Lab #3 – Robot Motion Control

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1. Exercise 1

1.1 Circuit:

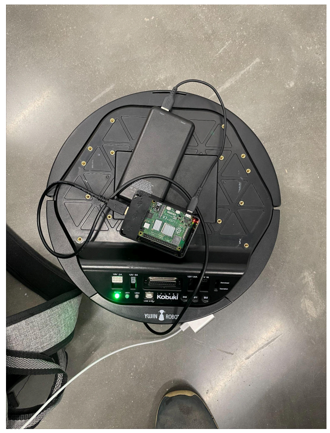

Figure 1.1.1 - Raspberry Pi Connected with Kobuki Robot

1.1 Summary:

In Exercise 1 we learned how to control the Kobuki Vacuum Robot using the Raspberry Pi. The objective of the exercise was to make the robot turn 90°, drive forward a designated distance of 50cm, and drive a quarter of the circle, with the turning radius being the same as the designated distance from earlier. This task was completed through serial communication with the Kobuki Robot and the RPi, using a set of 10-bytes to send one round of information to the Kobuki Robot.

2. Exercise 2.1

2.1 Circuit:

Figure 2.1.1 - Controller Connected to Raspberry Pi

2.1 Summary:

In Exercise 2, we learned how to take inputs from a Logitech controller and use those inputs to continuously move the robot. We used the D-pad for movement and used the start button for stopping movement. The Logitech select button was used to stop the communication of the Raspberry Pi to the Kobuki. We utilized the skills learned in Exercise 1 to move the Kobuki Robot. Once we received an input from the controller, we moved the robot with a set speed or radius, depending on the input. We took each input as on/off, where when the button is pressed it is at the maximum for that value. This will change in Bonus Exercise 2.

3. **Exercise 3.1**

3.1 Circuit:

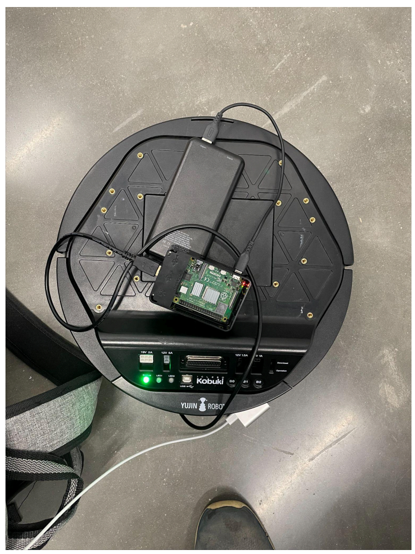

Figure 3.1.1 - Raspberry Pi Controlling Kobuki Robot as Server

3.1 Summary:

In Exercise 3, we worked with another team in the lab to set up a Client-Server system for controlling the Kobuki Robot. For our Exercise 3, we were the server side of the system. We learned how to wait for socket connections and receive inputs from the socket connection. Utilizing the knowledge learned in previous exercises, we used the inputs sent to us through the socket connection to move the robot as desired by the other team.

4. Bonus 1

<u>B.1 Circuit:</u>

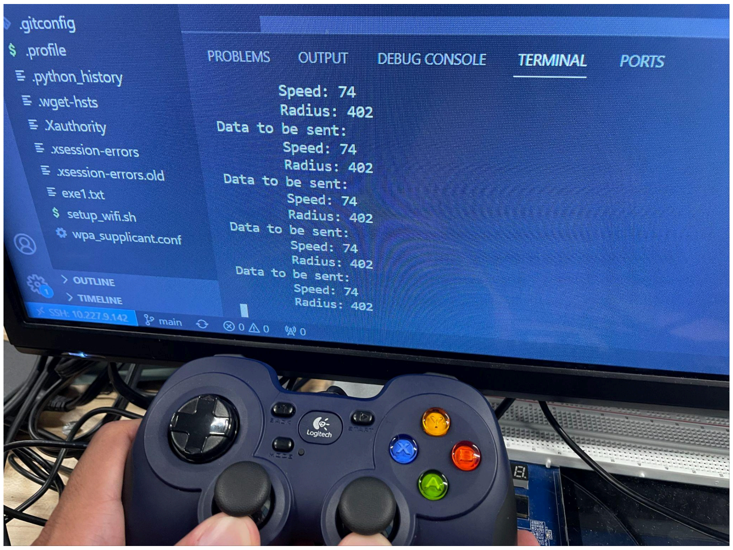

Figure B.1.1 - Raspberry Pi Sending Data to Client

<u>B.1 Summary:</u>

In Bonus Exercise 1, we switched roles with the other team, becoming the client side of the Client-Server system. We learned how to connect to the server side Raspberry Pi through socket connection. We then utilized what we learned about controller inputs to send the inputs of a controller to the server side robot.

5. Bonus 2

<u>B.2 Circuit:</u>

Figure B.2.1 - Radius Proportionally Changing Value with a Joystick

B.2 Summary:

In Bonus Exercise 2, we switched from using the D-pad on the controller to using the joy sticks. We switched the previous program to take in inputs from the joy sticks and converted the inputs, which ranged from 0 to 32767, to the desired range, either being 0 to 250 for speed or 0 to 500 for radius.

6. Supplemental Questions

1. Briefly summarize what you learned from this lab.

In this lab, we learned how to communicate and control a Kobuki Vacuum Robot using the Raspberry Pi. We used the serial communication standard for the Kobuki to transmit speed and radius commands to the Robot. We programmed it to take changing inputs from a Logitech controller, whether in an on/off configuration with the D-pad or in a proportional configuration with the joysticks. On top of all the previous, we learned how to communicate between two Raspberry Pi's over Wi-Fi using socket connections. We utilized this to become both a server and client in a Client-Server system that controls the Kobuki robot.

2. Explain the way the Kobuki's movement is controlled.

The Kobuki's movement is controlled through a serial communication set up with the Raspberry Pi. The Raspberry PI first converts the speed and radius desired to a value that the Kobuki can use to achieve the right results. Below is a given chart to show those conversions, where w is the rotation speed of the robot and b is the length between the center of the wheels.:

Motion	Speed(mm/s)	Radius(mm/s)
Pure Translation	Speed	0
Pure Rotation	w * b/2	1
Translation + Rotation	Speed * (Radius + b/2) / Radius, Radius > 1 Speed * (Radius - b/2) / Radius, Radius < -1	Radius

[1] *Kobuki Protocol Specification.pdf*

The Kobuki receives data through the serial communication of 10 bytes. The first two bytes are the header, where the first byte is fixed as 0xAA and the second byte is fixed as 0x55. The next bytes is the length of the payload, which for this lab was 0x06, or 6 bytes. The next six bytes are the payload, consisting of, in order, the identifier, size of data field, speed, and radius. The identifier and size of the data field are each 1 byte, being 0x01 and 0x04 for this lab, respectively. The speed and radius are each 2 bytes, being the conversion of the values in the table above into bytes. The final byte of the transmission is the checksum, being an XOR between all the previous bytes for error detection.

These bytes were each sent individually, one after another using the SerialPutchar method. In between each set of instructions, there is a 20ms delay as the Kobuki accepts these sets every 20ms.

<u>3. Explain the steps of a complete control request from the client to the server.</u>

At the start, the server starts its program, creating the socket connection for the client and begins checking for incoming data. The client side starts and connects with the server with their IP address using the socket connection. The client then sends the desired data using the send() function, specifying the socket to send to, the size of the data and the data itself. The server will then read that data using the recv() function, specifying the socket connection that was set up, the size of the desired data, and the data. That data is then used in whatever functionality is needed on the server side. The client side then closes the socket connection it made with the server. Once the server side detects the input from the socket to be nothing, it closes.

ACKNOWLEDGMENTS

I certify that this report is my/our own work, based on my/our personal study and/or research and that I/we have acknowledged all material and sources used in its preparation, whether they be books, articles, reports, lecture notes, and any other kind of document, electronic or person communication. I/We also certify that this assignment/report has not previously been submitted for assessment anywhere, except where permission has been granted from the coordinators involved.

Author-1 Signature ____________________

Author-2 Signature ____________________