# UNIVERSITI TEKNIKAL MALAYSIA MELAKA

## Development of An Educational Quiz Kit that Test Student Knowledge on Control System's Second Order Transient Response by using DC Motor Speed Control as Application (Transient Response Quiz Box)

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Electronic Engineering Technology (Industrial Power) with Honours.

by

**MUHAMMAD FARHAN ZUHAILI BIN MOHD ZAKARIA**
**B071410827**
**920726-14-5121**

FACULTY OF ENGINEERING TECHNOLOGY
2017

© Universiti Teknikal Malaysia Melaka

# UNIVERSITI TEKNIKAL MALAYSIA MELAKA

## BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

TAJUK: **Development of An Educational Quiz Kit that Test Student Knowledge on Control System's Second Order Transient Response by using DC Motor Speed Control as Application**

SESI PENGAJIAN: **2017/18 Semester 1**

Saya **MUHAMMAD FARHAN ZUHAILI BIN MOHD ZAKARIA**

mengaku membenarkan Laporan PSM ini disimpan di Perpustakaan Universiti Teknikal Malaysia Melaka (UTeM) dengan syarat-syarat kegunaan seperti berikut:

1. Laporan PSM adalah hak milik Universiti Teknikal Malaysia Melaka dan penulis.
2. Perpustakaan Universiti Teknikal Malaysia Melaka dibenarkan membuat salinan untuk tujuan pengajian sahaja dengan izin penulis.
3. Perpustakaan dibenarkan membuat salinan laporan PSM ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. **Sila tandakan (✓)

| | | |
|---|---|---|
| ☐ | SULIT | (Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia sebagaimana yang termaktub dalam AKTA RAHSIA RASMI 1972) |
| ☐ | TERHAD | (Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan) |
| ☐ | TIDAK TERHAD | |

Disahkan oleh:

_____ _____

Alamat Tetap:

N0 39, JALAN SATU,
KAMPUNG PANDAN,
55100 KUALA LUMPUR,
W.P KUALA LUMPUR.

Cop Rasmi:

Tarikh: _____

** Jika Laporan PSM ini SULIT atau TERHAD, sila lampirkan surat daripada pihak berkuasa/organisasi berkenaan dengan menyatakan sekali sebab dan tempoh laporan PSM ini perlu dikelaskan sebagai SULIT atau TERHAD.

© Universiti Teknikal Malaysia Melaka

# DECLARATION

I hereby, declared this report entitled "Development of An Educational Quiz Kit that Test Student Knowledge on Control System's Second Order Transient Response by using DC Motor Speed Control as Application" is the results of my own research except as cited in references.

| | | |
|---|---|---|
| Signature | : | ……. |
| Author's Name | : | MUHAMMAD FARHAN ZUHAILI |
| Date | : | …… |



© Universiti Teknikal Malaysia Melaka

# APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Electronic Engineering Technology (Industrial Electronics) (Hons.). The member of the supervisory is as follow:

……

(Amar Faiz Bin Zainal Abidin)



© Universiti Teknikal Malaysia Melaka

# ABSTRACT

Control principle are one of the subject available at UTeM. Unfortunately, many students having problem to understand and imagine the output from the equation given. Moreover, it is better for student to learn by having hands-on experience such as having an experiment in their laboratory session. The problem is in lab session student facing difficulties to practice proficiently due to lack of time. The objective of this project is to design a proof of concept of an electronic educational kit hardware that can help the student to get exposed with control system knowledge which require no supervision from the teacher, to build the proof of concept of the compatible (21x28 cm box which can be store in a bag and carry it anywhere) low cost (less than RM350) educational kit that using Arduino Mega as the controller, to verify the functionality of the educational kit by performing a set of system testing which will be based on a checklist, and to validate the effectiveness of the educational kit in aiding students learning control system by giving quiz to the target audience (UTeM students). A questionnaire will be use to measure the effectiveness. The project uses Arduino Mega as controller, DC motor for generate rpm, encoder to count the rpm, TFT LCD to display the graph, 20x4 LCD to display the question and 4x4 keypad for the user to insert the answer for the question. A survey consists of nine questions was done among the student and lecturer to verify whether the educational quiz kit is effective toward students to overcome the control system. The result indicates that the educational quiz kit proved to be effective by the positive feedback provide by the students and lecturer



© Universiti Teknikal Malaysia Melaka

# DEDICATION

Special dedicated to my beloved parents, my father Mohd Zakaria bin Mohd Zain and my mother Rosliza binti Mohamed, family members and friends.



© Universiti Teknikal Malaysia Melaka

# ACKNOWLEDGEMENT

Bismillahirrahmanirrahim,

Alhamdulillah. Thanks to Allah SWT, who with His willing give me the opportunity to complete Bachelor Degree Project with title "Development of An Educational Quiz Kit that Test Student Knowledge on Control System's Second Order Transient Response by using DC Motor Speed Control as Application". This bachelor degree project was prepared for Universiti Teknikal Malaysia Melaka (UTeM), basically for student in final year to complete the undergraduate program that leads to the degree of Bachelor of Electronics Engineering Technology (Industrial Electronics) (Hons.). This report is based on the methods given by the university.

Firstly, a million thanks to Amar Faiz Bin Zainal Abidin, a lecturer at Faculty of Engineering Technology and also assign, as my supervisor who had guided me a lot of task during this semester. I also would like to express my deepest thanks and appreciation to my parents, family, special mate of mine and others for their cooperation, encouragement, constructive suggestion and full of support for the report completion, from the beginning until the end of this Bachelor Degree Project. Also, deepest thanks to all of my friends and everyone, that has been contributed by supporting my work and helps myself during the Bachelor Degree Project until its fully completed.

Last but not least, million thanks to Faculty of Engineering Technology (UTeM) for great commitment and cooperation during my Bachelor Degree Project.



© Universiti Teknikal Malaysia Melaka

# TABLE OF CONTENT





© Universiti Teknikal Malaysia Melaka

© Universiti Teknikal Malaysia Melaka

**APPENDICES**





© Universiti Teknikal Malaysia Melaka

# LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

| | | |
|---|---|---|
| IDE | - | Integrated Development Environment |
| I/O | - | Input Output |
| SSID | - | Short set identifier |
| LED | - | Light Emitting Diode |
| LCD | - | Liquid Crystal Display |
| IR | - | Infrared |
| PWM | - | Pulse-Width Modulation |
| USB | - | Universal Serial Bus |
| CLK | - | Clock |
| V | - | Voltage |
| MHz | - | Mega Hertz |
| KB | - | Kilo Bytes |
| PC | - | Personal Computer |
| PIC | - | Peripheral Interface Controller |
| GND | - | Ground |
| TFT | - | Thin-film transistor |
| PCB | - | Printed Circuit Board |
| RPM | - | Rotation per minutes |
| DAQ | - | Data acquisition |
| I2C | - | Inter-integrated Circuit ($I^2C$) |
| TCK | - | Temperature Control Kit |



© Universiti Teknikal Malaysia Melaka

# CHAPTER 1

# INTRODUCTION

## 1.0 Introduction

The aim of this chapter is to create framework of this project. It contains detail of the project requirement. The background of this project will be explained briefly.

In this chapter, the topic that will be cover for this project is problem statement, objective, scope of work and project contribution.

## 1.1 Project Background

According to Ashaari (1999), educational kit is another alternative that used by lecture to teach student. Educational kit also defines as an equipment that used in teaching that act as an introduction of the hands on for the student in their learning session.

According to Udey (2009), "To control means to regulated, to direct or to command. Hence a control system is an arrangement of different physical element connected in such a manner to regulate, direct or command itself or some other system." Control system consist of subsystem and process assemble for controlling the output of processes purpose. Control system are dynamic: they response to an input by undergoing a transient response before reaching steady-state response which generally resemble the input.



© Universiti Teknikal Malaysia Melaka

Transient Response Quiz box is a trainer kit that test student understanding in control principle subject but just focus in second order transient response. This trainer kit will generate a graph and ask the user question about transient response based on the graph. Student is required to key in their answer and the trainer kit will check the answer given. Once user finished answer all the question, the trainer kit will display the score.

## 1.2 Problem Statement

In Universiti Teknikal Malaysia Melaka (UTeM), Control Principle subject will focus to student electric and electronic engineering. For this subject student will learn in theoretically and practically. For theoretical student will learn in lecture and tutorial but for practical student will learn in lab session.

During lecture, it will be held in a hall with a lot of students. Power Point slide will use to display the lecture note for this subject. Lecturer will explain that slide to student by theoretically. Not all student can stay focus in class like this, some student will feel bored and sleepy.

After each chapter finish covered, lecturer will have prepared some exercise for student. Student need to answer all questions and it will be discussed during tutorial session. During tutorial session, not all student will understand that chapter because majority lecturer only calls one student to solve one of the question and another student to solve another question. Furthermore, student just understand theoretical but do not know application for that chapter.

During the lab session, lab sheet already provided the procedure for the experiment. Moreover, lab session can only be conduct if there is a lecturer guide. If lecturer take emergency leave the lab session cannot be conduct. So, the weakness of this lab session



© Universiti Teknikal Malaysia Melaka

is student need the procedure to do that lab assessment. It cannot be done if that lab assessment does not have the procedure. Students also need a lecturer to guide them to make that assessment.

## 1.3 Objectives

The primary objective of this project is to purpose the development of an electronic educational quiz kit based on control system second order transient response by using DC motor speed control application. At the end of this project, the objective that are going to be archive are:

1. To design a proof of concept of an electronic educational kit hardware that can help the student to get exposed with control system knowledge which require no supervision from the teacher.

2. To build the proof of concept of the compatible (21x28 cm box which can be store in a bag and carry it anywhere) low cost (less than RM350) educational kit that using Arduino Mega as the controller.

3. To verify the functionality of the educational kit by performing a set of system testing which will be based on a checklist.

4. To validate the effectiveness of the educational kit in aiding students learning control system by giving quiz to the target audience (UTeM students). A questionnaire will be use to measure the effectiveness.



© Universiti Teknikal Malaysia Melaka

## 1.4 Scope of Work

In designing Transient Response Quiz box this project had limited certain criteria such as the maximum number of the dc motor RPM value. For starting it will only cover until 2000 RPM. This LCD will display question and answer based on graph generated on TFT LCD. I use the LCD to display the question and answer because the graph will be small if the question and answer display on the TFT LCD. As for the question set, this quiz box has 3 difficulty choice that is easy, medium and hard. Each set has four question that cover the topic of control principle second order transient response.

There is limitation in designing the external hardware. For hardware casing 8x10x4" project box was used because this box lightweight. This size are enough to represent the idea of this Final Year Project (FYP). This casing also can reduce cost to finish this project.

The circuit design and simulation also facing some limitation where certain component such Arduino and TFT 2.4" LCD display do not available in simulation. So, the connection from Arduino are done by using jumper wire without circuit design in software. Arduino Mega was used as a controller. Arduino is a complete development platform with its own standards, integrated development environment and programming interface. The reason for choosing Arduino Mega is because this Arduino have more pin compared with Arduino Uno. Arduino Mega has 54 digital input /output pin but for Arduino Uno just only has 14 digital input/output pin. This is because only TFT LCD 2.4" need 28 pin input/output. I also will be using I2C 1602 LCD to reduce the pins use for the input output.



© Universiti Teknikal Malaysia Melaka

## 1.5 Project Contribution

The project is about learning and understanding the basic of Control System. The students can apply the theory of control system on this educational kit.

This project can help student to understand a lot more about control system especially about transient response due to the lack of knowledge in class. Students will not feel bored if they understand this project instead they want to try another question.

This educational kit helps student to comprehend the application of control system for all intents and purposes. Students can understand about the control system by the application from this educational kit.

This educational kit will create a few questions concerning transient response and user will answer the question asked. This project will help student to comprehend the control system based on the questions asked, the data given and the displayed graph.



© Universiti Teknikal Malaysia Melaka

# CHAPTER 2

# LITERATURE REVIEW

## 2.0 Introduction

Literature review is an essential part before beginning any project. It provides all required data that related to the project and based on that, the correct direction in developing the project can be performed proficiently.

In this chapter, topic that will be explained are equipment and hardware that going to be implemented and previous related work.

## 2.1 Past Related Research

The research that will focus on each product and equipment that used to build up this venture. The source of these inquiries about must be satisfactory in the system format, for example, books, journals, articles and website that are authorized.

### 2.1.1 Educational Kit Using Robotic

Educational kit using robotic is a Java™ program executing robotics controller that enables your robot to function independently, analyzing input



© Universiti Teknikal Malaysia Melaka

from your robot's sensors, and controlling your robot's motors. In year 2009 RidgeSoft (2009), RidgeSoft™ provide education robotic platform for improving teaching-learning processes of technology in developing countries, the product is known as IntelliBrain™ Bot Deluxe. For this product, it was sold in two states in which $459 for assembled and $439 for unassembled. This product is used in education for embeded system or computer interfacing which are using java programming.

By creating and loading different programs you can program your robot to perform an extensive variety of functions.

Table 2.1: IntelliBrain-Bot Demo Program Functions (RidgeSoft, 2009)

| Function | Description |
|---|---|
| Do Nothing | Your robot does not attempt to move. This enables you to test the sensors while your robot stays stationary. You will find this is to a great degree helpful for troubleshooting sensor issues. |
| Play Tune | Plays Beethoven's Ode to Joy on the buzzer. |
| Remote Control | Enables you to remotely control your robot using a Sony compatible infrared remote control. Utilize the channel up button to advance your robot, the channel down button to move it in reverse, the volume up button to pivot right and the volume down button to pivot left. (Requires a Sony compatible infrared remote control. Most all-inclusive remote controls will work if programmed for a Sony TV.) |
| Navigate Forward | Uses wheel encoder sensors and route classes (given in the RoboJDE class library) to navigate your robot straight ahead 24 inches. |



© Universiti Teknikal Malaysia Melaka

| | |
|---|---|
| Rotate 180 | Uses wheel encoder sensors and route classes to turn your robot set up 180 degrees. |
| Navigate Square | Uses wheel encoder sensors and route classes to navigate your robot around a 16-inch square. |
| Random Dance | Uses programming created random numbers to play out a "move" consisting of random movements. |
| Follow Line | Uses line sensors to enable your robot to follow a dark line on a white surface. |
| Avoid Obstacles | Uses wheel encoder sensors, route classes, and infrared range sensors to navigate your robot 24 inches forward then back to where it began, dodging obstacles along the way. |
| Follow Object | Uses the ultrasonic range sensor to keep up a separation of 6 inches from an object before your robot, creating a "tractor shaft" effect. |

The advantage of this project compare to Transient Response Quiz Box is, it helps the user understand and witnesses what will happen when the programming they made applied to the robot meanwhile Transient Response Quiz Box only interact with the user by showing question, check the answer given and display the score. The disadvantages of this project is, it has too many component on it that cause the price is unaffordable for anyone to own it.



© Universiti Teknikal Malaysia Melaka

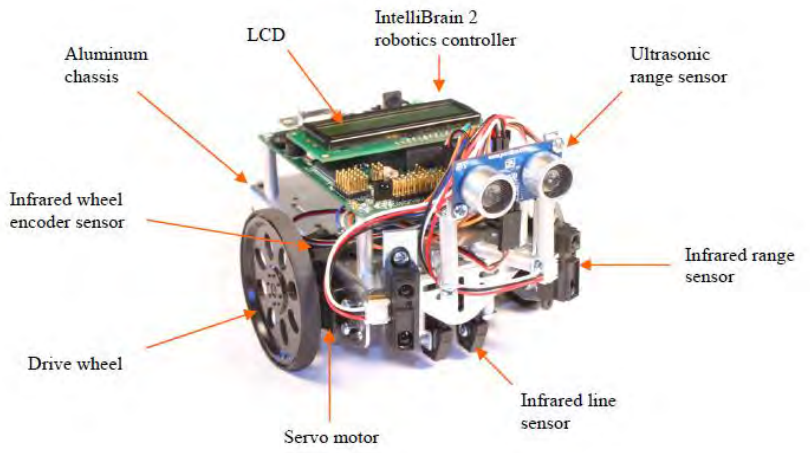


Figure 2.1: IntelliBrain-Bot Deluxe Robot (RidgeSoft, 2009)

### 2.1.2 Educational Kit for Learning Control System by Using Hot Air Blower

Educational Kit for Learning Control System is a quiz kit that used hot air blower as application to generate transient response by controlling the temperature blow from the hot air blower. M. Aideed and A.Ilham (2016) state that, these days many projects had utilized idea of educational toolkit for university and high school students to help them in their education. The cost for this project is RM 317 for one unit. This project is used in education for subject Control Principle which are learn by BETE course student during 4th semesters.

This educational kit will generate a few questions about transient response to test the knowledge of user. By controlling the temperature from the blower, a plot of graph will be generate based on the temperature value. Based on the graph generated, student should answer the question given by key in the answer using keypad and the kit will check the answer given.



© Universiti Teknikal Malaysia Melaka

The advantages of the project are, it used the temperature from hot air blower to generate the graph, so the programming is not so complicated as Transient Response Quiz Box where DC motor are used to generate the graph based on the speed value. In order to calculate the speed value, photoelectric speed sensor was used to count the RPM of the DC motor. The disadvantages of this project are, it consumes a lot of power in order to turn on the hot air blower. As for Transient Response Quiz Box, it used DC motor which only need 5v supply to turn it on.

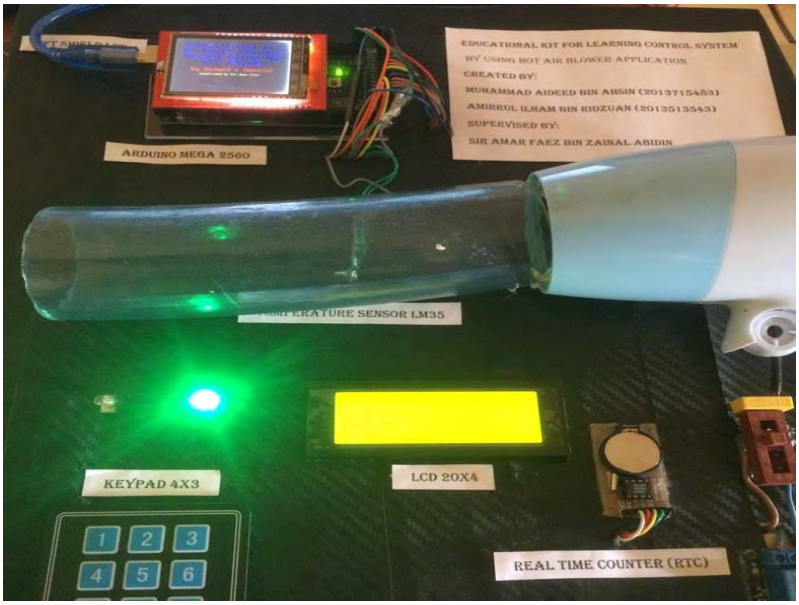


Figure 2.2: Educational Kit for Learning Control System Prototype (M. Aideed and A.Ilham, 2016)

### 2.1.3 e-Logic Gate Translator

The "e-Logic Gate Translator" is a device that created to be as a logic gate translator where it will translate the logic gate equation output into a truth table form. S.N Marcella and N. Umiza (2016) state there is an issue among student that



© Universiti Teknikal Malaysia Melaka

they couldn't comprehend the basics of logic gate circuit and how to control them by using it. The cost for one unit is RM 282. This project is used in education for subject Digital Electronic that was learn by student BETE during 3 semesters.

User have to make logic gate connection on the donut board, the truth table will be generated and Boolean equation, for example, Y = A + B + C will show up as the output result on a TFT LCD. It only provides AND, OR and NOT logic gates in this project. Even though not all type of logic gate provides on this device, there are 255 possibilities equation that are available with this device.

The advantages of this project are, it covers some of Digital Electronic syllabus which not cover by Transient Response Quiz Box. The disadvantages of this project are, it does not cover for Control Principle subject syllabus.

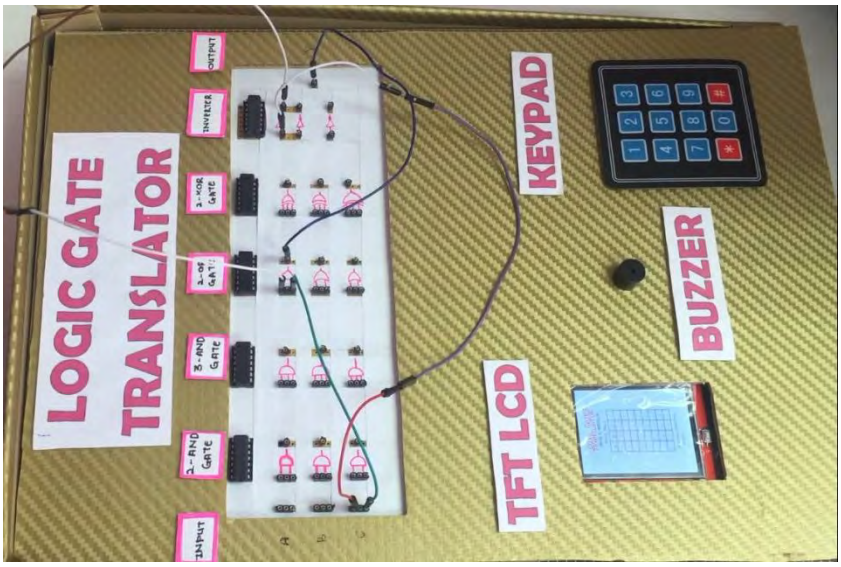


Figure 2.3: e-Logic Gate Translator Prototype (S.N Marcella and N. Umiza, 2016)



© Universiti Teknikal Malaysia Melaka

### 2.1.4 Teaching digital control using a low-cost microcontroller-based TCK

Temperature control kit is a device that based on PIC16F877 model microcontroller. According to Ibrahim (2003), "with the availability of low-cost computer and microcontrollers, digital control has gained popularity and most current control system are based on digital technique." The cost for the kit is around $200 where it is below the cost of other similar available educational temperature control kit. This kit only containing of low cost material which make so simple. There is a round plastic container that used to store the water and also immersed with it is the heater element and sensor.

The system used non-parametric modelling to identify the dynamic behavior by a reaction curve method. The feedback loop is open, and a step PWM input is applied to the heater driver by microcontroller. Then, the temperature of the water is measure and record for every second by connecting the sensor output to the voltage input of DrDaq hardware and Picolog software.

The advantages of this project are the kit is designed using a standard low-cost component which is easy to find and affordable. The disadvantages of this project are, it still need to be connect to other hardware and software which inconvenience to the user.



© Universiti Teknikal Malaysia Melaka

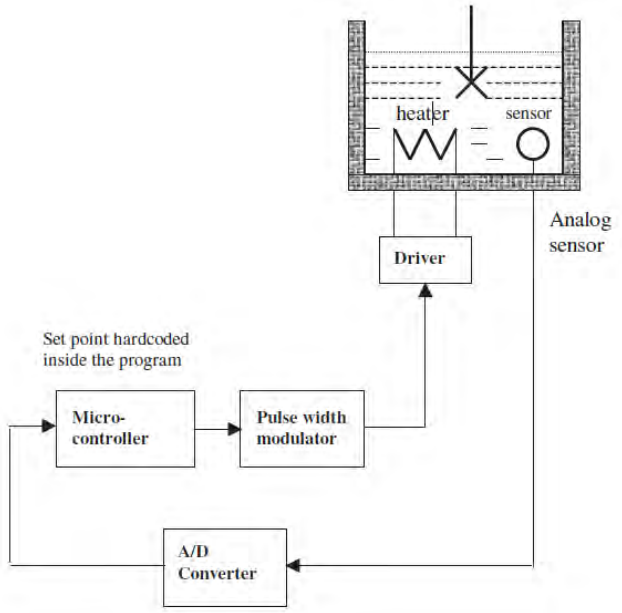


Figure 2.4: Block diagram of temperature control kit (Ibrahim, 2003)

## 2.2 Equipment and Hardware Used

### 2.2.1 Arduino MEGA 2560

According to Mellis (2011), "Arduino Mega 2560 is a microcontroller board based on the ATmega2560". This device has 54 digital input/output pins. Among the pins, there is 14 pins can be use as PWM output, 16 pins as analog input, 4 pins as UARTs ports and other 20 pins as digital input/output.

The purpose of choosing to use Arduino MEGA in this project is because this type of Arduino has more pins for input and output. For this project, it uses a lot of input and output pins, for TFT LCD there is 26 pins needed to operate it.



© Universiti Teknikal Malaysia Melaka