SMART PLANT WATERING SYSTEM USING SMARTPHONE

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ABSTRACT

Proper watering is exigent for the plants and trees which are grown in containers. Many people prevail to take good care of expensive plants or trees like Bonsai because of improper timing or lack of watering. An automated system which is capable of perceiving the proper situation of watering plants can be convenient in this regard. In this paper, a micro-controller board Arduino has been used, which has an ATMEGA 328p chip in it. Moisture sensor are integrated into it for detecting moisture of the soil in the plant's pot. A program has been set to the Arduino to take the norm from the sensor, comparing the retrieved value with our predefined standard threshold and turn on or off the water pump according to the plants need. A message alert system has been set to notify the owner if there is any problem in supplying water from the main source.

ABSTRAK

Penyiraman yang betul adalah sangat penting untuk tumbuh-tumbuhan dan pokok-pokok yang ditanam dalam bekas. Ramai orang yang berkuasa menjaga kebun atau pokok mahal seperti Bonsai kerana masa yang tidak betul atau kekurangan air. Sistem automatik yang mampu melihat keadaan yang sesuai dengan tumbuhan penyiraman boleh menjadi mudah dalam hal ini. Dalam makalah ini, papan pengatur mikro Arduino telah digunakan, yang mempunyai cip ATMEGA 328p di dalamnya. Sensor kelembapan digabungkan ke dalamnya untuk mengesan kelembapan tanah di periuk kilang. Satu program telah ditetapkan kepada Arduino untuk mengambil norma dari sensor, membandingkan nilai yang diambil dengan ambang standard yang telah ditetapkan dan menghidupkan atau mematikan pam air mengikut keperluan tanaman. Sistem peringatan mesej telah ditetapkan untuk memaklumkan kepada pemilik jika terdapat sebarang masalah dalam membekalkan air dari sumber utama.

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ABBREVIATION

ABBREVIATION	DETAILED FACTORS
IDE	Integrated Development Environment
AC	Alternating Current
DC	Direct Current
A	Ampere
V	Voltage
W	Watt
VCC	Voltage at Common Collector
GND	Ground
LCD	Liquid Crystal Display
PWM	Pulse Width Modulation
LED	Light Emitting Diode
PCB	Printed Circuit Board

CONTENT

CHAPTER 1

INTRODUCTION

1.1 Introduction

Most of the time for the lacking of water, the plants cannot raise well and become morbid. On the other hand, supply of excessive water at a time can result a venturesome effects on the plants especially the sensitive trees like bonsai. Such trees also need timely water supply for the perfect growth. That means, for the perfect growth, water is needed in proper time along with proper quantity. Currently there are some micro-controller based plant watering project available, but the problem with the projects are, they don't have a particular time for watering. But there are some sensitive and expensive plants which needs water at the particular time and unusual watering could cause them to death. Moreover, the best time for watering is early morning, while the environment is cool. This allows water to go into deep and reach the roots of the plants without too much excess water lost to vaporization. Watering at night could cause damage in the base of the plant and could also be responsible for fungal problems such as, powdery mildew or sooty mould, which is very harmful for plants. Besides, the existing works do not have the feature to track any leakage in water supply or identify the shortage in the water source. As a result, any implausible situation can be created in absence of person at home. To eradicate all of these problems, we have propounded a system for automated watering plants to make sure that the plants are getting water when its moisture of the soil is below a threshold value and sunlight is available.

1.2 Background

Plants need sufficient water resources to be healthy and fertile. Excess amount of water and less amount of water supplied to plant may cause the plant to wither and die. Past research has focused on the method on how to watering the plant water on the right time with the right amount of water. This research focussed on how to develop an auto watering system using Arduino that watering plant at the right time with the right amount. This home based system is to facilitate human in watering plant without involving any manpower. To develop a fully automated system that intelligently measures the soil moisture, different approaches of methods used in varying fields were reviewed.

1.3 Problem Statement

Many people are facing a lot of problem watering the plant in their gardens, especially when they're not at home. Irregular of watering the plants leads to mineral lost in the soil & might end up rotting the plant & causing the plant to wilt. Especially during dry season, due to insufficient water, plants will die due to lack in constant water supply from no human effort as we will be preoccupied with our other responsibilities.

1.4 Objective

Our objective for this project is:

- To build an auto watering system for plant.
- To design an auto watering system using soil moisture sensors, which helps in developing an auto watering system that facilitates human in the watering task.
- To ease the work of humans by creating a machine that waters the plant with a smartphone.

1.5 Research Question

In order to achieve the objectives of this project, the following research questions were summarized in designing a smart plant watering system using smartphone.

a) What methods can be used to water the plants?
b) Will the system irrigate if it is raining?
c) If I think the system is under-watering or overwatering, what should I do?
d) How to save cost on creating a smart plant watering system using smartphone?

1.6 Scope and Limitation

1.6.1 Scope

This project focuses to the low cost automatic plant irrigator design. The project involves the evolution of manually watering techniques to automatic watering techniques. The controlling automatic watering system in an agricultural. Some scope and limitation have been set to complete this project in a more systematic and organized. Sensor used to control the watering system is soil moisture sensor. Soil moisture sensor will be buried in the soil to a depth of about 3cm. The distance between the two rods in the probe is 2cm. The soil will be tested in three condition which is dry condition, and optimum condition.

1.6.2 Limitation

a) Limited Wi-Fi coverage distance to the ESP8266.
b) ESP8266 can't plug it into a breadboard without an adapter. The controlling of the automatic watering system in a gardening compound.
c) No access to all the input/output pins of the ESP8266 chip, which is a problem if you have complex projects that you want to build.

1.7 Significant

This project will beneficial to the society especially for those are busy with tight schedule whose do not have time to watering their plant, the people that usually forget to watering the plant. Besides that, this project proposed a solution by providing a method and system to facilitate human in watering plant task. Further studies on the system's approaches and method can be used to develop so that applicable in the wide areas such as to watering the plantation with a large number of crops. This project also contributes ideas for researchers to develop watering and irrigation system using Arduino system.

1.8 Working Principle and Operation

The main working principle behind the system is in connection the soil moisture sensor which was previously embedded into the plant, to the Arduino microcontroller, which is also connected to other electronic components. Measurements of soil moisture is done by the sensor which forward the information and parameters regarding the soil moisture to the microcontroller, which controls the pump. If the level of soil moisture drops below a certain value, the microcontroller sends the signal to the relay module which then runs the pump and certain amount of water is delivered to the plant. Once the enough water is delivered the pump stops doing its work. Relay module is a simple circuit consisting of single transistor, several resistors, diodes and a relay and is controlled digitally by a microcontroller. Since the complete system should be embedded in a small box, Arduino Mega is a perfect microcontroller for this purpose because of its dimension and its work performance. Water pump is connected to the relay module and it only works when the relay module gets the command from the microcontroller.

1.9 Summary

In this chapter, the project background, objectives, research questions, scope & limitation, significant and working principle and operation of the system has been stated as above.

Chapter 2

Literature Research

2.1 Introduction

A literature review is the effective evaluation of selected documents on a research topic. A review may form an essential part of the research process or may constitute a research project in itself. In the context of a research paper or thesis the literature review is a critical **synthesis** of previous research .This paper shows the reference a design of automatic irrigation system based on android application using Atmega 328 chip microcontroller, soil moisture and temperature sensor to help a famer to control and monitor a farm. This work facilitates the farm irrigation by switching the pump motor ON/OFF through android cell phone. This automatic irrigation system has a low cost and can be affordable by many Lao farmers. The study shows that the system is useful to provide optimal amount of water for increase the productivity of crop.

2.2 Concept / Theory

Project 1: Smart Irrigation System

Objective:

- Used to measure the loss of moisture in the soil over time due to evaporation and intake.
- Minimizes water waste and improves plant growth.

INPUT	MICROCONTROLLER	OUTPUT
• Moisture Sensor • Temperature Sensor • DC Motor	• Atmega 328 chip	• Light Emitting Diode (LED) Indicator • Water Pump Control

Method:

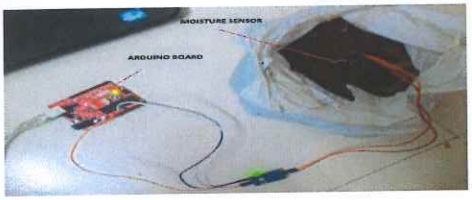
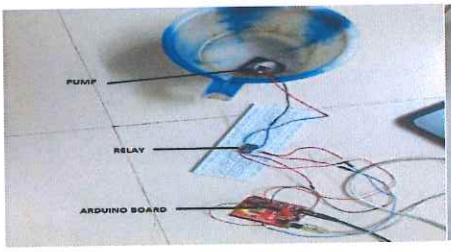


Figure 2.2(a): Moisture sensor connected to the input pin of the microcontroller

Figure 2.2(b): RTD connected to the input of the microcontroller



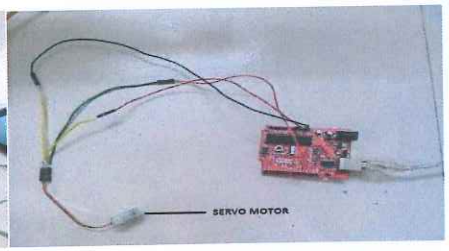


Figure 2.2(c): Interfacing Arduino with pump and relay

Figure 2.2(d): Servo motor connected to the Arduino Board

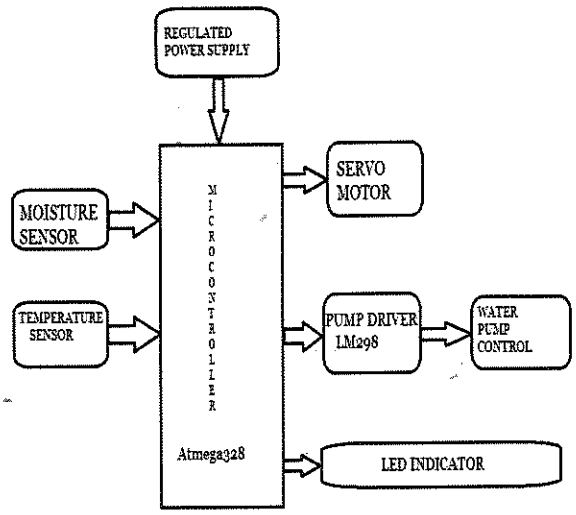


Figure 2.2(e): Block Diagram

Advantages:

- Efficient automated irrigation systems.
- Conserving water planning and irrigation scheduling.
- Maximum absorption of the water by the plant is ensured by spreading the water uniformly using a servo motor.
- Minimal wastage of water.
  Controlling the amount of water delivered to the plants when it is needed based on types of plants by monitoring soil moisture and temperature.

Disadvantages:

- Expensive

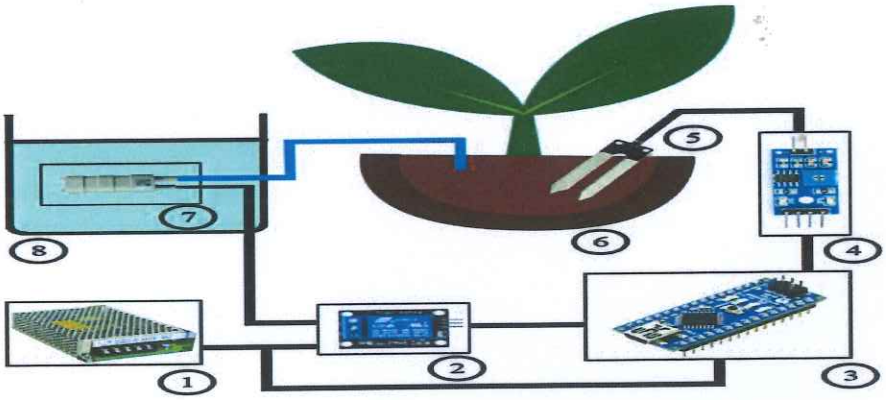
Project 2: Automatic Plant Watering System via Soil Moisture Sensing

Objective:

- To control irrigation facilities that uses sensor technology.
- To sense soil moisture with a microcontroller to make a smart switching device to help people.

INPUT	MICROCONTROLLER	OUTPUT
• Soil Moisture Probe • DC Motor	• Arduino Nano	• Water Pump • Light Emitting Diode (LED) Indicator

Method:



1) Power Supply (12V)
2) Relay module
3) Microcontroller (Arduino Nano)
4) Amplifier circuit as part of a soil moisture sensor
5) Soil moisture probes
6) Plant in the flowerpot
7) Water pump
8) Water container

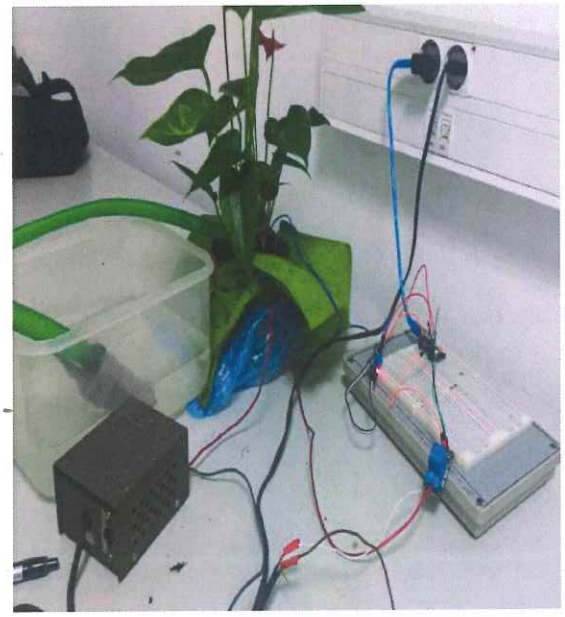


Figure 2.2(e): Diagram of Soil Moisture Sensor

Step 1: Connect power supply 12V to relay module

Step 2: Relay module is attached to the Arduino Nano

Step 3: The code is uploaded to Arduino and setup the drip irrigation kit

Step 4: The soil moisture probe is inserted into the soil to detect moisture

Step 5: Connect the pump to the drip main line

Advantages:

- Light weight and small size.
- Low power consumption.
- Small structure.

Disadvantages:

- Manually fill water in tank.
- Expensive

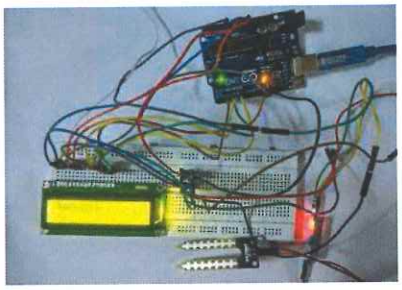
Project 3: Automatic Sprinkler System Using Smartphone

Objective:

- To devise an intelligent and autonomous sprinkler system that operates based on the real time moisture content in the soil.
- To automatically water the plant when nobody is around.

INPUT	MICROCONTROLLER	OUTPUT
• Moisture Sensor • Relay • Timer	• Arduino UNO R3	• Dip Irrigation Kit • Light Emitting Diode (LED) Indicator

Method:



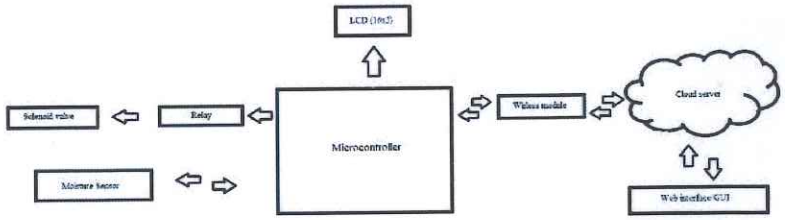


Figure 2.2(f): Diagram of Automatic Sprinkler System & Block Diagram

- First, a pipe is connected to the water resource which is then connected to the solenoid valve.
- The solenoid valve, only opens when it gets signal from the microcontroller otherwise it's always in closed state.
- The moisture is dipped under the ground near the plants.
- The sensor is always on and senses the moisture content and sends the data to the controller which in exploits it to the LCD for displaying the data.
- The wireless module connects the controller with a cloud server.

Advantages:

- Water spreads out in a wide area
- Low power consumption.

Disadvantages:

- Expensive
- Requires internet access

2.3 Primary Research

2.3.1 Soil Moisture Sensor (SMS)

Soil moisture sensor is a device which used to measure a physical quantity and convert this information into a signal that can be read by the observer or a tool. The sensor converts one form of energy into another form because the sensor is a transducer. For this reason, the sensor is categorized according to the type of energy transfer that they detected. Soil moisture measurement provides very useful information to agriculture, such as agriculture farm, soil stability, soil moisture and construction activities. The probe selection for sensor is very important. This is because the material that used in the probe. Sensor sensitivity is depending on the material that used to construct the probe and also depends on how the sensor operates. Typically, soil moisture sensor is based on the resistance value of the soil. Water is a type of electric conductance. So generally, if the resistance is low, the soil is dry and vice versa.

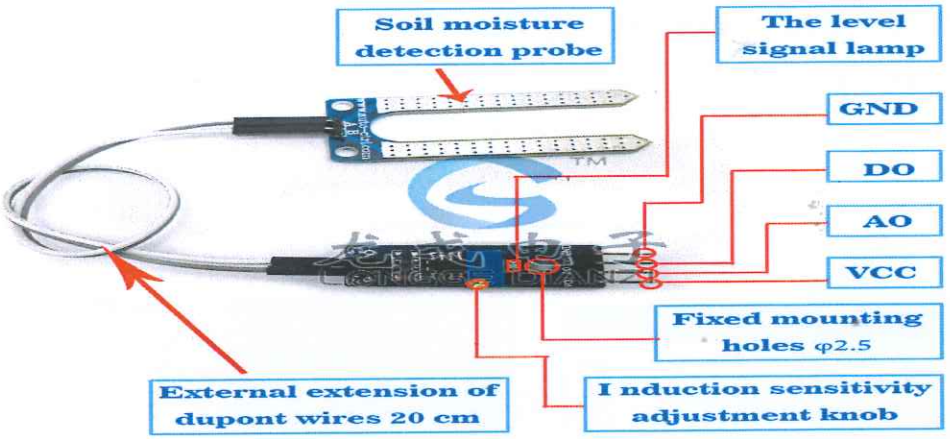
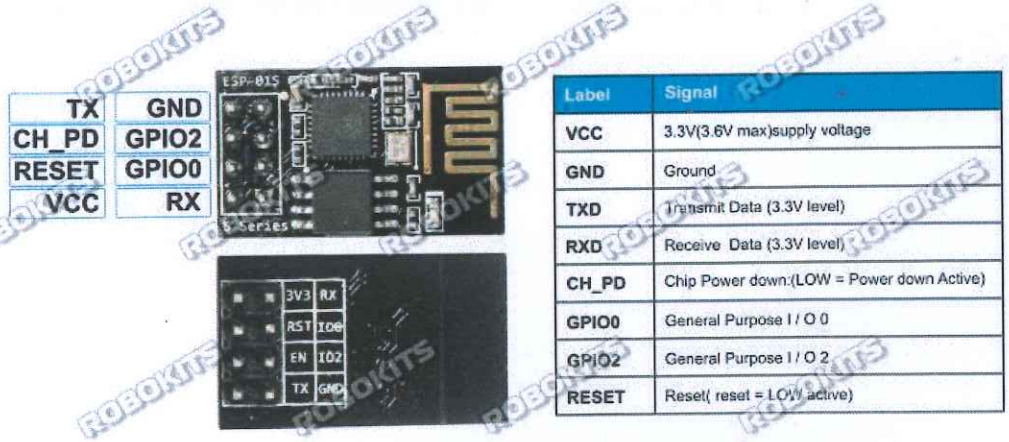


Figure 2.3(a): Soil moisture sensor

There are two transducers: one emits an ultrasonic wave and the other picks up reflections from the different objects in the area. The reflected waves arrive at the receiver in constant phase if none of the objects in the area are moving. If something moves, the received signal is shifted in phase. A phase comparator detects the shifted phase and sends a triggering pulse to the alarm.

2.3.2 ESP 8266 Wi-Fi

The ESP8266 Wi-Fi Module is a self-contained SOC with integrated TCP/IP protocol stack that can give any microcontroller access to your Wi-Fi network. The ESP8266 is capable of either hosting an application or offloading all Wi-Fi networking functions from another application processor. Each ESP8266 module comes pre-programmed with an AT command set firmware, meaning, you can simply hook this up to your Arduino device and get about as much Wi-Fi-ability as a Wi-Fi Shield offers. The ESP8266 module is an extremely cost effective board with a huge, and ever growing, community. This module has a powerful enough on-board processing and storage capability that allows it to be integrated with the sensors and other application specific devices through its GPIOs with minimal development up-front and minimal loading during runtime. Its high degree of on-chip integration allows for minimal external circuitry, including the front-end module, is designed to occupy minimal PCB area. The ESP8266 supports APSD for VoIP applications and Bluetooth co-existence interfaces, it contains a self-calibrated RF allowing it to work under all operating conditions, and requires no external RF parts.



Label	Signal
VCC	3.3V(3.6V max)supply voltage
GND	Ground
TXD	Transmit Data (3.3V level)
RXD	Receive Data (3.3V level)
CH_PD	Chip Power down:(LOW = Power down Active)
GPIO0	General Purpose I / O 0
GPIO2	General Purpose I / O 2
RESET	Reset(reset = LOW active)

Figure 2.3(b): ESP8266 Wi-Fi

Source: https://www.instructables.com/id/WiFi-Internet-Controlled-Relays-using-%20ESP8266-Quic/

2.3.3 Arduino Mega (ATMega2560)

The Arduino Mega 2560 is a microcontroller board based on the ATmega2560. It has 54 digital input/output pins (of which 15 can be used as PWM outputs), 16 Analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started. The Mega 2560 board is compatible with most shields designed for the Uno.

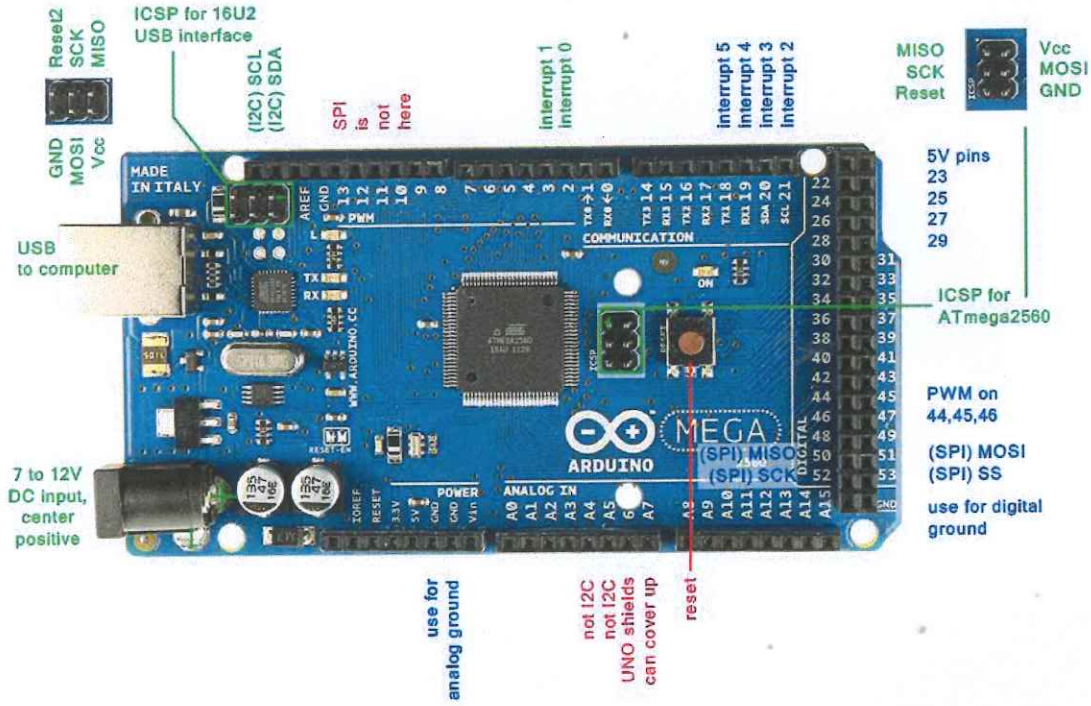


Figure 2.3(c): Arduino Mega Microcontroller

2.3.4 Water Pump

A pump is a device that moves fluids (liquids or gases), or sometimes slurries, by mechanical action. Pumps can be classified into three major groups according to the method they use to move the fluid: direct lift, displacement, and gravity pumps. Water pump is a device to transport liquid from one place to another. Small-scale water pump which is effective to lift more discharge is generally used. The ones that are most preferred are centrifugal types which having low absorbability. Pump performance is limited by pressure level in real electrical power whereas pump efficiency is influenced by head and discharge.

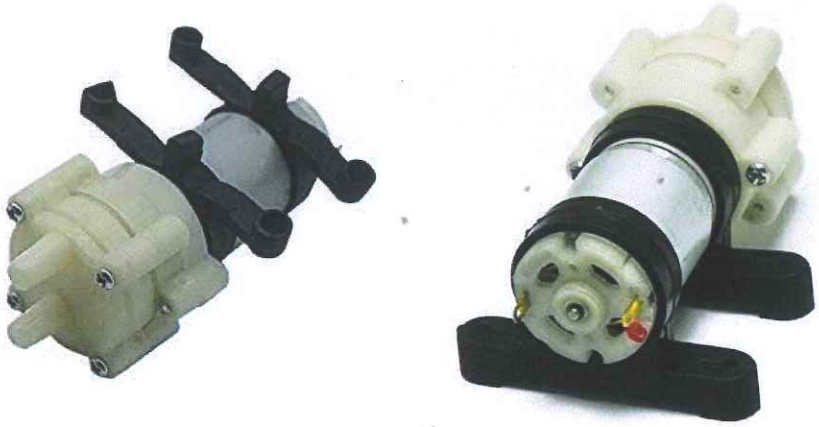


Figure 2.3 (d): Water Pump

2.4 Summary

In this chapter, concept / theory of few projects related to smart plant watering system were explained in detail. The primary research for the main electronic components were stated as above.

CHAPTER 3

METHODOLOGY

3.1 Introduction

There are two functional components in this project. They are the moisture sensors and the motor/water pump. Thus the Arduino Board is programmed using the Arduino IDE software. The function of the moisture sensor is to sense the level of moisture in the soil. The motor/water pump supplies water to the plants.

3.2 Arduino Software IDE

The coding for smart plant watering system is stated as below:

```
#define BLYNK_PRINT Serial
#include <ESP8266_Lib.h>
#include <BlynkSimpleShieldEsp8266.h>
#include <Wire.h>

#define EspSerial Serial1

#define ESP8266_BAUD 115200

char auth[] = "b2ef39a130ad4a95b27832c241a04d3a";
char ssid[] = "mitti";
char pass[] = "lollollol";
int flag = 0;
ESP8266 wifi(&EspSerial);

WidgetLCD virtualLCD(V0);
```

```
void setup()
{
 Serial.begin(9600);
 EspSerial.begin(ESP8266_BAUD);
 delay(10);
 Blynk.begin(auth, wifi, ssid, pass);
 pinMode(A0, INPUT);
 pinMode(5, OUTPUT);
 virtualLCD.print(0, 0, "  SMART  PLANT  ");
 digitalWrite(5,HIGH);
}

void loop()
{
 int moisture = analogRead(A0);
 Serial.println(moisture);

 if (moisture <= 500 && flag == 0){
  Blynk.notify("MOTOR OFF");
  virtualLCD.print(0, 1, "    MOTOR OFF    ");
  digitalWrite(5,HIGH);
  flag=1;
 }
 else if (moisture > 500 && flag == 1) {
  Blynk.notify("MOTOR ON");
  virtualLCD.print(0, 1, "    MOTOR ON    ");
  digitalWrite(5,LOW);
  flag=0;
 }
}
```

3.2.1 Etching & Soldering process

Step 1: The very first step of the etching process is designing the circuit, using the Proteus ISIS/ARES software of your choice. Once the design is ready, flip it, and then get it printed.

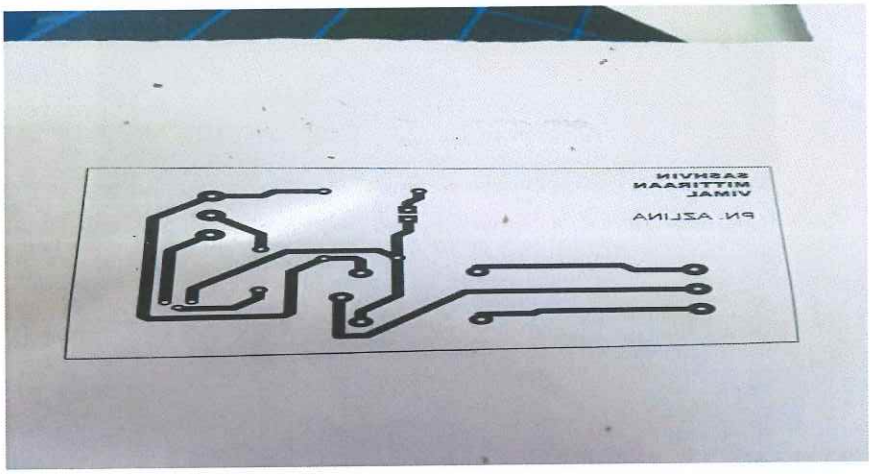


Figure 3.2(a): Copper tracing on PCB

Step 2: Print the circuit design on the glossy paper. Make sure that the design is printed on the shiny side of the paper.

Step 3: Take the copper board, and rub sand paper on it. This will make the surface of copper rough, and thus helps it to hold the design efficiently.

Step 4: Wash the board with water, so that any small particles of copper that get removed from the surface during sanding are washed off. Let the board to dry after washing.

Step 5: Cut the printed design properly, and place them on the copper board facing down.

Step 6: Run the copper plate with the design face down through a laminator 5-7 Times until the plate is hot

Figure 3.2(b) PCB laminator

Step 7: Take the plate out from the laminator. A traced circuit in black on the copper board can be seen.

Step 8: Place the copper board in the etching solution. Agitate the copper board for around 10 minutes at 38°C. Ensure that all the copper around the design is dissolved.

Figure 3.2(c): Etchant Solution