DCOTECH WATER LEVEL SYSTEM

*Mazratul Firdaus Mohd Zin, Fatimah Nur Mohd Redzwan, Farid Zuhri Kamal

Faculty of Electrical Engineering
Universiti Teknologi MARA Cawangan Terengganu
23000 Dungun, Terengganu, Malaysia

*Corresponding author's email: mazratul204@tganu.uitm.edu.my

Abstract

This paper presents the DCOTECH water level control system which monitors the water level of a tank. Water level management approach would help in reducing water overflow and possibility of flash floods. The reservoir provided is one of a preventive action to prevent flood. The DCOTECH water level system is a warning system for residents to be more prepared whenever flood is approaching. A prototype of the DCOTECH water level system has been constructed and it resembles a miniature dam or reservoir with installed system. The system automatically switches OFF the motor which controls the drainage valve once the tank is empty. The valve is switched ON whenever the tank is FULL. DCOTECH water level system uses the microcontroller for water level sensing and control. The microcontroller could detect the water level and stated as low, average, and high level. Each level is indicated with three different LEDs. When the water level is low, a green led will light up, yellow led turns ON when the water is at average level and red led will light up when the water level is high.

Keywords: valve; water level; led; controller;

1.0   INTRODUCTION

Floods are defined as a temporary condition of partial or complete blizzard caused by overflow of inland or tidal waters accumulated at a normally dry area. In other words, floods can be simplified as a large amount of water covering an area of land that is usually dry, or a rising and overflowing of a body of water especially onto normally dry land (Hua, 2014). The change of climate such as movement of natural conditions on earth, temperature, rainfall, evaporation and wind are the main causes of floods (Balek, 1983). In fact, flooding is a natural disaster that also achieves 40 per cent to 50 per cent of all types of disasters causing deaths in the world (Shafiai & Khalid, 2016).

A study has been carried out recently analysing the flood management in Malaysia. The study found out that there were lack of pre-disaster actions have been taken. Structural measures have been taken by constructing dams. Few years until 2009, Department of Irrigation and Drainage (DID) has installed about 335 telemetric rain gauges and 208 water level stations telemetric around 40 river basins to get real-time flood monitoring. Another 400 river gauges have been provided at 250 observation centers (Shafiai & Khalid, 2016). Floods have led to destruction, physical and mental changes of the flood prone area residents. In order to adapt with the situation, some physical

amendments have taken place such as rebuilding the house, emergency roof top, and flood warning system and allocating high area for documents (Hua, 2014).

However, when the flood approaches, many of the local residents are not aware and unprepared due to the lack of mechanism to warn and alert the residents. Consequently, the residents would lose their belonging and incurred detriment. Hence, by implementing DCOTECH water level system at the flood prone area, the local residents are aware and be prepared before the flood approaches.

2.0   DCOTECH WATER LEVEL SYSTEM

Last few decades, several monitoring systems integrated with water level detection have been done. The water level sensor is made with a metal plate mounted at the bottom of a reservoir, with a sensor attached to create the top level and a detection sensor for the lower level and ground lines connected to the bottom of reservoirs. This project aims to embed a control system into an automatic water level controller. This research is significant to bring a solution in order to solve the problem of horrendous flood, and to warn the residents when the water reaches the hazardous level.

Previous studies have discovered that the water level monitoring and management systems apply the context of electrical conductivity. The project investigated the microcontroller based water level sensing and controlling in a wired and wireless environment. Wireless control using radio frequency communication is applied in (Khaled Reza, Md. Tariq & Mohsin Reza,2012, Shankari, Manu & Naveen, 2013). The DCOTECH is focused only in wired connection and environment using similar water level sensor. A connecting rod made of iron and steel is connected to the ground and at least two rods are needed connected with the voltage and resistance. When the sensor touches water, the iron rods get electric connection using water conductivity.

Fuzzy logic control implementation based on mathematical model of tank and using MATLAB has been done in (Senka, Muhidin, Aida & Samim, 2012). The controller is applied on a Friendly ARM - embedded computer. Festo Didactic DD 3100 tank system is used incorporated with Arduino board which is used as an acquisition board for collecting sensor data and as a PWM signal generator for water pump control. The control system has been experimentally verified with successful results. Low cost PIC16F84A microcontroller is used in another study to control the water level system and has proposed a web and cellular based monitoring service protocol to detect the water level (Ebere & Fransisca, 2013). On the other hand, the DCOTECH project uses ATMEGA328P as the microcontroller. Another study on fuzzy logic control has been carried out in (Komeswarakul et al, 2011). The remote terminal unit (RTU) based on DSPIC30F4011 microcontroller is mainly designed to precisely measure, store and transmit the instrument's outputs to the computer server including real-time communication for dam behaviour monitoring system. Besides, the least square method is applied in order to minimize the analog-to-digital converter (ADC) errors. It is to determine ADC linear parameters of each analog input channel.

After all researches have been done, a project named DCOTECH Water Level System is designed which is mainly focused on water level controlling. The DCOTECH is a system process to control the level of water by using microcontroller ATMEGA328p and it is a series of functions to stabilize the water level of the reservoir to prevent from flash flood. Proper monitoring is needed to ensure water sustainability, which is directly linked to sensing and controlling. Moreover, DCOTECH IS incorporated with a warning system using a buzzer to produce alarming sound.

A water level controller in an overhead tank has been done in (Electronics H., 2015). The project is controlled by 8051 microcontrollers with LCD (Liquid Crystal Display) as the water level indicator. This system mainly works on a principle of "water conducts electricity". The three wires which are dipped into the tank will indicate the different water levels. Based on the outputs of these wires, microcontroller displays water level on LCD as well as to control the motor. The Dcotech applies similar concept as in (electronic.h), however it is implemented using Atmega328p microcontroller. In

DCOTECH, the LCD is replaced with three LEDs (Light Emitting Diode); red, green and yellow. Each color indicates three water levels; green indicates LOW level, yellow indicates AVERAGE while red indicates HIGH level.

The DCOTECH only focuses on the application for residential area because the objective of this project is to prevent flash flood in small area. At current stage, the DCOTECH is presented in prototype form. It is significant to know that this design is limited to 12V valve. The scope of this project is to control the water level by opening the valve and an alarm will be produced by a buzzer as a warning system. DCOTECH has to be water-resistant, but yet to be implemented in this prototype.

3.0   METHODOLOGY

This chapter shows the methodology of the overall project, the simulation work has been carried out as well as the hardware implementation in building the prototype of the DCOTECH water level system.

3.1   Flow of Works
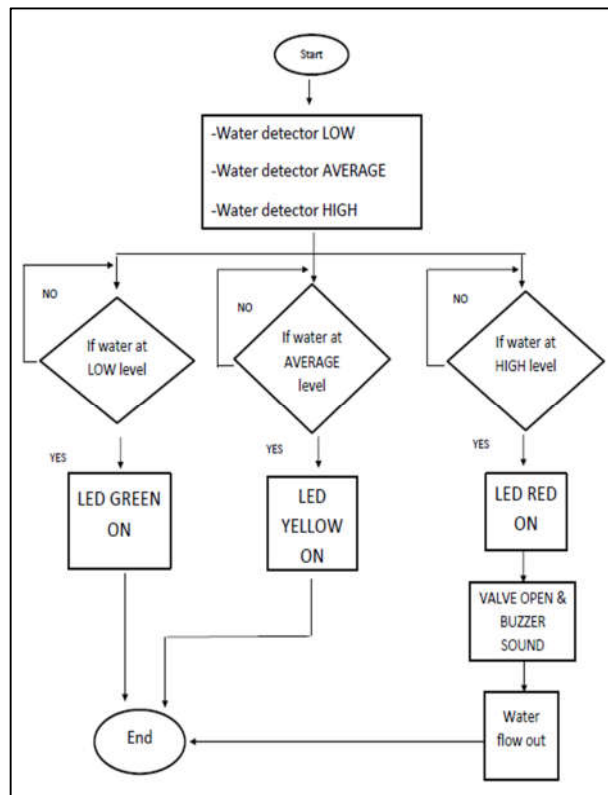
Figure 1 Flowchart of overall project

Figure 1 shows the flowchart of the DCOTECH water level system operation. The DCOTECH is enabled by a switch. Once the metal rods touch the water, an electrical connection is available. When the metal rods at the LOW level touch the water, green LED will be turned ON. If the metal rods at the AVERAGE level touch the water, the yellow LED will be turned ON and automatically turns OFF

the green LED. Then, if the metal rods at the HIGH level touch the water, the red LED turns ON and instantaneously turns OFF the yellow LED. Simultaneously, the valve and the buzzer are turned ON. The valve acts as the drainage system to prevent overflow of the water. The buzzer alerts and warns the residents at the area.

3.2   Simulation Works

This section explains the simulation works involved in this project. All the circuit constructions using Proteus 8 software are shown in the section.
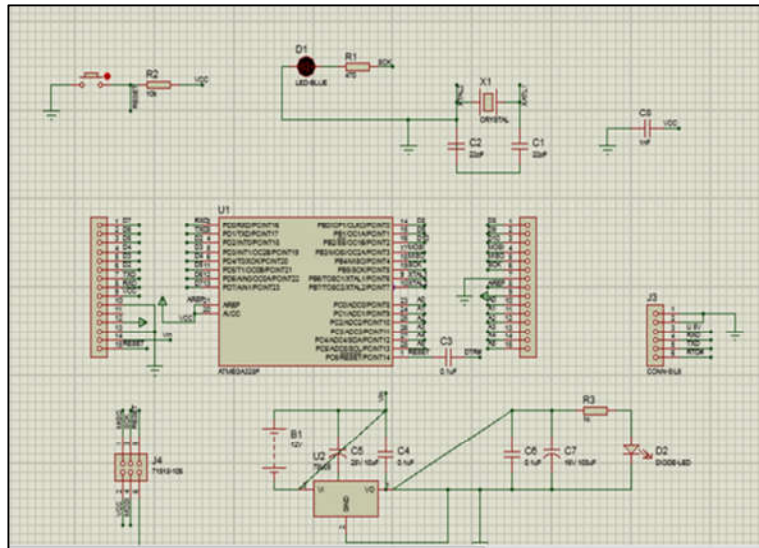

Figure 2 Arduino Circuit Diagram

Figure 2 shows the Arduino circuit diagram constructed and simulated using Proteus 8 software. Arduino is a microcontroller to control the operation of the DCOTECH. The circuit consists of ATmega328P IC that is programmed and uploaded using its compatible software. A 12V voltage source which is connected at the input is reduced to 5V by a voltage regulator. The voltage regulator is used to maintain a steady output voltage of the circuit. Firstly, this circuit is tested using LED in order to determine the functionality of the circuit. A push button switch is mounted at the circuit to disconnect the circuit because the condition of the component is normally closed.
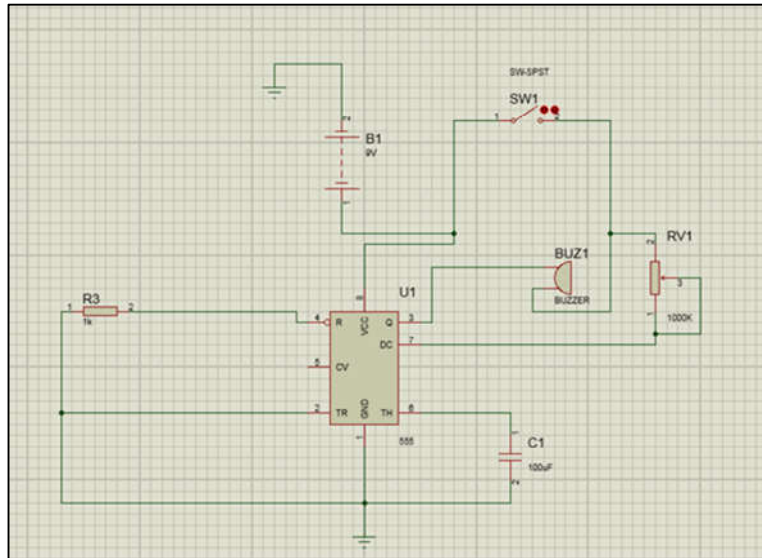
Figure 3 IC Timer Circuit

Figure 3 shows the IC timer circuit which only works instantaneously when the water level is at the highest state. Once the red LED is turned ON, the probes which are mounted at the HIGH level would allow the electricity to flow through IC Timer 555. The IC is then stabilized and rectifies the buzzer to produce a loud sound that acts as the warning system to show that the tank is in dangerous state.
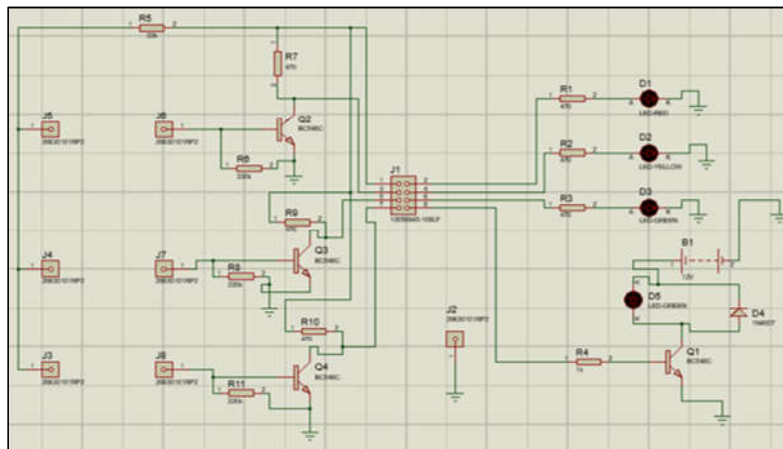

Figure 4 Motor/Valve Circuit Diagram

The controller circuit is the main part in this project. There are three transistors mounted at every desired level and are enabled once the water is at its respective level which are LOW, AVERAGE or HIGH. When the water is at the HIGH level, the transistor will be triggered and acts as a switch where current flows and connects the Arduino circuit. The green, yellow and red LED will turn ON to indicate the water levels.

3.3   Hardware Implementation

This section shows the hardware implementation of the DCOTECH water level system. The implementation includes the PCB layout of the Arduino UNO, the buzzer circuit and the controller circuit.
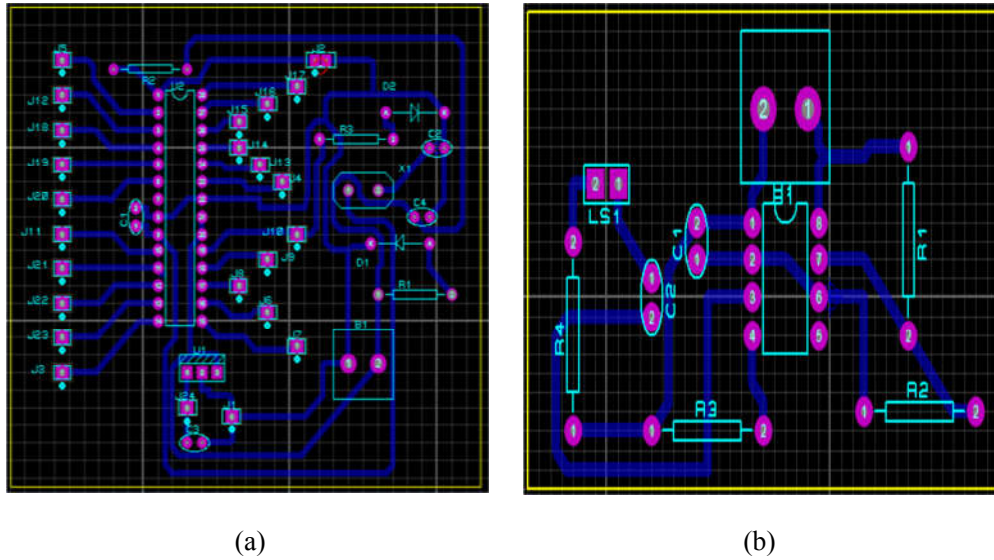

(a)   (b)

Figure 5 (a) Arduino UNO PCB Layout (b) Buzzer PCB Layout

Figure 5(a) shows the Arduino UNO PCB layout designed using Proteus 8 software which is used to construct the PCB board. Figure 5(b) shows the PCB layout of the buzzer circuit. The PCB layout of the controller circuit constructed using Proteus 8 software is shown in Figure 6 (a). The completed Arduino and controller circuit are shown in Figure 6(b). Figure 7 shows the completed buzzer circuit on PCB board.
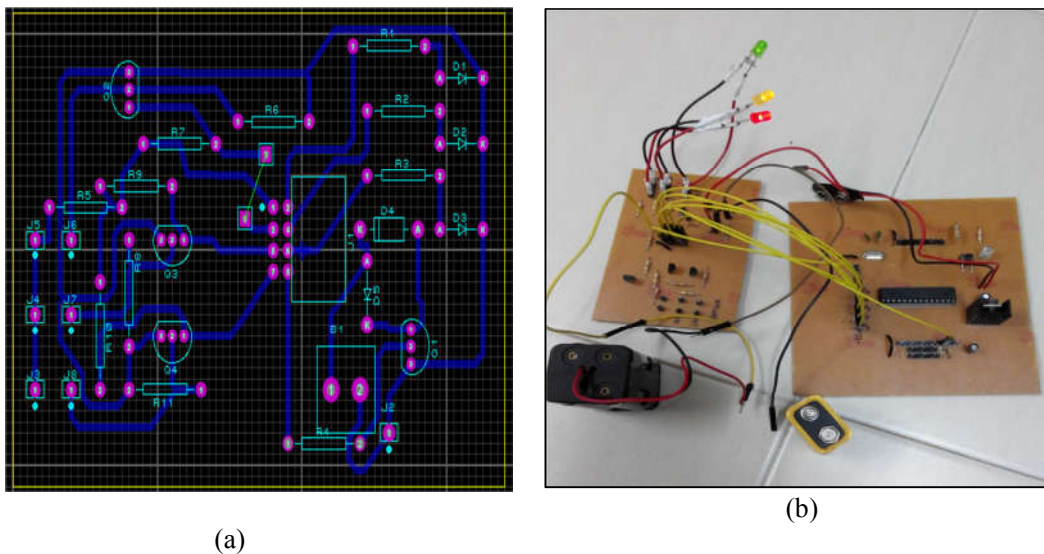

(b)

(a)

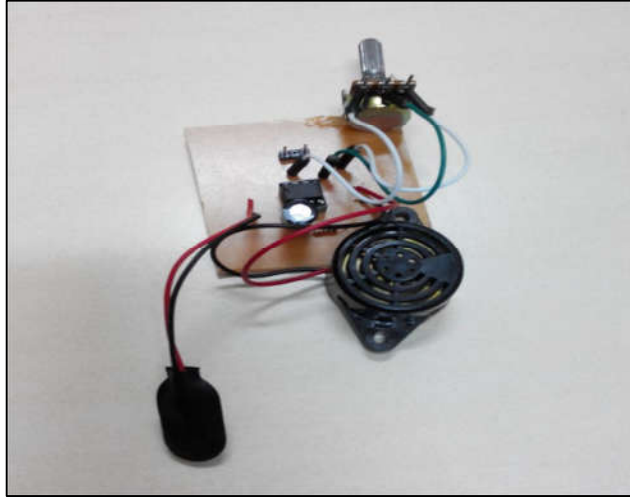**Figure 6 (a) Controller PCB Layout (b) Arduino and Controller Circuit**

Figure 7 Buzzer Circuit

4.0   RESULT AND DISCUSSION

This chapter presents the results obtained from the simulation and experimental verification. All the results are discussed and explained. The results are tabulated and compared.

4.1   Output Voltage for LED

Table 1 shows the output voltage measured at the LED. The results obtained are compared between the measured value of the simulation and the value measured from the hardware implementation set up.

Table 1 Output Voltage for LED

Condition Of Water Level	Red Led	Yellow Led	Green Led	Sim. Value (V)	Exp. Value (V)	Valve Output
LOW	0	0	1	2.213	2.119	(OFF) 0V
AVERAGE	0	1	0	2.213	2.201	(OFF) 0V
HIGH	1	0	0	2.213	2.14	(ON) 4.877V

Based on the simulation circuit constructed in Proteus 8 software, the result obtained from the valve circuit simulation shows that when the water level is at HIGH level, the red LED would lighten up and continuously turned ON the buzzer. The valve is opened and allowed the overflow water to be drained out until the AVERAGE level is reached. As for the motor circuit simulation, the voltage supply has to be in between 4V to 5V in order to enable the motor circuit. The experimental results obtained are nearly accurate as compared to the simulation results measured. Hence, it shows that the hardware implementation is successful. At LOW level, the output voltage obtained in the simulation is 2.213V while the output voltage obtained from the experiment is 2.119V. As for the AVERAGE level, the simulation measurement is 2.213V while the experimental measurement is 2.201V. The output voltage at the HIGH level is 2.213V in the simulation while the experiment is 2.14V.

4.2   Output Voltage for Buzer

Table 2 shows the output voltage measured at the buzzer comparing the simulation and experimental measurement.

Table 2 Voltage Output for Buzzer

Condition Of Water Level	Buzzer	Simulation Value (V)	Experimental Value (V)
LOW	OFF	0	0.016m
AVERAGE	OFF	0	0.127m
HIGH	ON	2.30	2.16

The output voltage of the IC Timer circuit simulation is measured and tabulated. A 5V DC supply is used in the simulation and when the buzzer is ON, the voltage output obtained is in between 3-4V. The results obtained from the hardware implementation show the output voltage of 0.016mV for LOW level, 0.127mV for the AVERAGE level and 2.16V for the HIGH level. As the output voltage in the simulation are 0V, 0V and 2.30V for LOW, AVERAGE and HIGH level respectively. The simulation results are successfully verified by the experimental set up.

4.3   Prototype Design

The prototype is designed as shown in Figure 8. An aquarium is used to resemble the reservoir and all circuits are connected together. The circuits are placed outside the aquarium due to the non water-resistant characteristics.
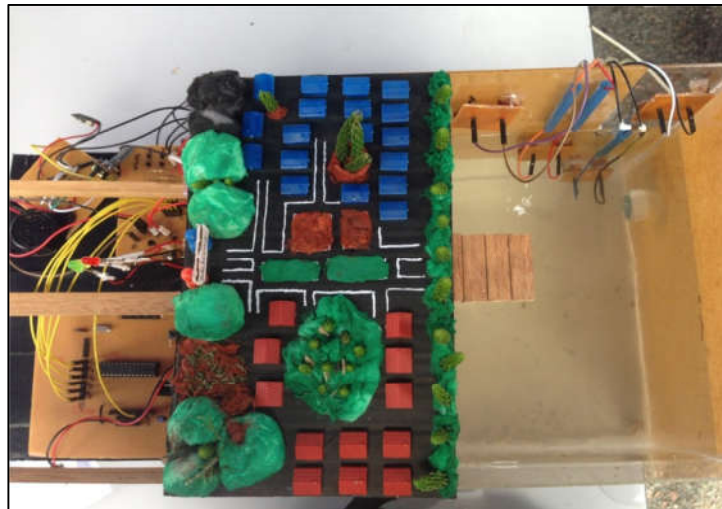

Figure 8 DCOTECH Water Level System Prototype

The DCOTECH water level system prototype has successfully operated as expected. All the LEDs turned ON as programmed. The buzzer circuit has functioned well to represent the alarm system.

5.0   CONCLUSION AND FUTURE RECOMMENDATION

The DCOTECH water level system is designed as a solution for pre-disaster action to be taken before the floods take place. It could help to reduce the loss of belonging incurred by the residents due to the impact of flood disaster. The DCOTECH also helps the drainage system to be more systematic because it controls the water level from being overflowed. The reservoir provided could prevent and lower the risk of floods. The alarm system of the DCOTECH is significant for the residents to be more prepared whenever flood is approaching the area. The DCOTECH water level system prototype implemented in this project is successful and met the expectation. The water level control system works as expected. The green, yellow and red LEDs are turned ON whenever the respective water levels are reached. The buzzer circuit has functioned accordingly which symbolizes the flood warning system.

In future work, this project can be improved by implementing different methods and operations because it is a general project which can be applied in different places and situations. Firstly, this project can be carried out using Programmable Logic Controller (PLC) which is suitable for real-time application. Besides that, this project can be realized in bigger scale that could be commercialised to authorities and implemented in residential areas. Last but not least, this project can be improved by adding the water-resistant characteristic to prolong its lifetime.

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