Development of arduino basic learning kit in robotics for beginner level learning

Tan Kooi Lim[*]**, Ahmad Zumali Mohammad and Mohd. Noor bin Ismail**

Department of Mathematics, Science and Computer, Polytechnic of Sultan Mizan Zainal Abidin, **MALAYSIA**

[*]Corresponding author: tankl@psmza.edu.my

Abstract—This Basic Arduino Learning Kit in Robotics is developed to help someone who wants to learn the basic concepts of Arduino and its operation in the field of robotics which is becoming increasingly important in our daily lives. This learning kit, it provides three practical works that allow students to deepen their knowledge of the Arduino Uno microcontroller in robotics step by step. In Practical Work 1, students are exposed to the experiment of lighting three LED lights with a pattern of running lights and flashing lights. In Practical Work 2, students are exposed to measurement work using an ultrasonic detector and displaying its reading on a computer screen and the screen of a mobile phone with the Android operating system via a Bluetooth module. In Practical Work 3, students are shown how to build a three-wheeled prototype robot and how to control the robot using a mobile phone with the Android operating system. The effectiveness of this learning kit has been tested in a learning workshop on 21 Pre-Diploma students of the Session of June 2020 Polytechnic of Sultan Mizan Zainal Abidin and has shown very encouraging feedback.

Keywords: *Arduino Basic Learning Kit, Robotics, Bluetooth module, a three-wheeled prototype robot*

I. INTRODUCTION

The use of robotics is increasingly popular among young people and has become an important technology in the development of the country. This can be seen when the use of robotics brings importance in various fields such as in the medical and military fields.

Figure 1. Robotic Technology Used in Diagnosing Cancer Cell Growth in the Lung

In medicine, one of the uses of robotics is to help doctors to analyze and diagnose various types of diseases in a patient's body, such as diagnosing the growth of cancer cells in the body of cancer patients. According to local news in the United States, M-Live Media Group, an international healthcare company, Spectrum Health, has completed diagnosing a total of 200 procedures of lung conditions at risk for cancer using robotic technology (Fisher, 2020).

In addition, the use of robotics also brings importance to the military field. This can be explained when robotic technology helps the military detect bombs, landmines, and so on. For example, TALON (*TALON Tracked Military Robot - Army Technology*, 2020)is an explosives detection robot developed by the QinetiQ company in North America that is capable of receiving and executing instructions to extinguish the explosives it detects. Although this robot was developed in the year 2000, it is still used today on the battlefield.

Figure 2. TALON Robot Detecting Explosives

Therefore, the objective of the development of this Arduino Basic Learning Kit in Robotics (Figure 3) is to help someone who wants to learn the basic concepts of Arduino and its operation in the field of robotics which is increasingly important in our daily lives, as well as to the engineering students who want to use Arduino equipment to build their study projects in the final year at their educational institution. In addition, this kit also aims to expose students and fans of electronic projects to the concept of wireless communication by using Bluetooth modules through the implemented practical works.

Figure 3. Arduino basic learning kit in robotics

II. LITERATURE REVIEW

To develop a robot that is smart and can be operated according to the user's commands, it needs to be equipped with a microcontroller that can be programmed as the main controller, which is like a brain to a robot. Therefore, to develop the Arduino Basic Learning Kit in Robotics, we have chosen the Arduino Uno microcontroller as the robot's central controller, and components such as Light Emitting Diode (LED), ultrasonic detector, and 4-6 volt direct current motor as input-output components to the kit. In addition, we also use the Bluetooth module in our learning kit so that all the performed practical works can be upgraded and can be controlled from a certain distance (maximum distance of 9 meters). Thus the concept of wireless communication which is becoming increasingly important in our daily lives this day can be adapted through practical works.
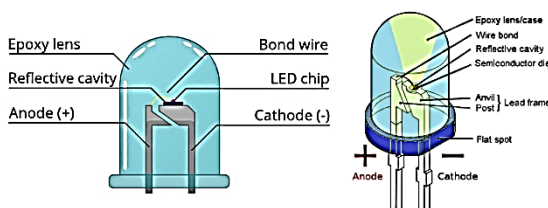

Figure 4. Light Emitting Diode and
The Specification (*Working Principle of Light Emitting Diode | Electrical4U*, 2020)

A. Arduino Uno Microcontroller

The Arduino Uno microcontroller is a microcontroller developed by the company Arduino. cc. This microcontroller is very famous nowadays in the field of robotic learning and is always being used to fabricate final year study projects by engineering students in any educational institution everywhere. It is easy to pick up the knowledge of the microcontroller and is suitable to be used by a student when they want to fabricate their final year study project. Here are the features and specifications of the Arduino Uno microcontroller (A. Aqeel, 2018):

Microcontroller	ATMega328
Operating Voltage	5 V
Input Voltage (recommended)	7 – 12 V
Input Voltage (limits)	6 – 20 V
Digital Input / Output 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

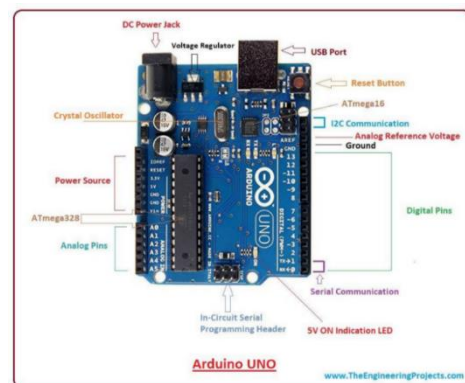Technical specifications of Arduino Uno board

Figure 5. Arduino Uno Microcontroller

B. Light Emitting Diode (LED)

The LED is an electronic light that is usually used in student electronics projects and it serves as an indicator/marker to an operation. When it is used in fabricating electronic projects, it needs to be connected with a resistor with a resistance of between 150 ohms to 1-kilo ohm to ensure that it does not exceed its load and is burnt out subsequently.
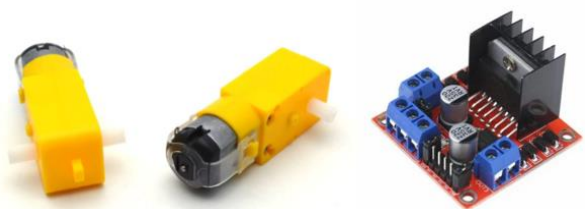

Figure 7. DC Motor and Motor Driver L298N(*Controlling DC Motors with Arduino | Arduino L298N Tutorial*, 2020)

C. Ultrasonic Detector

The SR04 ultrasonic detector is an electronic component commonly used to measure distances (maximum distance of 4 meters) in electronic projects. It uses the principle of ultrasonic wave reversal (more than 20 kHz) to measure the distance of an object from it (Last Minute Engineers 20 (Last Minute Engineers (*How HC-SR04 Ultrasonic Sensor Works & How to Interface It With Arduino*, 2020).

For example, an ultrasonic detector is placed facing an object whose distance is to be measured. At this moment the ultrasonic detector will emit ultrasonic waves at its transmitter (Tx) against the object. The emitted ultrasonic wave will be reflected when it is blocked by an object and the ultrasonic wave will be received back by the receiver (Rx). Thus the time taken for the ultrasonic waves to travel and with a known speed of sound (343 meters per second), will be channeled to the central processing section to carry out the analysis.
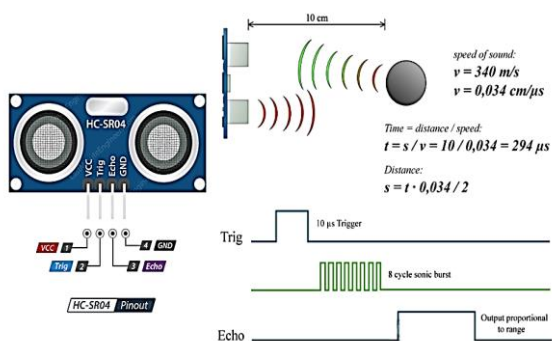

Figure 6. Ultrasonic Detector and its Operation

D. Direct Current Motor (DC Motor)

In the Arduino Basic Learning Kit in Robotics, there are two direct current motors used in practical work and they can operate at a supply voltage of 4 - 6 volts. It is used to build a three-wheeled prototype robot that can be controlled using a mobile phone with the Android operating system. A motor driver, the L298N as shown in Figure 7, should be used to drive the two direct current motors in the construction of the prototype robot and it should be supplied with a separated power supply.

E. Bluetooth Module

The Bluetooth module is also used in the practical work in the learning kit. The purpose of the Bluetooth module is implemented so that all the performed practical works can be controlled or monitored from a distance (maximum distance of 9 meters). The Bluetooth module used is HC-06 type

and it is very suitable to be used by students who want to learn the concept of wireless communication because the connection is very easy and the price is cheap. It can also be compatible with the Android operating system mobile phones that are now affordable for many students.

Figure 8. Bluetooth Module HC-06

III. METHODS

To achieve the development objectives of the kit, three practical works are introduced. It includes the installation of three LED lights and an ultrasonic detector to the Arduino Uno microcontroller (Practical Work 1 and Practical Work 2) and the construction of a three-wheeled prototype robot (Practical Work 3) that can be driven using two 5 volt direct current motors with controls from a distance.

A. Practical Work 1 – Lighting Three LEDs

In the practical work, students are provided with electronic components such as an Arduino Uno microcontroller, a piece of connection board (breadboard), three LED lights, and three resistors with 330 ohms and some wires. Students are shown circuit connections as in Figure 9. The completed circuit will be tested with a program that will be executed on the Arduino IDE software.
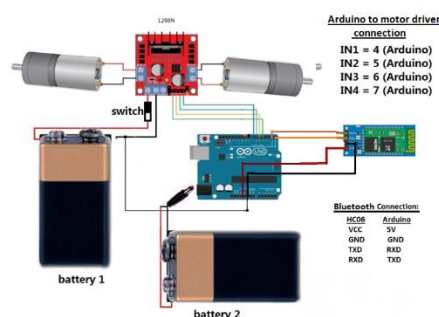

Figure 11. Three -Wheel Prototype Robot Connection (R. Chan, 2020)

B. Practical Work 2 - Measuring the Distance of an Obstacle

In this practical work, students are provided with an Arduino Uno microcontroller, an SR04 ultrasonic

detector, and an HC06 Bluetooth module. Students are shown the circuit connection as shown in Figure 10. The completed circuit will be tested with a program that will be executed on the Arduino IDE software. Students are also shown how to download the Bluetooth Electronics application from the Play Store on their mobile phone so that distance monitoring on an obstacle can be displayed on the screen of their mobile phone.
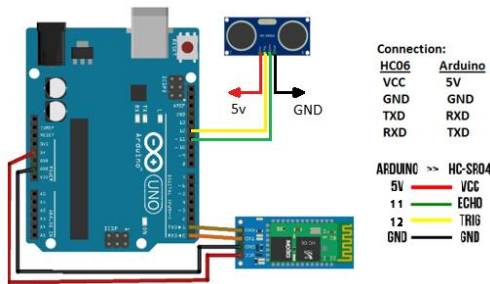

Figure 10. Ultrasonic Detector Connection and Bluetooth Module (Ultrasonic Distance Sensor Demo, 2020)

C. Practical Work 3 - Building a Three -Wheeled Prototype Robot

In the practical work, students are provided with the components of a set of three-wheeled prototype robot and the connection is as in Figure 11. Students are also shown how to assemble them. In addition, students will need to download the Car Bluetooth RC application from the Play Store on their respective mobile phone for movement control of the three-wheeled robot.
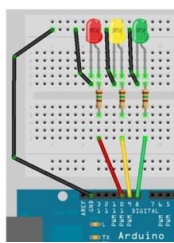

Figure 9. Connection of Three LEDs on Breadboard

IV. RESULTS

The following are the findings of the three practical works that have been implemented.

A. Practical Work 1 - Lighting Three LED Lights in a Running Light Pattern

To light up three LED lights in a running light pattern, a program as Figure 12 below is developed in the Arduino IDE software:
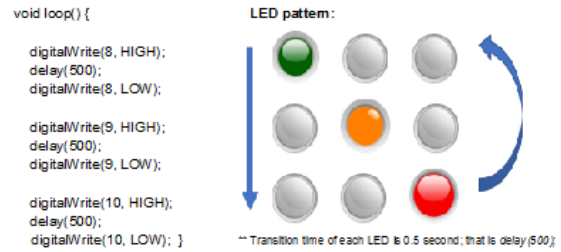

Figure 12. Three LED Lights in Running Pattern

B. Practical Work 2 - Distance Display of an Obstacle

To read the distance of an obstacle by an ultrasonic detector, the program [7] as in Figure 13 needs to be downloaded into the Arduino Uno microcontroller, and the findings are as follows:
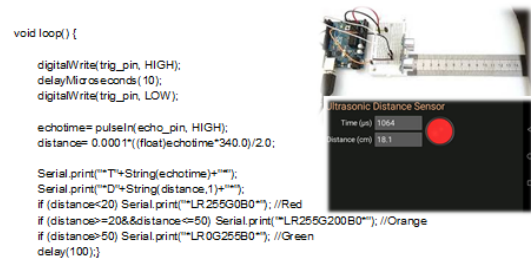

Figure 13. Reading and Distance Display on Mobile Phones

C. Practical Work 3 - Movement of a Controlled Three -Wheeled Prototype Robot

Figure 14 shows a complete assembled three - wheeled prototype robot and part of the program that moves the robot to left, right, forward or backward, depending on the button being pressed on a mobile phone with the Android operating system.
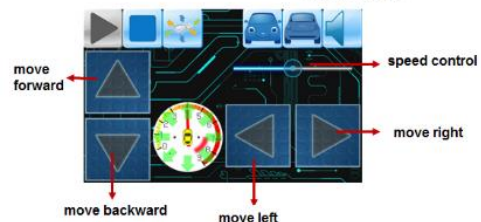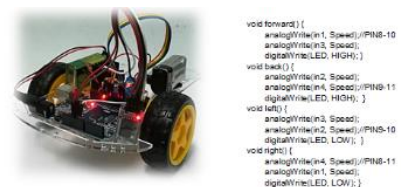

Figure 14. Picture of a Three -Wheel Prototype Robot and a Bluetooth RC Car Application

V. DISCUSSION

A workshop on the use of the Arduino Basic Learning Kit in Robotics has been conducted upon 21 Pre-Diploma students of the session of June 2020 Polytechnic of Sultan Mizan Zainal Abidin and very positive feedback has been given upon this learning kit. Figure 15 below are some questions that have been asked after the workshop and the feedback received from the attendants.
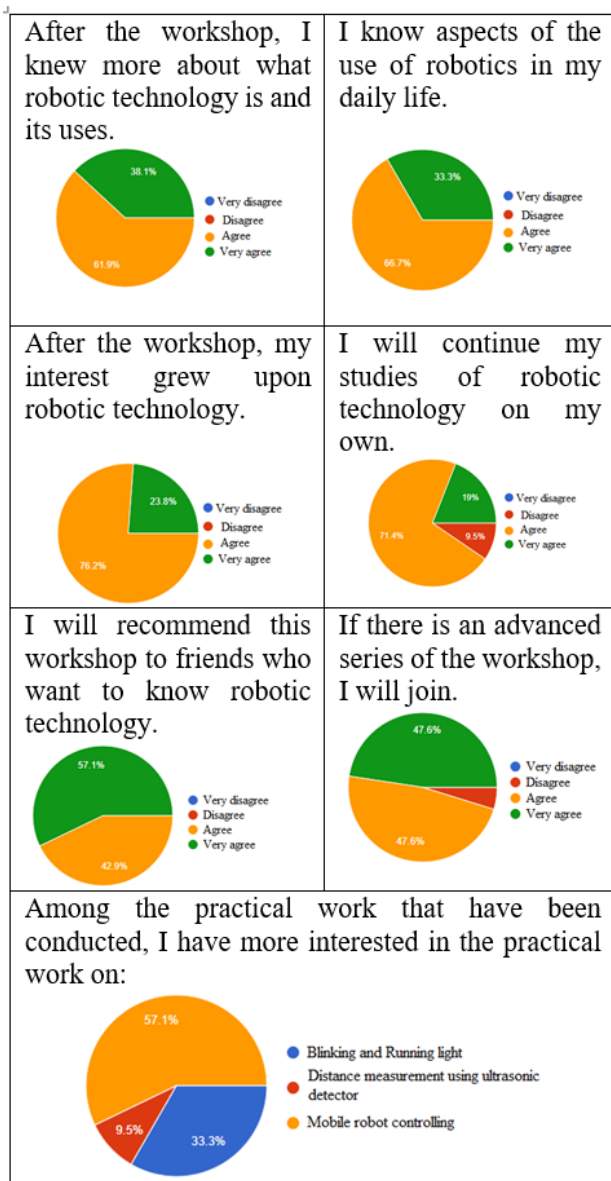

Figure 15. Feedback from 21 Students on the Learning Kit

VI. CONCLUSION

The Arduino Basic Learning Kit in Robotics has been successfully produced to help a student and enthusiast of electronic projects to understand and get involve into the robotic technology. The practical work produced in this kit is easy to understand and easy to follow by students and project enthusiasts even if one does not have in-depth knowledge and experience on robotics. The kit is expected to be used as a lifelong learning program and promoted to outsiders of our educational institution in the future.

REFERENCES

A. Aqeel. (2018, June 21). *Introduction To Arduino Uno*.Https://Www.Theengineeringprojects.Com.

Controlling DC Motors with Arduino | Arduino L298N Tutorial. (2020). Https://Electronicshobbyists.Com.

Fisher, J. (2020, October 13). *Spectrum Health completes 200th diagnostic procedure for lung conditions using robotic technology - mlive.com*.https://www.mlive.com/news/grand-rapids/2020/10/spectrum-health-completes-200th-diagnostic-procedure-for-lung-conditions-using-robotic-technology.html

How HC-SR04 Ultrasonic Sensor Works & How to Interface It With Arduino. (2020). Https://Lastminuteengineers.Com/. https://lastminuteengineers.com/arduino-sr04-ultrasonic-sensor-tutorial/

R. Chan. (2020, July 17). *How to use the L298N Motor*. Https://Create.Arduino.Cc.

TALON Tracked Military Robot - Army Technology. (2020, February 21). https://www.armytechnology.com/projects/talon-tracked-military-robot/

Ultrasonic Distance Sensor Demo. (2020). Https://Www.Keuwl.Com.

Working Principle of Light Emitting Diode | Electrical4U. (2020). https://www.electrical4u.com/working-principle-of-light-emitting-diode/