ECEN 4213:
Embedded Computer System Design

Lab 3: Robot Motion Control

Ex #	Max Points	Points Earned	Grading Criteria	Instructor Initial
1	5		Program entered correctly, compiles, and runs as specified (5.0) _____	
2	5		Program entered correctly, compiles, and runs as specified (5.0) _____	
3	5		Program entered correctly, compiles, and runs as specified (5.0) _____	
BONUS 1	6		Program entered correctly, compiles, and runs as specified (6.0)_____	
BONUS 2	3		Program entered correctly, compiles, and runs as specified (3.0)_____	
Doc	2		Supplemental Questions (2.0)_____	
TOTAL:				

Team Members:	TA Observations:
_____	_____
_____	_____
_____	_____

OBJECTIVE

This lab will give students hands-on experience in using the Raspberry Pi to control the movement of the Kobuki, a wheeled mobile robot. The Raspberry Pi communicates with the Kobuki through serial communication. Students will also work on interfacing the Pi with a joystick to control Kobuki movement. Finally, students will create a client-server connection using Wi-Fi to control the Kobuki movement wirelessly.

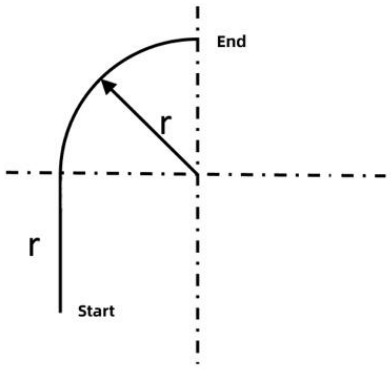
⚠**Warning!** Consult the lab TA before you connect the power to the RPi or any external hardware.

LIST OF DOCUMENTS USED IN THIS LAB

1. *Kobuki_User_Guide.pdf.*
2. *Kobuki Protocol Specification.pdf*
3. *Serial Library_Wiring Pi.pdf*
4. Socket programming: *https://beej.us/guide/bgnet/html/split/*

Exercise 1

1. Use serial communication to control the Kobuki. Do this by connecting one end of the USB cable to the Kobuki's serial port, and the other to one of the USB ports on the Raspberry Pi.
2. Study the lab supplement (*Serial Library _ Wiring Pi.pdf*) to understand the usage of the Wiring Pi serial library.
3. Complete the code given in **Lab3EX1.cpp** to control the movement of the Kobuki.
4. Write a program to move the Kobuki in the path shown below where the radius r is 50cm. The length of the straight line is the same as the radius. The distance between the two wheels of the Kobuki is 230 mm.



5. Demonstrate to the lab instructor.

Exercise 2

1. In this exercise you will interface the Pi with the joystick provided to you to control the Kobuki's movement.
2. Study the lab supplements (*joystick-api.txt* and *joystickInput.txt*) to understand the usage of the Logitech F310 gamepad.
3. Using **Lab3EX2.cpp**, write a program to control the Kobuki in the following ways:

D-Pad Up	= moves the Kobuki forward
D-Pad Down	= moves the Kobuki backward
D-Pad Right	= rotates the Kobuki 90° clockwise
D-Pad Left	= rotates the Kobuki 90° counterclockwise
Start	= stops the Kobuki
Logitech (Select)	= closes out of all connection cleanly

4. Compile and run your program. Make sure it works according to the specifications.
5. Demonstrate your program to the lab instructor.

Exercise 3

Exercise 3 contains two parts. Collaborate with another lab group to create a server and/or a client. You will write a client program which takes the joystick commands and sends them to the Kobuki using Wi-Fi. The server on the Kobuki accepts joystick commands and controls the Kobuki's movement accordingly. You will make use of the code you wrote in Exercises 1 and 2 to read the joystick and drive the Kobuki. To understand how a Wi-Fi server and a client work, study the lab supplement *SocketProgramming.pdf*. In this exercise, you are asked to implement either PART A or PART B. If a group implements both the client and server sides of **Exercise 3**, the group will get another 3 points, as shown in **Bonus.**

PART A (Wi-Fi Server)

1. Create a Wi-Fi Server program to receive drive commands from the client and move the Kobuki accordingly.
2. Work with another group to verify the format of commands being sent to the server.
3. Print the output to both terminal screens to verify the connection was created.
4. Make sure to cleanly close all connections at the end of the script. Not doing so will result in the need to restart the server and the Kobuki.
5. Demonstrate your program to the lab instructor.

PART B (Wi-Fi Client)

1. Create a Wi-Fi Client program to send drive commands to the server.
2. Work with another group to verify the format of commands being sent to the server.
3. Print the output to both terminal screens to verify the connection was created.
4. Demonstrate your program to the lab instructor.

Thoroughly comment your code. Make sure your name and the exercise number clearly appear in the comments.

Supplemental Questions

1. Briefly summarize what you learned from this lab.
2. Explain the way the Kobuki's movement is controlled.
3. Explain the steps of a complete control request from the client to the server.

Bonus Exercises

1. Use the joystick on the Logitech gamepad controller to variably control the movement of the Kobuki. The values of each joystick range from -32767 to 32767. Convert these values into a range the Kobuki can use. Use one joystick to control the speed of the Kobuki and the other joystick to control the radius. Thoroughly comment your code explaining any algorithm used and demonstrate to your instructor.
   If you implement the client or server side correctly, you will get 4 points. If you implement both the client and server sides, you will get 6 points totally.

2. If a group implements both client and server side of Exercise 3, the group will get another 3 points.

Submission

Submit your lab report through **Canvas**. Your lab report should include code, supplemental questions and answers of all exercises, along with the screenshots or pictures of the circuit. Put your supplemental questions and answers of all exercises, along with the screenshots in a word file or PDF file. Your code should be in the .cpp file. Make sure your code is thoroughly commented. Zip all files into one when you submit.