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Design and Develop a Wireless Control Motorized Stage Using Blynk

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Abstract: Motorized stage is generally a foundation to a certain application such as laser, CNC machine, 3D printing and microscope. Operational of CMS controlled by human can lead to human error and hazard while working. Application such as laser can be harmful to people that working in high power laser field. The hazardous of laser including handing the laser while micro-positioning the laser. WCMS consists of four main parts which are mechanical stage specifically rotational stage, motor driving circuit, software controller and interfacing devices. The rotational mechanical stage was designed and developed using 3D CAD and was printed using 3D printer. The material of rotational mechanical stage is PLA plastic. The motor driver for WCMS is L298N motor driver and was used NodeMCU 2688 microcontroller for the WCMS. The system was powered by 12V 3A power supply. A smartphone is used to control the WCMS using WIFI and Blynk application was used for the interface. In order to control the WCMS, programming codes were developed by using Arduino IDE and send wirelessly via WIFI to Blynk and NodeMCU microcontroller. WCMS can be operated anywhere as long as the smartphone and the WCMS is connected to internet. As stepper motor is move, the stage of WCMS also experiencing translation. As for 1, 5, 25, 50, 100 and 200 revolution per minutes, the time taken for stage is 70, 15, 3.7, 2.2, 1.3 second, respectively.

Keywords: Motorized Stage, Control System, Wireless, Stepper Motor, Arduino.

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1. Introduction

A motorized stage (MS) is used to precisely move and position an object along in a single axis or a multiple axis. MS is a moving platform and a stationary base connected by a bearing system and another option for MS is a belt-driven stage. MS is usually wired to the computer. However, MS is a device that used in industrial and scientific automated motion application [1]. Application of MS such as laser is being used in various of field of manufacturing process machining of engineering process [2]. since it has high power density, high directionality and better focusing characteristic that is useful material for machining process such as, machining, cutting, forming, joining, and drilling.

Wired motorized stage limit the user in term of mobility, damage, and expansion of the CMS. To operate the MS more safely and precisely, WCMS is a perfect option in order to conveniently and safely control the MS. WCMS is combination of electronic components with microcontroller NodeMCU, motor driver, stepper motor and mechanical stage. The wireless control eases the user to input the command for the CMS to move accordingly. As in micro-positioning, it refers to mechanical movement that can be controlled since it has high accuracy of positioning suitable for this application.

In this study, WCMS has the combination of mechanical stage, NodeMCU and Motor driver to operate. The mechanical stage is designed using 3D CAD and printed using 3D printer. It's made with strong and lightweight PLA plastic. Next is the NodeMCU, its is a microcontroller with build in Wi-Fi module. It can hold the command from Arduino IDE and send the data to the CMS.

Motor driver act as interfacing device within NodeMCU and stepper motor [3]. It acts as a controller to control the speed and direction of stepper motor. To control the CMS wirelessly, WIFI was used to connect WCMS to a smartphone, user able to control CMS from a distance wirelessly via smartphone. As long as the smartphone and the WCMS has connected to internet, user can control the CMS from anywhere.

2. Design of WCMS

Figure 1 shows the block diagram of interfacing circuit of WCMS. Controlled motorized stage, stepper motor and motor driver were integrated to NodeMCU board. Interfacing coding were developed to establish the interfacing circuit and as for controller, a smartphone will be used to control the CMS by connected to the Wi-Fi integrated microcontroller.

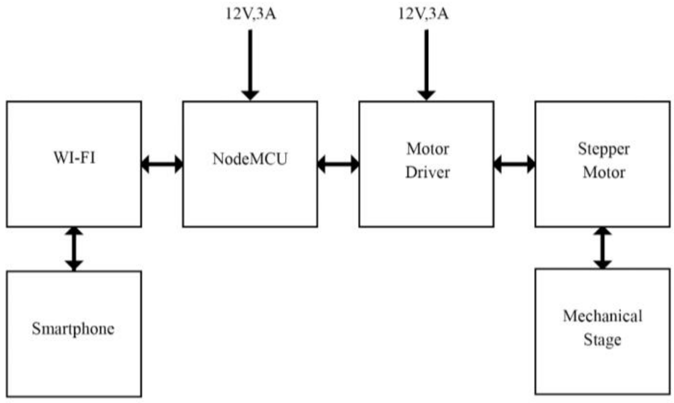

Figure 1: Block diagram of WCMS

3. Development of WCMS

WCMS is designed by integrating stepper motor into motor driver, motor driver to NodeMCU. Node MCU has a WIFI module integrated in the chip. While smartphone and NodeMCU is connected to the internet, NodeMCU will execute all the process and command written in Arduino IDE for WCMS to moves using smartphone.

Figure 2 show the schematic diagram of WCMS The four wired on the stepper motor was connected to OUT1, OUT2, OUT3 and OUT4 of L298N motor driver as an output for stepper motor to moved. Then, INPUT1, INPUT2, INPUT3 and INPUT4 of motor driver connected to pins 2, 3, 6 and 7 of NodeMCU. These input and output are important as to write and develop programming code in order to move the WCMS.

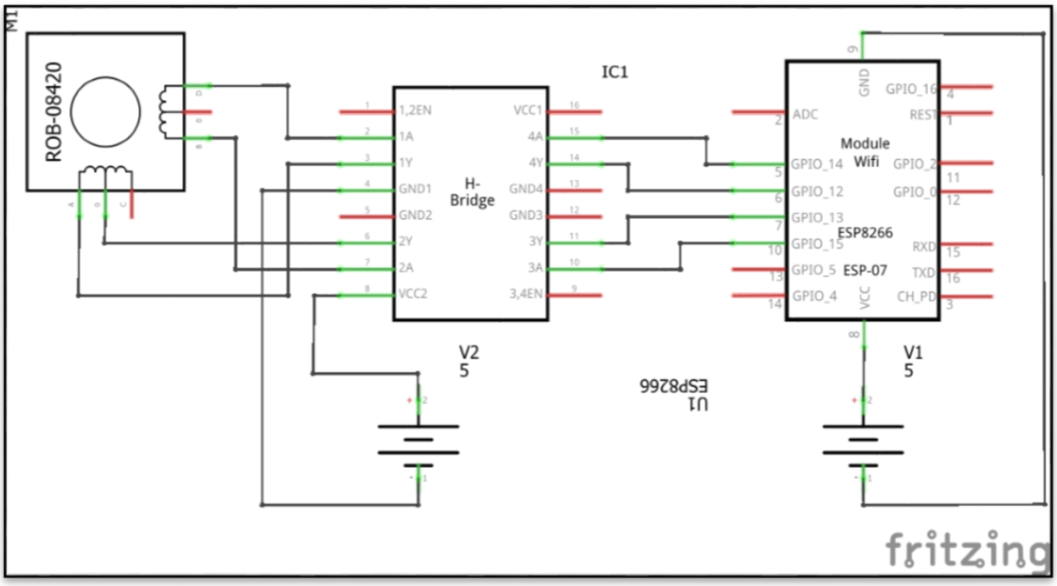

Figure 2 : schematic of WCMS

a. Design of mechanical stage

The rotational stage was designed using AutoCAD. There is 3 main parts of the mechanical stage. The base is 162.5 × 73.1 × 76.2mm while the 2 pully is 6.6 × 28.1 × 28.1 mm and finally the top plate is 76.2 × 57.1 × 76.2 mm. 12mm shaft rod is connected through pully to the top plate. 29cm close loop belt timing belt used to powered the top plate through the stepper motor. The mechanical stage was constructed using 3D printer because inexpensive and environmentally friendly. PLA plastic was the material of choices for the mechanical stage. This is because of the PLA plastic is inexpensive and have wide assortment of colours. figure 3 show the design of motorized stage. The WCMS use belt driven design because of its simplicity of the design. The MS use Timing belt and its can transmit power at a constant speed.

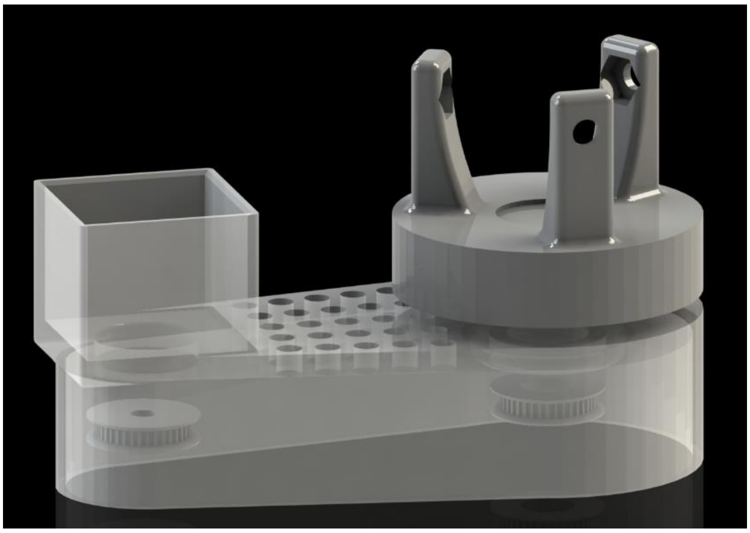

Figure 3: Design of motorized stage

b. Programming code of WCMS

Figure 4 shows programmed codes used to upload to the system of WCMS. To connect NodeMcu to the Blynk server, Blynk Authorization Token need to be created. Wifi ID and password are also need to be defined in the programming code. Next, the step per revolution need to be declared based of the stepper motor. before starting the program and Blynk. xVal value need to declare. This is for the Blynk to control the value of stepper motor. the program vas run on void loop. This means that the program will repeat itself when the program is running. the RPM of the WCMS can be change on the delay of stepper. Lower the delay, higher the RPM of the WCMS

```
#define BLYNK_PRINT Serial

#include <Stepper.h>

#include <ESP8266WiFi.h>

#include <BlynkSimpleEsp8266.h>



char auth[] = "Blynk Auth Token";

char ssid[] = "your ssid";

char pass[] = "wifi password";


const int stepsPerRevolution = 200;


Stepper myStepper(stepsPerRevolution,
14, 12, 13, 15);


int xVal=512;

void setup() {


   Serial.begin(9600);

   Blynk.begin(auth, ssid, pass);

}
```

```
void loop() {

  Blynk.run();

if( (xVal < 500)  ){

     myStepper.step(1);

     delayMicroseconds(3000);

  }else if( xVal > 550){

     myStepper.step(-1);

     delay (3000);

  }

}

BLYNK_WRITE(V1)

{

  xVal = param[0].asInt();

 // int y = param[1].asInt();

}
```

Figure 4: Programming code of WCMS

c. Software controller

Arduino IDE was used to developed programming code for the WCMS. Command was executed on the Arduino IDE and while Blynk and NodeMCU was connected to the Wi-Fi. Blynk application on the Smartphone can be used as an interfacing device to control the WCMS. Figure 5 show the interface of the Blynk when connected to the WCMS. The joystick able user to control WCMS left and right.

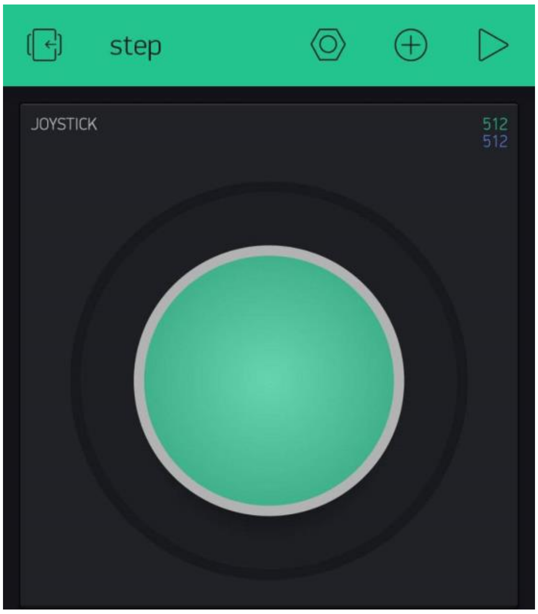

Figure 5: Interface of Blynk connected to the WCMS

d. Method of testing

WCMS was tested by setting the frequency on the code at the Arduino IDE. The delay on the programming code can be changed to increase or decrease the rotation per minute of the stepper motor. by changing the RPM, the WCMS can be tested for the accuracy. The user can control the WCMS by sliding the Blynk controller to the left or to the right. The time taken for the stage will be observed when the stage is completed full one rotation. Eye observation was the method of testing for the measurement of time for the WCMS. Figure 6 show the wireless control motorized stage.

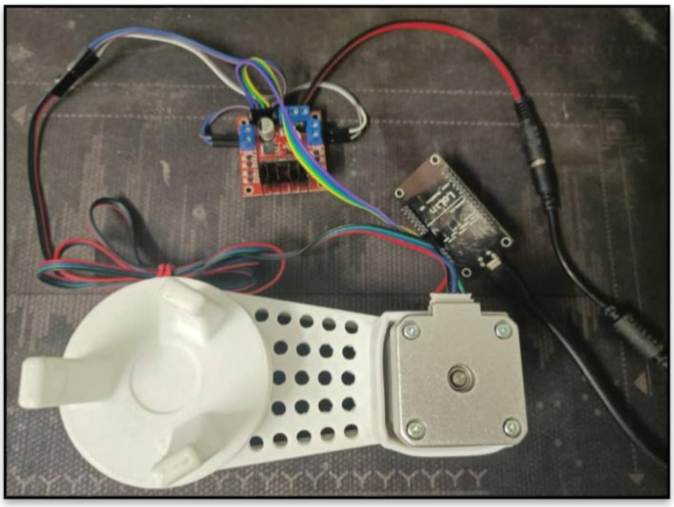

Figure 6: wireless control motorized stage

4. Result and Discussion

WCMS were tested in term of micro-precision and the performance of the WCMS at difference RPM. Stepper motor moves in discrete step and 200 steps will make a full one rotation of the stepper motor. the rotation of the stage for each step 1, 25, 50, 100, 125, 200 step are 1.7°, 40°, 85°, 170°, 255°, 340° respectively. Figure 7 shown the micro-rotation of the stage

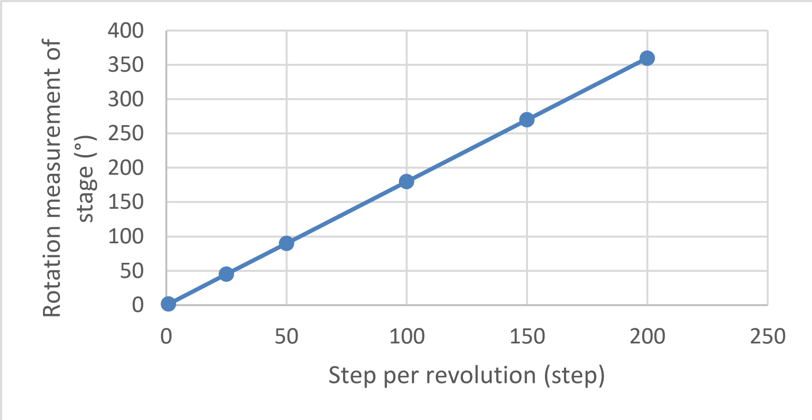

Figure 7: Graph of measurement movement of stage against steps per revolution

For the performance of the WCMS, the stage was tested in 1, 5, 25, 50 and 100 RPM for completing a full one rotation. the result for the stage is 70, 15, 3.7, 2.2, 1.3 second respectively. The time taken for the stepper motor to complete one rotation is 60, 12, 2.4, 1.2, 0.6 second respectively.

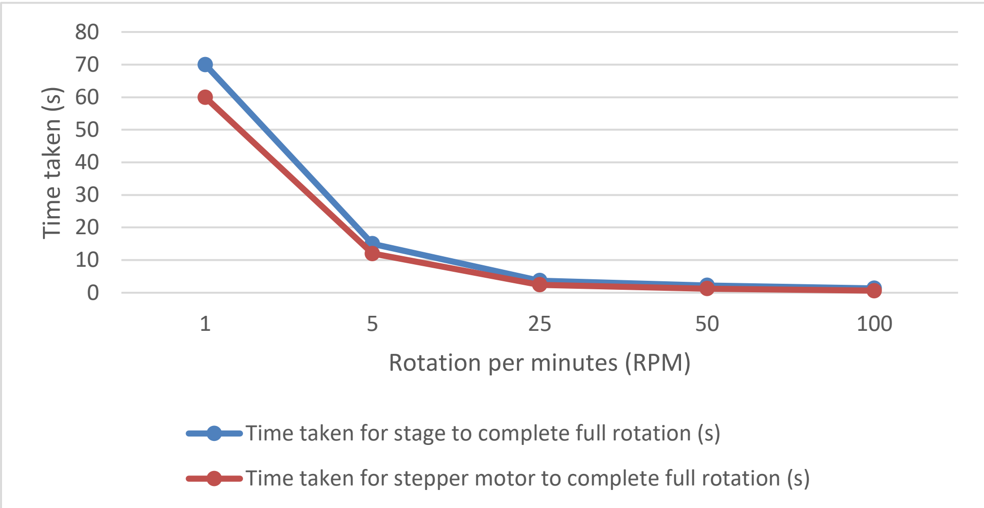

Figure 8: precision of WCMS

This trend shows that the gap between the stage and stepper motor is bigger at lower RPM. This is because of the stage suffer more belt slippage at lower rpm. Belt slippage happened because of the torque of the stepper motor is higher than friction availability on the pulley. Moreover, the imperfection tooth on the pulley because of 3D printing makes Belt slippage more frequent.

5. Conclusion

As a conclusion, WCMS were design and developed with NodeMCU, driver motor, stepper motor and rotational stage. The rotational stage was design and printed using 3D printer. WCMS was design for a simple rotational movement. The potential application of WCMS is metrology, micro-robotic, sensor testing, laser movement or anything that called for automated rotation. Blynk application is used to as an interface for controlling the WCSM using a smartphone. The stage moves accordingly to the user command. Because of WCMS was using WI-FI and the WI-FI server from Blynk. User able to control the stage rotation from anywhere in the world as long as the user have controller and Wi-Fi connection. Lastly, all the components were successfully integrated, the WCMS has been designed using 3D CAD, developed with Arduino IDE and constructed using a 3D printer.

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