LOW COST SPIN COATINGSYSTEM FOR THIN FILM DEPOSITION WITH IOT

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LOW COST SPIN COATINGSYSTEM FOR THIN FILMDEPOSITION WITH IOT

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

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DECLARATION

I declare that this report entitled "LOW COST SPIN COATINGSYSTEM FOR THIN FILMDEPOSITION WITH IOT" is the result of my own work except for quotes as cited in the references.

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APPROVAL

I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the award of Bachelor of Electronic Engineering with Honours.

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DEDICATION

This thesis is dedicated to my parents for their endless love, support and encouragement.

ABSTRACT

Spin coating is a widely used coating method for the preparation of uniform thin films in many industries as well as advanced materials functions such as sensors, solar cells and filters. Spin coating mechanism is called spin coater that create thin films with the right product speed and density. This project is about the construction of low cost spin coating machine incorporating inexpensive electronic components and open source technology. Most conventional spin coaters have high cost to purchase and it does not have a database system to store data for future reference. The system was designed and produced using a microcontroller as the main system and brush motor to spin the substrate. The spin coater is capable to spin around 200 to 6000 rpm that can be controlled manually and automatically. The system is built with the Internet of Thing (IoT) platform that can be connected to Wi-Fi. From this IoT platform, the system can store data for substrates by uploading it to the open source cloud for future reference. In addition, the system will use an LCD screen to display the job settings during operation. As a result, by comparing with standard commercial spin coaters, the performance of low cost spin coaters is similar to that of commercial and most importantly this spin coater is low cost and has IoT elements.

ABSTRAK

Kaedah pelapisan putaran adalah kaedah lapisan yang digunakan secara meluas untuk penyediaan filem nipis seragam dalam sektor industri untuk membuat komponen berfungsi canggih seperti penderia, sel suria, dan penapis. Mekanisma pelapisan putaran juga disebut pelapis putaran membuat filem tipis dengan kelajuan dan ketumpatan produk yang betul. Sebilangan besar pelapis putaran konvensional mempunyai kos yang tinggi untuk dibeli dan ia tidak mempunyai sistem pangkalan data untuk menyimpan data sebagai rujukan masa depan. Projek ini adalah mengenai pembinaan mesin pelapis putaran berkos rendah yang merangkumi komponen elektronik dan teknologi sumber terbuka yang murah. Sistem ini direkabentuk dan dihasilkan menggunakan pengawal mikro sebagai sistem utama dan motor sikat untuk memutar substrat. Pelapis putaran mampu berputar sekitar 200 hingga 6000 rpm yang dapat dikendalikan secara manual dan automatik. Sistem ini dibina dengan platform internet benda (IoT) yang dapat dihubungkan menggunakan Wi-Fi. Dari platform IoT ini, sistem dapat menyimpan data untuk substrat dengan memuat naiknya ke awan sumber terbuka untuk rujukan masa depan. Selain itu, sistem akan menggunakan panel LCD untuk menampilkan pengaturan pekerjaan selama operasi. Hasilnya, dengan membandingkan dengan pelapis putaran berpiawaian komersial, prestasi pelapis putaran kos rendah adalah bersamaan dengan pelapis berputar komersial dan yang paling penting pelapis putaran ini adalah berkos rendah dan mempunyai elemen IoT.

ACKNOWLEDGEMENTS

Thanks to Allah, the Almighty God, and my parents, Razak Bin Rykan and Siti Nashariah Bt Mohd, for giving me the strength and possibility to complete this Final Year Project. Bearing in mind previous I am using this opportunity to express my deepest gratitude and special thanks to my supervisor, Encik Zul Atfyi Fauzan Bin Mohammed Napiah and Co supervisor, Encik Muhammad Idzdihar Bin Idris , who in spite of being extraordinarily busy with his duties, took time out to guide and keep me on the right path throughout this project. It is my radiant sentiment to place on record my best regards, most profound sense of gratitude to everyone who helped and eased me for their useful and precious guidance, which were extremely valuable for my study both theoretically and practically. I perceive at this opportunity as a big milestone in my studies. I will strive to use gained skills and knowledge in the best possible way, and I will continue to work on their improvement to attain desired career objectives.

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CHAPTER 1

INTRODUCTION

1.1 Project Overview

Spin coating is a widely used coating method for the preparation of uniform thin films in many industries as well as advanced materials functions such as sensors, solar cells and filters [1]. Spin coating process using the coating materials principle of centrifugal force to achieve uniform thin films. The substratum is then rotated at high speed so that the coating material is distributed by centrifugal force. A spin-coating mechanism is called a spin-coater, or just a spin-coater. Spin coater creates thin films by proper speed and product density. A thin film is a sheet of material from nanometer fractions (monolayer) to several micrometer thickness. The width of the film in the spin coating method is based on the nature of the polymer, solvent, and spinning speed. Besides, the spin coating method is easy to operate by controlling the speed corresponding to the desired film thickness.

This project is about developing a low-cost spin-coating system that integrates cheap electronic components and open source technology. The importance of spin-coating is expressed in its widespread use in science and industry. The discrepancy between the two values is referred to as an error used by using a microcontroller to control the speed. To prepare a thin ZnO film, a machine equipped with the Arduino Mega 2560 microcontroller-based control system was tested. The weight percentage of the film thickness was examined concerning the speeds and time to coating.

This model of design corresponds to Industry Revolution 4.0 (IR 4.0), as shown in figure 1.1. The fourth industrial revolution brings manufacturing process automation to a new level by incorporating personalized and scalable mass production techniques. This concept can prove that industrial machines can be connected to the cloud database to save data. Manufacturers should be able to connect with machines, rather than operating them. IR 4.0's main characteristics are:

- Large Data
- Connectivity
- Digitalization
- Artificial Intelligence

This project system is under digitalization, which works through the IoT. IR 4.0's massive data sets mean that data sharing is not only beneficial but also necessary to maximize the full potential within the value chain. However, the vast quantities of information obtained will be processed and analyzed by a few manufacturing plants. Thankfully, cloud service providers have the capacity to create private clouds that are ideal for data storage and processing output [2].

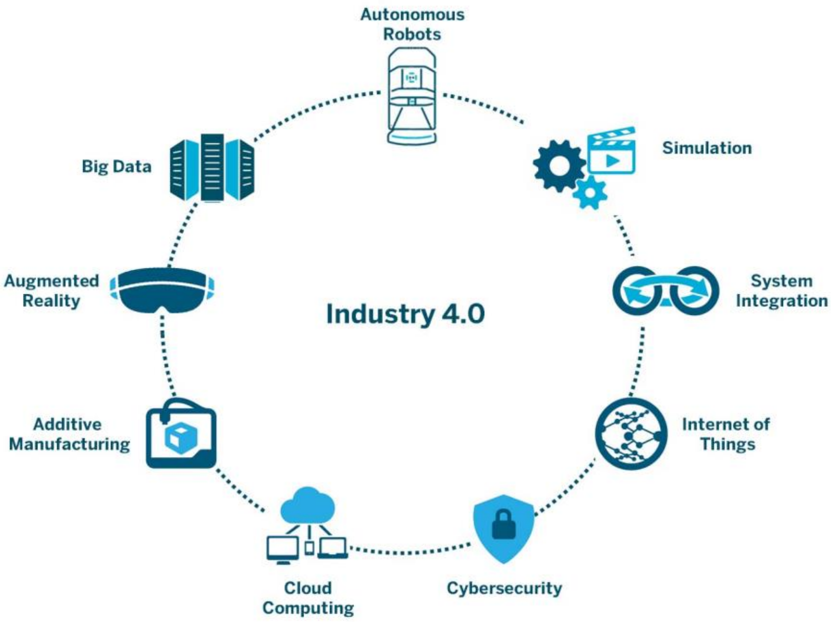


Figure 1.1: Industry Revolution 4.0 [2]

1.2 Problem Statement

Conventional spin coating system mostly are high cost to purchase, and it has no database system to record the data such as speed rotation, time taken, etc. In a cleanroom for example, only inside equipment can be used and it is hard to bring outside equipment because it can cause dust to the cleanroom. For conventional spin coating, the coating performance needs to analyse manually.

1.3 Project Objective

The objective for this project are:

- To design and develop the low-cost spin coating system.
- To enhance the function of the spin coating system by adding the IoT element.
- To analyze the thickness of the film that produce by low cost spin coating system against speed and time.

1.4 Scope of Project

1.4.1 Hardware

- Arduino Mega 2560 will be integrated with 20X4 Liquid Crystal Display (LCD), L298N Motor Driver, Push Button, and ESP-8266 Wi-Fi Module.
- LCD will display the Menu, File number, Step, Speed, and time of the spin process.
- Motor driver L298N as the driver to control motor speed.
- Keypad Metrix 4x4 will be input control.
- Wi-Fi Module will Enable the Arduino Mega to send data into Cloud via internet access.

1.4.2 Software

- Google Spreadsheet Cloud Platform
  - To enable data storage in the Cloud.
- Arduino IDE
  - To configure Arduino Mega to communicate with Wi-Fi Module.
  - To control L298N Motor Driver operation.

1.5 Thesis Outline

The structure of this thesis divided into five main chapters. There are Chapter I is Introduction, Chapter II for Literature Review, Chapter III for Project Methodology, Chapter IV for Result and Discussion and Chapter V for Conclusion and Future Work.

The introduction for this thesis is in Chapter I. This chapter briefly describes the spin coating system function for use in science and industry. The introduction also includes the Statement of Problems, Project Objective and Project Scope.

Chapter II deals with the Literature Review which is an integral part of this project and the most critical part of this study. Maximizing knowledge in this chapter is a must for research, reading-related journals and articles. Some useful knowledge can be derived from the related references for the improvement of a commercialized spin coating system.

Chapter III describe the methodology of the project. The methods used to complete the system will be explained in this chapter. The flow chart explains the system's step-by - step process. The source code is compiled using Arduino IDE program.

Chapter IV discussed the results and discussion, such as the review and conclusions of this project. Several experimental tests were performed in this chapter to analyze the function of the design system to reach the goal of the expected result. The data were gathered and the project proved a success.

Chapter V summarized the project into Conclusion and Suggest for Future Work. Within this section a few ideas and further changes were discussed. To conclude, the result and analysis for the whole project ware.

CHAPTER 2

LITERATURE REVIEW

2.1 Overview

The related works were studied in this chapter for better understanding and improvement of the weaknesses of those works. Information and techniques are gathered and recorded during this work in order to avoid unnecessary errors or decision making.

2.2 System Specification and Details

2.2.1 IoT

The Internet of Things (IoT) theory brings objects of contact identities to live in the real world. It connects all devices or devices with a given character over the Internet so that users can access, monitor, and collect connected device information via remote devices or computers [3]. After the conventional Internet and mobile communication networks, IoT is known as the third wave of information technology in which loT expands the interoperability of the Internet by providing inter-network communication between the host and the slave. The advent of loT makes things smart and intelligent by using an embedded device to introduce sensor and data processing, enabling communication between objects and humanity [3][4] .

People may think of loT as an emerging technology, but in reality, the concept of loT transforms from interaction from machine to machine (M2M). M2M communication is where mobile devices are interconnected facilitating contact between two users when loT connects to man rather than computer using the internet [5]. Kevin Ashton invented the loT concept from a place called Proctor & Gamble in 1999 as a corporate presentation name. Gradually, with innovation, these "things" have grown to be more diverse, covering different applications. The word meaning has become, but the loT's vision of using computers to enable information sensing without human intervention remains unchanged. Previously, drastic and far-reaching Internet transition has resulted in a ground-breaking scale and speed interconnection between mankind. As for now, the next engineering breakthrough for a smarter society will be incorporated, linking people and objects. As predicted, the speed of the revolution is uncontrollably taking over the world's population by the number of interconnected devices in 2011 [6]. In 2020, the loT is expected to have 50 billion devices [7].

Due to the massive increase in loT use, IoT standardization was launched as the IoT Global Standards Initiative (loT-GSI) to unify loT development standards. IoT deployment, interoperability, and reliability include standardization activities. This is also important in order to avoid multi-standard in industry and to coordinate with other service providers based on the agreed standard. Therefore, any communication conflict can be avoided with the loT-GSI system [8][9]. The aims of loT-GSI are to accomplish the following objectives:

- Definition of "Internet of Things (loT)",
- To provide an optimal working environment for service providers,
- Optimizing a predominant loT of production from other organizations [8].

According to ITU, loT is defined as "a global infrastructure for the information society that enables advanced services by interconnecting (physical and virtual) stuff based on existing and emerging interoperable information and communication technologies" [10].

IoT varies from conventional Internet protocol and short-range communication network. The following figure shows the relationship between IoT and other existing systems. [11].

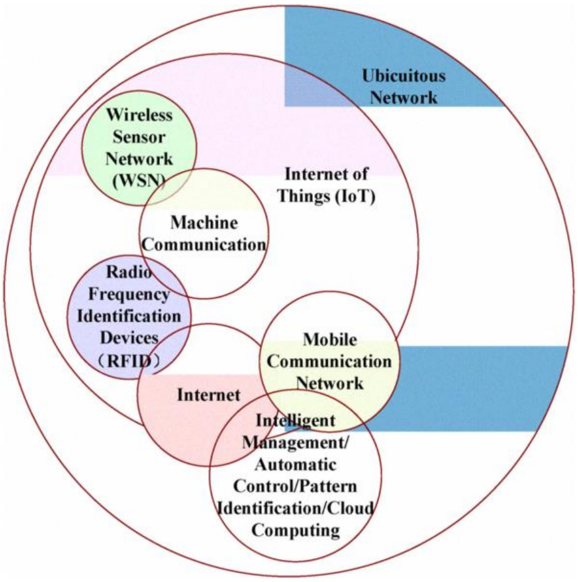


Figure 2.1: The Relationship Between IoT and Others Existing Network

According to ITU [10], there are four layers of the IoT reference model, i.e., system layer, service support and application support layer, network layer, and the device layer. On the security and protection side, there are two layers.

The application layer is at the top, consisting of several elements for IoT applications. The application layer enables the alignment of IT with the industry to achieve wide-ranging smart application solutions [11]. There are two classes of network support and the software support layer. The first, universal support capabilities, is a standard data processing or data storage capacity that can be invoked by specific support capabilities. The second, specific support capabilities are very comprehensive grouping capabilities that support different applications [10]. Networking capabilities in the network layer are to manage network connectivity functions. Access for loT operation, IoT control, and application-specific data transfer is a transport capability [11].

Capabilities of interface layers divided into two capabilities: capabilities and capabilities of gateways. Since they combine conditions, all capacities are not limited to the situation. Collecting and uploading information directly to the communication network and receiving data directly from the communication network are computer capabilities with direct interaction. Device capabilities with indirect interaction did the indirect way of the direct interaction. The gateway capabilities can interface with different technologies on the network layer. Protocol conversion happens when communications at the device layer apply different device layer protocols and when communications using different protocols in both the device layer and network layer. Protocol transition occurs when the application layer communicates using different device layer protocols and when the system layer and network layer communications use different protocols [10].

Management capabilities provide groups of common and specific management skills in fault, configuration, accounting, performance, and security (FCAPS). Standard management functions consist of device management, topology management of local networks and control of traffic and congestion. On the other hand, unique management skills are strictly compatible with the specifications relevant to the project. There are standard security capabilities and specific security capabilities in security capabilities. The system layer, network layer and computer layer are standard safety capabilities. Specific security features are paired with particular applications [10].

Several application domains were affected by the emerging Things Internet. These applications can be classified based on network types such as availability, coverage, scale, heterogeneity, recurrence, user involvement, and impact. The programs were divided into four categories.:

- Personal and Home
- Enterprise
- Utilities
- Mobile

Private and Home loT on an individual or home level, Enterprise loT on a group scale, Utility loT on a national or regional scale, and Mobile loT, which is typically distributed across other realms mainly because of the complexity of connectivity and size. Data is used widely between domains and crossover applications.

Last but not least, the development of IoT, which involving an upgraded cloud computing able to make loT application framework to provide support for reading data stream from sensors directly, easy on expressing data analysis logic as function and passing the outcomes to output stream when any event of interest is detected.

2.2.2 Google Cloud

Cloud computing is revolutionizing the way application developers plan, build, launch, manage, and remove their code. It took a few weeks to make a website public only a decade ago. Today, the same job can be completed in an hour, if not a few minutes, thanks to public cloud services such as Amazon Web Services, Google Cloud Platform, and Microsoft Azure [12]. In 1961, John McCarthy introduced the idea of "offering computing as a public service" Cloud computing has been developed today through various technological advances over the next five decades, including:

- During the 1960s J. C. R. Licklider developed ARPANET — the Internet precursor and what is considered the most influential contributor to the development of cloud computing during this time.
- In 1971, Intel engineer Ray Tomlinson created the software which enabled users to send messages from one computer to the next. This was recognized later as the first e-mail.
- Xerox 's Robert Metcalfe introduced Ethernet in 1976, essentially standardizing the wired network interface on a device level.
- In 1991 CERN introduced the World Wide Web for general (i.e. , non-commercial) use.
- In 1993, the Mosaic web browser allowed graphics to be displayed on the internet. In the same year private companies were permitted to use the internet for the first time.
- The advent of multi-tenant networks, omnipresent high-speed networking and international interoperability standards in technology created the perfect climate for cloud computing to eventually take off in the late 1990s and early 2000s (the dot-com era).

The two main driving forces behind cloud computing are the creation of a worldwide high-speed network and a utility-based business model.

Google Cloud Platform is based on the same world-class technology developed, produced, and used by Google for corporate services such as Google Search, providing trillions of millisecond search results. Google also has one of the world's largest, most widely distributed, most advanced computer networks [12].

Google's backbone network includes thousands of miles of fiber-optic cable, uses advanced software-defined networking, and provides fast, reliable, scalable performance coupled with edge-caching services. Google is also one of the few businesses in the Pacific Ocean that operates a single fiber optic cable.

Google Cloud Platform helps software developers to design, prototype, deploy, and monitor applications using Google's highly scalable, secure infrastructure. This also lets system administrators focus on the software stack while enabling them to outsource the challenging hardware assembly, repair, and refresh engineering work of Google experts.

2.2.3 Arduino

The advancement of current technology including the microelectronics industry, has undoubtedly ease mankind's life with a solution created to catalyze our high living pace. Arduino first made its appearance in the year 2005 on the Interactive Design Institute in Ivrea, Italy [13]. The founders of Arduino, David Cuartielles, Massimo Banzi and the team intended to provide a high-performance single-chip microcomputer that is easy to be used and low in cost where everyone can afford it. The invention of Arduino is then widely used as an education platform by students, researchers, or even professionals involving many areas of application [14][15].

The Arduino board is renowned as the founders decided to make its hardware (the board) and software (Arduino Integrated Development Environment, IDE) open-source, to enable fast development according to one's need through easily accessible platform where everyone can contribute information to make it an incredible pool of available knowledge to aid users' project development. The flexibility provided by low power consumption, full voltage, high integration and potent portability Arduino is able to run on Windows, Linux, and OSX operating systems, giving a plus point over any other microcontrollers available on the market [14].

The Arduino boards are made available ranging from small, entry-level 8-bit MCU board to robust, enhanced features 32-bit MCU board like Arduino Mega or the Arduino Due. All the Arduino boards come with a pre-burned bootloader that allows plug and plays without any additional hardware programmer such as a JTAG that communicates through the serial port. Besides, Arduino provides several programmer modules and shields to suit personal needs or to make the project fancier with expanded functionality [14] [16]. In my project, an Arduino Mega is selected as it has a more significant flash memory with more input/output pins.

Table 2.1: Specification Summaries of Arduino ATmega 2560

SPECIFICATION	ATmega 2560
Operation Voltage	5V
Recommended Input Voltage	7-12V
Input Voltage Limits	6-20V
Digital I/O Pins	54 (15 out of it provide PWM output)
Analog Input Pins	16
DC Current per I/O pin	20mA
DC Current for 3.3V Pin	50mA
Flash Memory	256KB
SRAM	8KB
EEPROM	4KB
Clock Speed	16MHz
Build-in LED	Pin 13
Length	101.52mm
Width	53.3mm
Weight	37g

.

Arduino can be connected to the USB port, battery, USB phone charger adapter or even a power bank via USB cable. It can also be powered up via a power jack using the AC-to-DC adapter. The power specification for Arduino Mega is listed in Table 2.1. Furthermore, some of the digital input/output pins of Arduino Mega come with unique functions such as serial pins, external interrupts, PWM, SPI and TWI, Arduino has four serial UARTS that enable transmission and reception of TTL serial data while external interrupts can be used to activate an interrupt on a low level, oscillating edge or a change in level [17]. Pulse Width Modulation (PWM) is an approach used to generate a digital square wave in analog means. This feature is especially useful in adjusting the brightness of an LED or controlling the speed of a motor [29]. SPI (MOSI, MISO, SCK, SS) and TWI (SCL, SDA) support communication using the SPI library and Wire library respectively. Digital pin 13 on the board is a unique pin because an LED is attached to this pin indicating the HIGH and LOW of the nail. The purpose of this pin is mainly used for testing purposes. Arduino Mega provides greater flexibility as it is compatible with most Arduino Uno or Arduino Lolin NodeMCU [17].

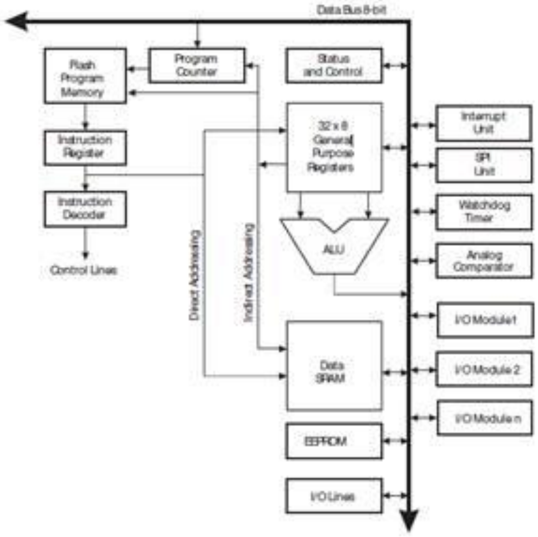


Figure 2.2: Arduino ATmega 2560 Board Architecture

2.3 Related Works

2.3.1 Fabrication of Digitalized Spin Coater for Deposition of Thin Films

The digitized spin coating device was incorporated with an automatic control setup, using a microcontroller panel, a character monitor, a matrix keypad, and a dc motor. The substratum was spinning by a dc motor. It's important to maintain the optimal speed for a controlling circuit. To offer the microcontroller control pulse, which overcame the difficulties of traditional SCR-based control circuits. The motor speed can be increased from 0 to 3300 rpm. The appropriate velocity (in rpm) and spinning time can be set from the matrix keypad as input. The display of LCD characters plays the role of showing the rpm and time you like. Zinc oxide thin films with the proposed digitized spin coater is deposited on a glass substrate. It has essential features that it can operate at various speeds and times immediately after the previous settings are complete [18].

Figure 2 shows the basic block diagram for the spin coating system being proposed. Ac to dc converter converts power supply of 220V ac into power of 12V and 5V dc. 5V was used for the ATmega32 microcontroller and the LCD display panel as power supply. Forgive desired input to control speed and time; use was made of a matrix keyboard. A motor driver circuit was used for regulating the motor and continuing its rotation. ATmega32 microcontroller drives the motor driver circuit, which, in effect, drives a 12V dc driven 3300 rpm engine. Throughout this work, the Pulse Width Modulation (PWM) technique was used to monitor the speed of the motor, where its signal is produced in a microcontroller. The PWM signal will be sent to the motor driver to vary the voltage supply to the motor to maintain a constant velocity.

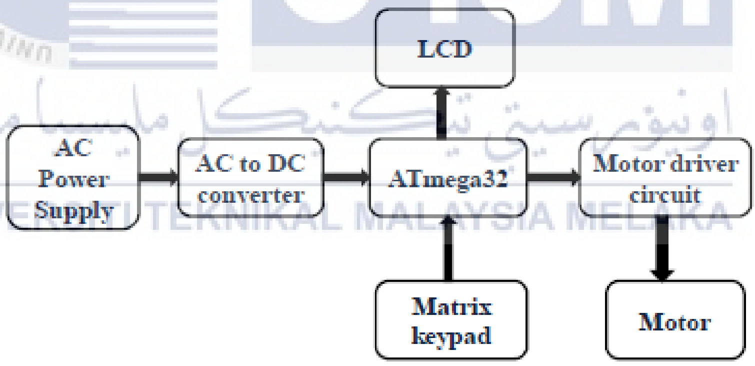


Figure 2.3: Basic Block diagram of proposed device

2.3.2 Spin coater based on brushless dc motor of hard disk drivers

The project is about creating a novel programmable, low-cost spin coater for applications where flat substrates are covered with a uniform thin layer of suitable material. The equipment is installed in most hard disk drives (HDDs) with dc brushless motor[1]. The system offers manual power, large range of speeds (from 0 to 10,000 rpm), steady spin speed and compact size. A built-in start-up circuit guarantees the power of the dc brushless motor, where the signals from the rotor location are obtained using the back-EMF sensing system. Using an electronic device, the current in the motor coils is precisely alternated, allowing the rotor to spin..

Logic control was written in assembly language and loaded into a Microchip Technology Inc. PIC 16F877 microcontroller. The current is regulated in full-wave commutation mode by a bipolar drive circuit (using push / pull drivers at the output stages) without sensors to position. A sample holder vacuum chuck may be added for the rotor by proper design, as shown in Figure 2.4. The present design allows control of the speed of the output spin as a function of the position of the knob (the speed control).

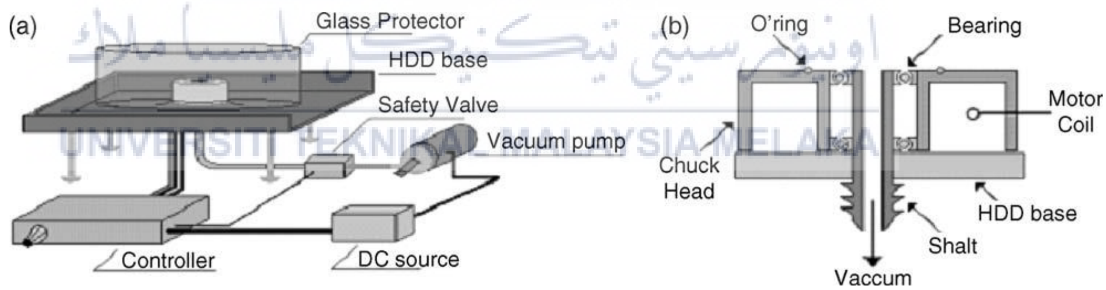


Figure 2.4: Basic Block diagram of the proposed device

2.3.3 Development of Spin Coater with Closed Loop Control System Using ATMega 8535 Microcontroller

This research concerns the event of a spin coater using the micro - controller ATMega8535 with a closed loop control system. The thickness of the thin film layer depends on the rotation of the spin coater, in which it is normally controlled by the open loop type. The motor performance has also deteriorated in the long-term use of the spin coater and caused the rotation speed to cease to be accurate. Therefore in the currently designed spin coater, a closed-loop approach is introduced to address the drawback. The speed range of the spin coater was designed between 450-6000 rpm, fitted with user interface via push button and LCD display. The rotary encoder transducer was added to sense the dc motor speed. The pulse width modulation (PWM) is the method for regulating the speed of the dc motor. The output of the control system was measured on the basis of the voltage applied to the PWM driver (L298) versus the speed of the motor and also the time of rise, overflow and setting of the control system [19].

2.3.4 Construction of Spin Coating Machine Controlled by Arm Processor for Physical Studies of PVA

The spin coating unit consists of stepper motor, syringe mount, brushless Dc motor and arm processor. The machine can cover thin film at a micro-level thickness and the arm processor (LPC 11U24) has controlled its spinning speed and liquid flux rate.. Film thickness is determined by the flow rate and spinning machine coating period [20]. Still spin coating machine has PLC and FPGA processor control but it stops costly, more or less spin coating machine is manually operated, in this research work spin coating machine is completely controlled by ARM processor at very low cost, in market so many spin coating machines are available such as KW Series, UF82 & LP384036TP, serious 2000S (PLC) device, these are some serious machine coating machines. [20].

All devices have an arm processor connection, the supply voltage of a 5v processor, a processor allowing maximum output voltage is 3.3v, its very low voltage, a driver can only understand 5v so that the amplifier amplifies a processor output voltage, the processor output is Pulse width modulation based on PWM output motor speed as shown in Figure 2.5.

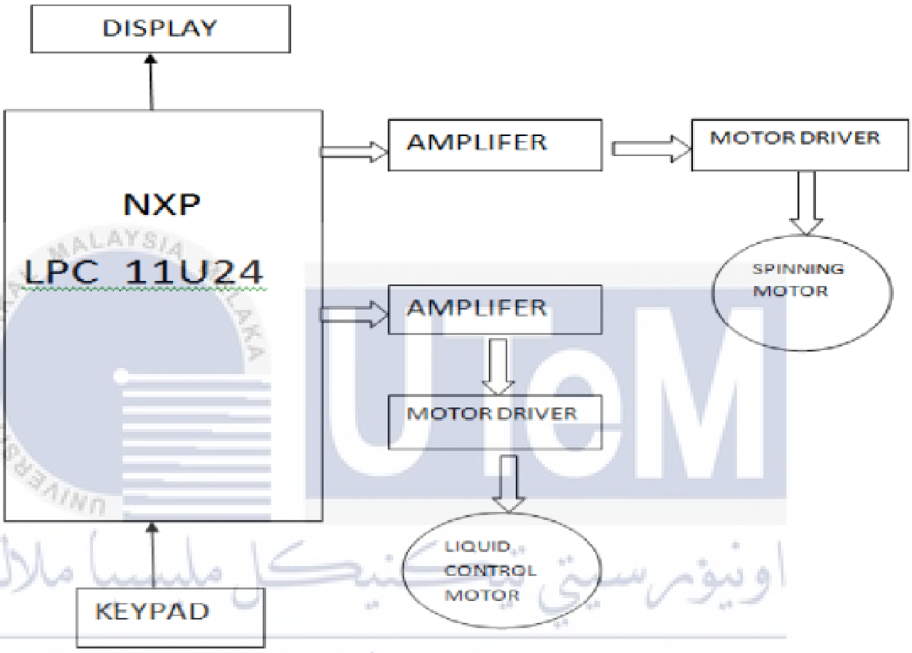


Figure 2.5: Basic Block diagram of using Arm Processor

2.4 Summary of Related Works

Based on the previous works that have been discuss earlier some key point are selected to be compare as shown in table 2.2.

Table 2.2 Summary of Related Works

Title	**Year**	**Type Peripheral Interface Controller**	**Type of DC Motor**	**Type Motor Driver**	**Speed of Motor**	**IoT Connection Device**
Fabrication of Digitalized Spin Coater for Deposition of Thin Films [1]	2014	Microcontroller ATmega32	DC brush motor	L298N Motor driver	Maximum speed 3300 RPM	-
Spin coater based on brushless dc motor of hard disk drivers [2]	2006	PIC16F877 Microcontroller	Brushless motor from HDD	-	0 to 10,000 rpm	-
Development of Spin Coater with Close Loop Control System Using ATMega8535 Microcontroller [3]	2016	ATMega8535 Microcontroller	DC brush motor	L298 Motor driver	450-6000 rpm	-
Construction of Spin Coating Machine Controlled by Arm Processor for Physical Studies of PVA [4]	2015	ARM Processor (LPC 11U24)	DC brush motor	L293 Motor driver	maximum speed of 3000	-
Universal BLDC Controller –	2017	MCU MC9S08mp16	Brushless DC motors	6 MOSFETs for three phases	0 to 5000 rpm	Wi-Fi connection using

With IoT Set of Features [5]						ESP8266 module
IoT-based Control and Monitoring for DC Motor Fed by Photovoltaic System [22]	2018	Raspberry Pi	DC brush motor	PID algorithm	speed of 4300 rpm	Wi-Fi connection
S-MOM: Smart Mom On The Move [21]	2018	Arduino Uno	DC brush motor	-	-	ESP8266 wifi shield

From the table above, it shows various type of peripheral interface controller, type of Dc motor and motor driver that can be used to built up this project. Hence, by reviewing all this works, some good information can be adapted and improved my work to produce a better system.

2.5 Summary

This chapter provides all the information and knowledge that I should understand and know in order to proceed with my work. Many aspects and criteria from past works need to be considered and referred so that this work can be done on time and achieve the objectives which have been set.

CHAPTER 3

METHODOLOGY

3.1 Introduction

In the following chapter. The methodology based on the experiment and process developed for this project was explained. This section is therefore addressing the methods and methodologies used from the earliest starting point to the conclusion of this project. Each part of the project is discussed in detail, along with the step process.

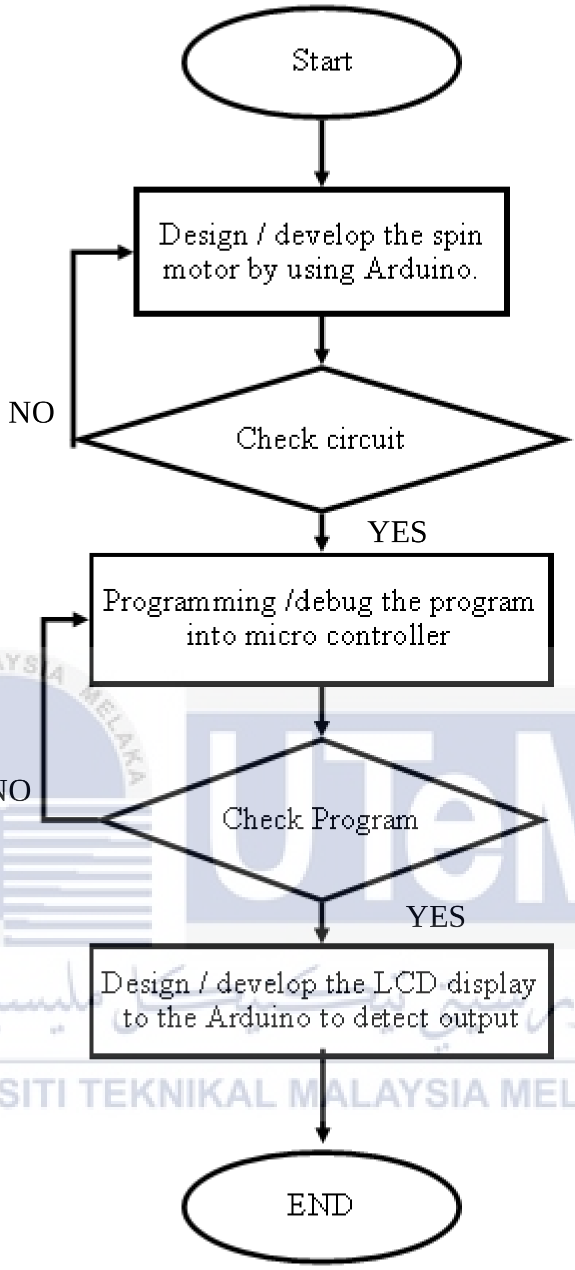


Figure 3.1: The first stage flow chart for the project

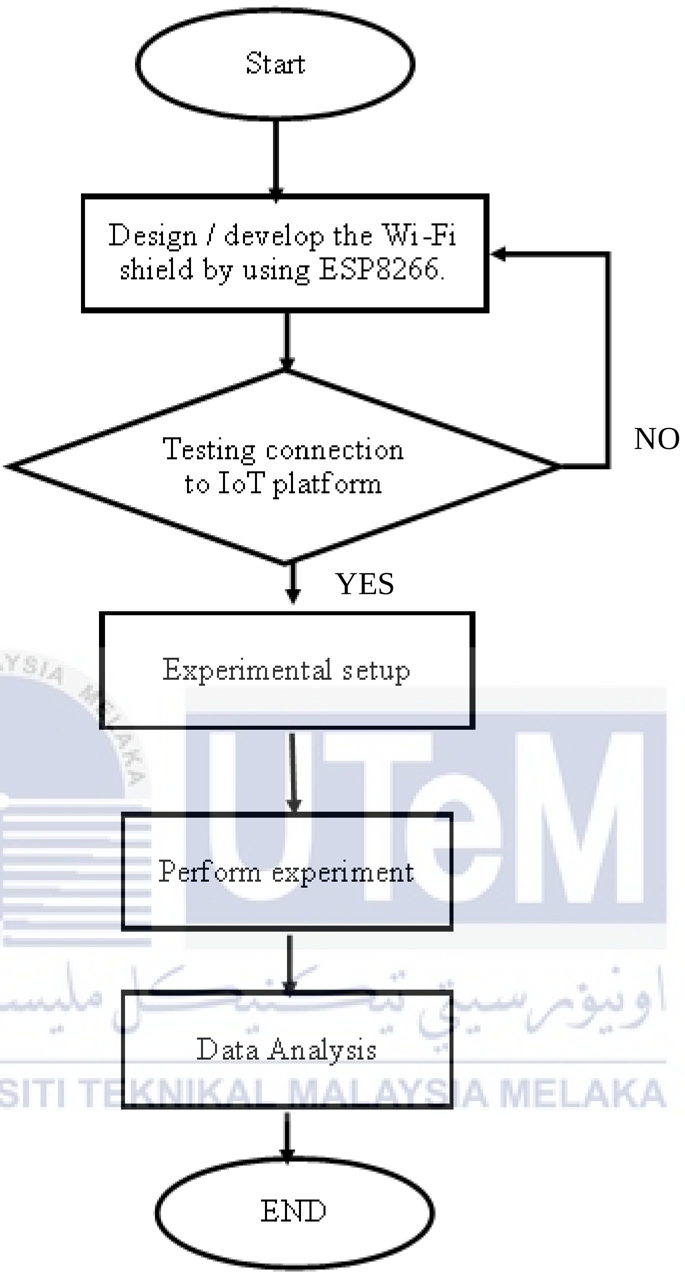


Figure 3.2: The second stage flow chart for the project

The system can be divide into 2 stage that is first stage develop prototype and the second stage IoT connectivity and Cloud platform.

Based on flow chart shown in Figure 3.1, the prototype of the project is being develop and attach DC motor to the circuit. The DC motor was controlled by L298N motor driver. After that the circuit is tested to make sure the connectivity is connect.

Then using Arduino Ide, the program to control motor was developed. Using keypad metric 4x4 the input for the system can be control. After success to control Dc motor, the prototype was upgrade by adding LCD to display output. The system was tested by put input of time and speed to be test. After all the test is complete the first stage of prototype is complete.

For the second stage, Figure 3.2, the system is upgraded by connecting the Wi-Fi module ESP 8266 to the Arduino. After the order has been attaching with a Wi-Fi module, a program to connect the system to the cloud database is build up. Then perform analysis of the system.

As conclusion, the system can be control by user and save data to the cloud.

3.2 Planning

The preceding projects were identified, examined, and investigated at this point. From this stage, in this phase, the missing elements in their projects will be strengthened and implemented to strengthen the program.

Next, as part of the initiative, more data on the correct parts is being used. This process takes a lot of time because the careful segments for the project need to be picked. In this stage, a percentage of the desired parts faced some trouble. Make the data about the component dissected and pick the correct segments for this project at that stage. The main components used in this project are summaries such as:

1. Arduino ATmega 2560
2. ESP8266 Wi-Fi Module
3. Dc motor and L298N motor driver
4. LCD display
5. Relay Control
6. Google Spreadsheet

Hence, project step planning and process is vital. The Gantt chart is utilized to illustrate the project planning procedure as in Figure 3.3.

Project Planning																																							
List the main activities for the proposed project. Specify the time period required for each activity.																																							
	PSM 1																										PSM 2												
	2019															2020																							
Main activity	Sep			Oct				Nov				Dec				Jan				Feb				Mar				Apr				May				Jun			
	1	2	3	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Literature review		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X										
Proposal preparation	X	X	X																																				
Design / develop the spin motor by using Arduino.				X	X	X	X	X	X	X	X	X	X																										
Electronics Circuit testing														X	X	X	SEMESTER BREAK																						
Design / develop the Wi-Fi shield by using ESP8266.																				X	X	X																	
Experimental setup																							X	X	X														
Perform experiment																										X	X	X											
Data Analysis																													X	X	X								
Thesis writing					X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X							
Thesis Submission																																	X	X					

Figure 3.3: Gantt chart for the project planning

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Introduction

In this chapter, the discussion on the result and validation of the usability of the result will be done. The outcome is then checked if the objective are fully fulfilled. The project was conducted successfully in line with what had been planned in the previous chapter and the objective is achieved. Within this chapter the main concept and project flow will be explored in depth. Analysis of project limitations or restrictions will also be addressed in this chapter later.

4.2 Result of the Project

4.2.1 Hardware

The low-cost spin coating system prototype has been successfully developed and build. As shown in Figure 4.1 the front view of the prototype. As the label on the figure, there are few main component of the system that are the keypad and the push button for the input and the output is the chamber for turn the substance and the LCD for display.

Figure 4.1: Front view of the prototype

From the side view the system integrated with 3 pin Socket for the vacuum pump, as shown on Figure 4.2. The socket is control by the system to supply the power to the vacuum. It integrated with relay module that control by Arduino ATmega.

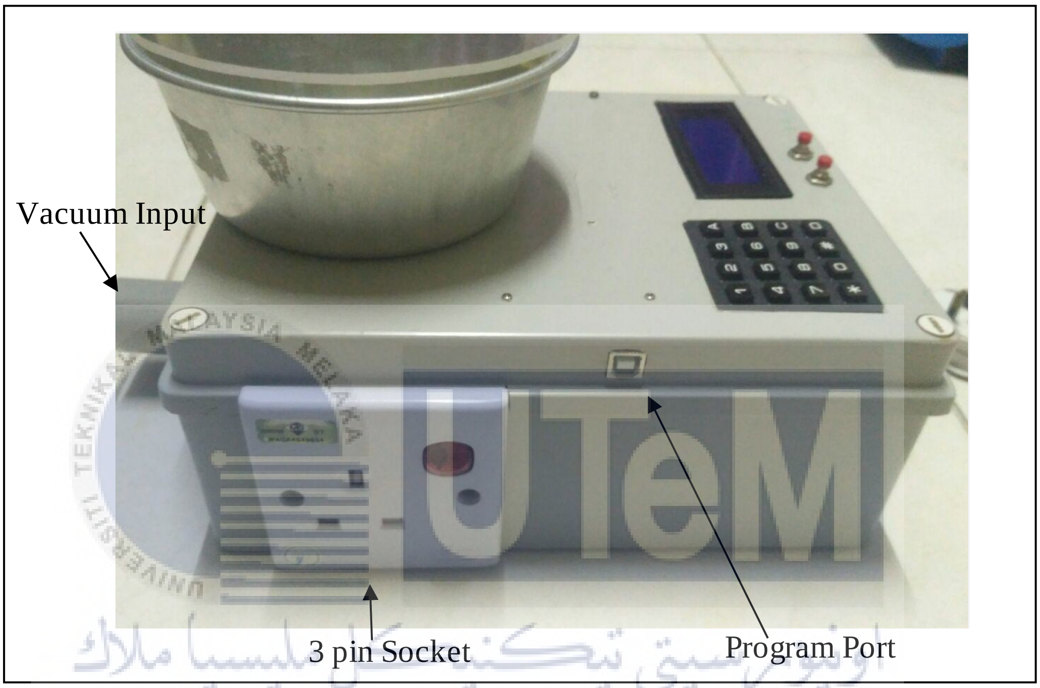


Figure 4.2: Side View of the Prototype

4.2.2 System of the Low-Cost Spin Coating

The system of the prototype can be divided into three part that is the Manual input, Preset input, and Wi-Fi test system. As show on the Figure 4.3 the main menu for the system. The keypad is used to select the system that need to used. The program then moves to the submenu shown in Figure 4.4 for manual input and Figure 4.5 for preset input. On the sub menu of manual input, user can input the name of the file, the step size of the spinning, the speed and time for every step. Then the system continues to the confirmation sub menu for the cloud data and process the data.

Figure 4.3: The Main Menu of System

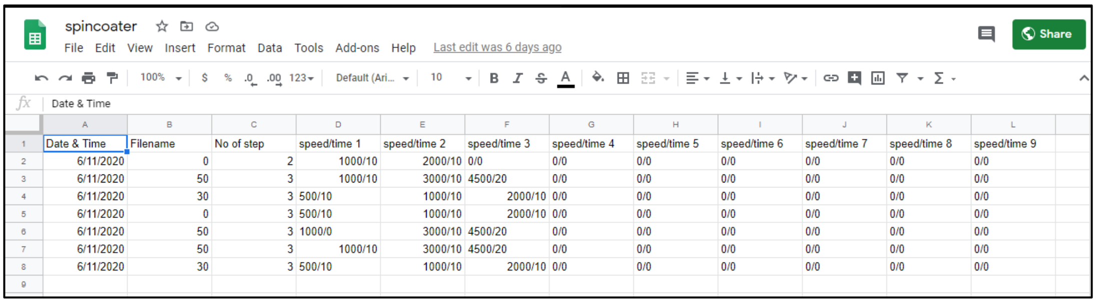
Figure 4.4: The Manual input Sub Menu

Figure 4.5: The Preset input Sub Menu

For the preset system, user need to input the file name and the profile that has been setup. The profile can be setup up to 10 profile with different step, speed, and time.

4.2.3 Database

The system use google spreadsheet to save the data from the user. On the google spreadsheet the profile for the time and date, file name, step size, speed and time from user input is created in the table as shown on Figure 4.6.



spincoater
File Edit View Insert Format Data Tools Add-ons Help Last edit was 6 days ago
Date & Time

	A	B	C	D	E	F	G	H	I	J	K	L
1	Date & Time	Filename	No of step	speed/time 1	speed/time 2	speed/time 3	speed/time 4	speed/time 5	speed/time 6	speed/time 7	speed/time 8	speed/time 9
2	6/11/2020	0	2	1000/10	2000/10	0/0	0/0	0/0	0/0	0/0	0/0	0/0
3	6/11/2020	50	3	1000/10	3000/10	4500/20	0/0	0/0	0/0	0/0	0/0	0/0
4	6/11/2020	30	3	500/10	1000/10	2000/10	0/0	0/0	0/0	0/0	0/0	0/0
5	6/11/2020	0	3	500/10	1000/10	2000/10	0/0	0/0	0/0	0/0	0/0	0/0
6	6/11/2020	50	3	1000/0	3000/10	4500/20	0/0	0/0	0/0	0/0	0/0	0/0
7	6/11/2020	50	3	1000/10	3000/10	4500/20	0/0	0/0	0/0	0/0	0/0	0/0
8	6/11/2020	30	3	500/10	1000/10	2000/10	0/0	0/0	0/0	0/0	0/0	0/0
9												

Figure 4.6: Example Data from Google Spreadsheet

4.3 Cost

The total cost for the Low Cost Spin Coating System For Thin Film Deposition With IoT is Rm 252.2. the list of components that be use is shown on Table 4.1 below.

Table 4.1: List Cost of Component

ITEM	Price (RM)
Microcontroller Arduino ATmega 2560	**70.00**
Keypad Metrix	**15.80**
Arduino L298N DC Motor Driver Dual H Bridge	**8.50**
12VDC regulated power supply	**30.00**
Arduino LCD Display Blue 2004 (20x4) IIC	**25.40**

ESP8266 ESP-01	**22.50**
5V Relay And 13A socket	**10.00**
12v Brush Dc Motor	**30.00**
Casing and Chamber mount	**35.00**
Wire and Jumper	**5.00**
Total	**252.2**

4.4 Output test

The system is testing using a few profiles to test the output of the spinning. The test is using food cordial as substance and the difference of thickness is produce when the different speed and time is set. The profile of the test is shown on Table 4.2 below.

Table 4.2: List Profile for Testing Sample

Profile	No of step	Step 1 speed/time	Step 2 speed/time	Step 3 speed/time	Step 4 speed/time
1	2	500/10	1000/20	-	-
2	3	500/10	1000/10	2000/10	-
3	4	500/10	1000/10	2000/10	4500/10

Using the listed profile, the substance is testing to coat the sample glass. The output of the coating can be seen when the higher the speed the thickness is decrease. Figure

4.7 show the output of profile 1, Figure 4.8 show using profile 2 and Figure 4.9 using profile 3.

Figure 4.7: Thickness of the Substance Using Profile 1

Figure 4.8: Thickness of the Substance Using Profile 2

Figure 4.9: Thickness of the Substance Using Profile 3

4.5 Summary

Overall, through the implementation of the methodology mention in the previous chapter, the desired result is achieved successfully. Findings were examined in depth and the debate was extensively deliberated. Conclusion and future work will be explained in next chapter based on the results of this chapter.

CHAPTER 5

CONCLUSION AND FUTURE WORKS

5.1 Introduction

The completion of entire project will be covered in this chapter. This conclusion will wrap up the goal accomplished and the innovation, effect and sustainability of the project will be addressed as well. This chapter will conclude with potential changes because it is necessary, for instance, taking this project to another level with an updated framework and additional features.

5.2 Conclusion

Once this project was completed, the objective was reviewed again to ensure that those goals were achieved. The very first objective of this project is to design and develop the low cost spin coating system that using Arduino ATmega as microcontroller and motor driver to control the speed of dc motor. The implementation of this objective focused on the keypad as the input and the programming of the system to control the motor driver and LCD display.

Next objective is to integrate the system with IoT element by adding Wi-Fi module to the microcontroller. The system then connects to the database Goggle Spreadsheet as the database to save the data.

The last objective is to analyze the thickness of the film that produce by low cost spin coating system against speed and time. This can be seen from the result that when the speed is increase the thickness of the food cordial will be decrease.

The goal of this project is successfully achieved and it has been established that with engineering experience, costs can be reduced to build a spin coating system and the system suitable for small industries to use it. In addition, the system can connect and communicate with the cloud database that can prove that concept Industry Revolution 4.0 that uses the Internet of Things as a cloud database.

5.3 Project Impact and Sustainability

The Low Cost Spin Coating System For Thin Film Deposition With IoT will be accepted by the user because of the system has been improve from the commercial spin coating system. The price for the system is low then the commercial spin coating and it has database system for user to use.

5.4 Future work

For future improvement, the limitation of the input keypad can be improve by using touch screen LCD that can enhance the input source. Next the system can be use vacuum free that much easy to be use and it can save the power usage. The last suggestion is the system can integrate with humidity and temperature sensor that can improve the output of the coating, this is because different temperature and humidity will affect the thickness of coating layer.

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