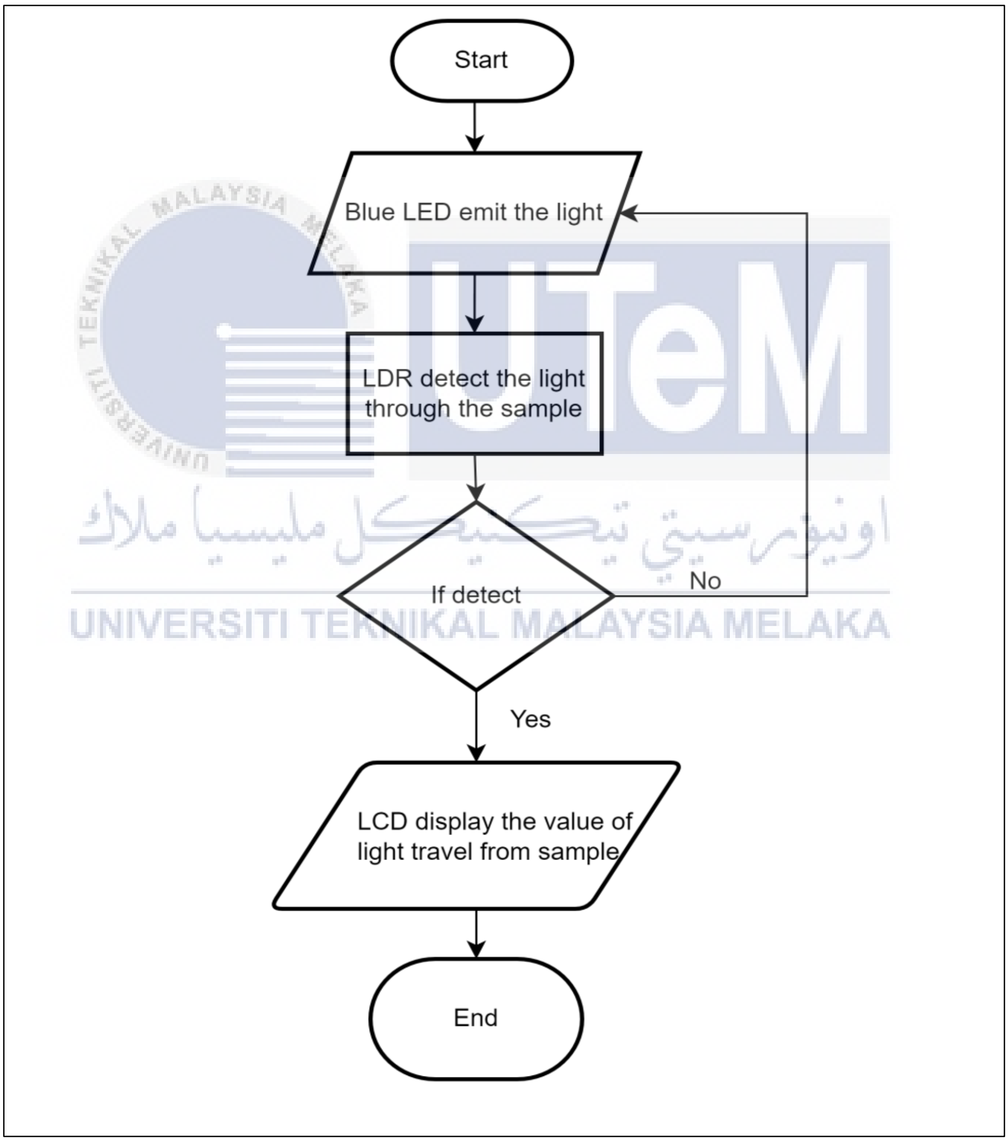

Figure 3.19 Flowchart of the prograrm

3.11 Estimated Cost

The projected cost of the project is presented in Table 3.6. The essential elements required for the project consist of an Arduino Uno R3 microcontroller, a 1602 LCD display, a green light-emitting diode (LED), a 10ml glass beaker, a Light Dependent Resistor (LDR), a jumper wire, a breadboard, transistors with a resistance of 10k ohm, coconut oil, and a custom acrylic enclosure. These components can be purchased on Shopee or at an electronics store. The project necessitates a complete payment of RM 80.90, exclusive of the postage fee, which can be executed via the Shopee website. The overall cost may vary based on whether the transaction occurs in a physical retail location or if there is a sudden electrical malfunction necessitating the replacement of the existing parts. Considering the potential benefits and available resources, the estimated cost of the project is both justifiable and manageable. Moreover, it is significantly more cost-effective than alternative choices, making it a financially efficient option for the project.

Table 3.6 Estimating cost for the project.

NO	COMPONENT	UNIT	PRICE PER UNIT (RM)	PRICE (RM)
1	Coconut oil	1	4.50	5.00
2	UNO R3 Board	1	39.00	39.00
3	1602 Display	1	8.50	8.50
4	Green LED	1	0.20	0.20
5	LDR	1	0.30	0.30
6	Battery	1	4.80	4.80
7	Push Button Switch	1	1.00	1.00
8	PCD breadboard	1	2.00	.00
9	Jumper wires	8	0.20	1.60
10	Resistor (10K ohm)	2	0.10	0.20
11	Glass beaker (10ml)	1	3.30	3.30
12	Custom Acrylic Box	1	15.00	15.00
Total Cost				**80.90**

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 Introduction

The project "Development of Coconut Oil Concentration level via Green LED Detection" has been thoroughly presented and analyzed. Following the phases of hardware testing, software testing, and the comprehensive testing of both software and hardware, the attention now shifts to the examination of outcomes obtained from testing using different oil concentration levels. The data analysis phase is critical for interpreting the overall performance of the green LED sensor and LDR detector.

4.2 Project Prototype

A prototype is an early iteration, model, or version of a product that is created to assess a concept or procedure. Usually, it is used to verify the design and functionality of the product and gather input from end-users before moving forward with large-scale production. Furthermore, it assists in the development of precise requirements for the ultimate product.

The prototype of my project is depicted in Figure 4.2. As shown in the diagram below, an acrylic box has been used to arrange and store all the components, leading to a more organized arrangement. The components were affixed to the storage box using PCB standoff spacers. In addition, a hot glue gun was used to hold on the components at the box and affix the 9V battery holder. The Arduino UNO and battery were placed adjacent to each other to facilitate the power supply. Placing the LCD screen on the outside of the storage box improves the readability of the dBm measurement. The LCD was linked to the Arduino via the IIC I2C protocol, which minimizes the required number of wires by utilizing a two-line SDA and SDC connection. The green Light Emitting Diode (LED) and Light Dependent Resistor (LDR) were affixed to the Printed Circuit Board (PCB). The green LED was connected to a digital pin to determine the presence of either a high or low voltage level, while the LDR was connected to an analogue pin to supply an analogue voltage that can be converted into a digital value. The beaker was placed in the middle of the Light Dependent Resistor (LDR) and the green Light Emitting Diode (LED).

An illustration of the project is provided in the form of a flowchart. The Arduino UNO will turn on the green LED as soon as it is supplied with power, which will result in LED emitting light. Through the process of transmitting light through the sample, the LDR will look at the light sample. Additionally, the dBm value of the light that has propagated from the sample will be displayed on the LCD once it has been detected. As an alternative, the process will continue to emit the green LED light in a repetitive manner.

Figure 4.1 Acrylic board had been drilling and cutting

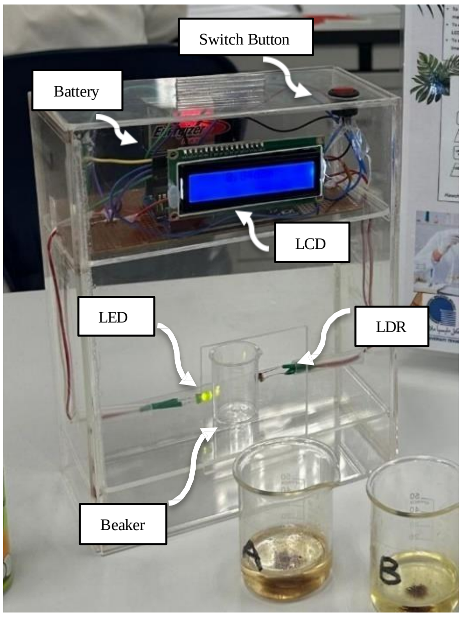

Figure 4.2 The overall view of prototype

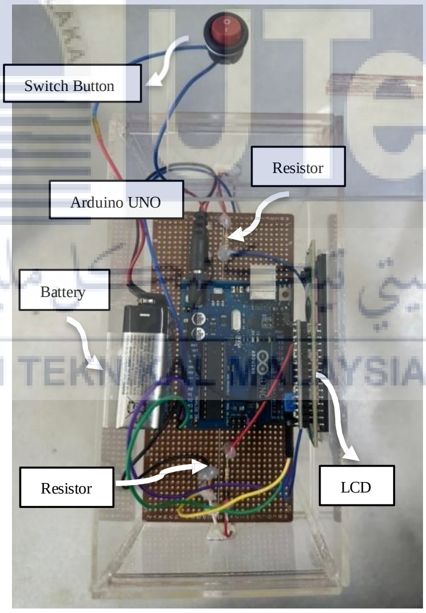

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Figure 4.3 The components inside the arcylic box

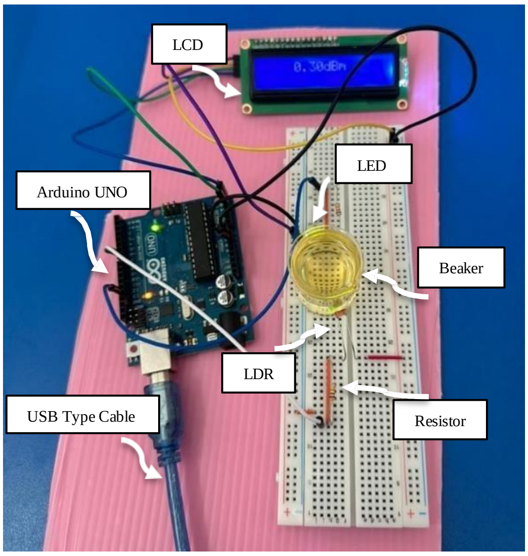

Figure 4.4 Hardware setup for collecting data

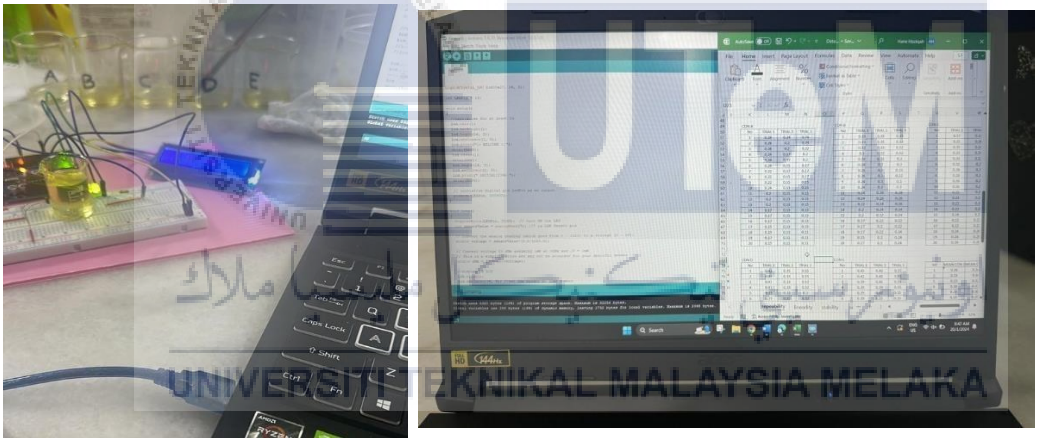

Figure 4.5 The deployment phase of collecting data

4.3 Result

This section talks about how Arduino code initializes and sets up a simple electronic system with an LCD display and a Light Dependent Resistor (LDR) sensor. The LCD is used to provide a welcome message and indicate the initialization process, followed by a loop where the system continuously measures the analog input from the LDR sensor, converts it to a voltage reading, and then calculates the corresponding decibel level (dBm) assuming 1mW at 0dBm. The calculated dBm value is then displayed on the LCD, and the LED connected to pin 13 is turned on simultaneously. This process repeats in a loop, providing real-time feedback on the LDR sensor's light-dependent readings and displaying the dBm value on the LCD screen, with a delay of 4 seconds between each iteration.

Table 4.1 Coding for oil sensor via green LED detection using Arduino UNO

```
#include <Wire.h>
#include <LiquidCrystal_I2C.h>


LiquidCrystal_I2C lcd(0x27, 16, 2);

int LEDPin = 13;

void setup()
{
  //initialise for at least 2s
  lcd.init();
  lcd.backlight();
  lcd.begin(16, 2);
  lcd.setCursor(1, 0);
  lcd.print(":> WELCOME <:");
  delay(5000);
  lcd.clear();
  delay(500);
  lcd.begin(16, 2);
  lcd.setCursor(1, 0);
  lcd.print(" INITIALIZING ");
  delay(8000);
```

```
// initialize digital pin ledPin as an output.
  pinMode(LEDPin, OUTPUT);
}

void loop()
{
  digitalWrite(LEDPin, HIGH);  // turn ON the LED
  int sensorValue = analogRead(7); //7 is LDR Sensor pin

  // Convert the analog reading (which goes from 0 - 1023) to a voltage (0 - 5V):
  double voltage = sensorValue*(5.0/1023.0);

  // Convert voltage to dBm assuming 1mW at 0dBm and 1V = 1mW
  // This is a simplification and may not be accurate for your specific sensor
  double dBm = 10*log10(voltage);

  //display on LCD
  lcd.clear();
  lcd.setCursor(4, 0); //set the cursor to line number
  //lcd.print(voltage);
  //lcd.print("volt");

  lcd.print(dBm);
  lcd.print("dBm");
  delay(4000); //1000ms = 1s
```

Figure 4.6 The data in dBm shown at LCD display

4.4 Analysis

In this section of the chapter provides a detailed account of the results and analysis of the development of a oil sensor that detects concentration level level levels using green LED technology. The project was developed in a sequential manner, following the established methodology. The project will produce three separate categories of graphs, specifically stability, linearity, and repeatability, in order to visually represent the overall performance of the green LED. Every graph employed scattered plotting.

Repeatability refers to the variation that arises when the identical component is measured multiple times using the same instrument. The repeatability graph of this project illustrates the consistent performance of the green LED sensor. It demonstrates the sensor's ability to produce the same output when subjected to identical conditions and exposed to the same input over a prolonged period and across multiple tests. This measures the level of precision demonstrated by the green LED. In order to consistently produce the same output when given the same input, a sensor must have a high level of repeatability. The attribute of high repeatability is greatly sought after in a sensor. In order to determine the repeatability graph for this project, it is essential to carry out the project three times in order to minimize the margin of error.

A linear graph illustrates the direct correlation between two variables on a Cartesian plane, displaying their relationship as a straight line. A linear relationship is characterised by a constant rate of change, where a change of one unit in the independent variable results in a consistent change in the dependent variable. These linear equations also demonstrate these relationships and can assist in determining the information conveyed by the linear graph. The term "linearity" in the context of a graph refers to the degree of correlation between the output response of a green LED sensor and the input.

The input throughout the entire range of operation of the sensor. Doubling the value of the input parameter in an ideal linear green LED sensor will result in a proportional doubling of the output value. The graph allows for the analysis of sensitivity and linearity performance. The sensitivity value, denoted as m, is obtained from the gradient of the line. The variable "m" in the equation $y = mx + c$ represents the slope of the straight line. The linearity of R can be obtained from the equation:

$$\boldsymbol{R^2 = x}$$

$$\boldsymbol{R = \sqrt{x} \times 100\%}$$

Equation 1: Linearity equation

The stability graph is a useful tool for visually representing and distinguishing the various modes of a tested structure. A traditional method for determining the modal parameters is the stability graph. The physical poles (modes) with identical or nearly identical values will indicate the stability of the structure being tested. In this project, "stability" refers to a sensor's ability to maintain its performance parameters consistently over its lifetime. When subjected to a consistent input for an extended period, a stable sensor will exhibit minimal drift in its output. Temperature changes in sensor components are one of the many factors that can affect stability. This project's stability graph will be generated within one hour.

4.5 Sensor performance of Sample A

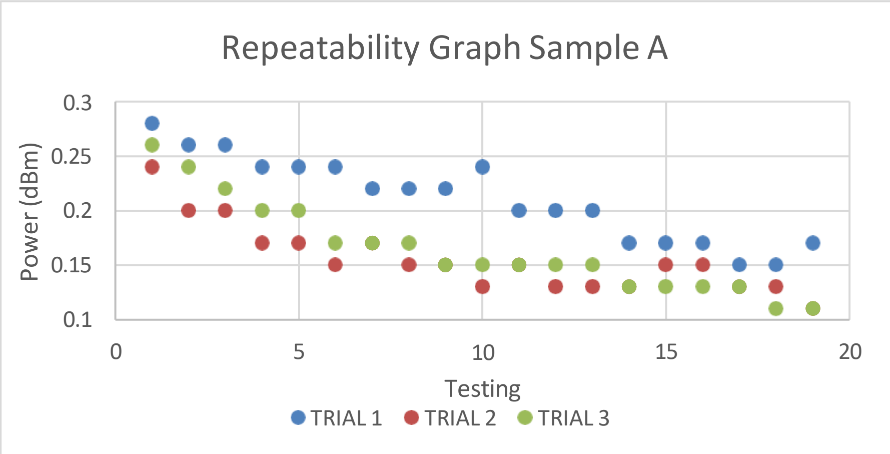

Figure 4.7 Repeatability graph for Sample A

In Trial 1, as shown in Figure 4.7, the power levels are mostly consistent, going from about 0.2 dBm to a high point of about 0.25 dBm. There is a lot of clustering in the data points, which means that this experiment is more consistent and less variable. The trend is going down. There is a clear change in the power values during Trial 2. The very low value is about 0.15 dBm, and the very high value is about 0.2 dBm. Compared to Trial 1, this suggests a wider range of outcomes and maybe less consistency. The trend is stable, with a small rise in the middle. There is some spread in the power values in Trial 3, but not as much as in Trial 2. The lowest value is a little above 0.15 dBm and the highest is a little below 0.25 dBm. This shows a range that includes the values from both trials. The trend is going down. This picture shows a repeatability graph called "Repeatability Graph Sample A." There are lines connecting the colored dots to show what they are. Blue dots show Trial 1, red dots show Trial 2, and green dots show Trial 3. "Testing" is written on the x-axis, which goes from 0 to just above 20. "Power (dBm)" is written on the y-axis, which goes from about 0.10 to 0.30. The power levels in all three trials change during the testing periods, but they change in clear ways.

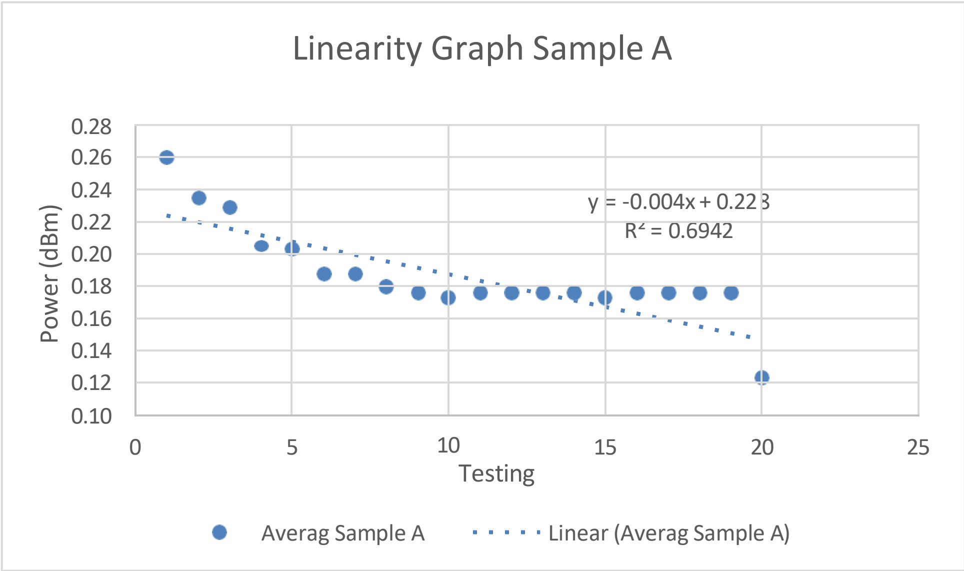

Figure 4.8 Linearity graph for Sample A

The graph depicted in Figure 4.8 represents the mean values derived from the data presented in Figure 4.7. Based on the data presented in Figure 4.7, the experiment exhibited repeatability on three separate occasions. The graph presented in Figure 4.8 represents the average values derived from the repeatability data. Based on the available data, it can be observed that there is a declining tendency in the range of -2.30dBm to -2.67dBm. In this analysis, the performance of sensitivity and linearity is evaluated, yielding values of 0.0004 dBm per percent parts per million (%ppm) and 83.32%, respectively. The average performance of the newly developed sensor in my project is considered satisfactory.

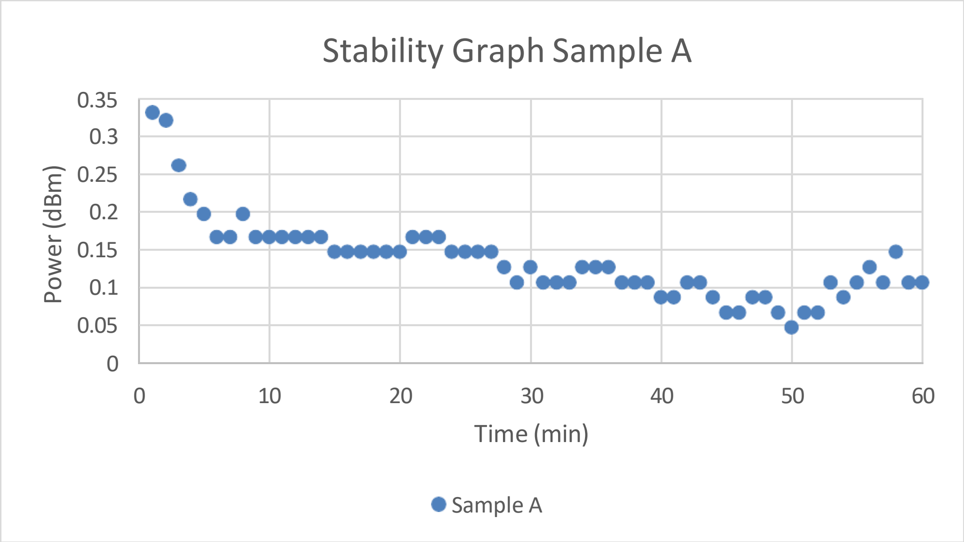

Figure 4.9 Stability Chart for Sample A

The graph depicted in Figure 4.9 represents the mean values derived from the data presented in Figure 4.7. Based on the data presented in Figure 4.7, the experiment exhibited repeatability on three separate occasions. The graph presented in Figure 4.8 represents the average values derived from the repeatability data. Based on the available data, it can be observed that there is a declining tendency in the range of 0.26 dBm to 0.14 dBm. In this analysis, the performance of sensitivity and linearity is evaluated, yielding values of 0.0111 dBm per percent parts per million (%ppm) and 83.32%, respectively. The average performance of the newly developed sensor in my project is considered satisfactory.

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4.6 Sensor performance of Sample B

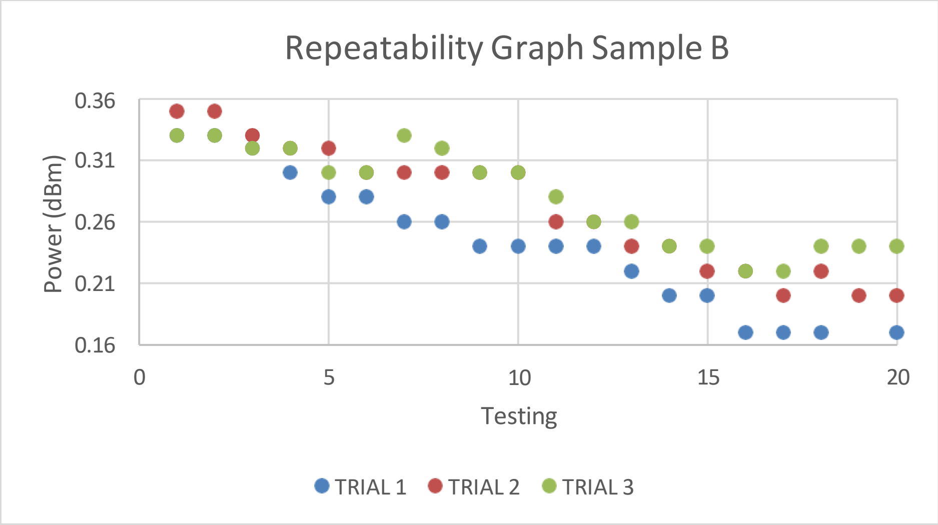

Figure 4.10 Repeatability Chart for Sample B

In Trial 1, the graph shows a decreasing trend with lower values towards the end of the testing period. It starts at about 0.31 dBm and ends at about 0.26 dBm. In Trial 2, the data shows a consistent decreasing trend, beginning at the highest starting point of approximately 0.36 dBm and decreasing to approximately 0.31 dBm. Trial 3 begins with a starting value of roughly 0.21 dBm and increases slightly to about 0.26 dBm by the fifth test. Thereafter, there is a decrease, and the value stabilizes at roughly 0.21 dBm near the end of testing. Trial 3 shows a slight initial increase but overall, a stable trend. These three trials, which followed different trends and had varying power levels throughout the testing periods, are depicted in the accompanying "Repeatability Graph Sample B". "Testing" is represented by the x-axis, which runs from zero to twenty, and "Power (dBm)" is represented by the y-axis, which has values roughly between 0.16 and 0.36.

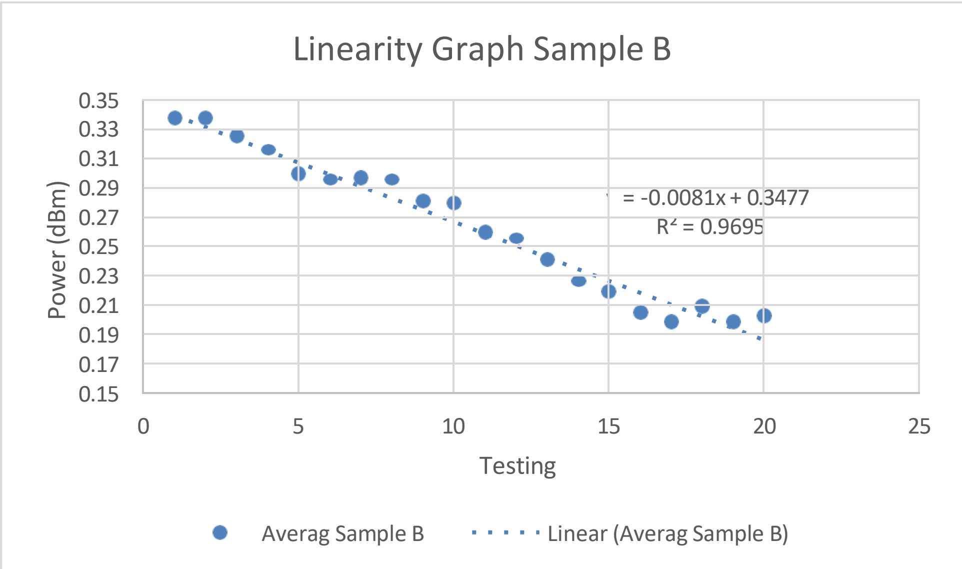

Figure 4.11 Linearity Chart for Sample B

The Figure 4.11 graph represents the mean value derived from the data shown in the Figure 4.10 graph. The Figure 4.10 graph provided three instances of experimental reproducibility. The Figure 4.11 graph represents the mean value of the repeatability data. Based on the available data, it can be observed that there is a downward tendency in the values, specifically ranging from 0.35 dBm to 0.19 dBm. In this analysis, the performance of sensitivity and linearity is examined, yielding values of 0.0081 dBm per percent parts per million (%ppm) and 98.46%, respectively. This signifies that it is the greatest average value achieved in the development of the new sensor within my project.

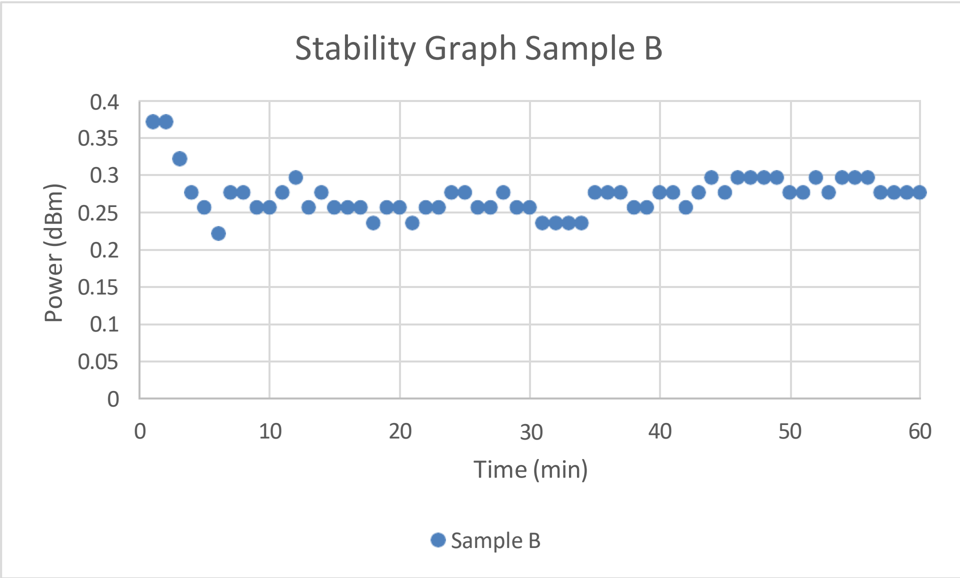

Figure 4.12 Stability Chart for Sample B

The graph titled “Stability Graph” plots Power (dBm) against Time (minutes) for Sample B. Initially, the power is at its highest point of approximately 0.35 dBm at 0 minutes. It then decreases sharply to stabilize around 0.3 dBm from about 20 minutes onwards. The highest stable point is at the start, around 0.35 dBm, and the lowest stable point is at approximately 0.3 dBm from minute 20 onwards. The trends show that the power levels decrease sharply at the beginning of the experiment and then stabilize around a lower level for about 20 minutes. After this period, the power levels remain relatively stable. The graph shows that the power levels for each trial are within a narrow range, suggesting that the experiment is precise.

4.7 Sensor performance of Sample C

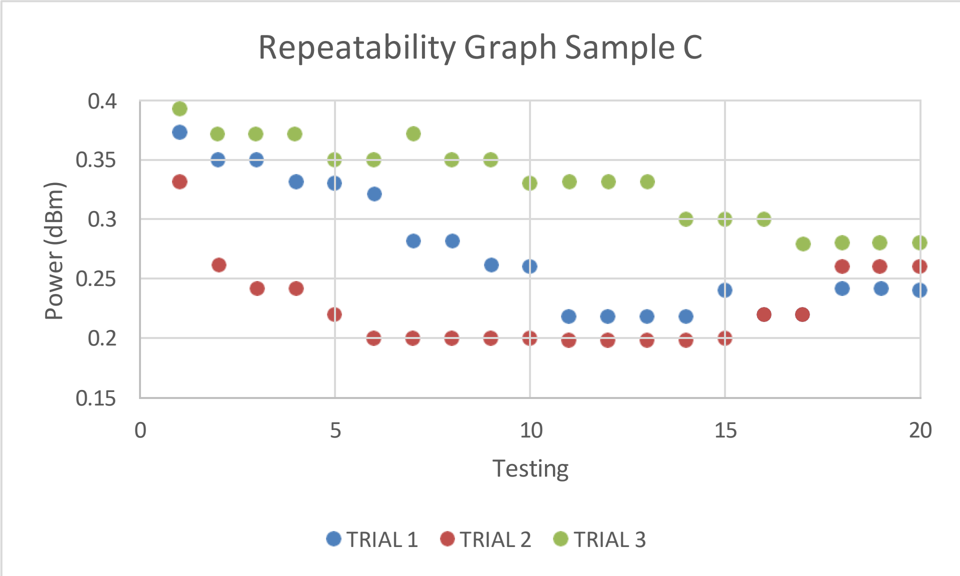

Figure 4.13 Repeatability Chart for Sample C

The "Repeatability Graph Sample C" shows that Trial 1 follows a consistent pattern with small variations, starting and ending at around 0.3 dBm. This suggests that there is no notable change in power during the testing process. Meanwhile, Trial 2 begins at approximately 0.25 dBm and shows a declining pattern, reaching slightly above 0.2 dBm by the conclusion of the testing period. Conversely, Trial 3 commences at approximately 0.35 dBm and sustains a consistent power level throughout the testing, devoid of any discernible increments or decrements. The graph visually depicts the trials, where the x-axis represents "Testing" ranging from 0 to around 20, and the y-axis represents "Power (dBm)" with values ranging approximately from 0.15 to nearly 0.4. Every trial exhibit unique patterns, demonstrating fluctuations in power levels throughout the testing periods.

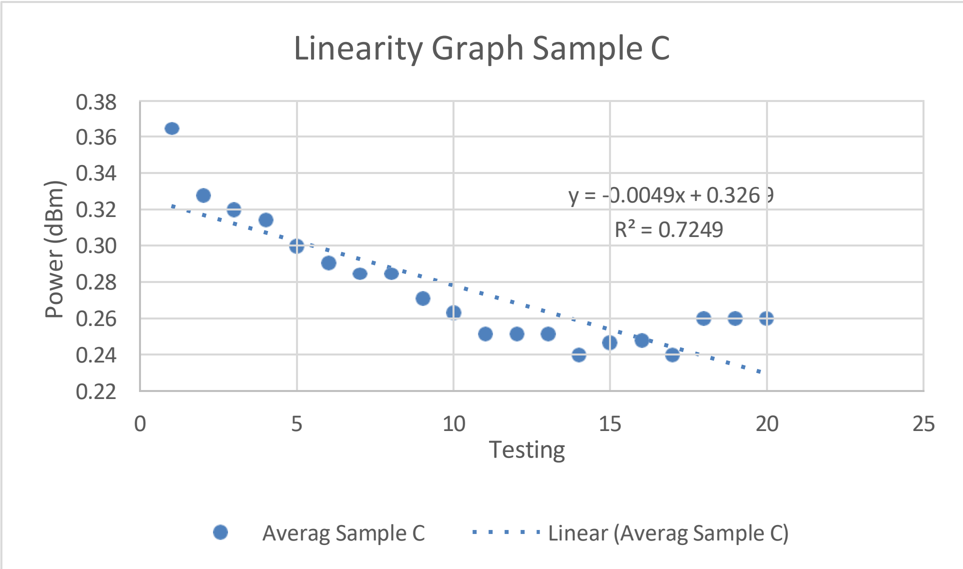

Figure 4.14 Linearity Chart for Sample C

The Figure 4.14 graph represents the mean value derived from the Figure 4.13 graph. Based on the data presented in Figure 4.13, the experiment was repeated three times, demonstrating repeatability. The graph labelled Figure 4.14 represents the average values derived from the repeatability data. Based on the available data, it can be observed that there is a downward trend in the values, specifically from 0.36 dBm to 0.24 dBm. In this analysis, the performance of sensitivity and linearity is examined, yielding values of 0.0049 dBm per percent parts per million (ppm) and 85.14%, respectively. The average performance of the new sensor development in my project is relatively low.

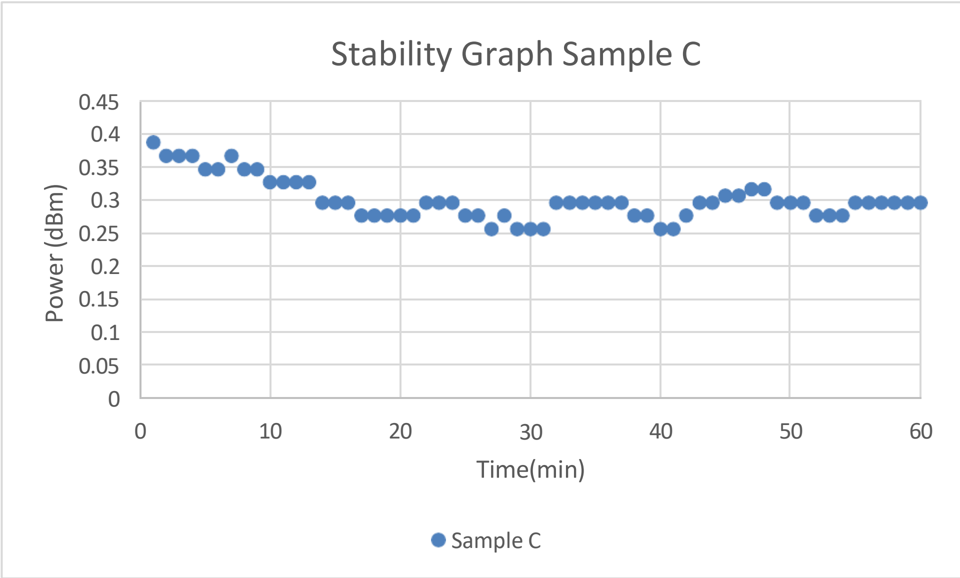

Figure 4.15 Stability Chart for Sample C

The graph titled "Stability Graph" plots Power (dBm) against Time (minutes) for Sample C. Initially, the power is at its highest point of approximately 0.4 dBm and remains stable for the first 20 minutes. It then experiences a sharp decline to reach its lowest point of about 0.25 dBm at around the 30-minute mark. After this point, the power begins to increase slightly and stabilizes again around 0.35 dBm for the remaining duration. The trends show that the power levels decrease sharply at the beginning of the experiment and then stabilize around a lower level for about 20 minutes. After this period, the power levels remain relatively stable. The graph shows that the power levels for each trial are within a narrow range, suggesting that the experiment is precise.

4.8 Sensor performance of Sample D

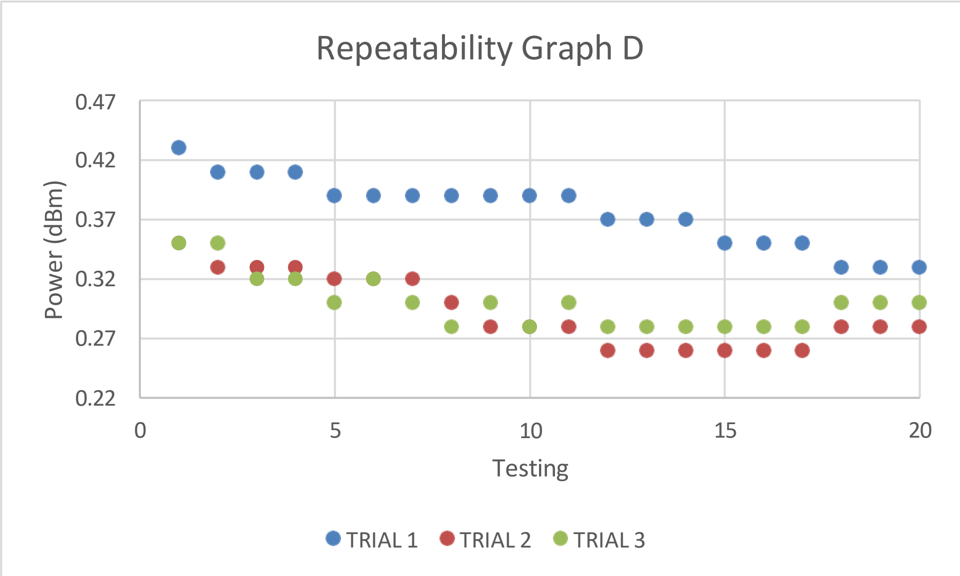

Figure 4.16 Repeatability Chart for Sample D

In "Repeatability Graph D," Trial 1 commences at a power level of around 0.42 dBm and remains consistent throughout the duration of the testing period. It demonstrates a stable pattern with no notable rise or decline. The second trial commences at approximately 0.32 dBm and exhibits a marginal decline in power throughout the testing process, culminating near 0.30 dBm, suggesting a downward trend. Trial 3 commences at approximately 0.27 dBm and exhibits a more prominent downward trend compared to Trial 2, concluding around 0.25 dBm. The graph visually depicts the trials using blue, red, and green dots that are connected by lines. The x-axis represents the variable "Testing" with a range from 0 to slightly above 20, while the y-axis corresponds to "Power (dBm)" with values ranging approximately from 0.22 to slightly below 0.47. Each of the three trials exhibits fluctuations in power levels over the course of the testing periods, adhering to specific patterns.

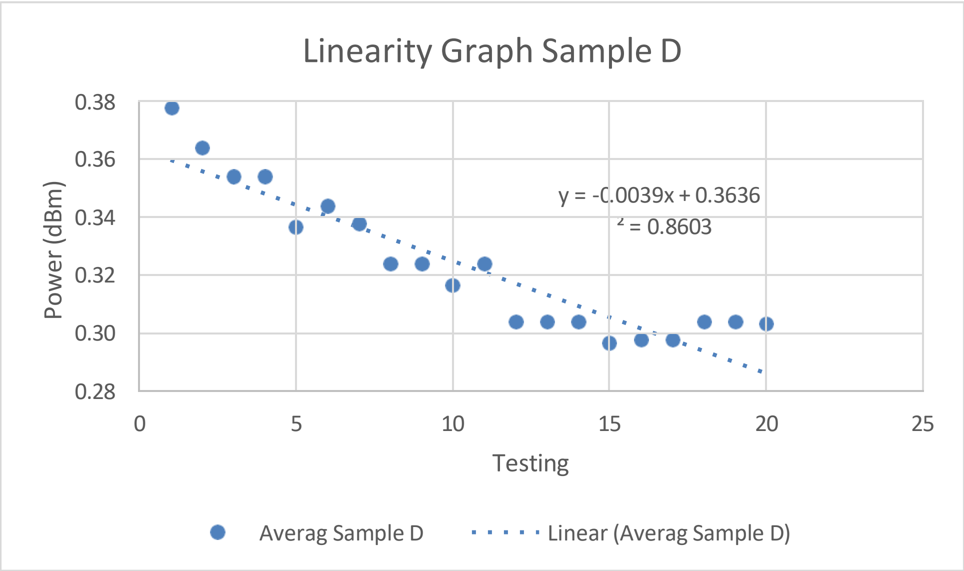

Figure 4.17 Linearity Chart for Sample D

The Figure 4.17 graph represents the mean value derived from the Figure 4.16 graph. The graph in Figure 4.16 demonstrates the repeatability of the experiment, which was observed three times. The graph labelled Figure 4.17 displays the average values derived from the repeatability data. Based on the available data, it can be observed that there is an upward trend in the values, starting from 0.36 dBm and progressing to 0.28 dBm. In this analysis, the performance of sensitivity and linearity is examined. The sensitivity is found to be 0.0039 dBm per percent parts per million (%ppm), while the linearity is determined to be 92.75%. The average performance of the newly developed sensor in my project is considered satisfactory.

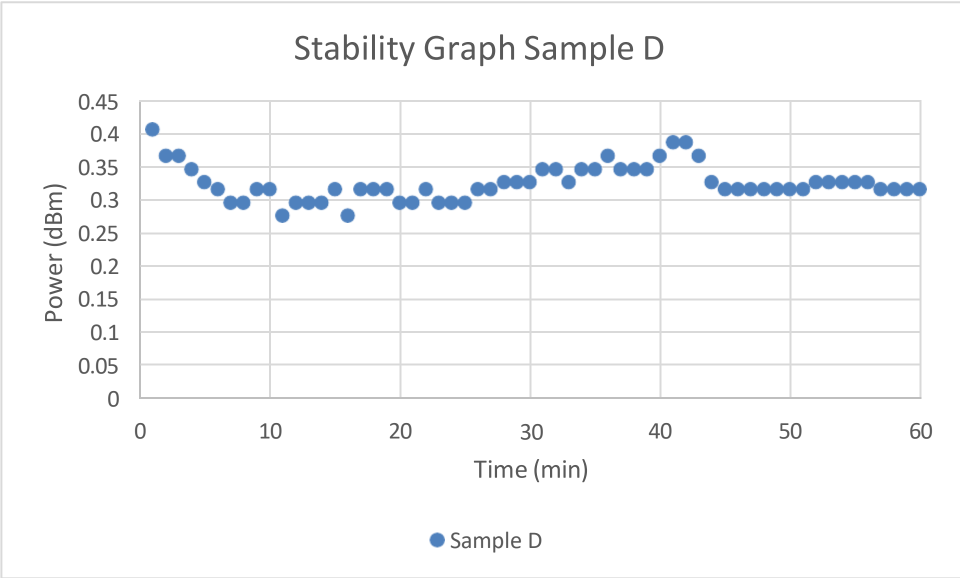

Figure 4.18 Stability Chart for Sample D

The graph titled “Stability Graph” plots Power (dBm) against Time (minutes) for Sample D. Initially, the power is at its highest point of approximately 0.4 dBm and remains stable for the first 20 minutes. It then experiences a sharp decline to reach its lowest point of about 0.25 dBm at around the 30-minute mark. After this point, the power begins to increase slightly and stabilizes again around 0.35 dBm for the remaining duration. The trends show that the power levels decrease sharply at the beginning of the experiment and then stabilize around a lower level for about 20 minutes. After this period, the power levels remain relatively stable. The graph shows that the power levels for each trial are within a narrow range, suggesting that the experiment is precise.

4.9 Sensor performance of Sample E

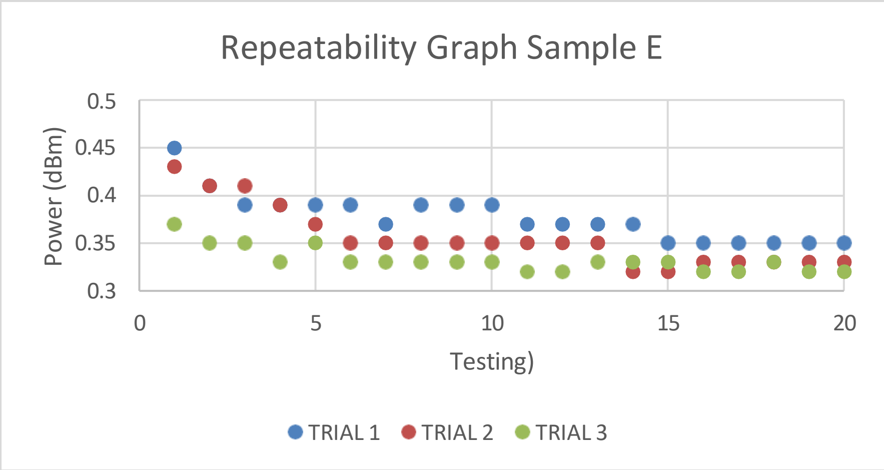

Figure 4.19 Repeatability Chart for Sample E

As shown in "Repeatability Graph Sample E," Trial 1 (Blue) commences at a relatively high value of around 0.45 dBm and displays a discernible decline over the course of the experiment, eventually stabilising at approximately 0.35 dBm. A decline in power is indicated by the values that have decreased steadily throughout the testing period. Trial 2, denoted in red, commences at an approximate value of 0.32 dBm and exhibits a less abrupt, incremental decline in magnitude in comparison to Trial 1. It maintains a relatively constant power level throughout the test, stabilising more rapidly. Trial 3 (Green) commences with an initial value of approximately 0.35 dBm, which signifies the minimum value. Despite minor fluctuations, the power level remains relatively constant throughout the duration of the testing process. These trials are graphically represented on the graph by lines connecting blue, red, and green dots. The variable "Testing" is represented along the x-axis from 0 to just over 20, while "Power (dBm)" is denoted along the y-axis with values ranging approximately from 0.3 to 0.5. Varying power levels are observed in all three trials during the testing periods, with each trial following a unique pattern.

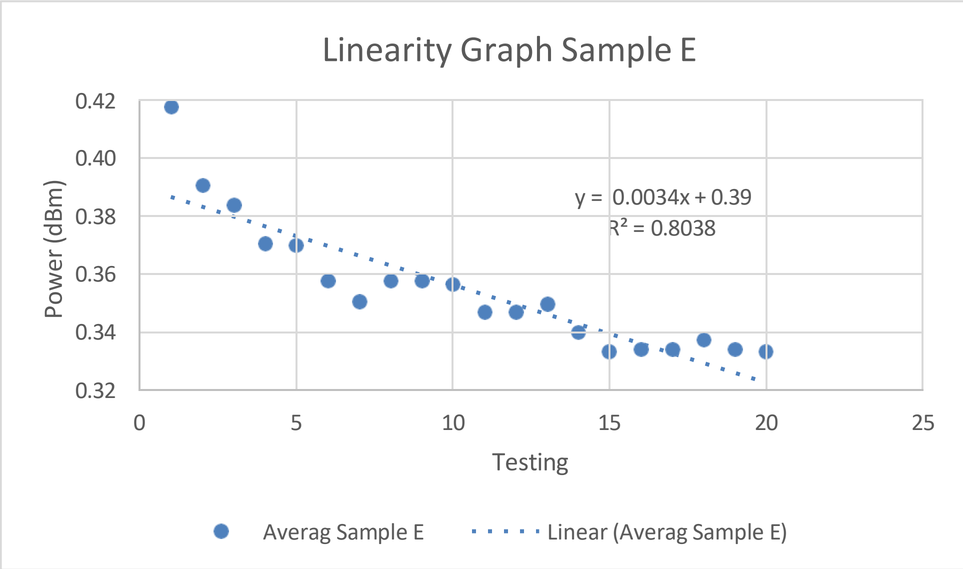

Figure 4.20 Linearity Chart for Sample E

The graph labelled Figure 4.20 represents the mean value derived from the data shown in the graph labelled Figure 4.19. The graph presented in Figure 4.19 demonstrates the reproducibility of the experiment, which was observed to occur three times. The graph labelled as Figure 4.20 represents the average values obtained from the repeatability data. Based on the available data, it can be observed that there is a downward tendency in the values, specifically ranging from 0.42 dBm to 0.32 dBm at the time 0 to 140 seconds . In this analysis, the performance of sensitivity and linearity is examined, yielding values of 0.0034 dBm per percent parts per million (%ppm) and 89.65%, respectively. The average performance of the newly developed sensor in my project is considered satisfactory.

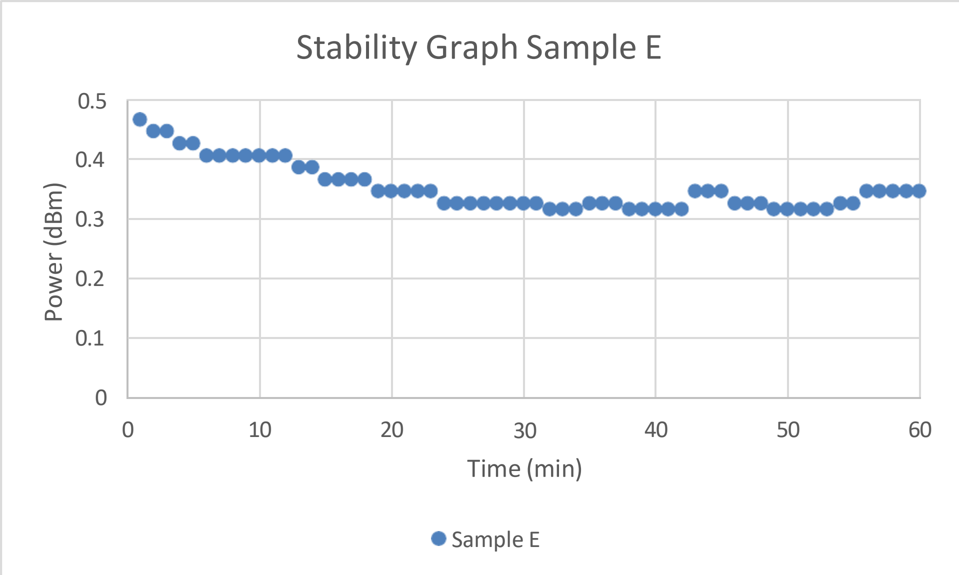

Figure 4.21 Stability Chart for Sample E

The graph titled "Stability Graph" plots Power (dBm) against Time (minutes). Initially, there is a sharp decline in power from 0 to approximately 10 minutes, where it stabilizes around the 0.3 dBm mark. The power remains relatively constant from this point onwards until 60 minutes. The highest point is at the start, around 0.5 dBm, and the lowest stable point is around 0.3 dBm from approximately 10 to 60 minutes. The trends show that the power levels decrease sharply at the beginning of the experiment and then stabilize around a lower level for about 10 minutes. After this period, the power levels remain relatively stable. The graph shows that the power levels for each trial are within a narrow range, suggesting that the experiment is precise.

4.10 Summary

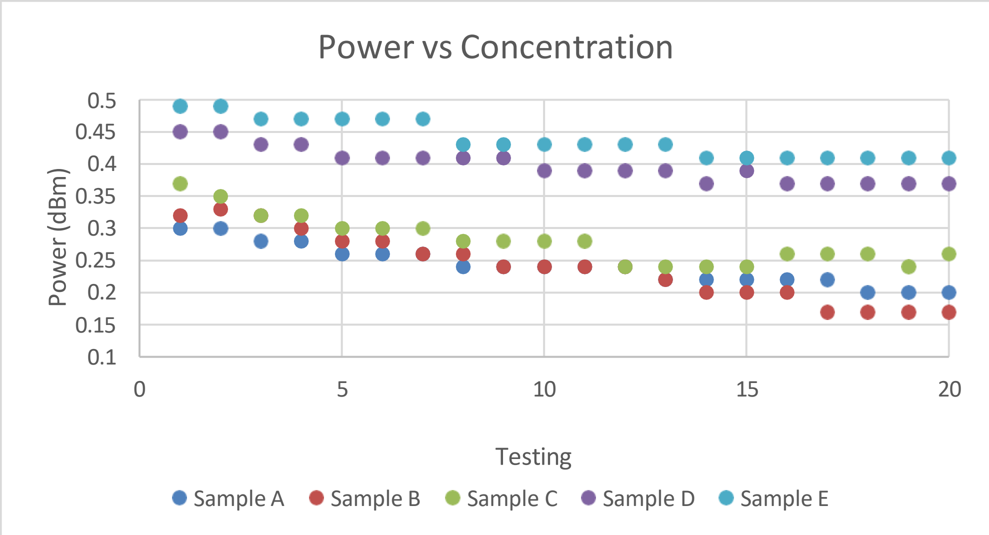

Figure 4.22 Power verse Concentration

The "Power vs. Concentration level" graph shows how five distinct samples A to sample E hold their power levels throughout testing. Over the testing range, Sample A progressively loses power, beginning at about 0.45 dBm. With minor oscillations, Sample B starts out at about 0.25 dBm and keeps it there most of the time. As testing goes on, Sample C, which started at roughly 0.35 dBm, shows a small drop. Throughout the test, Sample D's initial level is kept at or near 0.5 dBm. When compared to the other samples, Sample E exhibits the highest degree of stability, consistently maintaining a power level of approximately 0.4 dBm throughout testing at all concentration levels. This indicates minimal variation. Labelled "Testing," the x-axis extends from 0 to 20 and the y-axis, labelled "Power (dBm)," from 0 to 0.5 dBm.

4.11 Enhancing Precision

In this analysis, the performance of sensitivity and linearity is assessed through the evaluation of the slope (*m*) in the linear equation *y*=*mx*+*c*, where *y* represents a measured quantity, *x* represents an independent variable, and *c* is the y-intercept that have showed in Linearity graph. The obtained slope (*m*) is then used to convert the measurements into units of decibels per percent parts per million (%ppm). This conversion reflects the relationship between the measured quantity and the independent variable in terms of dBm per %ppm, providing a standardized measure that incorporates sensitivity and linearity considerations for a more meaningful assessment of performance.

$$\boldsymbol{y = mx + c}$$
$$\boldsymbol{R^2 = x}$$
$$\boldsymbol{R = \sqrt{x} \times 100\%}$$

Equation 2: Linearity equation

- The value R for Linearity graph for Sample A

$$R = \sqrt{0.694} \times 100$$
$$= 0.833 \times 100$$
$$= 83.32\%$$

- The value R for Linearity graph for Sample B

$$R = \sqrt{0.9695} \times 100$$
$$= 0.9846 \times 100$$
$$= 98.46\%$$

- The value R for Linearity graph for Sample C

$$R = \sqrt{0.7249} \times 100$$
$$= 0.8514 \times 100$$
$$= 85.14\%$$

- The value R for Linearity graph for Sample D

$$\boldsymbol{R} = \sqrt{\mathbf{0.8603}} \times \mathbf{100}$$

$$= \boldsymbol{0.9275} \times \mathbf{100}$$

$$= \boldsymbol{92.75}\%$$

- The value R for Linearity graph for Sample E

$$\boldsymbol{R} = \sqrt{\mathbf{0.8038}} \times \mathbf{100}$$

$$= \boldsymbol{0.8965} \times \mathbf{100}$$

$$= \boldsymbol{89.65}\%$$

In summary, the R values for linearity graphs of Samples A, B, C, D, and E are 83.32%, 98.46%, 85.14%, 92.75%, and 89.65%, respectively. The highest linearity, indicated by Sample B with a value of 98.46%, suggests a strong correlation between the measured variable and coconut oil concentration level. In practical terms, this implies that changes in coconut oil concentration level have a more predictable and linear impact on the measured quantity for Sample B compared to the other samples. Therefore, Sample B may be considered as having a more reliable and consistent response to variations in coconut oil concentration level, making it potentially favorable for applications where precise and linear measurement of coconut oil content is crucial.

4.12 Limitation of project

This project faces several limitations that may impact the reliability and precision of the sensor readings for coconut oil concentration level. External light sources in the testing environment could introduce inaccuracies, necessitating the implementation of shielding or compensation mechanisms to mitigate the influence of ambient light. Frequent readings may be required to sustain accuracy, with changes in environmental conditions or sensor aging potentially affecting accuracy and leading to inaccurate concentration level measurements. The sensitivity of the LDRs to specific wavelengths, especially if the green LED used for detection falls outside the optimal range, poses a risk to measurement accuracy. Additionally, the slower response time of LDRs compared to other light sensors may be a concern in applications requiring rapid detection of concentration level changes. Ensuring long-term stability is crucial, considering factors such as sensor degradation, wear and tear, or variations in LED intensity, which could compromise the overall reliability of the device over an extended period.

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CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.0 Introduction

The conclusion that is drawn from the project's results will be explained in the chapter that follows. This report section will provide a conclusion in line with the tasks of the Bachelor Degree Project (BDP I and II).

5.1 Chapter 2

In Chapter 2, the concentration level of coconut oil is examined using multiple research approaches and methodologies. The text provides an overview of oil concentration level, elucidating its fundamental principles, environmental and human health implications, and diverse measurement methods for coconut oil. This chapter examines the use of sensors, lasers, light-emitting diodes (LEDs), and Arduino-based devices for refractive index measurements. The goal of the analysis is to find the best strategy for given circumstances by weighing the benefits and drawbacks of each method. Based on the results in Chapter 2, the project chooses LEDs over lasers despite the latter's inherent limitations because the former better fits the project's goals and the problem statement. The conclusion underscores the crucial importance of employing the right instruments and methodologies for the accurate development of the concentration level oil sensor using green LEDs.

5.2 Chapter 3

The third chapter is devoted to the first objective, which is to develop an LDR sensor for detecting the concentration level of coconut oil. The project's primary light source was a green LED, which was employed to illuminate oil samples. An Arduino Uno was controlled by digital information. An LDR sensor measured the quantity of light that traversed the oil. The Arduino Uno subsequently performed data analysis using these analog values. The principal microcontroller, an Arduino Uno, managed the LED and calculated concentration level level levels using LDR data. The power value (dBm) of the concentration level level readings on an LCD was determined using the Arduino-sent measurements of the refracted light from the oil samples. This seamless connection between the LCD and the Arduino Uno enabled the data to be displayed clearly, which facilitated access to the project's results. Furthermore, this chapter also addresses the second objective, which is to develop a measurement setup that is both economical and easy for users to comprehend. To achieve this, concentrate on choosing inexpensive components, such as open-source hardware and sensors, streamlining the design process, and employing easily accessible materials. To ensure intuitive operation, integrate a user-friendly interface that includes explicit instructions. Adopt a do-it-yourself methodology that promotes user participation in the assembly or modification of the setup.

5.3 Chapter 4

In conclusion, the development of a coconut oil concentration level sensor using green LED detection holds great promise for advancements in sensor technology. The use of green LED-based methods is expected to provide an accurate, non-invasive, and cost-effective approach for measuring coconut oil concentration level with improved sensitivity and specificity. These anticipated results suggest potential applications in industries such as food processing, cosmetics, and pharmaceuticals, which would streamline quality control and formulation processes. However, challenges related to precise accuracy, management of environmental influences, and practical scalability may affect these expected outcomes. Future research should focus on improving sensor performance, refining accuracy techniques, and addressing limitations to ensure the applicability of these anticipated results in real-world scenarios. Overall, these expected results represent a significant step forward in sustainable sensing technologies, offering innovative solutions for measuring coconut oil concentration level using green LED detection in various industrial fields.

5.4 Potential for Commercialization

In summary, the green LED, when utilized as a sensor for detecting various coconut oil samples through the development of an oil concentration level level sensor via green LED detections project, offers a cost-effective solution that enhances accessibility, aligning with Sustainable Development Goal 6 (SDG 6) for universal access to and sustainable management of oil and sanitation. However, limitations, such as excessive heat affecting stability graph data and inaccuracies in refracted light measurements, highlight areas for improvement. Future enhancements could involve expanding the environmental circumstances under which the green LED-based coconut oil concentration level sensor operates effectively.

As for future work, the system can undergo further improvements, evolving into a comprehensive solution for monitoring and assessing different types of plants oils. Collaborations with industry partners, regulatory bodies, and certification organizations are crucial to ensure compliance with industry standards, fostering integration into established quality control processes. Exploring advancements in another type of green light and other light sensor technologies may lead to a more versatile and accurate detection system for a broader range of oils. The continuous development of such innovative solutions has the potential to revolutionize oil quality assessment, benefiting health-conscious consumers and various industries.

5.5 Recommendations

Several suggestions are made to address the project's identified limitations. First, to reduce the effect of outside light sources on sensor accuracy, put in place efficient shielding or compensation mechanisms. To guarantee continued accuracy, calibrate the sensor on a regular basis which is only focused to green LED light, accounting for potential ageing of the sensor and changes in the surrounding environment. To improve measurement accuracy, determine the LDRs' ideal wavelength sensitivity range and choose LEDs that fall within it. If quick detection of concentration level changes is essential for the application, take into account alternative light sensors with quicker response times. Make sensor stability a top priority by keeping an eye on and addressing elements like deterioration, wear and tear, and long-term changes in LED intensity. Establish a thorough maintenance plan as well to take care of sensor accuracy and possible component replacements, guaranteeing the accuracy and dependability of readings for coconut oil concentration level throughout the project's duration.

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