

Lab 1: Testing and Measurement on the r-one

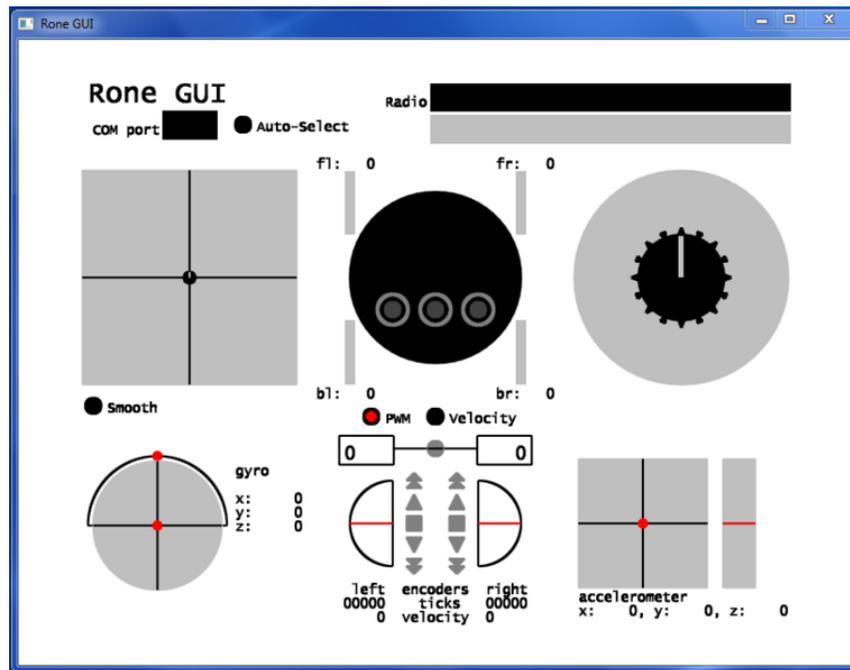
Note: This lab is not graded. However, we will discuss the results in class, and think just how embarrassing it will be for me to call on you and you don't have the work complete...

1 Testing your Robot

In this section, you will test most of the sensors and actuators on your robot. You will need a partner for some of these activities, and you will both need working robots and GUIs. Setup your robot and download the the r-one GUI:

<http://www.clear.rice.edu/engi128/resources.shtml>

Turn your robot off and plug it into your computer. Turn it on and note the serial port that it connects to using the device manager. Connect to this port with the r-one GUI.



1.1 Encoders

Write down the position value (the "ticks") of the left and right encoders. Push the robot forward 10 cm, being sure to keep the wheels from slipping (i.e. make sure the wheels turn). Record the new position values of the left and right encoders. What do the encoder ticks seem to be measuring? What is their resolution (mm/tick)?

Encoder values (initial) = _____ , _____

Encoder values (final) = _____ , _____

Quantity measured and resolution = _____ , _____

1.2 Motors

Click on the "Sync Motors" button, the grey circle under the picture of the robot. Select the "PWM" mode for the motor control. Click on the up buttons to give positive pulse-width modulation (PWM¹) to both motors. What is the minimum PWM you need to get the robot to move forward on level ground? Use your tape measure and a stop watch to measure the speed of the robot. Repeat this speed measurement for the maximum PWM.

Min PWM and min speed = _____, _____

Max PWM and max speed = _____, _____

1.3 Light Sensors

Cover the robot's front-right light sensor with your finger. Record the values from this sensor. Point robot to the ceiling lights and record the maximum value from a light sensor.

Light sensor min and max = _____, _____

1.4 Bump Sensors

Note the values of the bump sensors (middle circle on the GUI) while you move the bump skirt. Can you get a single sensor to activate? Two? Three? How would you compute the direction of the obstacle?

Bump Sensor Notes = _____, _____, _____

1.5 IR Obstacle Sensors

Observe the display of IR obstacles on the GUI (right circle). Slowly move your hands around the robot. What do all these lines mean? Can you get a single sensor pair to activate? Two? Three? How would you compute the direction of the obstacle? What is the maximum range to detect a wall?

IR obstacle notes = _____, _____, _____

IR obstacle max range = _____

1.6 Accelerometer

Record the x, y, and z values of the accelerometer while the robot is resting on your desk. Based on these measurements, what are the units of this sensor? In what direction is the z-axis pointed?

Accelerometer x, y, z = _____, _____, _____

Accelerometer units and z-axis direction = _____, _____

¹We will define this term next class. It is the amount of power you are giving to each motor

1.7 Gyroscope

Watch the values of the gyroscope while you are moving the robot. What does this seem to be measuring? How is it different from gyroscopes we talked about in class. If this question doesn't make any sense, isn't it still a really cool sensor?

Thoughtful answer = _____

Cool? = _____

1.8 IR communications

Find a partner. Place your robot around 50cm from each other on a flat surface. Look for their robot to appear on the neighbor map (the left side of the GUI). Use your tape measure to measure the range at which communication becomes unreliable. Note: IR communications uses light, so the transmitter robot needs to be on the same plane as the receiver robot.

IR communications max range = _____

1.9 Radio communications

Type a radio message in the textbox by "radio". Hit enter at the end of your message and verify your message on another person/team's GUI. Note the range at which radio communication becomes unreliable. This range will be large, you can use floor tiles to measure the range.

Radio communications max range = _____

2 Measuring voltages on the robot

2.1 Multimeter

A multimeter is a primary tool of electrical engineers. It is used to take a variety of electrical measurements; such as voltage, current, and resistance. In this lab, we will measure the direct current (DC) voltage of various points on the robot. The smallest voltage on the robot is 0 volts, and the largest is 5 volts. The multimeter can read DC voltage on several different range settings. Since the largest voltage on the robot is 5 volts, we want to set the multimeter's dial to the smallest voltage range that is greater than 5v, which is DCV 20 on your meters. If the multimeter is set to some large voltage, like 600V, the readings from the robot would be so small that it would barely read. In contrast, if the range were set to millivolts, the robot's voltage would exceed the range of this setting.

The multimeter has two probes, one black and one red. The black probe is for ground. In electrical engineering, ground is a reference point in an electrical circuit from which other voltages are measured. **To prevent damaging your robot, keep the black probe on the robot's ground and do not touch (short-circuit) the red probe to anything but the indicated test points.** Use the accompanying sheet to identify the places on the robot to measure voltage. To connect your multimeter to the robot's ground, put the black probe on **TP1**, or the small "square hole" directly to the right of it, inside the white rectangle. The red probe will touch other components of the

robot in order to measure the voltage *across* two points. If you get a negative voltage reading, it means that your test leads are reversed.

2.2 Battery and System Voltage

Use the multimeter to see the change in voltage on the main power supply when the robot is powered on. Turn the robot off, place the red probe on the via, and record the multimeter reading:

Battery voltage **TP3** (off) = _____

System voltage **TP2** (off) = _____

Turn on the robot and take another multimeter reading. What voltage does it read now?

Battery voltage **TP3** (on) = _____

System voltage **TP2** (on) = _____

Does this reading make sense?

2.3 Switches

Setup the GUI and connect your robot. Verify that you can control motors and read light sensors. Put the red probe on **TP5**, which is the signal for the red button. Record the voltage when you push the button and when you are not pushing the button:

Button voltage **TP5** (released) = _____

Button voltage **TP5** (pressed) = _____

Why do you think you get these particular voltages? Does it seem reversed?

2.4 Light Sensor

The robot has three light sensors. We will measure the front right (FR) sensor. Near the FR light sensor, put your probe on **TP12**. Record the voltage reading from this sensor and the number from the GUI with the robot just sitting on the desk. Record these same two measurements with the sensor covered, and then with a flashlight pointed at it.

Light sensor voltage **TP12**, GUI value (initial) = _____, _____

Light sensor voltage **TP12**, GUI value (covered) = _____, _____

Light sensor voltage **TP12**, GUI value (flashlight) = _____, _____

How does this data differ from the readings of the button? Can you get any voltage you want by moving the flashlight and covering the sensor?

2.5 Motors

Record the voltage reading from the two pulse width modulation (PWM) channels for the left motor. Use the GUI to set the PWM for the left motor to the specified values:

PWM voltage A, B **TP14, TP15** (PWM setting = 0) = _____, _____

PWM voltage A, B **TP14, TP15** (PWM = 50%) = _____, _____

PWM voltage A, B **TP14, TP15** (PWM = 75%) = _____, _____

PWM voltage A, B **TP14, TP15** (PWM = 100%) = _____, _____

PWM voltage A, B **TP14, TP15** (PWM = -50%) = _____, _____

How are the A and B PWM voltages different? What is the range of the measured voltage? How does the measured voltage compare to the PWM value from the GUI and the system voltage from Section 2.2?

2.6 Encoders

Record the voltage reading from the left encoder channels. Use the GUI to set the PWM for the left motor to the specified values:

Encoder voltage A, B **TP16, TP17** (PWM = 0) = _____, _____

Encoder voltage A, B **TP16, TP17** (PWM = 50%) = _____, _____

Encoder voltage A, B **TP16, TP17** (PWM = 75%) = _____, _____

Encoder voltage A, B **TP16, TP17** (PWM = 100%) = _____, _____

Encoder voltage A, B **TP16, TP17** (PWM = -75%) = _____, _____

How are the A and B encoder channels different? What is the range of the measured voltage? How does the measured voltage compare to the PWM value and the system voltage? How do these measurements compare to the PWM voltages from above? What were you expecting?