

Faculty of Electrical and Electronic Engineering Technology



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

ADIB ZIKRY BIN ABDUL KASIMIN

Bachelor of Electrical Engineering Technology (Industrial Power) with Honours

2023

DEVELOPMENT OF KUIH BAHULU BATTER DISPENSER VIA ELECTRICAL MACHINE WITH LOW POWER CONSUMPTION

ADIB ZIKRY BIN ABDUL KASIMIN

A project report submitted in partial fulfillment of the requirements for the degree of Bachelor of Electronics Engineering Technology with Honours



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2023

DECLARATION

I declare that this project report entitled "Development Of Kuih Bahulu Batter Dispenser Via Electrical Machine With Low Power Consumption" is the result of my own research except as cited in the references. The project report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

AYSI. Signature ADIB ZIKRY BIN ABDUL KASIMIN Student Name 20/01/2023 Date UNIVERSITI TEKNIKAL MALAYSIA MELAKA

APPROVAL

I approve that this Bachelor Degree Project 2 (PSM2) report entitled "Development of Kuih Bahulu Batter Dispenser Via Electrical Machine With Low Power Consumption" is sufficient for submission.

Signature	IR. DR. MOHD FARRIZ BIN BASAR Timbalan Dekan (Penyelidikan dan Jaringan Industri) Fakulti Teknologi Kejuruteraan Elektrik & Elektronik Universiti Teknikal Malaysia Malaka (UTEM)	
Supervisor Name	: IR. DR. MOHD FARRIZ BIN HJ MD BASAR	
S.		
Date		
ملاك	اونيۈمرسىيتى تيكنيكل مليسيا	
UNIVER	RSITI TEKNIKAL MALAYSIA MELAKA	

APPROVAL

I hereby declare that I have checked this project report and in my opinion, this project report is adequate in terms of scope and quality for the award of the degree of Bachelor of Electrical Engineering Technology with Honours(Indusrtial Power).

Signature :	IR. DR. MOHD FARRIZ BIN BASAR Timbalan Dekan (Penyelidikan dan Jaringan Industri) Fakulti Teknologi Kejuruteraan Elektrik & Elektronik Universiti Teknikal Malaysia Melaka (UTeM)
Supervisor Name :	IR. TS. DR. MOHD FARRIZ BIN HJ MD BASAR
- K	
Date :	20/01/2023
E	
NILLER	
Signature بالك	اونيۆم سيتى تيكنيكل مليس
Co-Supervisor	SITI TEKNIKAL MALAYSIA MELAKA
Name (if any)	
Date :	

DEDICATION

To my beloved parents Mr. Abdul Kasimin Bin Japin and Mrs. Ennun Binti Esit for their support and pray. A full appreciation to my supervisor Ir. Ts. Dr. Mohd Farriz Bin Hj Md Basar for advisng and helping me through this project.



ABSTRACT

This paper presents a new design and development of an autonomous traditional pastry batter ("Kuih Bahulu") dispenser. Kuih bahulu is a traditional cake or snack that is typically baked in brass moulds of varying sizes and shapes. Making "kuih bahulu" may seem simple, but the manual production system adds labour and time, making them expensive. Due to the manual manufacturing process, the shape, size, and aesthetic of the product are not always to the customer's liking. The development adheres to a standardized engineering design procedure. Then, software development and testing were conducted to determine which hardware components could be utilized for this project with the greatest efficiency. An Arduino UNO board was used to command the entire control system and perform the automatic functions of the machine. This project also investigates the performance of autonomous kuih bahu machine operations so that periodic enhancements can be made. Based on the analysis and result, this machine is able to produce minimum time taken of 45.50 seconds per mouldings filled. The machine power output is measured to be at 30.13W at its maximum output with 50% motor speed. This machine is certain to be a brilliant idea that will assist individuals in enhancing their lives and marketing strategies.

ABSTRAK

Kertas kerja ini membentangkan reka bentuk baru dan pembangunan dispenser adunan pastri tradisional autonomi ("Kuih Bahulu"). Kuih bahulu merupakan sejenis kuih tradisional atau makanan ringan yang biasanya dibakar dalam acuan tembaga dengan pelbagai saiz dan bentuk. Membuat "kuih bahulu" mungkin kelihatan mudah, tetapi sistem pengeluaran manual menambah buruh dan masa, menjadikannya mahal. Oleh kerana proses pembuatan manual, bentuk, saiz, dan estetik produk tidak selalu disukai pelanggan. Pembangunan ini mematuhi prosedur reka bentuk kejuruteraan standard. Kemudian, pembangunan dan pengujian perisian dijalankan untuk menentukan komponen perkakasan mana yang boleh digunakan untuk projek ini dengan kecekapan yang paling tinggi. Papan Arduino UNO digunakan untuk memerintahkan keseluruhan sistem kawalan dan melaksanakan fungsi automatik mesin. Projek ini juga menyiasat prestasi operasi mesin kuih jari autonomi supaya penambahbaikan berkala dapat dibuat. Berdasarkan analisis dan hasilnya, mesin ini mampu menghasilkan masa minimum yang diambil sebanyak 45.50 saat bagi setiap acuan yang diisi. Output kuasa mesin diukur pada 30.13W pada output maksimumnya dengan kelajuan motor 50%. Mesin ini pasti menjadi idea cemerlang yang akan membantu individu dalam meningkatkan kehidupan dan strategi pemasaran mereka.

ACKNOWLEDGEMENTS

First of all, Alhamdulillah thanks to Allah S.W.T for giving me a chance and helping me in completing this final year project report. In addition, I would like to give my full credit to all my family members for their continued encouragement throughout the preparation of this report.

I would like to share my excitement and acknowledgment to anyone that has helped and assisted me to finalize this report. Besides that, I would like to express my feeling and gratitude to my supervisor Ir. Ts. Dr. Mohd Farriz bin Hj Md Basar for his guidance and advice that is related to the project "Development of Kuih Bahulu Batter Dispenser Via Electrical Machine With Low Power Consumption" and manage to complete the project smoothly.

I am very thankful for all my lecturers and friends that commit to the preparation of completing the report and always supported me in completing my work and provide me with undivided moral support so that I could prepare a comprehensive report within a set time.

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Finally, I would like to thank all my fellow colleagues and classmates, the faculty members, as well as other individuals who are not listed here for being cooperative and helpful.

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LIST OF SYMBOLS

- Voltage angle

-

δ

- -
- -
- -
- -
- -



vi

LIST OF ABBREVIATIONS

V	-	Voltage
Ι	-	Current
W	-	Watt
g	-	gram
kg	-	kilogram
kw/h	-	Kilowatt per hour
mm	-	Millimeter
S	-	Seconds



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CHAPTER 1

INTRODUCTION

1.1 Background

Kuih Bahulu is a traditional Malaysian snack that is frequently served at celebrations and festivals. It is a type of sponge cake that is typically made with a batter consisting of eggs, sugar, and flour. The batter is poured into small moulds before being steamed or baked until light and fluffy. Kuih bahulu typically takes the form of a small bun and has a delicate, spongy texture. Colors such as green, pink, and blue can be achieved by adding pandan juice or food coloring. Traditionally, it is light yellow or brown in color. They may be consumed plain or with a variety of sweet toppings, including coconut and gula melaka. It is a popular snack among Malaysians and is available in supermarkets, traditional kuih (snack) shops, and online. They are typically consumed as a snack or dessert, but they can also be consumed for breakfast.



Figure 1.1: Three Different Shapes of Kuih Bahulu

Manually making Kuih Bahulu requires a certain level of skill and experience in order to achieve the desired texture and form. Obtaining the correct consistency of the batter

is one of the difficulties people may encounter when making kuih bahulu by hand. The batter for kuih bahulu must be light and fluffy and the ingredients must be thoroughly combined to achieve this consistency. If the batter is too thick, the kuih bahulu will be dense and heavy; if the batter is too thin, the kuih bahulu will not hold its shape. In another instance, the formation of kuih bahulu. Kuih bahulu are traditionally made in small moulds, making it difficult to achieve a uniform shape. People may have difficulty evenly filling the moulds with the batter or removing the kuih bahulu from the moulds after they have been baked or steamed.

The production of traditional foods like kuih bahulu can be significantly increased by having a traditional food machine. Many of the processes involved in making the food, such as mixing the batter, filling the moulds, and baking or steaming the kuih bahulu, can be automated using traditional food machines, like a kuih bahulu machine. Because of the time and labor savings, manufacturers may be able to produce more kuih bahulu in a given period of time. Because it can be programmed to follow a specific recipe and ensure that the batter is mixed properly, the temperature is accurate, and the kuih bahulu are shaped consistently, a traditional food machine can also help to improve the consistency and quality of the finished product.

By minimizing human intervention and offering more precise monitoring of temperature, timing, and other production-related parameters, using machines also ensures the hygiene and food safety standards that are essential for the food industry. Overall, using a traditional food machine can greatly improve the consistency and quality of final product while also increasing output and efficiency of traditional food production. Additionally, it can improve the hygienic and customer safety of the production process.

1.2 Problem Statement

The production of kuih bahulu today faces several limitations that may affect the quantity, quality and safety of the final product. One of the limitations include limited production capacity: Some traditional kuih bahulu makers still use manual methods to produce the snack, which can limit the quantity that can be produced in a given amount of time. This can make it difficult for these producers to meet the demands of a larger market, and can make it difficult to compete with larger, industrial manufacturers.

Next, lack of standardization and consistency. Traditional kuih bahulu is often made by hand, which can lead to variations in taste, texture, and appearance from batch to batch. This can make it difficult to achieve consistency in the final product, which can affect customer satisfaction. Another factor to consider is difficulty in scaling up the production process: While traditional kuih bahulu manufacturers may be able to produce a small quantity of the snack, scaling up the production process to meet larger demands can be difficult, and may require a significant investment in equipment and labor. As the demand for kuih bahulu increased, it requires more labor and more raw ingredients to produce. This can make the cost of production go up which may not be feasible for small scale traditional kuih bahulu producers.

Based on the foregoing, the goal of this research is to improve the kuih bahulu production process in term of reducing the time taken to fill the moulds and reducing manual labors. The study investigated the adoption of the autonomous kuih bahulu machine in relation to the productivity of the production line by constructing an automated batter dispensing system.

1.3 Project Objective

The main aim of this project is to develop a systematic and effective development of kuih bahulu batter dispenser via electrical machine with low power consumption. Hence, the objectives of this research are set as follows:

- a) To design a non-complex control system via integration of Arduino, sensors and motor driver.
- b) To develop an automated electric kuih bahulu batter dispenser machine.
- c) To test and investigate the performance of automated batter dispenser.

1.4 Scope of Project

The scope is this project is about the development of kuih bahulu batter dispenser with low power consumption. This task required the use of low powered device to actuate the machine process. This project also focusses on developing an appropriate dough/batter dispensing mechanism.

Based on low power consumption system, this project was constructed mainly using DC powered components rated from 5V-12V input supply. DC components were chosen due to the simplicity of assembly. The machine was also constructed to run on 12V DC supply. The decision to run the machine on 12V DC supply is mainly for the reason that both feedback and actuating device requires 5V-12V DC supply.

Dispensing mechanism are built using stainless steel material. Stainless steels material was used because of the ease of maintenance such as cleaning and hygiene control. Furthermore, most of industrialize food production use stainless steel equipment because it is durable, easy to clean, and resistant to corrosion. Stainless steel also does not react with most food products, making it a safe choice for food-grade equipment. Additionally, it is

non-toxic and non-leaching, which helps to ensure that the food produced is safe for consumption.

1.5 Summary

Background, problem statement and objectives are important to determine the direction of the study and then be able to focus the priority of producing the study. Based on the problem statement and objective, the study will be done in the next chapter on previous studies, appropriate methods, related components, and methods to develop a prototype. The scope of the project ensures the boundaries of a project in order to achieve the objectives easily.



CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter discusses the ideas for the design, concept, specifications, and other project-related information. This is determined through research into previous similar projects and through research into automated pastries machines currently in development and on the market. Additionally, this chapter discusses the theory underlying the system that will be used to construct the machine.

2.2 Food Production

Foods and beverages are the primary necessities for humans and animals. The increase in global population increases the demand for food and drink. The food industry has a significant obligation to fulfil and satisfy the needs and desires of consumers by achieving nutrition properties, food security, and food safety[1]. Automated systems are required in the food industry to carry out food production with maximum precision and efficiency while maintaining the necessary level of product quality control. It is commonly associated with science and technology. In recent years, the use of automation systems in the contemporary food industry has increased. Many food industries have already automated their entire production process, from the selection of raw materials to the final serving. The primary objective of the industry's computerized system is to carry out the process with maximum precision and efficiency. Therefore, more benefits can be realized than with the use of manual techniques in the food industry. This paper discussed the significance of automation systems in the food processing industry. With an emphasis on automation tools

Automating food production has numerous advantages. The capacity to mimic the appearance and quality of a product with the fewest possible ingredients not only increases line efficiencies, resulting in a rise in bottom-line profit, but also has the potential to boost sales. Improving the traceability of raw materials will also result in enhanced food safety. There are so many processes, people, and touchpoints along the food and beverage supply chain that it can be challenging to monitor and track food quality. It goes without saying that product quality is of the utmost importance, yet it is challenging to minimize safety problems in a complicated system.

Automation can assist in resolving these difficulties by increasing line productivity, maximizing ingredient utilization, and enhancing food safety while decreasing the likelihood of human error. Consistency is also essential for food businesses, as people want to purchase the same product repeatedly and expect it to have the same flavor, taste, and texture. Automation achieves this by removing the possibility of human error and efficiently controlling manufacturing, which in turn decreases the danger of product recalls and safeguards the brand.

2.2.1 Semi-automated machine

There are various types of automated or semi-automated machines located in the Malaysian market that are used in food product dispensing operations. Here are some of the machines that are widely used:

- i. Confectionary Molders
- ii. Bread Molders
- iii. Piston filling machines
- iv. Muffin and cupcake Formers

Piston filling machine as shown in Figure 2.1 is a type of filling machine that uses a piston to dispense a specific volume of product into containers or packages. The piston is a cylindrical component that moves up and down within a cylinder and is connected to a product supply source. When the piston moves downward, it draws product into the cylinder, and when it moves upward, it pushes the product out of the cylinder and into the container or package.

The piston filling machine typically consists of several main components: a product hopper, a cylinder, a piston, a control system, and a filling nozzle. The product hopper holds the product that is to be dispensed, and the cylinder contains the piston and serves as the product chamber. The control system controls the movement of the piston, and the filling nozzle is used to dispense the product into the container or package[2].

Piston filling machines can be used to fill a wide range of products, including liquids, pastes, creams, and gels, and can be adjusted to dispense a wide range of volumes, from a few milliliters to several liters. They are commonly used in food, beverage, pharmaceutical, and chemical industries.



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Figure 2.1: Piston Filling Machine

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2.2.2 Automated Food Machine

The automation of the food industry implies machine control, and each process must be maintained by independent systems using computer software or robotics to make them more efficient. The food processing industry utilizes automated systems more than any other industry[1]. Robots are used for sowing, watering, harvesting, slicing, processing, and packaging food product as shown in Figure 2.2, similar to the beverage industry, where bottles are cleaned, filled, and arranged on a conveyer belt automatically, and dairy and chocolate products are placed on a conveyer belt[3]. The automated food machine system is primarily driven by the safety and competitiveness of the food industry or manufacturing facility. The automated system has a number of benefits for the food industry, including increased productivity, product quality, and profitability, as well as enhanced hygiene, safety, and worker protection. Additionally, the use of automated systems reduces injuries



Figure 2.2: Automated Packing Machine

Packaging machines are equipment that are used to package items or components. At various levels of automation, this product category comprises equipment that forms, fills, seals, wraps, cleans, and packages. Packaging machines also comprise sorting, counting, and accumulating equipment. There are numerous package types[4]. Here are several examples:

- i. Labelling machines
- ii. Tape machines
- iii. Filling machines
- iv. Sealers

2.3 Traditional Food Machine

Mechanization and automation are two technologies that have the potential to drive the growth of the country's traditional food industry. The application of this technology in the traditional food industry is able to produce a constant supply of high-quality, consistent products, reduce production costs, increase production rates, and reduce labour costs. The National Agro-Food Policy 2011–2020 outlined the significance of mechanisation and automation in its strategic direction, namely to establish the direction of research and development (R&D), innovation, and the application of technology[5]. Through its Engineering Research Center, MARDI has developed mechanisation and automation technologies for use in the nation's traditional food industry.

Research and development are conducted in the areas of post-processing and food processing automation. The primary objective of post-processing and food processing mechanisation research is to provide solutions to issues relevant to the mechanisation of small and medium-sized food companies (SMIs). In addition, it aims to provide a solution for the post-processing handling and storage of traditional products through the creation of a more efficient and effective automation system. This paper will focus on the automation of selected traditional foods from Malaysia.

2.3.1 Semi-Auto Batter Dispensing System: Kuih Bahulu

This research focuses on enhancing the production system of a traditional food process. Specifically, by developing a semi-automated production line to enhance the current kuih bahulu process flow's production rate. In this study, Arena simulation software is used to simulate the production line. First, the identification of the production line's process flow bottleneck issues. Second, design a semi-automated batter dispenser using the SolidWorks software for the development of a dispensing system. The semi-automated batter dispensing system installed in the system production line has resulted in significant improvements of 243.6% to the production line, as demonstrated by simulations conducted with the Arena software.[6]. Figure 2.3 and Figure 2.4 shows the prototype design and the dispensing



Figure 2.3: Prototype Design for Semi Automated Kuih Bahulu Dispensing Machine[6]



Figure 2.4: The mechanism of kuih bahulu batter dispensing machine[6]

2.3.2 Automated Sarawak Layered Cake Machine

Layered cake, also known as kek lapis, is synonymous with Sarawak and a popular souvenir for tourists who visit the state. The unique flavor and colorful layered design have ensured its year-round popularity, particularly during holiday seasons. The products are exported to Peninsular Malaysia, Singapore, and Brunei in addition to Sarawak. The industry contributes nearly 3 million Ringgit to the entrepreneurs annually. However, the tedious traditional procedure cannot keep up with demand. The manual process relies heavily on labor, and the skills of the labourers have a direct impact on the quality of the cakes produced. The development adheres to a methodical engineering design procedure. The sectional base mechanism concept has been selected for the machine. The automatic machine includes all fundamental processes, including filling the baking tray with batter, baking, layering, pressing, and cooling. The proposed model is anticipated to produce 216 moulds per day, a 430 percent increase over the current rate of production (50 moulds).[7]



Figure 2.5: Table of Conceptual Design[7]

2.3.3 Autonomous Cupcake Machine

This paper presents a new design and development of a cupcake machine with autonomous operation. Cupcakes are becoming increasingly popular, but the current production system is manual and labor-intensive, making them costly. Due to the manual production method, the shape, size, and aesthetics of the product are not always to the customer's liking. This work discusses the development of an autonomous cupcake machine and the resolution of the issues. The essential components include an Arduino microcontroller board, motors, a thermocouple, and inexpensive materials like plastic and wood. It focuses on system development, the fundamental methodology, and applications. Ultimately, it justifies development costs for the future market.[8]



Figure 2.6: Preliminary Design (left) and Prototype Model (right)[8]

2.3.4 Automated Kuih Penderam Stamping Machine

It is crucial to design a control system for the stamping process in the production of Kuih Penderam. Due to the high demand but low energy consumption, the production of Kuih Penderam is the primary issue. The purpose of this study is to automate the Kuih Penderam stamping process, which is currently performed manually. The system consists of the necessary software and components. PLC systems, compressors, sensors, connectors, and push buttons are among the few components utilized in the design of the automatic system. The results of the system's reliability indicate that all LED lights function when the signal is connected directly to the PLC system on the circuit. This case demonstrates that all testing components are operating properly [9]. From Figure 2.7, time taken for manual stamping process is higher than automated stamping process which is 6.0s for automatic method and 29.0s for manual method. This data has proved that manual method takes a long time to achieve a high demand of production.

	Automatic Time (s)						Manual Time (s)				
No. of	Cy1.	Cyl.	Cyl.	Cy1.	Cy1.	Cyl.	Total	Stamping	Stamping	Place	Total
mixture	В	B	Ā	B	B	A	time	the outer	the inner	on	time for
	extent	reset	extent	extent	reset	reset	taken	shape	shape	tray	stamping
1	1	1	1	1	1	1	6	8.2	14.62	16.61	39.43
2	1	1	1	1	1	1	6	6.89	10.8	12.27	29.96
3	1	1	1	1	1	1	6	6.31	10.78	13.13	30.22
4	1	1	1	1	1	1	6	6.39	8.02	12.39	26.8
5	1	1	1	1	1	1	6	5.42	8.75	11.8	25.97
6	1	1	1	1	1	1	6	5.41	8.34	11.19	24.94
7	1	1	1	1	1	1	6	4.75	7.67	10.64	23.06
Average time taken (automatic)				6	Ave	rage time (n	nanual)	28.63			

Table 1 Data for production time against automatic and manual stamping process

Figure 2.7: Table for Data Obtain[9]

2.4 DC Motor

The speed-torque relationship can be varied to almost any useful form for both DC motor and regeneration applications in either direction of rotation, which is why DC motors are the type of DC motor that are used in industrial applications. This is shown in Table 2.1, which shows the type of DC motor that was used. A speed range of 8:1 is typically available for continuous operation with DC motors. It is normal practice to use an infinite range (smooth control down to zero speed) for brief periods of time or under reduced load.

There are many applications for direct-current motors, some of which require them to momentarily deliver three or more times their rated torque. DC motors are capable of delivering almost five times their rated torque in an emergency circumstance without stalling (power supply permitting). In applications that require quick stops, DC motors can be used to achieve either dynamic braking, in which the energy generated by the DC motor is fed to a resistor grid, or regenerative braking, in which the energy generated by the DC motor is fed back into the supply for the DC motor. This either eliminates the need for a mechanical brake or reduces the size of the mechanical brake. DC motors have a speed that can be controlled smoothly down to zero, which is then immediately followed by acceleration in the opposite direction. This all happens without the need to switch the power circuit. A high ratio of torque to inertia is a characteristic of DC motors, which enables these motors to react rapidly to shifts in control signals. As shown in Table 2.1, DC motor have four types which is as listed as below:



Table 2.1: Types of DC Motor

2.4.1 DC Brush Motor as Conveyor Driver

The operation of DC geared motors can be divided into two distinct phases. The worm or screw gear is mostly driven by an electric motor. As the worm gear rotates, it also rotates the main gear, producing motion and torque[10]. The worm gear itself is the first component of worm gear motors. This item consists of a shaft with spiraling threading on the shaft. This worm gear is embedded within the teeth of another gear. The worm gear's rotational speed would rotate the gear to which it is linked. As its name suggests, the motor is the second component of the motor[11]. The motor is connected to the worm gear, which rotates at varying speeds according on the amount of torque produced by the main gear[11]. Figure 2.8 show a 12V DC Geared Motor.



Figure 2.8: 12V DC Geared Motor

2.4.2 DC-DC Buck Converter

The buck converter is a common DC-DC converter that efficiently transforms high voltage to low voltage[12]. The LM2596 DC-DC buck converter step-down power module with the high-precision potentiometer[13] as shown in Figure 2.9 is capable of driving a load of up to 3A with high efficiency and is compatible with the Arduino UNO, other mainboards, and basic modules[13]. In this project, this buck converter is used to step-down the 12V

supply from the 12V DC adapter to 5VDC to supply power for the Arduino and other electronics components that have voltage rating of 5V.



2.4.3 Servo Motor

A servo motor, also known as a rotary actuator or linear actuator, is a rotary actuator or linear actuator that allows for precise control of angular or linear position, velocity, and acceleration [14](see Figure 2.10). A position feedback sensor is connected to an appropriate motor. It also necessitates a sophisticated controller, which is often a separate module designed specifically for servo motor use. Industrial position control applications frequently used servo motors, which have a feedback control system to alter a mechanism's performance. Additionally, because of the high accuracy of its angle movement, it is crucial in industrial life. It has many benefits, including simple control, high efficiency, and control over position applications[15]. Servo motor functions in a closed system, where information and data are used to control or accelerate the movement of the machine being moved based on an image of the signals coming from that machine[16]–[18].



Figure 2.10: Servo Motor

2.5 Controller System

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The definition of a control system is a system of devices that manages, controls, directs, or regulates the behavior of other devices or systems to achieve a desired outcome. This is accomplished by a control system's control loops, which are designed to maintain a process variable at a particular set point[19]. In other terms, a control system can be defined simply as a system that controls other systems. In tandem with the continuous modernization of human society, the demand for automation has expanded. Control is required over systems of interoperating devices for automation. Depending on the system's feedback path, control systems can be divided into two distinct categories: open loop control system and close loop control system. This article will discuss all of the major configurations of open loops, taking into account various parameters such as definition, feedback path, complexity, and applications.

In an open loop control system, the output has no effect on the system's control action. Consequently, the open loop control system follows its input signals regardless of the
outcomes[20]. Figure 2.11 depicts the block diagram of the open loop control system. Here, the key elements are the controller (microcontroller) and the plant (or processing system). The controller receives the input and generates an actuating signal (or control signal). This actuating single is supplied to the controllable plant or processing system. The primary drawback of an open loop control system is that it is ill-equipped to deal with disturbances that could hinder its ability to complete the desired task[20]. Examples of common open loop control systems include the traffic light system, the field-controlled DC motor, and the automatic washing machine[20].



A microcontroller is a small integrated circuit designed to manage a specific embedded system operation. A typical microcontroller contains on a single chip a processor, memory, and input/output (I/O) peripherals. A microcontroller is embedded within a system to control a single device function. It accomplishes this by utilizing its central processor to interpret data received from its I/O peripherals.

Temporary data received by the microcontroller is stored in its data memory, where the processor can access it and use instructions stored in its program memory to decode and apply it. It then utilizes its I/O peripherals to communicate and carry out the required action. Microcontrollers are utilized in numerous systems and devices. Multiple microcontrollers that collaborate within the device to perform their respective tasks are frequently used in devices. The vast majority of microcontrollers are programmed using a variant of the C programming language. The C programming language strikes a nice balance between programmer control of microcontroller hardware and program writing speed. As an alternative, the Arduino Development Environment (ADE) provides a user-friendly interface for rapidly developing a program, converting it to machine code, and then loading the machine code into the Arduino processor in a series of straightforward steps.

2.5.1 Arduino

Arduino is an open-source electronics platform or board, as well as the programming software used to control it. Arduino is intended to make electronics more accessible to artists, designers, enthusiasts, and anyone else interested in the creation of interactive objects or surroundings. Due to the open-source nature of the hardware design, a pre-assembled Arduino board may be ordered, or the board can be made by hand. In either case, customers can modify the boards to their specifications and release their own versions.

The microcontroller on a preassembled Arduino board is programmed using the Arduino programming language and the Arduino development environment[21]. This platform enables the construction and programming of electronic components. Arduino's programming language is a simplified version of C/C++ based on what Arduino calls "sketches," which employ fundamental programming structures, variables, and functions. This information is subsequently translated into a C++ program.

The Arduino UNO, Red Board, LilyPad Arduino, Arduino Mega, and Arduino Leonardo are among the different versions of Arduino boards available on the market. All of these Arduino boards varies in terms of specs, features, and applications, and they are employed in a variety of electronic projects. Figure 2.12 shows the Arduino UNO R3.



2.5.2 Digital Adjustable Infrared Proximity Sensor

An electronic sensor known as a passive infrared sensor, or PIR sensor, is one that monitors the amount of infrared light (IR light) radiating from objects that are within its field of view. They are utilized most frequently in passive infrared (PIR) motion detectors. Applications such as security alarms and automatic lighting frequently make use of passive infrared (PIR) sensors[22]. PIR sensors can detect motion in general, but they are unable to provide information on who or what moved. Figure 2.13 shows the digital adjustable infrared proximity sensor.



Figure 2.13: Digital Adjustable Infrared Proximity Sensor

An infrared sensor, as depicted in Figure 2.13, is one of the most common and fundamental sensor modules in electronic devices. This sensor is equivalent to the human visual senses; it can be used to identify obstructions and is one of the most prevalent real-time applications[23]. This circuit is made up of the following elements; When an object enters the range of a proximity sensor, an infrared beam is emitted, and reflections are monitored. When a sensor detects reflections, it proves the presence of a nearby object[24].

The components of an inductive proximity sensor are an oscillator, a ferrite core with coil, a detector circuit, an output circuit, housing, a cable or connector, and a housing. The oscillator produces a sine wave with a constant frequency. This signal is utilized for coil driving. In conjunction with the ferrite core, the coil generates an electromagnetic field[25]. When a metal object interrupts the field lines, the oscillator voltage decreases in proportion to the size and distance of the object. The decrease in oscillator voltage is the result of eddy currents created in the metal interfering with the field lines. This decrease in oscillator voltage is recognized by the detecting circuit[26]. Figure 2.14 shows the working principle of IR sensor.



Motor Driver circuits are current amplification components. In a motor drive, they provide as a link between the controller and the motor. Motor drivers are comprised of discrete components integrated within an IC. A low current signal is input to the motor driver IC or motor driver circuit. The circuit's purpose is to transform the low-current signal into a high-current signal. This signal is then transmitted to the motor. The motor may be a brushless DC motor, brushed DC motor, stepper motor, or any other type of DC motor.

2.5.3

A motor driver is essentially a current amplifier that receives a low-current input from a microcontroller and outputs a correspondingly greater current signal that can control and drive a motor. Usually, a transistor can serve as a switch and accomplish this function, which operates the motor in a single direction.

To regulate a single motor in a single direction, only one switch is required to turn a motor ON and OFF. What if you wish to reverse the direction of your motor? The straightforward solution is to reverse its polarity. This can be accomplished using four switches set in such a way that the circuit not only drives the motor, but also controls its direction[27].



CHAPTER 3

METHODOLOGY

3.1 Introduction

This study was carried out to improve productivity of the traditional food production system through visits to the home-made traditional industry. The purpose of the industrial visit is to explore and investigate the problems through the interview session with the owner and operators, besides in-place observation towards the process flow for the kuih bahulu production line. Besides that, qualitative studies are also carried out to study and take detailed data on the development of the machine to be carried out. In addition, exploratory studies are carried out to study methods that will be useful for the additional development of studies conducted in the future to provide support to existing studies.

اونيونرسيتي تيڪنيڪل ملي Project Flowchart

This study was conducted to increase the efficiency of the traditional food production system by direct visits to the traditional home-based business. The objective of the industrial visit is to explore and study the difficulties through an interview session with the owner and operators, as well as on-site inspection of the production line's process flow.



Figure 3.1: Flowchart of the Overall Project

3.3 Design for Controller System

In a project development, software development is the earliest method or procedure that can be implemented after conducting a detailed study. Software development requires a test, simulation, or design to be implemented without the use of high costs. This allows any changes to be made to a project even if the study has been carried out. This is due to the fact that when a test or simulation is carried out, there are a number of parameters that can be taken into account because it resembles the parameters that will occur in real time. To implement the Development of Kuih Bahulu Batter Dispenser Via Electrical Machine with Low Power Consumption project, there are three software used to perform software development.

3.3.1 Proteus 8.12 Professional

This software is used to design the electronic circuit involving the Arduino and other components such as DC Motor and Servo Motor. There are three parts of circuit design which is LCD display part, PIR sensor and buzzer, and conveyor belt motor control and dispenser servo motor controller (see Figure 3.6). These three parts of circuit is controlled by the Arduino, which is programmed in the Arduino IDE (will be explain in the next subtopic).



Figure 3.2: Three Parts of Circuit in Proteus

3.3.2 Arduino IDE

Arduino IDE is open-source software developed by Arduino.cc for writing, compiling, and uploading code to most Arduino modules. A set of coding is written in the Arduino IDE which is later compiled and exported to the Proteus software to enable to run the simulation. This is also known as programming the Arduino. The Arduino that is being utilized for this project will act as the primary microcontroller unit for the system as a whole. In order to use an Arduino board, a program must first be created using the Arduino IDE and then it can be transferred to the board.

The availability of a circuit design for the project can make the process of developing the program more manageable. This is due to the fact that it will be simpler to declare the input and output of the Arduino pins, select the library that will be utilized, and choose which data will be read and displayed. The startup interface of the Arduino IDE is depicted in figure 3.5, and the steps required to develop a program using the Arduino IDE are outlined in table 3.2. the full coding of the program are shown in appendix A.



Figure 3.3: Startup Interface of the Arduino IDE

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Step	Procedure	Description
1	Determine the set of libraries to	Correct libraries must be used to interface with
	be used	the hardware electronic components.
2	Declare the input and output	Input pins are used to read data and receive
	pins	sensor feedback. Depending on the type of
	کل ملیسیا ملاك	hardware component employed, output pins are utilized to transmit commands to electronic
	UNIVERSITI TEKNIK	components. Move the motor, display text or data on the LCD display, and control the servo
		motor's movement time, for instance.
3	State the initial condition of the	Setup the initial condition for each of the
	system	electronic components.
4	Program the initial setup of the	Setup the system condition before its
	system	operation.
5	Program the system operation	The system will execute the specified program.
	condition using if-else	
	argument.	
6	Test run the program in Proteus	To determine if the program has error and to
	software	determine if the program operate as required.
7	Determine if the program meet	The finalized program will be used for the
	the requirement. If met, finalize	project.
	the program. If not, repeat step	
	3-6.	

3.4 Hardware Development

This subtopic will discuss the physical components utilized in the development of this project. However, the components utilized in the construction of the prototype may differ from the system's fundamental components. Given that a prototype is a product created to test a concept or a method, the variances are related to the limitations of knowledge and expense. Following is a list of the materials used in this project:

3.4.1 Project Integration

Table 3.1 shows the list of components of this project. All part data information has been described to show the function of each component. The flow of the project can be seen step by step from the input to the desired output. Figure 3.2 shows the component integration mindmap.

	Components	Brand	Product No.	Description	Quantity
1.	Microcontroller	Arduino UNO R3	ARDUINO- UNO	Microcontroller for the machine	1
2.	Motor Driver	Cytron Technologies	MDD3A	To operate the motor based on the input logic signal from the microcontroller	1
3.	12V DC Brush Worm Gear Motor	Cytron Technologies	SPG30-60K	Main motor for the conveyer belt	1
4.	Servo Motor	Cytron Technologies	MG995	Main motor to operate the mechanical parts in	1

Table 3.1: List of Components.

		the dispenser				
				component		
5 12	I2C I CD 16v2	Cytron	DS-162A-	To display the	1	
5.	12C LCD 10x2	Technologies	I2C-G	machine interface	I	
	Digital			To detect obstacle and send signal to		
6.	Adjustable	LEFIRCKO	E18-D80NK	the microcontroller	2	
	Infrared			for next operation	-	
	Proximity Sensor			of the machine		
7.	12V DC Power	OEM	1250	Power supply	1	
	Adapter	~				
8.	DC – DC Buck	Cytron	LM2596	To step down 12	1	
	Converter	Technologies		VDC to 5VDC		
	S.S.	110		Operate as switch		
9.	ON/OFF Switch	NY A		from power supply	1	
	I.			to the motor		
10	Push Button			To switch the	2	
10.	1 ush Dutton			machine on/off	2	
12.	Jumper cables	کل ملیس	تيكنيه	To connect electrical and		
	and wires RS	ITI TEKNIK	AL MALAY	SIA electronic A	-	
				components		



Figure 3.4: Component Integration

3.4.2 AutoCAD

To develop a machine, a sketch of the machine must be created to visualize the design and dimensions of the machine. In this project, AutoCad software is used to sketch the preliminary design of the semi-autonomous kuih bahulu machine. Sketches of the design are shown in Appendix C.

3.4.3 Brushed Motor (DC Geared Motor)

A DC geared motor is utilized to drive a conveyor belt for the semi-autonomous kuih bahulu machine, as shown in Figure 3.5. Worm gear motors operate by moving the main gear using a worm gear coupled to a motor. This configuration is appropriate for a machine that requires a high reduction ratio, which means more torque for less speed.



Figure 3.5: 12V DC Motor

3.4.4 MG955 Servo Motor

Due to the pinpoint accuracy of rotation of the servo motor, MG955 Servo Motor is used in this project to operate the valve opening in the dispenser mechanism. Accurate opening of the dispenser will result in equal flow of the batter through the nozzle of the dispenser thus filling the moulding equally. Figure 3.6 shows the MG955 servo motor.



Figure 3.6: MG995 Servo Motor

3.4.5 Arduino UNO R3

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The Arduino Uno is an ATmega328-based microcontroller board. Arduino is an open-source prototyping platform. The application of Arduino UNO in this project is to run all the automation system programmed in the machine. This will include the operation of the dispenser, receive feedback signals from the sensors, load the display on the LCD, store memory of data and declare each function of buttons or feedback components.

3.4.6 Conveyor Belt

A conveyor belt is an important piece of equipment in the material handling industry. Figure 3.7 shows the function of a conveyor belt in the prototype, which transports the mouldings. As long as the supply is turned on, the conveyor will operate continuously. It is also used to move the mouldings in a short period of time.



Figure 3.7: Conveyor Belt of The Prototype Model

3.4.7 I2C LCD 16x2

To display the usage interface of this machine to the user, an I2C LCD 16x2 type display is used. This type of display has a light blue backlight that fits the interface clearly on dark areasThe data displayed by this component are, among them, the state of the machine, which is on or off, the amount of mold that has been filled and will display an error in case of lack of batter on the dispenser. Figure 3.8 shows the I2C LCD 16x2.



Figure 3.8: I2C LCD 16x2 Display

3.4.8 Digital Adjustable Infrared Proximity Sensor

An infrared sensor, as shown in Figure 2.5, is an electrical device that produces infrared rays in order to detect certain features of the environment. These are radiations that are invisible to the naked eye but can be detected by an infrared sensor. In this project, an infrared sensor is used to detect the bahulu mouldings. Two digital adjustable infrared

proximity were used in this machine; sensor 1 to detect the moulding and stop the conveyer belt to start the operation of filling the mould. Sensor 2 to operate as limit switch which will stop the conveyer belt if a mould tray that was filled up is not removed at the end of the line.

3.4.9 Motor Drivers

Motor drivers, an example of which can be seen in figure 2.6, are the modules that are utilized to run a motor. In a brief, they are typically utilized in the process of motor interfacing. The DC Worm Gear Motor that is being used for this project is being driven by an MDD3A motor driver. The operation of this kind of motor driver involves transforming the input logic signal that is received from the Arduino into a result that then results in the direction of the DC Motor's rotation.

3.4.10 Prototype Model

This subchapter provides the figure for the fully build prototype model. The prototype frame is built with steel frame and welded to a steel base. Plywood is used as the base for the conveyor belt. The conveyor belt frame is built with aluminum frame. Figure 3.3 shows the full prototype model of the Kuih Bahulu Batter Dispenser Via Electrical Machine with Low Power Consumption. On the top right corner of the figure shown is the control panel for the system which also place the controller system. Figure 3.4 shows the controller unit closeup view.



Figure 3.9: Full Prototype Model



Figure 3.10: Controller Unit Closeup View

The dispensing unit of the machine is made of stainless steel. The dispensing unit is design using AutoCAD software then implemented into hardware design. The dispenser is

made up of three dispensing nozzle and dispensing mechanism which is moved by the servo motor. Figure 3.5 shows the closeup view of the dispensing unit.



3.5 Commissioning and Testing

Testing is performed to determine whether the machine is capable of producing the results specified in the simulation. If the machine fails to achieve the target or objective, an analysis must be performed to determine the improvements that must be implemented. Among the components tested in this project are the machine's ability to dispense dough accurately, the precision of the sensor, energy consumption, and the motor's ability.

3.5.1 Testing Procedure

Dispensing testing purpose is to investigate the performance of the dispenser whether it is able to dispense the dough to fill the moulding accurately. Below are the procedure taken to carry out the testing.

- Before the testing start, the servo angle is set to 40° and motor speed at 100% in the Arduino coding.
- 2. Plug in the power supply and turn on the plug and press the ON/OFF button at the side of the controller unit. Make sure the LCD lights up to confirm the machine is functioning.



4. Test the IR sensors by placing hand under the sensors. The red LED indicator

should light up to show that the sensor is functioning.

5. Place the moulding on the conveyor belt and position the moulding until the

sensor detect the marking on the moulding.



Figure 3.13: Placing the Moulding

- 6. The first sensor should detect the tagging on the moulding and the red LED indicator will light up.
- 7. Push the green button or start button on the controller unit to start the machine. The machine only runs when the first sensor detects the moulding.



Figure 3.14; Push the Start Button

- 8. The machine will start, and the LCD should display "Mesin Beroperasi".
- 9. At the same time, a stopwatch is started to start measuring the time taken to fill in the moulding and multimeter is used to measure the power consumption.



Figure 3.15: Stopwatch to Measure Time

10. The second sensor should detect the tagging on the moulding to enable the dispensing procedure. The red LED indicator will light up and the LCD should display "Mesin Mengisi".

Figure 3.16: The Sensor Red LED Lights Up



Figure 3.17: Filling Process

- 11. After the moulding is filled in, LCD will display "Mesin Beroperasi" and the stopwatch is stopped. The time taken and the power consumption measurement is recorded.
- 12. Repeat step 4-10 to measure the data with different number of moulding,



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CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 Introduction

No

This chapter presents the results and analysis on the development of Kuih Bahulu Batter Dispenser Via Electrical Machine With Low Power Consumption. A case study is conducted to demonstrate the usability and efficiency of the developed system. The case studies are based on production results and their relationship to parameters such as Voltage, current and power. The recorded data includes power output in several conditions such as: (i) power output per hour, (ii) power output per target (the amount of the mold is filled). It is important to note that, this case study aims to illustrate the results of the estimated production and power efficiency obtained. The results obtained lead to feasible approaches for future improvements. اونيۆمرسىتى تيكنىكل مليسى

Test Variables and Parameters 4.2

To carry out tests and studies, the important thing to have is the variables and parameters to be tested. This aims to facilitate data collection and also ensure that the purpose of the test is in line with the objective of the study, where the objective of the study includes the study of machine performance. Table 4.1 shows the variables and parameters tested and measured.

Parameter	Components
	• Servo angle (40°, 50°, 60°)
Variables	• Motor speed (50%, 100%)
	• Nozzle size (6mm, 7mm, 8mm)
	• Voltage (V)
Observed/Measured	• Current(A)
Observed/Measured	• Power(W)
	• Time(s)

Table 4.1: Parameters and Components

4.2.1 Sample Used for Production Target

A sample of one kuih bahulu packaging was used in the calculation and measurement of the variables related to the production target. This sample packaging contains 50 pieces of kuih bahulu with net weight of 850gram(g). Meanwhile, sample for daily production tested is 10kg and 15kg which equals to approximately 12 packaging and 18 packaging respectively. The moulding size used are moulding with 12 moulds of 3x4.

4.2.1.1 Sample tested table

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Table 4.2: Sample Tested Table

Sample nett weight(g) for one piece of kuih bahulu						
Daily production average	Total packaging					
10kg	Approximately 12 packaging					
15kg	Approximately 18 packaging					
Estimated weight of one pieces of kuih bal	hulu;					
$\frac{850g}{50} = 17g$						
∴Approximately 17g of one piece of kuih ba	hulu.					
Production weight per one moulding;						
$12 \times 17g = 204g$						
∴Approximately 204g of one moulding of kuih bahulu.						

Number of moulding required to meet daily production target				
For 10kg,	For 15kg,			
$\frac{10kg}{0.204kg} = 49.02$	$\frac{15kg}{0.204kg} = 73.53$			
∴Approximately 49 mouldings required.	∴Approximately 73 mouldings required.			

4.3 Result and Analysis

In this chapter, the test results and analysis are displayed. The results and analysis obtained are based on the tests carried out to obtain the performance data of this machine. The data obtained is displayed in tables and graphs to give a rough idea of the capabilities of this machine.

4.3.1 Time Taken To Fill The Number of Moulding

This test was carried out to measure the time taken to fill the number of moulding. The result is shown in Table 4.3, Table 4.4 and Table 4.5. This test is carried out by using different servo angle, motor speed and size of dispenser nozzle. The equipment used to measure the data are stopwatch and multimeter.

Servo	Motor	Nozzle	Number				
Angle(°)	Sneed(%)	Size	of	Time(s)	Voltage(V)	Current(I)	Power(W)
mgie()	Spece()	(mm)	Moulding				
40	50	6	1	106.54	11.8	1.32	15.576
			2	214.77	11.8	1.33	15.694
			3	321.20	11.8	1.33	15.394
			4	429.02	11.8	1.34	15.812
			5	534.42	11.8	1.35	15.93
		7	1	101.22	11.8	1.30	15.576
			2	204.03	11.8	1.32	15.576
			3	305.14	11.8	1.32	15.576
			4	407.56	11.8	1.32	15.576
			5	507.70	11.8	1.33	15.694
		8	1	96.16	11.8	1.32	15.576
			2	199.96	11.8	1.32	15.576
	MA	LAYSIA	3	289.89	11.8	1.33	15.694
	S		🌾 4 🚽	387.18	11.8	1.34	15.812
	3		3 5	482.31	11.8	1.36	16.048
	100	6	1	46.32	11.8	1.37	16.166
	=		2	93.38	11.8	1.36	16.048
	Par la		3	139.65	11.8	1.36	16.048
	YAIN	n .	4	186.53	11.8	1.32	15.576
	chi	()	5	232.36	11.8	1.33	15.694
	ملاك	Lu7ul	r Ji	44.01	11.8	1.40	16.52
		11 11	2	88.71	11.8	1.38	16.284
	UNIVE	RSITI '	TEK3IIK/	132.67	AY11.8 M	EL1.35A	15.93
			4	177.20	11.8	1.34	15.812
			5	220.74	11.8	1.34	15.812
		8	1	41.81	11.8	1.38	16.284
			2	86.94	11.8	1.35	15.93
			3	126.04	11.8	1.33	15.694
			4	168.34	11.8	1.31	15.458
			5	209.70	11.8	1.29	15.222

Table 4.3: Performance of Machine at Servo Angle 40°



Figure 4.1: Graph of Time vs Number of Moulding at Servo Angle 40°

Based on Figure 4.1 and Table 4.3, at 50% motor speed and 6mm nozzle size settings, the time taken for the machine to fill the moulding is at the slowest time at 106.54s and 534.42s to fill five mouldings. The fastest time recorded to fill the moulding is at 100% motor speed and 8mm nozzle size settings. The time taken to fill one moulding and five moulding are 41.81s and 209.70s respectively. Based on the recorded time, there is 64.73s or 60.76% difference in speed when filling one moulding and 324.72s or 60.76% when filling five mouldings.



Figure 4.2: Graph of Current vs Number of Moulding at Servo Angle 40°

Based on Figure 4.2 and Table 4.3, at 50% motor speed setting, the measured current increased as the number of moulding increase. Meanwhile, at 100% motor speed setting, the measured current decreased as the number of moulding increase. From the graph, it is observed that at 100% motor speed and 8mm nozzle size settings, the measured current significantly drop when filling 5 moulding where the measured current is 1.29A. as a comparison, at 50% motor speed and 8mm nozzle size settings, the measured current is 1.36A. There are 0.07A or 5.14% of difference in current measurement when filling five mouldings.



Figure 4.3: Graph of Power vs Number of Moulding at Servo Angle 40°

Based on Figure 4.3 and Table 4.3, the graph also display the same trendline as the current graph. Based on the observation, at 100% motor speed setting, the power measurement decrease as the number of moulding increase, meanwhile at 50% motor speed setting, the power measurement increased as the number of moulding increase. The lowest power measured to fill one moulding is at 50% motor speed and 7mm nozzle settings. This is different when filling five moulding as the lowest power measured is at 100% motor speed and 8mm nozzle size settings. The power measured is at 15.222W which is the lowest compared to the power measured at 50% motor speed and 8mm nozzle size settings which is 16.048W. as a comparison, there are 0.826W power difference or 5.14% power difference percentage.

Servo	Motor Speed(%)	Nozzle	Number				
Angle(°)		Size	of	Time(s)	Voltage(V)	Current(I)	Power(W)
Aligie()	Speed(70)	(mm)	Moulding				
50	50	6	1	105.09	11.8	1.33	15.694
			2	213.16	11.8	1.35	15.93
			3	319.75	11.8	1.36	16.048
			4	427.48	11.8	1.36	16.048
			5	532.93	11.8	1.37	16.166
		7	1	99.84	11.8	1.35	15.93
			2	202.52	11.8	1.40	16.52
			3	303.76	11.8	1.42	16.756
			4	406.11	11.8	1.41	16.638
			5	506.28	11.8	1.44	16.992
		8	1	94.85	11.8	1.30	15.34
			2	192.37	11.8	1.32	15.576
	MA	LAYSIA	3	288.58	11.8	1.33	15.694
	ST		🎨 4 🚽	385.80	11.8	1.33	15.694
	E C		7 5	480.95	11.8	1.36	16.048
	100	6	- 1	45.69	11.8	1.34	15.812
	E		2	92.68	11.8	1.35	15.93
	(Participation)		3	139.02	11.8	1.35	15.93
	AIN	n .	4	186.86	11.8	1.36	16.048
	del	()	5	231.71	11.8	1.38	16.284
	ملاك	Lugul	- 1 م	43.41	11.8	1.33	15.694
		41 41	2	88.05	11.8	1.33	15.694
	UNIVE	RSITI "	TEK3JIK/	132.07	AY11.8 M	1.35	15.93
			4	176.57	11.8	1.41	16.638
			5	220.12	11.8	1.40	16.52
		8	1	41.24	11.8	1.27	14.986
			2	83.64	11.8	1.28	15.104
			3	125.47	11.8	1.30	15.34
			4	167.74	11.8	1.34	15.812
			5	209.11	11.8	1.35	15.93

Table 4.4: Performance of Machine at Servo Angle 50°



Figure 4.4; Graph of Time vs Number of Moulding at Servo Angle 50

Based on Figure 4.4 and Table 4.4, at 50% motor speed and 6mm nozzle size settings, the time taken for the machine to fill one moulding is at the slowest time at 105.09s and 532.93s to fill five mouldings. The fastest time recorded to fill the moulding is at 100% motor speed and 8mm nozzle size settings. The time taken to fill one moulding and five moulding are 41.24s and 209.11s respectively. Based on the recorded time, there is 63.85s or 60.76% difference in time when filling one moulding and 323.82s or 60.76% when filling five mouldings.



Figure 4.5: Graph of Current vs Number of Moulding at Servo Angle 50°

Based on Figure 4.5 and Table 4.4, at 50% motor speed setting, the measured current increased as the number of moulding increase. Meanwhile, at 100% motor speed setting, the measured current increased as the number of moulding increase. This is different compared to the current measured trend on Figure 4.2. From the graph, it is observed that at 100% motor speed and 8mm nozzle size settings, the measured current to fill one moulding is the lowest at 1.27A. As a comparison, at 50% motor speed and 7mm nozzle size settings, the measured current to fill one moulding is 1.36A. There are 0.09A or 6.62% of difference in current measurement when filling one mouldings.



Figure 4.6: Graph of Power vs Number of Moulding at Servo Angle 50°

Based on Figure 4.6 and Table 4.4, the graph also dislpay the same trendline as the current graph. Based on the observation, the lowest power measured to fill one moulding is at 100% motor speed and 8mm nozzle settings. This is also applied when filling five moulding as the lowest power measured is at 100% motor speed and 8mm nozzle size settings. The power measured is at 15.93W which is the lowest compared to the power measured at 50% motor speed and 7mm nozzle size settings which is 16.992W. As a comparison, there are 1.062W power difference or 6.25% power difference percentage.

Servo	Motor Speed(%)	Nozzle	Number				
Angle(°)		Size	of	Time(s)	Voltage(V)	Current(I)	Power(W)
	Speed(70)	(mm)	Moulding				
60	50	6	1	104.65	11.8	1.35	15.93
			2	212.70	11.8	1.4	16.52
			3	319.26	11.8	1.42	16.756
			4	426.97	11.8	1.41	16.638
			5	532.38	11.8	1.44	16.992
		7	1	99.43	11.8	1.30	15.34
			2	202.08	11.8	1.32	15.576
			3	303.30	11.8	1.33	15.694
			4	406.63	11.8	1.33	15.694
			5	505.77	11.8	1.36	16.048
		8	1	94.46	11.8	1.34	15.812
			2	191.98	11.8	1.34	15.812
	MA	LAYSIA	3	288.14	11.8	1.34	15.812
	J.F.		🏷 4 —	385.34	11.8	1.35	15.93
	E C		7 5	480.49	11.8	1.40	16.52
	100	6	1	45.50	11.8	1.28	15.104
	E		2	92.48	11.8	1.29	15.222
	· Pa		3	138.81	11.8	1.32	15.576
	AIN	n .	4	185.64	11.8	1.33	15.694
	del	()	5	231.47	11.8	1.33	15.694
	ملاك	Lugul	0 j = 7	43.23	11.8	1.30	15.34
		44 44	2	87.86	11.8	1.29	15.222
	UNIVE	RSITI '	TEK3JIK/	131.87	AY11.8 M	1.38	16.284
			4	176.36	11.8	1.40	16.52
			5	219.90	11.8	1.40	16.52
		8	1	41.07	11.8	1.34	15.812
			2	83.47	11.8	1.36	16.048
			3	125.28	11.8	1.37	16.166
			4	167.54	11.8	1.39	16.402
			5	208.91	11.8	1.41	16.638

Table 4.5: Performance of Machine at Servo Angle 60°


Figure 4.7: Graph of Time vs Number of Moulding at Servo Angle 60°

Based on Figure 4.7 and Table 4.5, at 50% motor speed and 6mm nozzle size settings, the time taken for the machine to fill the moulding is at the slowest time at 104.65s and 532.38s to fill five mouldings. The fastest time recorded to fill the moulding is at 100% motor speed and 8mm nozzle size settings. The time taken to fill one moulding and five moulding are 41.07s and 208.91s respectively. Based on the recorded time, there is 63.58s or 60.75% difference in time when filling one moulding and 323.47s or 60.76% when filling five mouldings.



Figure 4.8: Graph of Current vs Number of Moulding at Servo Angle 60°

Based on Figure 4.8 and Table 4.5, at 50% motor speed setting, the measured current increased as the number of moulding increase. Meanwhile, at 100% motor speed setting, the measured current increased as the number of moulding increase. This is different compared to the current measured trend on Figure 4.2. From the graph, it is observed that at 100% motor speed and 6mm nozzle size settings, the measured current to fill one moulding is the lowest at 1.28A. As a comparison, at 50% motor speed and 6mm nozzle size settings, the measured current to fill one moulding is 1.35A. There are 0.07A or 5.19% of difference in current measurement when filling one mouldings.



Figure 4.9: Graph of Power vs Number of Moulding at Servo Angle 60°

Based on Figure 4.9 and Table 4.5, the graph also dislpay the same trendline as the current graph. Based on the observation, the lowest power measured to fill one moulding is at 100% motor speed and 6mm nozzle settings. This is also applied when filling five moulding as the lowest power measured is at 100% motor speed and 6mm nozzle size settings. The power measured is at 15.694W which is the lowest compared to the power measured at 50% motor speed and 6mm nozzle size settings which is 16.992W. As a comparison, there are 1.298W power difference or 7.64% power difference percentage.

4.4 **Power Output Comparison**

To meet the low power consumption objective, the power output obtained are compared to make a result on what setting are the best to meet the low power consumption objective. Compared data are all data collected across all variables tested. The results are shown in Figure 4.10.



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From the graph, it is observed that when the machine is filling one moulding, the lowest power consumed is at power 12 or power at 50degree servo angle, 100% motor speed and 8mm of nozzle size settings. The highest power consumed is at power 5 which is at 40 degree servo angle, 100% motor speed and 7mm nozzle size settings. When filling five moulding, the lowest and highest power consumption is at power 6 and power 8 and power 13 respectively. The settings at power 6 are 40-degree servo angle, 100% motor speed and 8mm nozzle size. At power 8, the settings are 50-degree servo angle, 50% motor speed and 7mm nozzle size while at power 13, the settings are 60-degree servo angle, 50% motor speed and 6mm nozzle size. Overall, the lowest and highest average power consumptions are 15.43W at power 12 and 16.57W at power 8 respectively. Thus, the most efficient in power consumption is the settings at power 12 which are 50 degree servo angle, 100% motor speed and

8mm nozzle size.



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CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

This project has successfully constructed an automated kuih bahulu machine that the user can operate easily in any location deemed suitable for installation in the area. This device is constructed with a mechanical frame, electrical and electronic components, and an Arduino Uno R3 application. This machine is constructed in response to the presented problem statement, which is that manual production using human power is both slow and insufficient. Through the creation of this machine, the study's objectives have been attained. Before transferring the analysis to the hardware design phase, the optimal output is obtained through software design. Test and study results are gathered in order to improve the machine for optimal results and analysis. Result and analysis are measured to ensure that the machine's performance is optimal.

This machine was developed to solve the problem of kuih bahulu production, which is closely related to the production method. Among them are the time-consuming manual method of filling kuih bahulu moulds and the imbalance when filling the mould. This machine can reduce the amount of manpower required to fill the kuih bahulu mould, as well as speed up the process of filling the mould in less time than the manual method. In addition, the components used in this machine consume less energy than existing industrial machines. This is due to the fact that this machine employs a low-energy microcontroller system controlled by Arduino. At the same time, it has no effect on the machine's operating costs. According to the production results that this automated kuih bahulu machine can achieve, this product is aimed at small-scale kuih bahulu entrepreneurs in Malaysia's small industry. There are numerous improvements that can be made to this machine in order to overcome its limitations. It is hoped that with future improvements, this machine will become widely commercialised in Malaysia.

5.2 Future Works

The objective of this study to design an automated kuih bahulu machine was successfully implemented. However, there are still many improvements that can be implemented to ensure that this machine runs more effectively and facilitates the targeted users. Among the improvements that can be made is to build a machine structure using stainless steel. By using stainless steel, the structure of the machine becomes stronger, and the durability of the machine can be used for a long time.

In addition, a fully automatic concept can also be achieved if there is a kuih bahulu making machine system that does not require or requires very little human effort to carry out the kuih bahulu baking procedure. This can be achieved by designing and building a kuih bahulu manufacturing system that covers procedures from mixing ingredients, arranging the mold, filling the mixture into the mold, and the mold sorting mechanism to bake kuih bahulu.

Furthermore, to add more control to the targeted user to control the machine, a timer knob can be added to enable the user to adjust the servo motor timing to lift the dispensing mechanism. With the additional of the knob, it adds more varieties of mouldings this machine can fill. Thus, this feature enables targeted user to produce variety of products.

An interesting idea that can be applied to this project is to integrate Internet of Things (IoT) applications into this project. Through the IoT application the user can control this machine easily through the user's smartphone. Besides that, there are also advantages obtained if the iot concept is implemented, for example, users can read production data or the number of molds that have been filled and the amount of batter left to be filled in the mold, thus making it easier for users to plan budgets and production and sales targets.



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APPENDICES

Appendix A Arduino Coding and AutoCAD Design

```
#include <LiquidCrystal I2C.h>
#include <lcdBase.h>
#include <u8x8 font.h>
#include <Servo.h>
#include <Wire.h>
const int seq sensor = A0;
const int prox sensor = 3;
const int in_A = 10;
const int in_B = 11;
const int start Btn = 4;
const int stop_Btn = 2;
int state = 0;
Servo myservo;
LiquidCrystal I2C lcd(0x27, 16, 2);
void setup() {
 pinMode (seq sensor, INPUT);
 pinMode (prox/sensor, Input) NIKAL MALAYSIA MELAKA
 pinMode(start Btn, INPUT PULLUP);
 pinMode(stop Btn, INPUT PULLUP);
 pinMode(in A, OUTPUT);
 pinMode (in B, OUTPUT);
 digitalWrite(seq sensor, LOW);
 digitalWrite(prox sensor, LOW);
 digitalWrite(start Btn, HIGH);
 Serial.begin(9600);
 myservo.attach(6);
 myservo.write(0);
 lcd.begin(16, 2);
  lcd.backlight();
  lcd.setCursor(0, 0);
  lcd.print("Dispensing");
 lcd.setCursor(0, 1);
```

```
lcd.print("Machine");
 delay(2000);
// lcd.clear();
}
void loop() {
 int seq = digitalRead(seq sensor);
 int prox = digitalRead(prox_sensor);
 int start B = digitalRead(start Btn);
 int stop B = digitalRead(stop Btn);
 if ((start B == LOW) && (prox == LOW) && (state == 0)) {
   Serial.println("PASS");
   state = 1;
 }
 if (state == 1) {
   if ((seq == LOW) && (state == 1)) {
     delay(200);
     Serial.println("PASS");
     lcd.clear();
     lcd.setCursor(0, 0);
     lcd.print("Mesin Mula");
     lcd.setCursor(0, 1);
     lcd.print("Mengisi Aduan");
     analogWrite(in A, 0);
     analogWrite(in B, 0);
     myservo.write(40);
     delay(3000);
     myservo.write(0); | TEKNIKAL MALAYSIA MELAKA
     delay(1000);
    }
    else if ((stop B == LOW) && (state == 1)) {
     lcd.clear();
     lcd.setCursor(0, 0);
      lcd.print("Mesin Berhenti");
     lcd.setCursor(0, 1);
```

```
lcd.print("Mengisi Aduan");
     analogWrite(in_A, 0);
     analogWrite(in_B, 0);
     myservo.write(0);
     state = 0;
   }
   else {
     lcd.clear();
     lcd.setCursor(0, 0);
     lcd.print("Mesin Mula");
     lcd.setCursor(0, 1);
     lcd.print("Beroperasi");
     analogWrite(in_A, 255);
     analogWrite(in_B, 0);
     delay(200);
   }
  }
}
          UNIVERSITI
                                                 SIA MELAKA
                                        MAI
```

```
Dispensing Mechanism Sketch 1
```



Full Prototype Design

Appendix B Datasheet





Support &

LM2596 SNVS124F - NOVEMBER 1999 - REVISED APRIL 2021

LM2596 SIMPLE SWITCHER[®] Power Converter 150-kHz 3-A Step-Down Voltage Regulator

1 Features

Texas

INSTRUMENTS

- New product available: LMR33630 36-V, 3-A, 400kHz synchronous converter
- 3.3-V, 5-V, 12-V, and adjustable output versions
- Adjustable version output voltage range: 1.2-V to 37-V ±4% maximum over line and load conditions
- Available in TO-220 and TO-263 packages
- 3-A output load current
- Input voltage range up to 40 V
- Requires only four external components
- Excellent line and load regulation specifications
- 150-kHz Fixed-frequency internal oscillator
- TTL shutdown capability
- Low power standby mode, IQ, typically 80 µA
- High efficiency
- Uses readily available standard inductors
- Thermal shutdown and current-limit protection
- Create a custom design using the LM2596 with the WEBENCH Power Designer

2 Applications

Appliances

- Grid infrastructure
- EPOS •
- Home theater

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3 Description

The LM2596 series of regulators are monolithic integrated circuits that provide all the active functions for a step-down (buck) switching regulator, capable of driving a 3-A load with excellent line and load regulation. These devices are available in fixed output voltages of 3.3 V, 5 V, 12 V, and an adjustable output version.

Requiring minimum number of external а components, these regulators are simple to use and include internal frequency compensation, and a fixedfrequency oscillator.

The LM2596 series operates at a switching frequency of 150 kHz, thus allowing smaller sized filter components than what would be required with lower frequency switching regulators. Available in a standard 5-pin TO-220 package with several different lead bend options, and a 5-pin TO-263 surface mount package.

The new product, LMR33630, offers reduced BOM cost, higher efficiency, and an 85% reduction in solution size among many other features. Start WEBENCH Design with the LMR33630.

and the second sec	20 E. E.	1.00
PART NUMBER	PACKAGE ⁽¹⁾	BODY SIZE (NOM)
Model AVC	TO-220 (5)	14.986 mm × 10.16 mm
LWI2090	TO 262 (E)	10 10 mm × 8 90 mm

(1) For all available packages, see the orderable addendum at the end of the data sheet



Typical Application

MG995 High Speed Metal Gear Dual Ball Bearing Servo



The unit comes complete with 30cm wire and 3 pin 'S' type female header connector that fits most receivers, including Futaba, JR, GWS, Cirrus, Blue Bird, Blue Arrow, Corona, Berg, Spektrum and Hitec.

This high-speed standard servo can rotate approximately 120 degrees (60 in each direction). You can use any servo code, hardware or library to control these servos, so it's great for beginners who want to make stuff move without building a motor controller with feedback & gear box, especially since it will fit in small places. The MG995 Metal Gear Servo also comes with a selection of arms and hardware to get you set up nice and fast!

Specifications VERSITI TEKNIKAL MALAYSIA MELAKA

- Weight: 55 g
- Dimension: 40.7 x 19.7 x 42.9 mm approx.
- Stall torque: 8.5 kgf·cm (4.8 V), 10 kgf·cm (6 V)
- Operating speed: 0.2 s/60° (4.8 V), 0.16 s/60° (6 V)
- Operating voltage: 4.8 V a 7.2 V
- Dead band width: 5 µs
- · Stable and shock proof double ball bearing design
- Temperature range: 0 °C 55 °C

() seeed

COMPACT DESIGN

40 x 50 x 13 (cm) 14.5 gram



MAKER MDD3A - Dual channel 3A DC Motor Driver

SKU 105090004

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Are you interested in the robot motor? Do you want to start a motor driver? Here is your chance! Dual channel 3A DC Motor Driver is a powerful motor driver which can support two brushed DC motors or one single bipolar/unipolar stepper motor from 4V to 16V. This motor driver is designed with discrete MOSFETs H-bridge. As a matter of fact, the motor driver is able to run with 3Amp current per channel continuously without any additional heatsink.

There are two groups of test buttons(each group contains two buttons) to correspond with two separated channels. With these test buttons, you don't have to connect with the controller to test the driver, which is very convenient. The module also provides 4V~5V output to support the controller.

Dual channel 3A DC Motor Driver is able to run with a wide power supply of 1.8V to 12V. What 's more? It can be compatible with many controllers, such as Arduino and raspberry pi. Besides, this driver support reverse polarity protection, so it will not be broken easily by misoperation.

Features

- Bidirectional control for two brushed DC motor.
- Control one unipolar/bipolar stepper motor.
- Operating Voltage: DC 4V to 16V
- Maximum Motor Current: 3A continuous, 5A peak
- Buck-boost regulator to produce 5V output (200mA max).
- Buttons for quick testing.
- LEDs for motor output state.
- Inputs compatible with 1.8V, 3.3V, 5V and 12V logic (Arduino, Raspberry Pi, PLC, etc).
- PWM frequency up to 20kHz (Output frequency is same as input frequency).
- Reverse polarity protection



Input A (M1A / M2A)	Input B (M1B / M2B)	Output A (M1A / M2A)	Output B (M1B / M2B)	Motor
Low	Low	Low	Low	Brake
High	Low	High	Low	Forward*
Low	High	Low	High	Backward*
High	High	High	High	Brake

 Actual motor direction is depending on the motor connection. Swapping the connection (MA & MB) will reverse the direction.



Draw:	备注(Remarks							DC14113.	Detaile.	参数			图纸	图号 (Drawing
Rev:	s):	旋转方向(Rotation Direction):	堵转力矩(Stall Torque)(kgf.cm):	堵转电流(Stall Current)(mA):	额定转速(Rated Load Speed)(r.p.m):	额定电流(Rated Current)(mA): ≤	额定力矩(Rated Load Torque)(kgf.cm):	空载转速(No Load Speed)(r.p.m):	空载电流(No Load Current)(mA):	减速电机参数(Geared motor specification):	客户确认(Customer APP.):	P.C.J ØJI G-M3 depth 3.5mm MAX.	版次:1.1	3 NO.) SG01 (60KBC) - 3004-000 型号
App.:	as to install it.	CW/CCW 5,请不要在安装零件时为了调整位置而从输出轴方向去回转齿轮马达。Do turn a seared motor by its output shaft when for example arranging its positi	that the adhesive does not spread along the shaft and flow into the bearing.	drawing. drawing. Are 经接到得计称计数分 结合 Trie monourment to be can	56 ± 5, 6 3, 安某螺丝清煎光确认外观图所标示之形式及长度尺寸。 Install the screws first checking the taps and tap depth against the dimensions entered on the e	<1200 process. It is prohibited to strike and crush directly on reducer output shaft.	 5.5 2. 在安架拉帮中不应使减速电机受到冲击、跌落。不允许直接在减速器出轴 打鼓压配。Prevent gear motor from being shocked or dropping in mounting 	75 ± 7.5 soldering iroa tip at a temperature of 340 - 400°C, within 2 seconds	< 320 1. 焊接作业请在短时间内实行。(推荐:焊接头的温度340~400度,2秒内2 Disease conduct the wolding work in a short time (Bacommendation: With the	注意事项(Notes):			12V DC	(Model No.) SPG50-60K 电压(Voltag



SN-E18-B03N1 Digital Infrared Sensor



User's Manual

V1.1

July 2012

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1. INTRODUCTION AND OVERVIEW

This <u>Digital Infrared Sensor</u> offers simple, user friendly and fast obstacle detection using infrared. This is an Digital Infrared Sensor. This product is used during the reflection of IR by obstacles. It is widely to use in various type of industry such as spinning and weaving, mechanical, iron and steel, chemical, electric power, security and so on. This product features include:



Figure 1.1 The reflection of Digital Infrared Sensor on the object

- Cylindrical, diffuse reflectance
- *NPN output
- Three-wire.
- **6V-36V powered, low current consumption, less than 300mA.
- ***Obstacle detection up to **30cm**.
- Adjustable sensing range (0cm-30cm).
- Small size makes it easy to assembly.
- High precision, waterproof, protect corrosion, resist of light.
- Widely useful for robot, interactive media, industrial assembly, etc.

* Though it is NPN output, but internally it is being pull up the power pin. ** Test show it can be powered as low as 5V. *** Longer distance can be achieve if power voltage is increase.

2. PACKING LIST

Please check the parts and components according to the packing lists. If there are any parts missing ,please contact us at <u>sales@cytron.com.my</u> immediately.



3. PRODUCT SPECIFICATION AND LIMITATIONS

3.1 Theory of Operation

The <u>SN-E18-B03N1</u> contains infrared sensor for use as reflection of IR signal barriers. It uses special sensor to detect the modulated IR signal reflected back from a nearby either or a far distance of the object. The transmitter and the receiver between the light intensity of the digital infrared sensor can change into for the purpose of current changes in order to achieve the detection. The output signal of Digital Infrared Sensor is needed to be pull high as it is NPN output. The module will output a HIGH if no object is detected and a LOW if an object is detected.

Note: Although the specification stated it is NPN output, we notice the sensor itself is being pull-up internally. Causing the output pin is being pull up to power pin. So if 12V is supply, you will get ~12V at output when no obstacle is detected.

3.2 Pin Definitions and Ratings

Color	Name	Function
Brown	VCC	Connects to VCC (+6V to +36V)
Blue	Ground	Connects to Ground
Black	Output Signal	Connect to an I/O pin of microcontroller which set to INPUT mode

Absolute Maximum Rating

UNIVERSITI TEKNIKAL MALAYSIA MELAKA									
Parameter	Min	Max	Unit	ALC: A Base					
Operating voltage	6	36	V						
Sensing meter	0	30	cm						

Lab test result show even as low as 5V the sensor can still function. Yet, we do no test for all sensor.

3.3 Sensitivity

The <u>Digital Infrared Sensor</u> has a sensing range of approximately 0cm to 30m for a white or shiny color object. For a dark or black color object, the Digital Infrared Sensor has a sensing range of approximately 2cm to 25cm. It shows that the sensor will reflect more on a white

surface than a black surface. The sensor is designed to adjustable sensing range. When user adjust the white preset (at the bottom of Digital Infrared Sensor, the range object detected also change. If user adjust the preset to counter-clockwise, the detected range will less than 30cm. The more user adjust the preset to counter clockwise, the more short the Digital Infrared sensor may detect object.



3.4 Test Result in Lab

We have tested the sensor in our lab with different voltage and here is the result.

alle	اويتوم سيتر تيكنيكا مليسيا
Voltage, V	Maximum detectable distance (obstacle)
5V ^{UNIVE}	RSITI TEKNIKAL MALAVSIA MELAKA
12V	60cm
30V	80cm

All test is using Cytron's packaging white color box as obstacle. Other object might have different result as it depends on the reflective of Infrared of object surface. The above result is just for reference.

4.PRODUCT DIMENSION AND LAYOUT

4.1 Product Dimension



Label	Function
Α	Connect VCC(+)

В	Connect GND(-)
С	Connect Output Signal (S)

A- User may supply 6V-36V to <u>SN-E18-B03N1</u>, the typical voltage is 12V.

B-User may connect the GND (-) of SN-E18-B03N1 to the Ground (0V) of he control board.

C-User may connect output signal to an I/O pin of microcontroller which set to INPUT mode. The output signal of Digital Infrared Sensor is needed to be pull high as it is NPN output. The module will output a HIGH if no object is detected and a LOW if an object is detected.

Note: Although the specification stated it is NPN output, we notice the sensor itself is being pull-up internally. Causing the output pin is being pull up to power pin. So if 12V is supply, you will get ~12V at output when no obstacle is detected.

5. GETTING STARTED





Example 4.1 Example interface for <u>Digital Infrared Sensor</u> (With <u>SK40C</u>), using <u>LC04A</u> as level shifter.

Part	Description
Digital Infrared Sensor Connector	Connects to Digital Infrared Sensor, pin 1 to output (Black Color),pin 2 to GND (Blue color) and pin 3 to Vcc (Brown color)
Vcc	Connects to Vcc ($+6V$ to $+36V$), 5V is possible too.
LC04A	As logic level shifter
SK40C	The output of sensor is shifted to logic 5V via LC04A and go into RB0 of SK40C. RB0 is input of SK40C.

The interface of <u>Digital Infrared Sensor</u> is shown in Figure 4.1, with reference to the schematic, the output signal which sends to microcontroller with LOW wherever there is a infrared detected and high if no object detect. **6. WARRANTY**

- Product warranty is valid for 6 months.
- Warranty only applies to manufacturing defect.
- Damaged caused by misuse is not covered under warranty
- Warranty does not cover freight cost for both ways.



Prepared by Cytron Technologies Sdn. Bhd. No. 16, Jalan Industri Ringan Permatang Tinggi 2, Kawasan Industri Ringan Permatang Tinggi, 14100 Simpang Ampat, Penang, Malaysia.

> Tel: +604-504 1878 Fax: +604-504 0138 URL: www.cytron.com.my Email: support@cytron.com.my sales@cytron.com.my