DESIGN OF SMART LIGHT/SHADOW DETECTION FOR MARKET UMBRELLA

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DESIGN OF SMART LIGHT/SHADOW DETECTION FOR MARKET
UMBRELLA

MUHAMMAD SALMAN IRFAN BIN MOHD SANUSI

Thesis submitted in fulfilment of the requirements
for the award of the degree of
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ABSTRACT

Market umbrella sometimes is also known as patio umbrella is an outdoor leisure type of umbrella. The existing market umbrellas are not able to give fully shade. Furthermore, it does not stable in a sandy surface. This smart market umbrella is designed to rotate 360˚ and move according to the direction of the sunlight. This umbrella consists of four Light Dependent Resistor (LDR) sensor, 12V Direct Current (DC) motor, gear, 12V dry battery and Arduino Uno R3 board. The rotation on the umbrella depends on the sensor value by comparing the value on average top and average bottom whether it exceeds or less than 20. This umbrella has been modified with minimum cost by adding DC motor, sensor and gear to rotate the umbrella automatically for full shade. Addition of 15 cm x 10cm of mild steel plate at the base improves the stability of umbrella. In the end, the addition of the fabrications to the umbrella is done and perfectly working just as wanted with plenty of room for improvement that can be added.

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LIST OF SYMBOLS

A	Ampere
k	kilo
n	nano
m	mili
m	meter
M	Mega
R	Resistance
V	Volt
Ω	Ohm
%	Percent
°	Degree

LIST OF ABBREVIATION

DC	Direct Current
Eq	Equations
I2C	Inter-integrated Circuit
KG	Kilogram
LCD	Liquid Crystal Display
LDR	Light Dependent Resistor
PC	Personal Computer
PCB	Printed Circuit Board
PPE	Personel Protective Equipment
PWM	Pulse Width Modulation
RPM	Revolution per Minute
SPST	Single Pole Single through

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CHAPTER 1

INTRODUCTION

</div>

1.1 Background

The word of umbrella comes from the Latin word which means shadow (The History of Umbrella, 2011). This reflects the original of umbrella use as shade from the sun. The umbrellas probably inspired by the trees, as the man developed the agriculture, hunted for the food, sitting under the canopy of a tree helped to cool off and keep comfortable during the hot days (Noble History of the Patio Umbrella, 2018). The first umbrellas must probably banana tree branches. The origin of the modern umbrella can be found between 1100 and 1200 BC in the courts of China and Egypt. The historians are really unsure as of it originated first but everyone agrees that the sun shade or the outdoor umbrella has been existing a very long time ago.

The first umbrellas or parasols mostly used by the royalty and the royal court. It was the sign of nobility to have fair skin in Egypt and the protection provided by sun umbrella to make sure their skin would not tan. In Assyria, the umbrella was the king's privileged article and the king must have one. There is the evidence of the used of outdoors that we call patio umbrella today in the ancient art of Assyria, Egypt, China and Greece. The use of outdoor umbrellas has been found in ancient cities such as Nineveh, Persepolis, and Thebes, Egypt. At this period, there is also the evidence of umbrellas being used in India.

The Pope used the ceremonial parasol umbrella as ceremonial regalia during the middle ages. There are the rumours that it is originated from a brown and white umbrella given by Constantine the Great. The stripped canopy of the umbrella is depicted in papal colours red and gold across keys of St. Peter. It is still used until today and known as ombrellino. In part of influence the church, the spread of umbrellas and shade structures across Europe. The trend began in Italy, and Pope Alexander the III traced back to 12th century when he granted the night to have the parasol carried over the Doge of Venice. The famous English weather ensured the

outdoor umbrellas success, where the market umbrella was used by the coffee houses to shelter their customers between 1685 and 1705. Samuel Fox has invented the steel ribbed umbrella in 1852. William C. Carter who is African-American as the inventor patented an umbrella stand on August the 8th, 1885 with the stand and steel ribbed umbrella.

The smart detection is using sensors to detect such as temperature, light, motion and others. A sensor exists almost in every application. A sensor is defined as a device used to measure a property such as position, temperature, pressure or acceleration and respond to the feedback. The sensor also defined as an input device that provides an output (signal) with respect to the specific physical quantity (input) (Ravi, 2017). There are many types of sensor used in various application. The commonly used type of sensors is a temperature sensor, pressure sensor, light sensor, humidity sensor, tilt sensor, accelerometer, ultrasonic sensor and others. We choose light sensor to use in our project. The light sensor is a circuit or device which detects the intensity of light that incident on it (Anusha, 2017).

1.2 Motivation

Malaysia has two seasons, summer and rainy seasons. There are many benefits and opportunities that we can use in during hot weather such as use of solar energy. The current issues are most of the people in this country are lack of exposure and knowledge about technology like solar energy. Thus, this smart umbrella is equipped with a photovoltaic cell where energy can be produced through the sunlight. Therefore, people can familiarize themselves with renewable energy (sun) compared to non-renewable energy (diesel). We all know that the use of renewable energy is better and have a positive impact on the environment. Typically, night market traders use generators to produce electricity for lighting. The use of generators brings a lot of side effects such as noise pollution and high cost (diesel usage). Thus, with this smart umbrella, noise pollution can be reduced because electricity is generated from sunlight and energy from sunlight to light up the bulb. In addition, this smart umbrella also provides enough protection from direct sunlight because it was designed to move according to where the light come from so it can provide full protection. We all know that the patio umbrella also an umbrella that has the latest technology features and expensive. Therefore, we modified typical umbrella used by traders in the night market to have features same as features in the patio umbrella with affordable price. This smart umbrella is simply designed (foldable) and equipped with technology (solar panel and sensor) rather than the patio umbrella which is a bit complicated.

1.3 Problem Statement

Market umbrella is the type of umbrella that is invented to shade those beneath from the sun and were frequently used in trade circumstances. These market umbrella can cover food vendors, farmers market stalls, night market and other commercial spaces. Market sellers bring the umbrellas, set up their stands and attach the market umbrella during the time they are out selling to protect them and their sales item from the sun. The existing market umbrella has a straight pole with a base attached on the bottom. The umbrella can only stand upright and do not fully shade the sun.

The market sellers need to use the generator to turn on the light at night this can cause noise pollution and can disturb other people. Market sellers who use generators require gasoline or petrol as a source of energy. Since the price of petrol increasing from time to time then replacing using of non-renewable energy with solar energy is one of the best methods to produce energy without giving a negative impact on the environment and more economical.

Therefore, the market umbrella needs to be modified so that they can be tilted to make sure fully shade from the sunlight. Other than that, the use of a generator to light up the bulb can be replaced by using photovoltaic. Photovoltaic is generating electric power from sunlight by using solar cells to produce DC electricity to light up the bulb. The use of sensors also can make the market sellers life easier because the sensor detects the sunlight and the market umbrella tilt towards the sunlight to give the shade. Thus, the new market umbrella has the improvement of the technology.

1.4 Objective
- To design the market umbrella that can be tilted, rotate $360°$ and can move according to the direction of sunlight or the intensity of light.
- To improve the existing market umbrella function.
- To create an eco-friendly market umbrella with minimum cost

1.5 Project scope

This project is for the addition of a system to an existing item to be specific a smart light detection system to be implemented to a market umbrella. The smart light detection system will consist mainly of sensors to detect the sunlight intensity, solar cells act as a clean energy supplier, some mechanical parts such as joints and motors to move the upper part of the umbrella and a microcontroller or few microcontrollers depending the on the design for the input from sensors and solar cells to the output which is the mechanical parts. To detect sunlight, this smart light detection for market umbrella will be placed preferably near the user or at an open place as the umbrella will track the sunlight and providing a larger coverage of protection for the user from the sunlight. The target audiences can be for food vendors, merchants and even local restaurants that provide an outdoor place to dine.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In this part will be explained brief details about the parts that are to be used for the smart light/shadow detection for market umbrella. The parts that make up the whole system are the type of umbrella, microcontroller, sensors, and motor.

2.2 Type of Umbrella

Market umbrella has been used since by food vendors and merchants alongside with patio umbrella but with some differences. Usually, market umbrella comes in shape of octagonal but it can be rectangular but the main differences between patio are market umbrella has a base to its poles while patio umbrella designed to fit through a hole into the center of a table. That is one of the differences of it but patio umbrella can be a standalone type umbrella with a base to it but then what does it makes a difference to market umbrella? Both can be the same thing actually since over time, both of the umbrellas have merged together in modern terms and usage.

Figure 2.2: Round PVC Market Umbrella Rainbow

(Source: Carousell, n.d.)

Based on the figure 2.2 is a type of a market umbrella and one of the main features about market umbrella is it can be tilted to give more shade or cover to the vendors and merchants. Since the market umbrella is usually huge in shape, it can give a lot more of cover to the user however, the user needs to manually tilt it. Therefore, what we wanted to give is a smart detection of light or shadow to help automatically tilted the upper part of the umbrella without any interaction from the user.

2.3 Microcontroller

A microcontroller consists of integrated circuit and has input/output, memory and processors on a single chip (Margaret Rouse, n.d.). For microcontroller, it will act as a medium for the input and output for any kinds of system or projects such as sensors act as input and the microcontroller will process the information and depending on the coding in C++ language or assembly language the output can be given to the motors, light-emitting diode (LED), or even liquid-crystal display (LCD) for examples.

Figure 2.3: Arduino Uno Board

(Source: Arduino Store, n.d.)

Figure 2.1 is an example of a microcontroller board which is known as Arduino Uno R3. This board runs on low voltage supply besides being having 14 digitals pins with 6 analog pins. Other boards may be different in size, performance, and number of pins for both digitals and analog.

2.4 Sensors

Sensors are generally a device that converts electrical properties to a physical parameter such as humidity, temperature or even light intensity. The best type of sensors depend on the accuracy to precisely detects the physical properties, having a resolution which is the smallest increment detection and affordable at low cost. For smart light/shadow detection for market umbrella the most suitable type sensors are the light sensor.
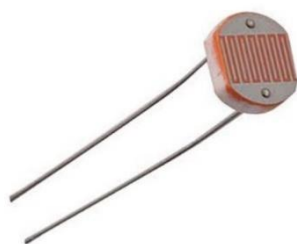

Figure 2.4: LDR sensors

(Courtsey of Wikipedia, n.d.)

Figure 2.4 is a LDR sensor, a type of photoresistors that is to be used to detect or measures light intensity. Photoresistors are a light-sensitive components that are used to measure or detect the intensity of light. When in presence of light, the resistance will drop up to 0.1kohm (kΩ) while in dark room conditions, it can go high up 1MΩ depending on the characteristic of the device. There are many applications for the LDR which usually is acting as light sensors where it is required to detect the presence or absence of light. Such applications are night light and photography light meters (Photo resistor, n.d.).

2.5 Motors

To rotate the smart umbrella, there are few types of motor that can be used which is the stepper motor and DC motor however most suitable to be used depends on the criteria of the motors in terms of the motor performance, the torque of the motors and its revolution per minute (RPM).

The motor performance should be at least supplied with 12 V. Below than 12V may cause the motor not able to rotate or not having enough power rated to move an umbrella. As for the RPM, the higher the RPM the faster it will rotate. As for precaution, the speed may be reduced if necessary and usually, the higher RPM the lower will be a torque of a DC motor.

For the torque, it is the measured force to move an object in one axis (Torque, n.d.). It is recommended for the torque the be at least 50% higher than the weight of the load so that if there is sudden more load than the usual for example a wind force to the market umbrella, it still able to rotate it.

Figure 2.5: Micro Gear 12V 100RPM DC Motor

(Source: Robu.in, n.d.)

Above figure 2.3 is a type of DC motor with power rating 12V, high torque and moving at 100 RPM. This is one of DC motor type that can be used to rotate the market umbrella since it fulfils one of the requirements by having a 12V as a power source.

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter explains the following begin with designing the circuit for the system by simulations and buying the requires component to be arranged on the breadboard, calibrating it with the simulations circuit and do a field testing after completing the circuit permanently using solder.
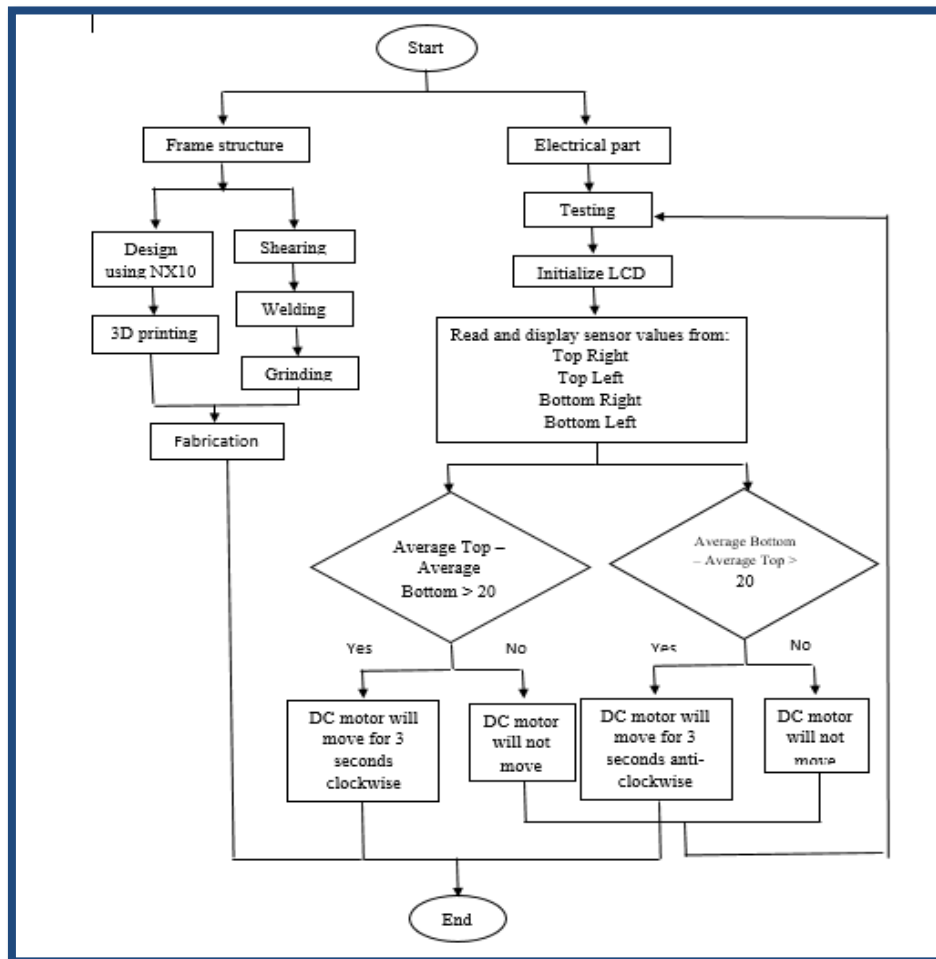

Figure 3.1: Flowchart of the System

Figure 3.1 shows the flow chart that is divided into two parts which are the electrical parts and frame structure or fabrications. The electrical parts mainly consist of electrical components and the coding for the smart umbrella. As for the frame structure, the fabrication of it is the design of gear and DC motor holder. Also in a frame structure, the shearing and welding for the base to make it more stable are also done.

3.2 Design of Circuit
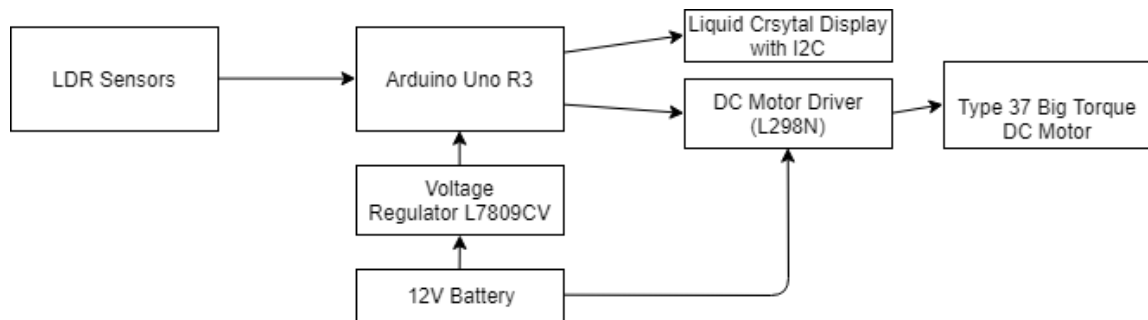
Figure 3.2.1: Block Diagram of Smart Light for Market Umbrella

The figure 3.2 above show the block diagram of the flow of the system which Arduino Uno R3 board is the core of the system which is acting as receiving the changes of values in sensor and based on the programming that is uploaded, will then display on the LCD and give command the DC motor through the DC motor driver either in clockwise or anti-clockwise direction. The power supply however is step down using a voltage regulator of 9V to the Arduino board and directly to the DC motor driver.
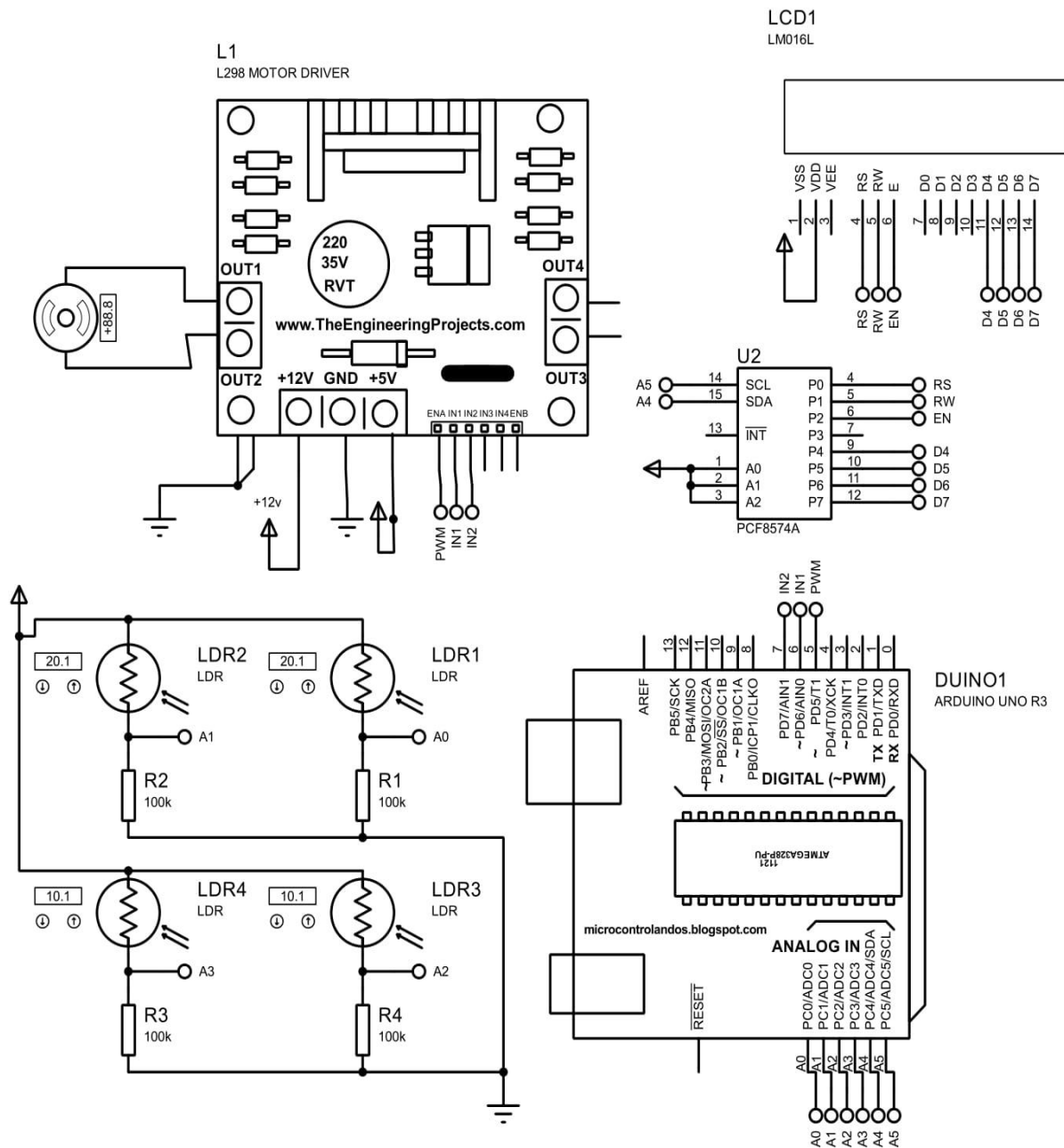
Figure 3.2.2: Schematic Circuit Diagram Using Proteus 8 Software

Looking at figure 3.2.2, the schematic circuit diagram is first drawn in the Proteus 8 software to simulate the circuit checking whether it displays the wanted result before assembling it in real life. This is crucial since the components selection will be based on the simulation. There are four major components which are the Arduino Uno R3 acting as a microcontroller, LDR sensors to receive the light intensity values, high torque DC motor to rotate the smart umbrella and DC motor driver to connect between the DC motor and microcontroller.

3.3 Main Components Selection

The main components that are chosen are the Arduino Uno R3 as microcontroller, LDR sensors, type 37 big torque DC motor, L298N Dual Motor Controller Module 2A as a motor driver and 16x02 LCD with Inter-integrated Circuit (I2C).

3.3.1 Microcontroller

Arduino Uno is among the type of microcontrollers available in Arduino stores. Arduino also specifically is less expensive compared to other microcontroller boards and the software can run on both Windows and Macintosh OSX making it easier to simulate or programmed the codes. (Arduino – Introduction, December 26, 2018).
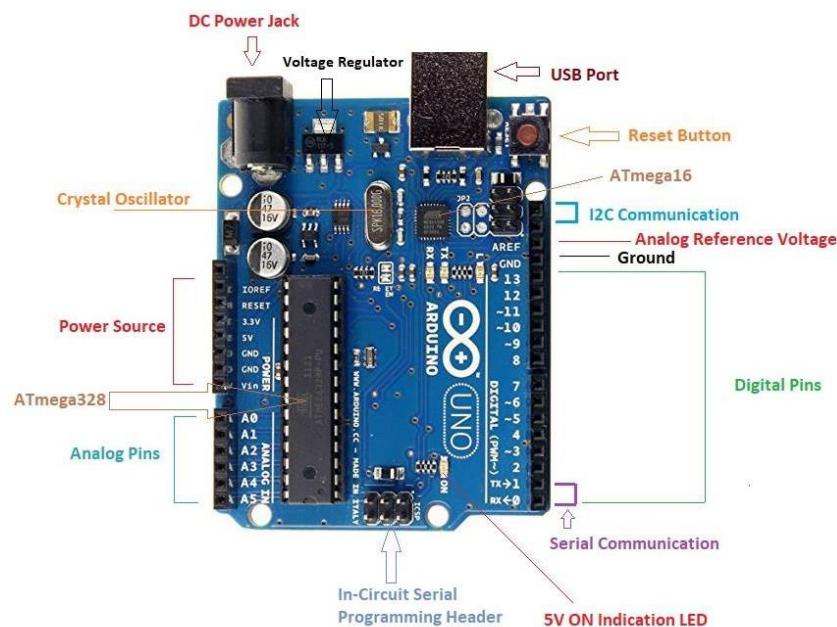
Figure 3.3.1: Arduino Uno Board Pinouts

(Source: The Engineering Projects, 2018)

Based on figure 3.1 above are the specifications of the Arduino Uno model that is to be used in the smart umbrella. What makes this the most suitable are the pins both analog and digital which is more than adequate for the project especially the sensors and I2C of LCD which requires 6 of analog pins and Arduino Uno are able to provide it. Below are the specifications or features of Arduino Uno.

Table 3.3.1: Arduino Uno R3 Specifications

Microcontroller	ATmega328
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limits)	6-20V
Digital I/O Pins	14 (of which 6 provide PWM output)
Analog Input Pins	6
DC Current per I/O Pin	40 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB of which 0.5 KB used by bootloader
SRAM	2 KB (ATmega328)
EEPROM	1 KB (ATmega328)
Clock Speed	16 MHz

Table 3.3.1 above shows the feature of the Arduino Uno R3 board. One of the major differences between Arduino boards is the number of pins for digital and analog. In which the Arduino Uno R3 consisted of 6 analog pins and 14 digital pins and at the same time out of 14 digital pins, 6 of it are Pulse Width Modulation (PWM) output. Therefore, the pins are more than adequate to be used for the circuit design of the smart light/shadow detection for the market umbrella. Referring to the figure 3.2.2 which is the schematic circuit diagram, there is still even more pins left out at the digital pins however the analog pins are fully used from A0 to A5.

3.3.2 Sensors

Photoresistors or LDR sensors are chosen considering it one of the types for the light sensor and easy availability. Also the price is one of the cheapest to be known therefore, any replacement can be easily be made if there are any problems later on.
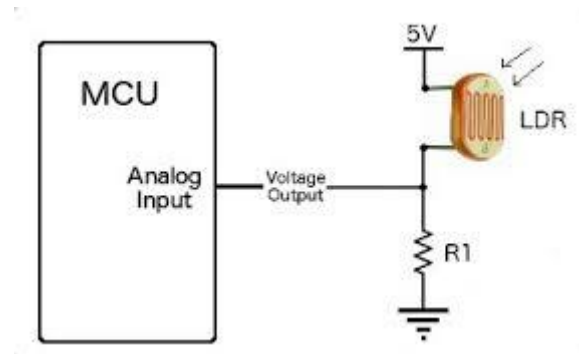

Figure 3.3.2.1: LDR schematic diagram

(Source: Cactus.io, n.d)

LDR sensor will be connected as above figure 2.2.1, pairing it with a resistor to prevent the circuit being short-circuited and also to have a voltage divider so that the changes in LDR sensor values can be measured.

Table 3.3.2 : LDR specifications

Max power dissipation	200mW
Max voltage @ 0 lux	200V
Peak wavelength	600nm
Min. resistance @ 10lux	1.8kΩ
Max. resistance @ 10lux	4.5kΩ
Typ. resistance @ 100lux	0.7kΩ
Dark resistance after 1 sec	0.03MΩ
Dark resistance after 5 sec	0.25MΩ

Above are the specifications of the LDR sensors. The resistance when in dark room condition can go up to 0.25MΩ while the max lightroom condition is as low as 1.8kΩ.
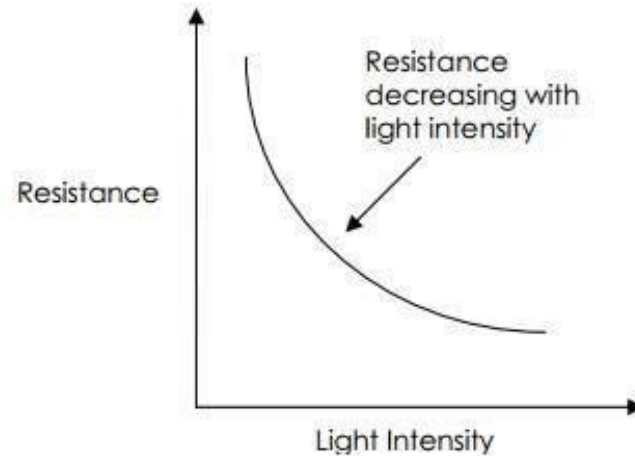
Figure 3.3.2.2: Resistance Vs Light Intensity Graph

(Source: Kitronik, 2018)

Figure 3.2.2 is a resistance vs light intensity graph for the LDR sensors in which when exposed to the intense light intensity the resistance for the sensor will drop or becomes very low. As for the absence of light, the resistance will then will rise or becoming very high up to 1MΩ depending on the characteristic of the LDR sensors. Therefore by having these values, the coding for Arduino Uno R3 can be done in the Arduino software according to the requirements to rotate the umbrella under the presence of sunlight.

3.3.3 Motors

To rotate the smart umbrella, there are few types of motor that can be used. One of it is the DC motor. Since the umbrella is quite heavy, a high torque DC motors are required to safely rotate the smart umbrella.

Figure 3.3.3: Type 37 Big Torque DC Motor

Figure 3.3 is a type 37 big torque DC motor that is used to rotate the smart umbrella. It is small in size and the torque it is able to handle the weight of the umbrella is sufficient. The torque needed at least to be 50% higher than the load that is required to move or to rotate. The voltage rating for it is also 12V. See below table 3.3 for more of the specifications.

Table 3.3.3: Type 37 Big Torque DC Motor

Rated voltage	12V
RPM	70
Torque	2.5 KG
Reduction ratio	1:8 6
The reducer diameter	37 mm
Reducer length	24mm
The motor diameter	34.4 mm
The motor length	24 mm
High shaft order	4.5 mm
Axial length (6)	16 mm
Trunnion	6 mm, type D axis (The 0.65 mm pin)

Based on the table 3.3 above, the rated voltage is 12V and the RPM is 70. The torque of the DC motor is 2.5KG. In other words, by supplying directly 12V to the DC motor, it can rotate with a load of maximum 2.5 KG at 70 RPM. When moving the load, there may be a sudden excessive current so, precautions must be taken to not damaging other electrical

components such as using a voltage regulator and a DC motor driver since both have a rated current that it is able to handle.

3.3.4 DC Motor Driver

DC motor usually when connected directly to a power source is only able to move in one direction, either in clockwise or anti-clockwise depending on the connection of the power source to the polarity of DC motor. Therefore by using a relay or a motor driver, the motor can move in two directions when needed. A relay or motor driver can also act as a switch, a fuse and a medium for the power source and a microcontroller since the microcontroller unable to provide sufficient voltage supply to the DC motor. Also to prevent overload to the microcontroller board, only low current can be connected the Arduino Uno board and DC motor of a 12V draws high current and can damage the microcontroller board if connected without a motor driver.
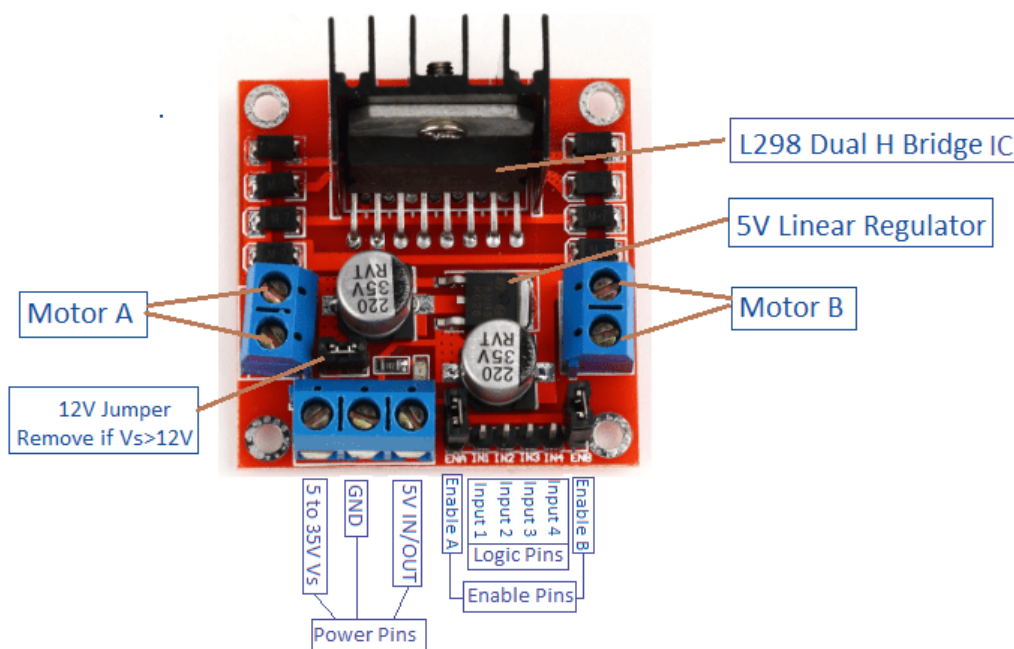
Figure 3.3.4: L298N Dual Motor Controller Module 2A Pinouts
(Source: Electronics Hobbyist, n.d.)

By looking at the figure 3.3.4 is an L298N dual motor controller meaning that it is able to support two motors at the same time however the rated current is only 2 Amperes (A). Depending on the usage there is much higher rated current for more much safer but for the smart light/shadow detection for a market umbrella, the L298N Dual Motor Controller Module 2A is more than sufficient since it doesn't draw too much current when functioning.

What makes the DC motor driver different from a relay is that the speed of the DC motor can be controlled through the motor driver by a microcontroller in the PWM digital pins.

3.3.5 Liquid Crystal Display (LCD) With I2C

The importance of LCD is to display data or values on the LCD. In the Arduino software, alternatively, the values can be displayed in the serial monitor which act as sending and receiving the data's from the Arduino board. The Arduino software, however, requires a laptop or PC and it can be a bit of nuisance due to its large size. Therefore instead of using serial monitor, the LCD can be used since it is small in size and only use a low voltage to power it up.

Figure 3.3.5.1 : Liquid Crystal Display (LCD)

(Source: Components101, n.d.)

Figure 3.3.5.1 shows a common type of LCD that used widely that is the 16x2 LCD meaning it can display 16 characters with 2 lines. As for the pins, there are 16 pins that will be connected to the microcontroller and since there are too many connections for it, I2C exists to simplify the 16 pins into 4 pins only.
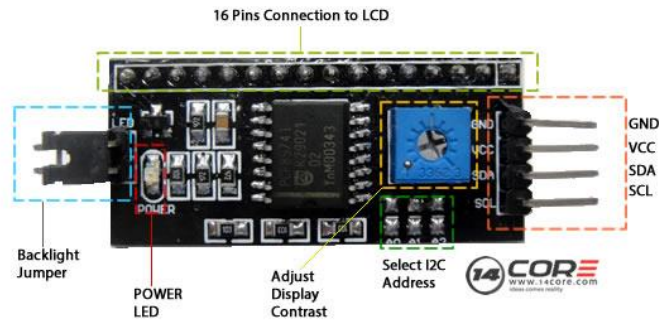
Figure 3.3.5.2: I2C Pinouts

(Source: 14core, n.d.)

Figure 3.3.5.2 is the I2C pinouts which the 16 pins connections will be connected directly to the LCD while only 4 pins instead of the usual 16 pins, will be connected the pins of Arduino Uno R3. The GND pins will be connected the GND of Arduino Uno R3, VCC is 5V, SDA to the analog pins A4 and SCL also analog pins A5. As for the coding, it must include the library of I2C into the software.

3.4 Other Components

There are other components that required for completing the circuit and for safety use such as a battery to supply the power or voltage, and switch acting as and turning off and on while also being a fuse, resistors to be paired with LDR sensors to prevent short circuit and to have a voltage divider and finally voltage regulator to step down the voltage from battery to the microcontroller.

3.4.1 Battery

To supply the whole circuit system a power source is needed. Small batteries of 12V can be made as a power source however in a long term it may not stay last meaning the battery will quickly run out of charges. Therefore, one of the alternatives besides using an AC power supply, a Dry-Cell battery of 12V is a suitable power source for the whole system since it portable making it easier to attach to the smart umbrella and replacing if there any malfunction.

Figure 3.4.1: Dry-Cell Battery

Dry-Cell battery as shown in figure 3.4.1 sometime also known as motorcycle battery is a portable and high-quality battery that provides for low current electrical devices for the long term.

3.4.2 Switch

A switch is one of the everyday's electrical components used in our everyday life, whether in the house turning on and off the light in the bathroom or while using a laptop pushing or holding the switch to turn it on. The normal type of switch consisted of ON and OFF mechanism in which it is either open or off. Further type can include normally closed or normally open just like in the refrigerator where only by opening the fridge the light inside can be turned on, this is the case of normally closed circuit (What is a Switch: Introduction and Explain About Types of Switches, 2016, March 23).

Figure 3.4.2: On Off 2 Pin Switch

Figure 3.4.2 is a type of 2 pin switch or also known as Single Pole Single through (SPST) where it can be turned on and off according to the required conditions. The connection for it in the smart light for the market umbrella in the circuit will be between the positive poles of the dry cell 12V battery. The switches also have a current rating to prevent any overload current damaging other components so if it will act as a fuse as protection.

3.4.3 Resistors

Resistors are component the resist the current, which is the flow of electricity. The resistor values are called ohm and the symbol is a Greek letter omega: Ω. The resistors values are printed as color coded on the components consisting usually four lines of colors (LEARN.PARALLAX.COM, n.d.).

Table 3.4.3 : Resistor Color Code Values

Digit	0	1	2	3	4	5	6	7	8	9
Color	black	brown	red	orange	yellow	green	blue	violet	gray	white

Based on the table 3.6.3 there are 10 types of color to determine the values of resistors and when trying to determine the values of resistors, the first two line of colour is the digit of the resistor while the third line if the number of zeros and last line is tolerance of the resistor which is usually the colors are gold (5%), silver (10%) or no stripe (20%) (Resistor Colour Code and Resistor Tolerances Explained, 2018, July 8).

Figure 3.4.3: 100kΩ Resistors

As for figure 3.6.3, is a 100kΩ resistor. The color stripe is brown which is 1 and the next stripe is the black color the digits will be 0 and the third stripe is yellow 4, therefore with four zeros and the tolerance is 5% since the last stripe is gold, therefore, making it a 100 000 Ω or 100kΩ resistor with 5% tolerance.

In the circuit design, the value 100kΩ is used to pair with each LDR sensors to have a voltage divider so that the analog signal can be sent to the microcontroller and at the same time preventing the circuit being short-circuited when in absence of light, the LDR sensors can go really low in Ω values and if the values is zero, it will short circuit if there are no other resistors.

3.4.4 Voltage Regulator

A voltage regulator is a component that is used to step down a high voltage from DC power supply and even AC power supply which is unstable to a lower voltage stable and usable output (Introducing Voltage Regulators, n.d.).This is due to the load may be excessive when DC motor is functioning and can cause a sudden high current taken from the microcontroller so by placing a voltage regulator between a power source and microcontroller, any overload current can be prevented. Also, there is a limitation on how many volts the Arduino Uno R3 can safely be supplied with.

Figure 3.4.4: L7809CV

Figure 3.4.4 is voltage regulator 9V since it will step down a high voltage to the 9V output. This output will be supplied to the microcontroller. This voltage regulator also acts as a fuse, preventing any excess current going to Arduino Uno R3. Arduino Uno R3 can be supplied directly with a 12V volts however 9V is a much safer volt to be supplied with.

3.5 Testing On Breadboard

Before soldering for it permanently to be attached at the smart umbrella, the circuit system must first be tested on the breadboard over and over until it runs smoothly as wanted and getting the result that is required. This step is crucial since there will be problems arise when testing the circuit if the simulations are working perfectly fine. Therefore, troubleshoot are needed to be done to find the faults since it may cause by improperly attached of electrical components on the breadboard or even the errors in coding.
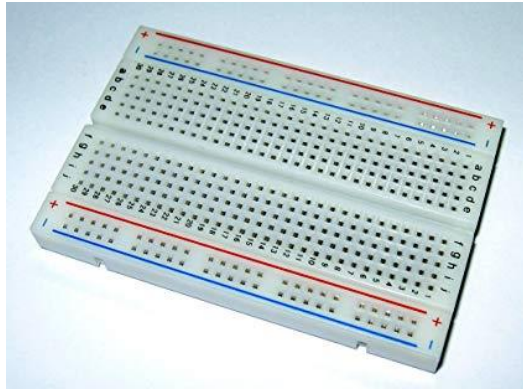
Figure 3.5: Breadboard

Figure 3.5 is an example of a breadboard. The breadboard is similar to the printed circuit board (PCB) except it doesn't need to be soldered to use it. The electrical components can be tested over and over again on the breadboard and permanently on the PCB.

3.6 Soldering

After testing on breadboard and checking everything is working, the circuit can be soldered into the PCB.
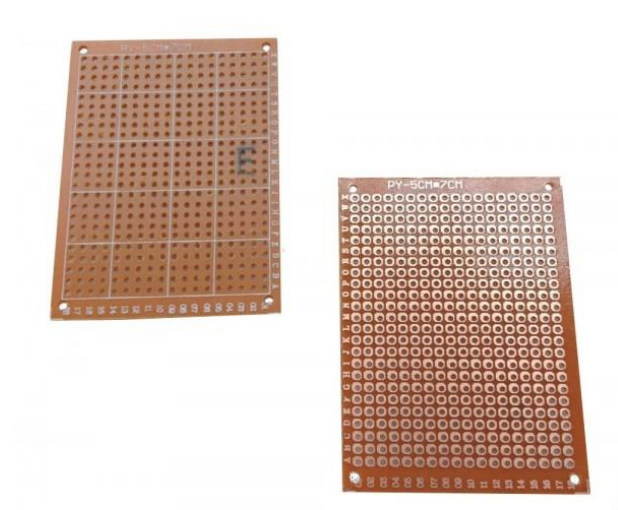

Figure 3.6.1: PCB

Figure 3.6 is the PCB board that will be used to be soldered the electrical components using leads. The electrical components are arranged nicely and neatly on the PCB before preparing to be soldered.
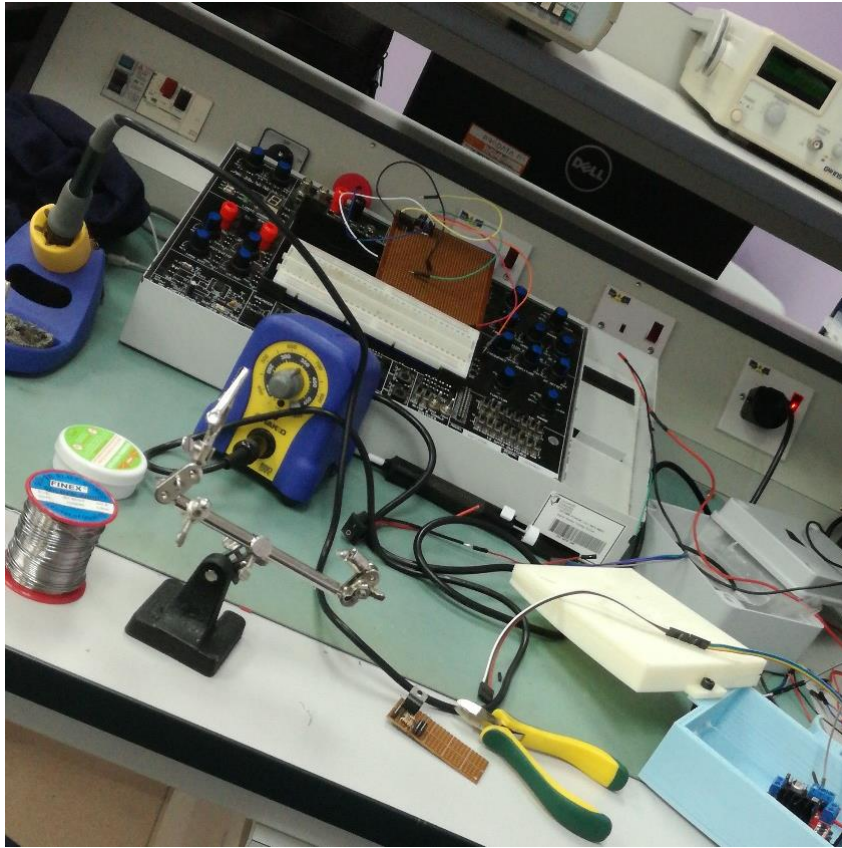
Figure 3.6.2: Soldering in the Digital Lab

The soldering process is done in the lab as in figure 3.6.2. Leads are used together with a soldering iron and the melted leads are then attached to the pin of electrical components.

3.7 Field Testing

After completing all the fabrications of the design of smart light/shadow detection for market umbrella, the field testing is carried out to record the value data based on data, any adjustment can be made until the smart umbrella will able to track the sunlight perfectly.

Figure 3.7: Field Testing

Figure 3.7 is the smart umbrella design that is fabricated and doing some filed testing outside where the light intensity values can be recorded. The data then will be evaluated for the result and any modifications in the coding.

CHAPTER 4

RESULT AND DISCUSSION

4.1 Results

There are few calculations that needed to be done, one of it is to find the suitable resistors that needed to be paired or series with the LDR sensors. Another calculations are to find the angle of the rotation for the type 37 big torque DC motor since DC motor movement or rotation depends on the PWM, not unlike stepper motor where it rotates within a very specific angle.

4.1.1 Finding The Resistors Values

$$R = \sqrt{R_{MIN} * R_{MAX}}$$

(4.1.1)

Using the equation (4.1.1.1) above, R_{MIN} and R_{MAX} values are needed to be measure first using the LDR sensors by exposing it with and without the presence of light. When exposing it to the presence of light, the values is recorded as R_{MIN} and when measuring it under the absence of light, the values is then kept as R_{MAX}.

Table 4.1: LDR measurements

Condition	LDR Resistance (Ω)
Min	$0.10k\Omega$
Max	$20M\Omega$

Based on table 4.1 is the data of measurement for the LDR sensors that are recorded under the absence and presence of light. Therefore, by inserting the following values from table 4.1 into the equation (4.1.1.1):

$$R = \sqrt{R_{MIN} * R_{MAX}}$$
$$R = \sqrt{0.10k\Omega * 20M\Omega}$$
$$R = 44.721k\Omega$$

The values that suitable to be used is $44.721k\Omega$ for each of the LDR sensors.

4.1.2 DC Motor Angle Calculation

As for the calculations for the DC motor angle, the important things that are to be highlighted here are the revolutions for the type 37 big torque DC motor is 70 PWM with 2.5KG torque however the speed that the microcontroller send to the DC motor driver is only 94.140625 % to prevent it from moving too fast but at the same time must be able to rotate the smart umbrella. See below calculations for more details.

$$\frac{x}{256} x100\%$$

With 'x' being the values in Arduino Software at PWM

(4.1.2)

$$y\% \, x \, n \, rpm$$

With 'y' is the percentage from eq. (4.1.2) and 'n' is the rpm for the specific motors

(4.1.3)

$$z \, rps \, x \, \left(\frac{pi}{30}\right) = w \left(\frac{rad}{sec}\right)$$

After converting rpm to revolution per seconds (RPS), rad/sec is find.

(4.1.4)

$$\left(w\ \frac{rad}{sec}\right)x\frac{180}{pi} = b\ °$$

.

$$(4.1.5)$$

By using the eq. (4.1.2) the percentage of rpm can be found and using eq. (4.1.3) the number of rpm at the output can be calculated.

$$240\ speed\ in\ arduino\ PWM\ digital\ pins : \frac{241}{256}x100 = 94.140625\ \%$$

$$94.140625\ \%\ x\ 70\ rpm = \ 65.8984375\ rpm$$

Converting from minutes to seconds are required to transfer the value into the rad/sec mode using eq. (4.1.2.3) and with that by inserting eq. (4.1.2.4), angle of the DC motor is known.

$$\frac{65.8984375\ rpm}{60} = \ 1.098307292\ revolutions\ per\ seconds$$

$$(1.098307292\ revolutions\ per\ seconds)x\frac{pi}{30} = 0.1150144706\frac{rad}{sec}$$

$$\left(0.1150144706\frac{rad}{sec}\right)x\frac{180}{pi} = 6.58984375\ °\ \#\ with\ no\ load$$

$$6.58984375°\ x\ 3\ sec = 19.79653125°\ \#$$

Therefore, the DC motor will only move for about 6.58984375 ° without any load for 1 second. Since in the coding the motor will only move for about 3 seconds because 1 second will not be enough to rotate the market umbrella, and at 3 seconds it will move for 19.79653125° in angle.
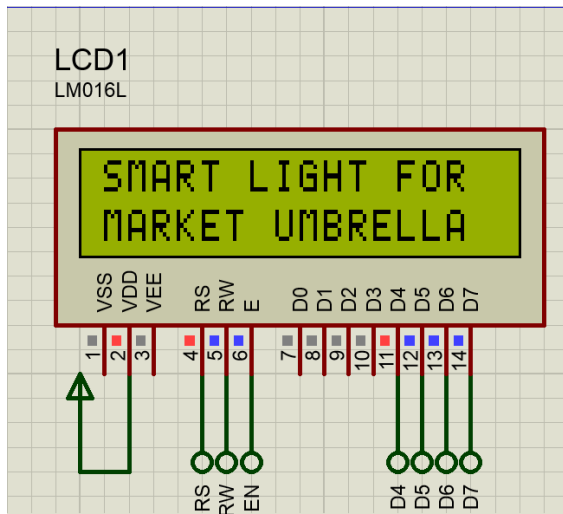
4.1.3 LCD Results

Figure 4.1.3.1: 1ˢᵗ Display
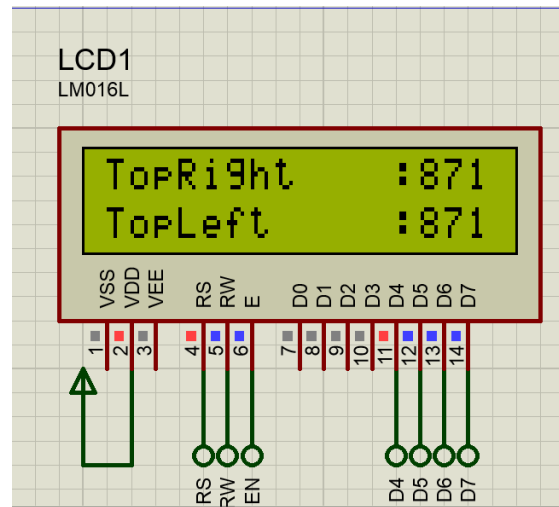
Figure 4.1.3.2: Reading the Top Values

Figure 4.1.3.1 is the display when the LCD when it is turned on. It will first display the introduction that is coded, which is "SMART LIGHT FOR MARKET UMBRELLA". As for figure 4.1.3.2 is displaying the values that it detects from the top side of the LDR sensors.

Figure 4.1.3.3: Reading the Bottom Values

Figure 4.1.3.4: Calculating the Average Values

As for figure 4.1.3.3 is the values from the bottom sides of the sensors. The figure 4.1.3.4 meanwhile is displaying the average after reading from both and top sides of the sensors which it will display the average values for top and average values for the bottom.

4.3 **COST ANALYSIS**

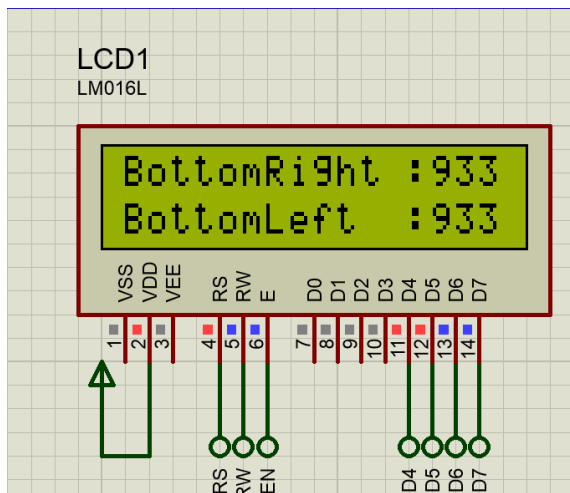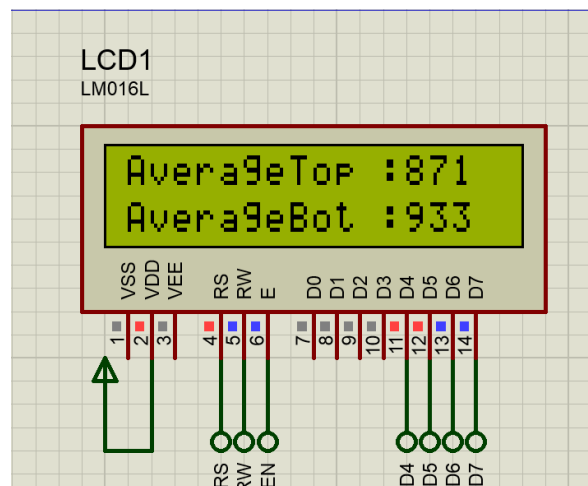The components for the smart umbrella are short-listed and electrical components for the simulations are then ordered or found at a nearby store so that the fabrication can be made. Furthermore, the budget can be made based on the materials that are bought for marketing purposes.

Table 4.1: Costing of the Materials

No.	Items	Quantity	Price (RM)
1.	Market umbrella	1	74.00
2.	Arduino	1	23.50
3.	Sensor	4	1.60
4.	Geared DC motor	1	43.00
5.	Resistor	4	0.60
6.	LCD 16x2	1	17.04
7.	Bread Board PCB Single Layer	1	5.00
8.	DC Motor Driver	1	14.00
9.	Battery	1	50.00
10.	PCB Stand	16	8.00
11.	Spiral wire	1	9.00
12.	Wire	1	8.00
13.	Switch	1	2.00
14.	3D printing (Holder, Box, Gears)	3	40.00
15.	Voltage regulator	2	1.40
		TOTAL	297.14

As for table 4.1, are listed all the materials that are bought. The total for it is RM 297.14, however it can be much cheaper when mass production since this is only 1 product or cost for only for 1 fabrication. When mass production, the materials can be much cheaper when bought it large quantities compared to only 1 product where the materials are bought only for one, therefore can be quite expensive.

4.4 **ETHICAL CONSIDERATION**

There are several work ethics that must be followed in order to complete the project and to avoid any unnecessary danger or troubles. When an electrical lab or doing circuit design, one of the priority is to wear a rubber type shoes or better, safety shoes. This is due to the when surrounded by a lot of electrical devices, there will be a situation that the user can be exposed with short circuit and by wearing shoes, any unwanted tragedy can be prevented. As for the workshop, when dealing with heavy lifting or welding, a safety shoe is a must wear to complete the PPE (Personel Protective Equipment). This is to follow the procedure when entering workshop as any danger or harmful event can be avoided when fabricating the market umbrella.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

For the summary, the objectives for the design of the smart light/shadow detection has been achieved in terms of mechanical design and electrical design.

I. The smart umbrella has been successfully design to be tilted and able to rotate at 360°. Furthermore, the tracking of the sunlight has been acquired according to the sunlight movement.

II. Existing market umbrella functions is also improves by adding a base to make it more stable and also LCD for much easier to read the values of the LDR sensors.

III. Using a dry-cell improves the eco-friendly environment instead of using gasoline to generate power to the whole system.

The smart umbrella also is able to work smoothly however some improvement can be made to make it more workable. Considering the market umbrella, it can be manually forced to rotate by the strength of a person but what if that market umbrella is much larger or the quantity of the market umbrella is more than a person can move it. Therefore, this system will help the user or customer to be cover or protected by the sunlight with optimizing shade when using this smart light/shadow detection.

As for the limitation of the electrical parts, the sensor used is much easier compared to another type of sensor however the quality of it is not quite good. As for the mechanical part, this market umbrella only able to rotate in one axis only, therefore limiting the movement and efficiency of this design.

5.2 Recommendations

        As for the recommendations, since the sensor is not highly accurate, a tube can be added directly above the LDR sensor so that it will only receive the sunlight directly above it. In normal condition, the sensor would detect the light intensity in the surrounding making it highly not accurate.

Figure 5.2: Tube

        Figure 5.2 is tube where it can be added atop of the sensor making it only able to receive light at specific point or angle.

        Furthermore, when using only one axis, the movement will be limited to a certain area or certain angles of the market umbrella. By adding another axis, the movement will be more flexible.

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APPENDIX A

GANTT CHART

Tasks	WEEKS													
	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13	W14
T1	█		█		█		█		█		█		█	
T2	█	█	█	█	█	█	█	█	█	█	█			
T3	█	█	█	█	█	█	█	█	█					
T4									█	█	█	█		
T5												█	█	█
T6												█	█	
T7														█

T1: Meeting With Supervisor To Update The Progress Of Works

T2: Listing And Finding The Material And Components

T3: Testing The Circuit And Making The Coding

T4: Field Testing

T5: Drafting The Thesis and Other Reports

T6: Poster Design

T7: Presentation Of Senior Design Project II

APPENDIX B

CODING FOR THE DESIGN OF SMART LIGHT/SHADOW DETECTION

FOR MARKET UMBRELLA

```
#include <Wire.h>
#include <LiquidCrystal_I2C.h> // I2C
LiquidCrystal_I2C lcd(0x27, 20, 4); // 16 by 2 LCD


const int IN1 = 6;        // Declaring DC motor driver IN1
const int IN2 = 7;        // Declaring DC motor driver IN2
const int ENA = 5;         // Declaring DC motor driver ENA for speed


int LDRbottomright  = A0; //bottom right LDR sensor
int LDRbottomleft   = A1; //bottom left LDR sensor
int LDRtopright     = A2; //top right LDR sensor
int LDRtopleft      = A3; //top left LDR sensor


void setup()
{
 lcd.begin(); // initialize the LCD
 lcd.backlight(); // Turn on the blacklight and print a message.
 lcd.print("SMART LIGHT FOR");
 lcd.setCursor(0, 1);
 lcd.print("MARKET UMBRELLA");
 lcd.setCursor(0, 2);
 lcd.print("SDP II");
 delay(3500);

 pinMode (IN1, OUTPUT); // Declaring DC motor driver IN1 as output
 pinMode (IN2, OUTPUT); // Declaring DC motor driver IN2 as output
 pinMode (ENA, OUTPUT); // Declaring DC motor driver PWM as output

 pinMode(LDRbottomright, INPUT);
 pinMode(LDRbottomleft,  INPUT);
```

```
  pinMode(LDRtopright,   INPUT);
  pinMode(LDRtopleft,    INPUT);


}


void loop()
{
 // put your main code here, to run repeatedly:
 int botr = analogRead(LDRbottomright);

 int botl = analogRead(LDRbottomleft);

 int topl = analogRead(LDRtopleft);

 int topr = analogRead(LDRtopright);


 int avgbot = (botl + botr) / 2; //average of top LDRs

 int avgtop = (topl + topr) / 2; //average of bottom LDRs

 //int avgleft = (topl + botl) / 2; //average of left LDRs

 //int avgright = (topr + botr) / 2; //average of right LDRs


 lcd.clear();

 lcd.print("TopRight    :");

 lcd.print(topr);

 lcd.setCursor(0, 1);

 lcd.print("TopLeft     :");

 lcd.print(topl);

 //delay(1500);

 //lcd.clear();

 lcd.setCursor(0, 2);

 lcd.print("BottomRight :");

 lcd.print(botr);

 lcd.setCursor(0, 3);
```

```
lcd.print("BottomLeft  :");
lcd.print(botl);
delay(2000);


lcd.clear();
lcd.print("AverageTop :");
lcd.print(avgtop);
lcd.setCursor(0, 1);
lcd.print("AverageBot :");
lcd.print(avgbot);
delay(1500);


if (avgbot > avgtop)
{
  if ((avgbot - avgtop) < 20)
  {
    digitalWrite(IN1, LOW);
    digitalWrite(IN2, LOW);
    delay(100);
  }
  else if ((avgbot - avgtop) > 20)
  {
    lcd.clear();
    lcd.print("Avgbot > Avgtop");
    lcd.setCursor(0, 1);
    lcd.print("Anti-Clockwise");
    delay(500);


    analogWrite(ENA, 240);
    digitalWrite(IN1, HIGH);
```

```
    digitalWrite(IN2, LOW);
    delay(3000);


    analogWrite(ENA, 0);
    digitalWrite(IN1, LOW);
    digitalWrite(IN2, LOW);
    delay(100);
  }
}
else if (avgtop > avgbot)
{
  if (( avgtop - avgbot) < 20)
  {
    digitalWrite(IN1, LOW);
    digitalWrite(IN2, LOW);
    delay(500);
  }
  else if ((avgtop - avgbot) > 20)
  {
    lcd.clear();
    lcd.print("Avgtop > Avgbot");
    lcd.setCursor(0, 1);
    lcd.print("Clockwise");
    delay(500);


    analogWrite(ENA, 240);
    digitalWrite(IN1, LOW);
    digitalWrite(IN2, HIGH);
    delay(3000);
```

```
    analogWrite(ENA, 0);
    digitalWrite(IN1, LOW);
    digitalWrite(IN2, LOW);
    delay(100);
   }
 }
 else
 {
  digitalWrite(IN1, LOW);
  digitalWrite(IN2, LOW);
  delay(500);
 }
}
```