

# ELECENG 3EY4: Electrical System Integration Project

## Lab03\_udev Rules and Testing McMaster AEV Components

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## **Objective 1: Review of the Lab Manual**

For Objective 2, we equally contributed to it.

For Objective 3, Yichen Lu led it.

For Objective 4, Junbo Wang led it.

For Objective 5, Preet Batra led it.

## **Objective 2: Setting up udev Rules**

**Question 1: Use your Linux knowledge from Lab 1 and write the command in the terminal to navigate to the rules. In your report, explain which command you used.**

We use the **cd /etc/udev/rules.d** command to navigate to the rules.

More specifically, cd means change directory. /etc/udev/rules.d is the directory that we want to go to.

**Question 2: First, add the rule file for the lidar. Use your Linux knowledge from Lab 1 and write the command in the terminal. Confirm with your TA that you have the correct command before executing it. In your report, explain which command you used.**

We use the **sudo gedit rplidar.rules** command to add the rule file for the lidar.

More specifically, sudo means superuser which gives us access to do the following command. gedit is the text editor we want to use to create the following file. rplidar.rules is the file name.

**Question 3: Save this file and repeat the process for VESC. Add a rule file vesc.rules following the same procedure. Confirm with your TA that you added the file correctly. In your report, explain which command you used.**

sudo gedit vesc.rules, we use this command to add the rule file for the VESC. More specifically, sudo means superuser which gives us access to do the following command.

gedit is the text editor we want to use to create the following file. vesc.rules is the file name.

**Question 4: Next, we add the udev rule for the Logitech F710 joypad. The name of the file should be joypad-f710.rules. In your report, explain which command you used.**

sudo gedit joypad-f710.rules, we use this command to add udev rule file for the Logitech F710 joypad. More specifically, sudo means superuser which gives us access to do the following command. gedit is the text editor we want to use to create the following file. joypad-f710.rules is the file name.

**Question 5: Lastly, you will add the udev rule for the RealSense camera, but it has already been provided for us. You will create a new rules file named 99-realsense-libusb.rules. In your report, explain which command you used.**

sudo gedit 99-realsense-libusb.rules, we use this command to create a new rules file named 99-realsense-libusb.rules. More specifically, sudo means superuser which gives us access to do the following command. gedit is the text editor we want to use to create the following file. 99-realsense-libusb.rule is the file name.

**Question 6: In your report, explain why you need to apply these commands and what they mean.**

"sudo udevadm control --reload-rules", sudo is the super user do, udevadm control is used to modify the rules in the udevd daemon, and the reload-rules command forces the udev daemon to reread the rule file. After adding these rules files, we need to use this command to instruct the udev daemon to reload the rules files.

"sudo udevadm trigger", udevadm trigger is used to request device events from the kernel. After reloading the rules file using the above command, "sudo udevadm trigger" will tell the udev daemon to process the rules and apply them to existing devices.

**Question 7: In your report, explain why you need to edit the ROS launch files for the lidar.**

We need to edit lidar's ROS launch files to set specific configurations. By changing the value in "serial\_port" to "/dev/sensors/rplidar," we can instruct ROS to communicate with the lidar device through the specified serial port and adjust the resolution, scan range, and frequency. This allows lidar performance to be optimized for specific tasks or environments.

**Objective 3: Experiment with the data input and output of the Lidar**

**Question 8: Put an object such as a notebook or a cardboard at 270 degrees around the lidar (at least 20 cm away), move the object back and forth and explain how and why the numbers change. Add screenshots of the array ranges when the object is the closest to the car and when it is the furthest from the car.**

As we moved the notebook closer to the car, the displayed number decreased steadily, reaching approximately 0.177. This value represents the minimum detection distance of the LiDAR, which is 0.177 meters. Subsequently, as we moved the notebook away from the LiDAR, the number gradually increased, eventually reaching around 3.16. This value indicates the LiDAR's maximum detection distance, which is 3.16 meters.

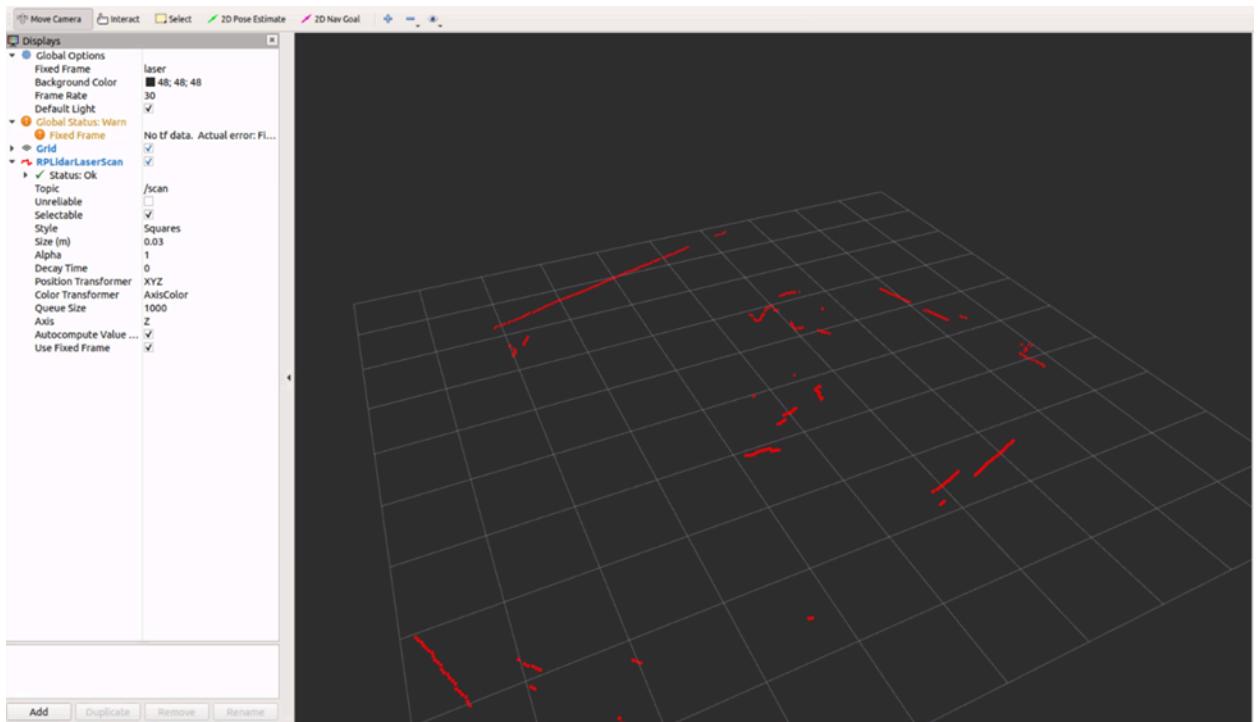
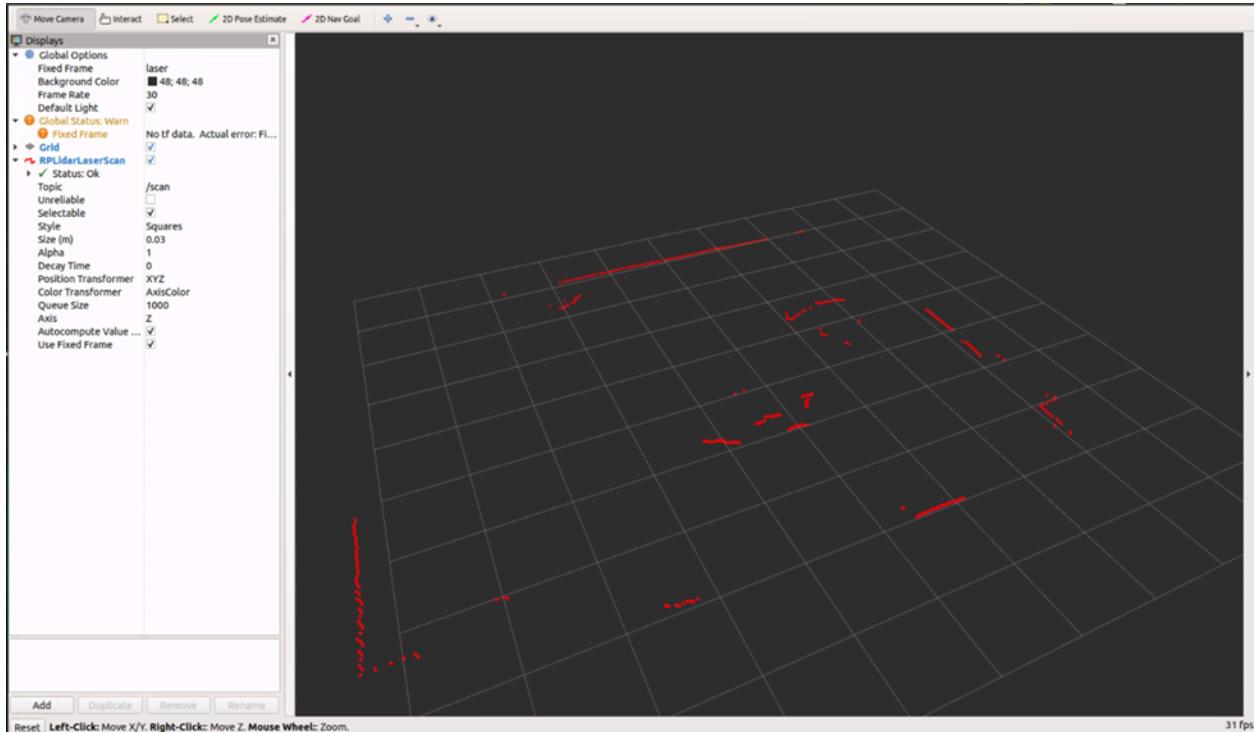
The reason is that the number keeps changing when we move the notebook backward or forwards from the lidar. The number stands for the distance between the notebook and the lidar. Additionally, there are minimum and maximum detection distances of the lidar, which are 0.177 meters and 3.16 meters respectively.

The screenshot on the bottom left shows the array ranges when the object is closest to the LiDAR. The screenshot on the bottom right shows the array ranges when the object is farthest from the LiDAR.

**Question 9:** Take a screenshot of the rviz page showing the point cloud map of the surrounding of the lidar and explain your observations of what the screenshot shows. Validate your observations by moving objects around the lidar and observe the change in the point cloud map.

From the screenshots of the rviz page, we observe that there are four walls in the lab room that we scanned using the LiDAR. At the center, there are some shorter red lines, which likely represent monitors and other small objects that are situated between the

walls in the lab room. Additionally, after moving the car, we can see that the cloud map remains largely unchanged, except that it shows the room from different angles.



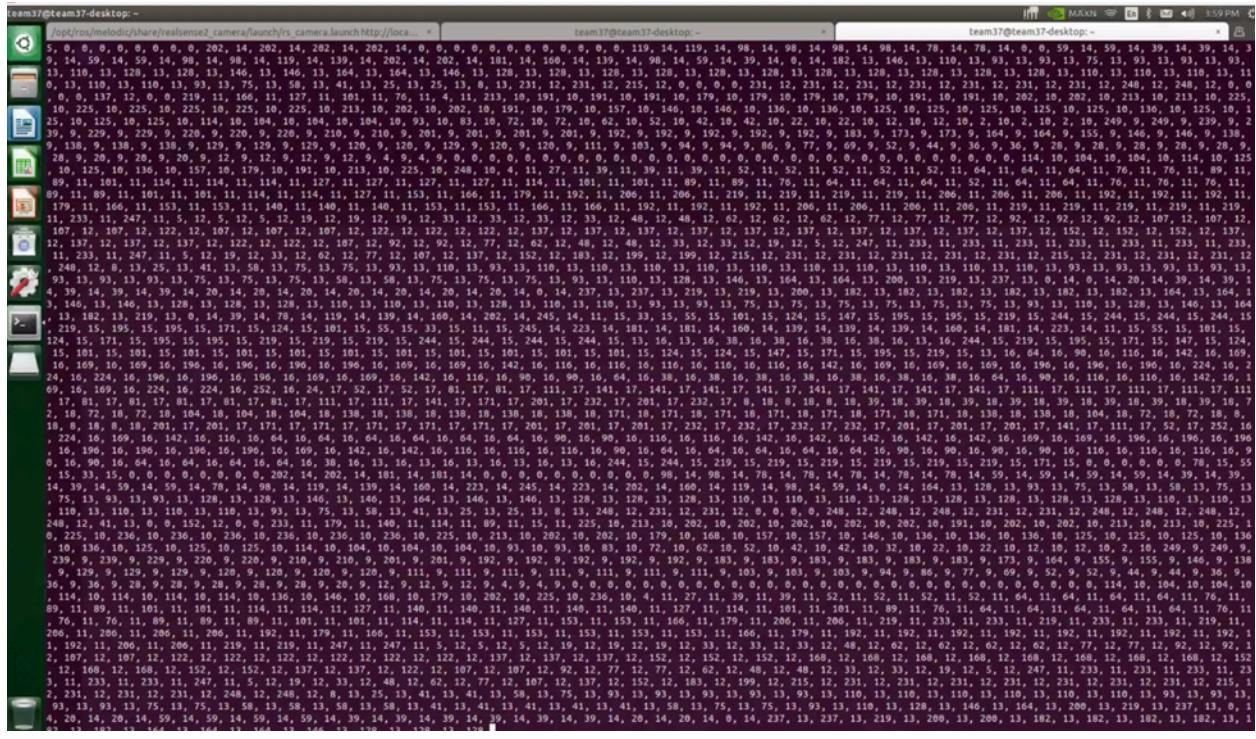
## **Objective 4: Experiment with the data input and output of the camera**

**Question 10:** In your report, include a screenshot of the output with the 8-bit unsigned integer range from 0 to 255 as you echo /camera/color/image\_raw and /camera/depth/image\_rect\_raw topics.

/camera/color/image\_raw

team37@team37-destop - team37@team37-destop - team37@team37-destop - team37@team37-destop -

/camera/depth/image\_rect\_raw



**Question 11: Take a screenshot of the camera and depth camera simultaneously in one screenshot (Hint: you can do that by adding another camera page and selecting the topic you need). Explain briefly how the depth camera represents the raw coloured image. Also, take a screenshot of the raw coloured image showing ALL your team members.**

Color appears darker in the depth camera as the object is closer to the camera.



## **Objective 5: Experiment with the data input and output of the joystick**

**Question 12:** The above explanation should have given you an idea about the parameters you added to the launch file. In your report, explain each line that you typed into the launch file (e.g., the four lines in the middle).

**<launch>**

Start the launch file and set parameters for the node in ROS.

**<node name="joy\_node" pkg="joy" type="joy\_node">**

Define a node named "joy\_node" from the "joy" package that runs an executable file called "joy\_node". This node is connected to the joystick device.

**<param name="dev" value="/dev/input/js0"/>**

The node "joy\_node" sets a parameter named "dev" with a value of "/dev/input/js0", which specifies the file of the joystick in the ROS system.

**<param name="autorepeat\_rate" value="2"/>**

This line sets the "autorepeat\_rate" value to 2, which means that if there is no change in the state of the joystick, two sets of messages will be sent every second. This ensures that the system receives data at a consistent and smooth rate.

**<param name="coalesce\_interval" value="0.05"/>**

This line sets the "coalesce\_interval" parameter to 0.05 seconds. Coalesce\_interval parameter defines the time interval to wait before publishing the next set of messages. It is used to combine multiple messages into a single message to be sent at this time interval, which helps improve the response time of vehicle input commands and makes the response smoother.

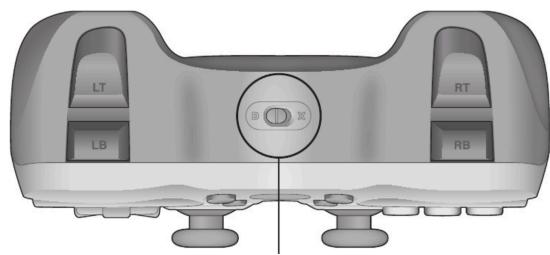
**</node>**

This line closes the defined node.

</launch>

This line ends the launch file.

**Question 13: Find out which element in the two arrays, axes and buttons correspond to which button by trying them all and seeing how the numbers change. Add screenshots showing the two arrays when each button is pressed and tested.**



Top & Front view of Logitech F710 Controller

## Green button

```
/opt/ros/melodic/share/r... x team37@team37-desktop:~ x team37@team37-desktop:~ x /home/team37/catkin_ws... x team37@team37-desktop...
header:
  seq: 398
  stamp:
    secs: 1706909119
    nsecs: 501186089
  frame_id: "/dev/input/js0"
axes: [0.0, -0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0]
buttons: [1, 0, 0, 0, 0, 0, 0, 0, 0, 0]
...
header:
  seq: 399
  stamp:
    secs: 1706909120
    nsecs: 1777888
  frame_id: "/dev/input/js0"
axes: [0.0, -0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0]
buttons: [1, 0, 0, 0, 0, 0, 0, 0, 0, 0]
...
header:
  seq: 400
  stamp:
    secs: 1706909120
    nsecs: 502494110
  frame_id: "/dev/input/js0"
axes: [0.0, -0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0]
buttons: [1, 0, 0, 0, 0, 0, 0, 0, 0, 0]
...
header:
  seq: 401
  stamp:
    secs: 1706909121
    nsecs: 3144342
  frame_id: "/dev/input/js0"
axes: [0.0, -0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0]
buttons: [1, 0, 0, 0, 0, 0, 0, 0, 0, 0]
...
header:
  seq: 436
  stamp:
    secs: 1706909138
    nsecs: 18212670
  frame_id: "/dev/input/js0"
axes: [0.0, -0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0]
buttons: [0, 1, 0, 0, 0, 0, 0, 0, 0, 0]
...
header:
  seq: 437
  stamp:
    secs: 1706909138
    nsecs: 518796340
  frame_id: "/dev/input/js0"
axes: [0.0, -0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0]
buttons: [0, 1, 0, 0, 0, 0, 0, 0, 0, 0]
...
header:
  seq: 438
  stamp:
    secs: 1706909139
    nsecs: 19483290
  frame_id: "/dev/input/js0"
axes: [0.0, -0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0]
buttons: [0, 1, 0, 0, 0, 0, 0, 0, 0, 0]
...
header:
  seq: 439
  stamp:
    secs: 1706909139
    nsecs: 520067894
  frame_id: "/dev/input/js0"
axes: [0.0, -0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0]
buttons: [0, 1, 0, 0, 0, 0, 0, 0, 0, 0]
```

## Red button

```
/opt/ros/melodic/share/r... x team37@team37-desktop:~ x team37@team37-desktop:~ x /home/team37/catkin_ws... x team37@team37-desktop...
header:
  seq: 436
  stamp:
    secs: 1706909138
    nsecs: 18212670
  frame_id: "/dev/input/js0"
axes: [0.0, -0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0]
buttons: [0, 1, 0, 0, 0, 0, 0, 0, 0, 0]
...
header:
  seq: 437
  stamp:
    secs: 1706909138
    nsecs: 518796340
  frame_id: "/dev/input/js0"
axes: [0.0, -0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0]
buttons: [0, 1, 0, 0, 0, 0, 0, 0, 0, 0]
...
header:
  seq: 438
  stamp:
    secs: 1706909139
    nsecs: 19483290
  frame_id: "/dev/input/js0"
axes: [0.0, -0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0]
buttons: [0, 1, 0, 0, 0, 0, 0, 0, 0, 0]
...
header:
  seq: 439
  stamp:
    secs: 1706909139
    nsecs: 520067894
  frame_id: "/dev/input/js0"
axes: [0.0, -0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0]
buttons: [0, 1, 0, 0, 0, 0, 0, 0, 0, 0]
```

## Yellow button

```
/opt/ros/melodic/share/r... x team37@team37-desktop: ~ x team37@team37-desktop: ~ x /home/team37/catkin_ws... x team37@team37-desktop... x
header:
  seq: 559
  stamp:
    secs: 1706909182
    nsecs: 92314441
  frame_id: "/dev/input/js0"
axes: [-0.0, -0.0, 0.0, -0.0, -0.0, 0.0, 0.0, 0.0]
buttons: [0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0]
---
header:
  seq: 560
  stamp:
    secs: 1706909182
    nsecs: 592907832
  frame_id: "/dev/input/js0"
axes: [-0.0, -0.0, 0.0, -0.0, -0.0, 0.0, 0.0, 0.0]
buttons: [0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0]
---
header:
  seq: 561
  stamp:
    secs: 1706909183
    nsecs: 93606951
  frame_id: "/dev/input/js0"
axes: [-0.0, -0.0, 0.0, -0.0, -0.0, 0.0, 0.0, 0.0]
buttons: [0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0]
---
header:
  seq: 562
  stamp:
    secs: 1706909183
    nsecs: 594192840
  frame_id: "/dev/input/js0"
axes: [-0.0, -0.0, 0.0, -0.0, -0.0, 0.0, 0.0, 0.0]
buttons: [0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0]
---
```

## Blue button

```
/opt/ros/melodic/share/r... x team37@team37-desktop: ~ x team37@team37-desktop: ~ x /home/team37/catkin_ws... x team37@team37-desktop... x
header:
  seq: 588
  stamp:
    secs: 1706909195
    nsecs: 880916106
  frame_id: "/dev/input/js0"
axes: [-0.0, -0.0, 0.0, -0.0, -0.0, 0.0, 0.0, 0.0]
buttons: [0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0]
---
header:
  seq: 589
  stamp:
    secs: 1706909196
    nsecs: 381712897
  frame_id: "/dev/input/js0"
axes: [-0.0, -0.0, 0.0, -0.0, -0.0, 0.0, 0.0, 0.0]
buttons: [0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0]
---
header:
  seq: 590
  stamp:
    secs: 1706909196
    nsecs: 882342554
  frame_id: "/dev/input/js0"
axes: [-0.0, -0.0, 0.0, -0.0, -0.0, 0.0, 0.0, 0.0]
buttons: [0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0]
---
header:
  seq: 591
  stamp:
    secs: 1706909197
    nsecs: 383096477
  frame_id: "/dev/input/js0"
axes: [-0.0, -0.0, 0.0, -0.0, -0.0, 0.0, 0.0, 0.0]
buttons: [0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0]
---
```

## Left stick

```
team37@team37-desktop: ~/catkin_ws/src/joystick_drivers/joy/launch
/opt/ros/melodic/share/r... team37@team37-desktop: ~ team37@team37-desktop: ~ /home/team37/catkin_ws... team37@team37-desktop...
header:
  seq: 671
  stamp:
    secs: 1706909219
    nsecs: 41816045
  frame_id: "/dev/input/js0"
axes: [-0.5963847041130066, 0.9958559274673462, 0.0, -0.0, -0.0, 0.0, 0.0, 0.0]
buttons: [0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0]
...
header:
  seq: 672
  stamp:
    secs: 1706909219
    nsecs: 542460747
  frame_id: "/dev/input/js0"
axes: [-0.5963847041130066, 0.9958559274673462, 0.0, -0.0, -0.0, 0.0, 0.0, 0.0]
buttons: [0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0]
...
header:
  seq: 673
  stamp:
    secs: 1706909220
    nsecs: 43140814
  frame_id: "/dev/input/js0"
axes: [-0.5963847041130066, 0.9958559274673462, 0.0, -0.0, -0.0, 0.0, 0.0, 0.0]
buttons: [0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0]
...
header:
  seq: 674
  stamp:
    secs: 1706909220
    nsecs: 543888117
  frame_id: "/dev/input/js0"
axes: [-0.5963847041130066, 0.9958559274673462, 0.0, -0.0, -0.0, 0.0, 0.0, 0.0]
buttons: [0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0]
...
header:
  seq: 675
  stamp:
    secs: 1706909220
    nsecs: 654716877
  frame_id: "/dev/input/js0"
axes: [-0.5963847041130066, 0.9958559274673462, 0.0, -0.0, -0.0, 0.0, 0.0, 0.0]
buttons: [0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0]
```

## Right stick

```
team37@team37-desktop: ~/catkin_ws/src/joystick_drivers/joy/launch
/opt/ros/melodic/share/r... team37@team37-desktop: ~ team37@team37-desktop: ~ /home/team37/catkin_ws... team37@team37-desktop...
header:
  seq: 836
  stamp:
    secs: 1706909281
    nsecs: 445121687
  frame_id: "/dev/input/js0"
axes: [-0.0, -0.0, 0.0, -0.20529800653457642, 1.0, 0.0, -0.0, -0.0]
buttons: [0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0]
...
header:
  seq: 837
  stamp:
    secs: 1706909281
    nsecs: 981397963
  frame_id: "/dev/input/js0"
axes: [-0.0, -0.0, 0.0, -0.4133378863334656, 1.0, 0.0, -0.0, -0.0]
buttons: [0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0]
...
header:
  seq: 838
  stamp:
    secs: 1706909282
    nsecs: 33162276
  frame_id: "/dev/input/js0"
axes: [-0.0, -0.0, 0.0, -0.521501898765564, 1.0, 0.0, -0.0, -0.0]
buttons: [0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0]
...
header:
  seq: 839
  stamp:
    secs: 1706909282
    nsecs: 93147182
  frame_id: "/dev/input/js0"
axes: [-0.0, -0.0, 0.0, -0.5381425023078918, 1.0, 0.0, -0.0, -0.0]
buttons: [0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0]
```

## Top arrow

```
team37@team37-desktop:~/catkin_ws/src/joystick_drivers/joy/launch
/opt/ros/melodic/share/r...  x  team37@team37-desktop:~  x  team37@team37-desktop:~  x  /home/team37/catkin_ws...  x  team37@team37-desktop...
header:
  seq: 869
  stamp:
    secs: 1706909294
    nsecs: 857970847
  frame_id: "/dev/input/js0"
axes: [-0.0, -0.0, 0.0, -0.0, -0.0, 0.0, -0.0, 1.0]
buttons: [0, 0, 0, 0, 0, 0, 0, 0, 0, 0]
...
header:
  seq: 870
  stamp:
    secs: 1706909295
    nsecs: 358690114
  frame_id: "/dev/input/js0"
axes: [-0.0, -0.0, 0.0, -0.0, -0.0, 0.0, -0.0, 1.0]
buttons: [0, 0, 0, 0, 0, 0, 0, 0, 0, 0]
...
header:
  seq: 871
  stamp:
    secs: 1706909295
    nsecs: 859274642
  frame_id: "/dev/input/js0"
axes: [-0.0, -0.0, 0.0, -0.0, -0.0, 0.0, -0.0, 1.0]
buttons: [0, 0, 0, 0, 0, 0, 0, 0, 0, 0]
...
header:
  seq: 872
  stamp:
    secs: 1706909296
    nsecs: 359966355
  frame_id: "/dev/input/js0"
axes: [-0.0, -0.0, 0.0, -0.0, -0.0, 0.0, -0.0, 1.0]
buttons: [0, 0, 0, 0, 0, 0, 0, 0, 0, 0]
...
Copilot (preview)
```

## Bottom arrow

```
team37@team37-desktop:~/catkin_ws/src/joystick_drivers/joy/launch
/opt/ros/melodic/share/r...  x  team37@team37-desktop:~  x  team37@team37-desktop:~  x  /home/team37/catkin_ws...  x  team37@team37-desktop...
header:
  seq: 909
  stamp:
    secs: 1706909314
    nsecs: 285532422
  frame_id: "/dev/input/js0"
axes: [-0.0, -0.0, 0.0, -0.0, -0.0, 0.0, -0.0, -1.0]
buttons: [0, 0, 0, 0, 0, 0, 0, 0, 0, 0]
...
header:
  seq: 910
  stamp:
    secs: 1706909314
    nsecs: 786219774
  frame_id: "/dev/input/js0"
axes: [-0.0, -0.0, 0.0, -0.0, -0.0, 0.0, -0.0, -1.0]
buttons: [0, 0, 0, 0, 0, 0, 0, 0, 0, 0]
...
header:
  seq: 911
  stamp:
    secs: 1706909315
    nsecs: 286860042
  frame_id: "/dev/input/js0"
axes: [-0.0, -0.0, 0.0, -0.0, -0.0, 0.0, -0.0, -1.0]
buttons: [0, 0, 0, 0, 0, 0, 0, 0, 0, 0]
...
header:
  seq: 912
  stamp:
    secs: 1706909315
    nsecs: 787586349
  frame_id: "/dev/input/js0"
axes: [-0.0, -0.0, 0.0, -0.0, -0.0, 0.0, -0.0, -1.0]
buttons: [0, 0, 0, 0, 0, 0, 0, 0, 0, 0]
```

## Left arrow

```
team37@team37-desktop: ~/catkin_ws/src/joystick_drivers/joy/launch
/opt/ros/melodic/share/r... team37@team37-desktop: ~ team37@team37-desktop: ~ /home/team37/catkin_ws... team37@team37-desktop...
header:
  seq: 960
  stamp:
    secs: 1706909338
    nsecs: 752580551
  frame_id: "/dev/input/js0"
axes: [-0.0, -0.0, 0.0, -0.0, -0.0, 0.0, 1.0, -0.0]
buttons: [0, 0, 0, 0, 0, 0, 0, 0, 0, 0]
...
header:
  seq: 961
  stamp:
    secs: 1706909339
    nsecs: 253169886
  frame_id: "/dev/input/js0"
axes: [-0.0, -0.0, 0.0, -0.0, -0.0, 0.0, 1.0, -0.0]
buttons: [0, 0, 0, 0, 0, 0, 0, 0, 0, 0]
...
header:
  seq: 962
  stamp:
    secs: 1706909339
    nsecs: 753761720
  frame_id: "/dev/input/js0"
axes: [-0.0, -0.0, 0.0, -0.0, -0.0, 0.0, 1.0, -0.0]
buttons: [0, 0, 0, 0, 0, 0, 0, 0, 0, 0]
...
header:
  seq: 963
  stamp:
    secs: 1706909340
    nsecs: 254551988
  frame_id: "/dev/input/js0"
axes: [-0.0, -0.0, 0.0, -0.0, -0.0, 0.0, 1.0, -0.0]
buttons: [0, 0, 0, 0, 0, 0, 0, 0, 0, 0]
...
header:
  seq: 964
  stamp:
    secs: 1706909340
    nsecs: 361592906
  frame_id: "/dev/input/js0"
axes: [-0.0, -0.0, 0.0, -0.0, -0.0, 0.0, 1.0, -0.0]
buttons: [0, 0, 0, 0, 0, 0, 0, 0, 0, 0]
```

## Right arrow

```
team37@team37-desktop: ~/catkin_ws/src/joystick_drivers/joy/launch
/opt/ros/melodic/share/r... team37@team37-desktop: ~ team37@team37-desktop: ~ /home/team37/catkin_ws... team37@team37-desktop...
header:
  seq: 1001
  stamp:
    secs: 1706909358
    nsecs: 859454451
  frame_id: "/dev/input/js0"
axes: [-0.0, -0.0, 0.0, -0.0, -0.0, 0.0, -1.0, -0.0]
buttons: [0, 0, 0, 0, 0, 0, 0, 0, 0, 0]
...
header:
  seq: 1002
  stamp:
    secs: 1706909359
    nsecs: 360222235
  frame_id: "/dev/input/js0"
axes: [-0.0, -0.0, 0.0, -0.0, -0.0, 0.0, -1.0, -0.0]
buttons: [0, 0, 0, 0, 0, 0, 0, 0, 0, 0]
...
header:
  seq: 1003
  stamp:
    secs: 1706909359
    nsecs: 860839030
  frame_id: "/dev/input/js0"
axes: [-0.0, -0.0, 0.0, -0.0, -0.0, 0.0, -1.0, -0.0]
buttons: [0, 0, 0, 0, 0, 0, 0, 0, 0, 0]
...
header:
  seq: 1004
  stamp:
    secs: 1706909360
    nsecs: 361592906
  frame_id: "/dev/input/js0"
axes: [-0.0, -0.0, 0.0, -0.0, -0.0, 0.0, -1.0, -0.0]
buttons: [0, 0, 0, 0, 0, 0, 0, 0, 0, 0]
```

## Left button (LB)

```
team37@team37-desktop: ~/catkin_ws/src/joy/stick_drivers/joy/launch
/home/team37/catkin_ws/src/joy/stick_drivers/joy/launch/f710joy.launch http://... x
team37@team37-desktop: ~/catkin_ws/src/joy/stick_drivers/joy/launch x
header:
  seq: 67
  stamp:
    secs: 1706909621
    nsecs: 981515274
  frame_id: "/dev/input/js0"
axes: [0.0, -0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0]
buttons: [0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0]
...
header:
  seq: 68
  stamp:
    secs: 1706909622
    nsecs: 482720062
  frame_id: "/dev/input/js0"
axes: [0.0, -0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0]
buttons: [0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0]
...
header:
  seq: 69
  stamp:
    secs: 1706909622
    nsecs: 983539853
  frame_id: "/dev/input/js0"
axes: [0.0, -0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0]
buttons: [0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0]
...
header:
  seq: 70
  stamp:
    secs: 1706909623
    nsecs: 484352508
  frame_id: "/dev/input/js0"
axes: [0.0, -0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0]
buttons: [0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0]
...
header:
  seq: 71
  stamp:
    secs: 1706909623
    nsecs: 485175000
  frame_id: "/dev/input/js0"
axes: [0.0, -0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0]
buttons: [0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0]
```

## Right button (RB)

```
team37@team37-desktop: ~/catkin_ws/src/joy/stick_drivers/joy/launch
/home/team37/catkin_ws/src/joy/stick_drivers/joy/launch/f710joy.launch http://... x
team37@team37-desktop: ~/catkin_ws/src/joy/stick_drivers/joy/launch x
header:
  seq: 121
  stamp:
    secs: 1706909647
    nsecs: 459785346
  frame_id: "/dev/input/js0"
axes: [0.0, -0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0]
buttons: [0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0]
...
header:
  seq: 122
  stamp:
    secs: 1706909647
    nsecs: 960620630
  frame_id: "/dev/input/js0"
axes: [0.0, -0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0]
buttons: [0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0]
...
header:
  seq: 123
  stamp:
    secs: 1706909648
    nsecs: 461346592
  frame_id: "/dev/input/js0"
axes: [0.0, -0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0]
buttons: [0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0]
...
header:
  seq: 124
  stamp:
    secs: 1706909648
    nsecs: 962254583
  frame_id: "/dev/input/js0"
axes: [0.0, -0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0]
buttons: [0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0]
```

## Left top (LT) analog

```
team37@team37-desktop: ~/catkin_ws/src/joy/stick_drivers/joy/launch
```

```
/home/team37/catkin_ws/src/joy/stick_drivers/joy/launch/f710joy.launch http://... x
```

```
team37@team37-desktop: ~/catkin_ws/src/joy/stick_drivers/joy/launch
```

```
header:  
  seq: 106  
  stamp:  
    secs: 1706910079  
    nsecs: 633683260  
  frame_id: "/dev/input/js0"  
axes: [0.0, 0.0, -1.0, 0.0, 0.0, 1.0, 0.0, 0.0]  
buttons: [0, 0, 0, 0, 0, 0, 0, 0, 0, 0]  
...  
  
header:  
  seq: 107  
  stamp:  
    secs: 1706910080  
    nsecs: 134692983  
  frame_id: "/dev/input/js0"  
axes: [0.0, 0.0, -1.0, 0.0, 0.0, 1.0, 0.0, 0.0]  
buttons: [0, 0, 0, 0, 0, 0, 0, 0, 0, 0]  
...  
  
header:  
  seq: 108  
  stamp:  
    secs: 1706910080  
    nsecs: 635379546  
  frame_id: "/dev/input/js0"  
axes: [0.0, 0.0, -1.0, 0.0, 0.0, 1.0, 0.0, 0.0]  
buttons: [0, 0, 0, 0, 0, 0, 0, 0, 0, 0]  
...  
  
header:  
  seq: 109  
  stamp:  
    secs: 1706910081  
    nsecs: 136898347  
  frame_id: "/dev/input/js0"  
axes: [0.0, 0.0, -1.0, 0.0, 0.0, 1.0, 0.0, 0.0]  
buttons: [0, 0, 0, 0, 0, 0, 0, 0, 0, 0]
```

```
team37@team37-desktop: ~/catkin_ws/src/joy/stick_drivers/joy/launch
```

```
/home/team37/catkin_ws/src/joy/stick_drivers/joy/launch/f710joy.launch http://... team37@team37-desktop: ~/catkin_ws/src/joy/stick_drivers/joy/launch
```

header:  
  seq: 919  
  stamp:  
    secs: 1706909917  
    nsecs: 524358791  
  frame\_id: "/dev/input/js0"  
axes: [0.0, -0.0, -0.146284845161438, 0.0, 0.0, 1.0, 0.0, 0.0]  
buttons: [0, 0, 0, 0, 0, 0, 0, 0, 0, 0]  
...  
header:  
  seq: 920  
  stamp:  
    secs: 1706909917  
    nsecs: 580343928  
  frame\_id: "/dev/input/js0"  
axes: [0.0, -0.0, -0.17943759262561798, 0.0, 0.0, 1.0, 0.0, 0.0]  
buttons: [0, 0, 0, 0, 0, 0, 0, 0, 0, 0]  
...  
header:  
  seq: 921  
  stamp:  
    secs: 1706909918  
    nsecs: 81032526  
  frame\_id: "/dev/input/js0"  
axes: [0.0, -0.0, -0.17943759262561798, 0.0, 0.0, 1.0, 0.0, 0.0]  
buttons: [0, 0, 0, 0, 0, 0, 0, 0, 0, 0]  
...  
header:  
  seq: 922  
  stamp:  
    secs: 1706909918  
    nsecs: 588634284  
  frame\_id: "/dev/input/js0"  
axes: [0.0, -0.0, -0.17943759262561798, 0.0, 0.0, 1.0, 0.0, 0.0]  
buttons: [0, 0, 0, 0, 0, 0, 0, 0, 0, 0]

## Right top (RT) analog

```
team37@team37-desktop: ~/catkin_ws/src/joystick_drivers/joy/launch
/home/team37/catkin_ws/src/joystick_drivers/joy/launch/f710joy.launch http://... x
team37@team37-desktop: ~/catkin_ws/src/joystick_drivers/joy/launch x 4:35 PM
header:
  seq: 343
  stamp:
    secs: 1706909729
    nsecs: 129994216
  frame_id: "/dev/input/js0"
axes: [0.0, -0.0, 1.0, 0.0, 0.0, -1.0, 0.0, 0.0]
buttons: [0, 0, 0, 0, 0, 0, 0, 0, 0, 0]
...
header:
  seq: 344
  stamp:
    secs: 1706909729
    nsecs: 630655619
  frame_id: "/dev/input/js0"
axes: [0.0, -0.0, 1.0, 0.0, 0.0, -1.0, 0.0, 0.0]
buttons: [0, 0, 0, 0, 0, 0, 0, 0, 0, 0]
...
header:
  seq: 345
  stamp:
    secs: 1706909730
    nsecs: 131481343
  frame_id: "/dev/input/js0"
axes: [0.0, -0.0, 1.0, 0.0, 0.0, -1.0, 0.0, 0.0]
buttons: [0, 0, 0, 0, 0, 0, 0, 0, 0, 0]
...
header:
  seq: 346
  stamp:
    secs: 1706909730
    nsecs: 632082486
  frame_id: "/dev/input/js0"
axes: [0.0, -0.0, 1.0, 0.0, 0.0, -1.0, 0.0, 0.0]
buttons: [0, 0, 0, 0, 0, 0, 0, 0, 0, 0]
...
header:
  seq: 775
  stamp:
    secs: 1706909868
    nsecs: 422783322
  frame_id: "/dev/input/js0"
axes: [0.0, -0.0, 1.0, 0.0, 0.0, 0.2623515725135803, 0.0, 0.0]
buttons: [0, 0, 0, 0, 0, 0, 0, 0, 0, 0]
...
header:
  seq: 776
  stamp:
    secs: 1706909868
    nsecs: 474609847
  frame_id: "/dev/input/js0"
axes: [0.0, -0.0, 1.0, 0.0, 0.0, 0.2623515725135803, 0.0, 0.0]
buttons: [0, 0, 0, 0, 0, 0, 0, 0, 0, 0]
...
header:
  seq: 777
  stamp:
    secs: 1706909868
    nsecs: 526700744
  frame_id: "/dev/input/js0"
axes: [0.0, -0.0, 1.0, 0.0, 0.0, 0.2623515725135803, 0.0, 0.0]
buttons: [0, 0, 0, 0, 0, 0, 0, 0, 0, 0]
...
header:
  seq: 778
  stamp:
    secs: 1706909868
    nsecs: 658616014
  frame_id: "/dev/input/js0"
axes: [0.0, -0.0, 1.0, 0.0, 0.0, 0.22919882833957672, 0.0, 0.0]
buttons: [0, 0, 0, 0, 0, 0, 0, 0, 0, 0]
```

```
team37@team37-desktop: ~/catkin_ws/src/joystick_drivers/joy/launch
/home/team37/catkin_ws/src/joystick_drivers/joy/launch/f710joy.launch http://... x
team37@team37-desktop: ~/catkin_ws/src/joystick_drivers/joy/launch x 4:37 PM
header:
  seq: 775
  stamp:
    secs: 1706909868
    nsecs: 422783322
  frame_id: "/dev/input/js0"
axes: [0.0, -0.0, 1.0, 0.0, 0.0, 0.2623515725135803, 0.0, 0.0]
buttons: [0, 0, 0, 0, 0, 0, 0, 0, 0, 0]
...
header:
  seq: 776
  stamp:
    secs: 1706909868
    nsecs: 474609847
  frame_id: "/dev/input/js0"
axes: [0.0, -0.0, 1.0, 0.0, 0.0, 0.2623515725135803, 0.0, 0.0]
buttons: [0, 0, 0, 0, 0, 0, 0, 0, 0, 0]
...
header:
  seq: 777
  stamp:
    secs: 1706909868
    nsecs: 526700744
  frame_id: "/dev/input/js0"
axes: [0.0, -0.0, 1.0, 0.0, 0.0, 0.2623515725135803, 0.0, 0.0]
buttons: [0, 0, 0, 0, 0, 0, 0, 0, 0, 0]
...
header:
  seq: 778
  stamp:
    secs: 1706909868
    nsecs: 658616014
  frame_id: "/dev/input/js0"
axes: [0.0, -0.0, 1.0, 0.0, 0.0, 0.22919882833957672, 0.0, 0.0]
buttons: [0, 0, 0, 0, 0, 0, 0, 0, 0, 0]
```

**Question 14: What is the difference between analog and digital signals of a controller?**

Answer: The digital signals of the controller are either 1 or 0, while the analog signals range between -1 to 1 and are not whole numbers.