Lab 1: Wake Up, Stretch

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16-762: Mobile Manipulation
Spring 2026

Lab 1 Goals

1. Get connected to the robot.

2. Create a GitHub repo and clone the repo on the robot. Shared robot, so you should expect your code will be deleted after you log off the robot.

3. Visualize the robot's URDF in rviz (include a screenshot in your report).

4. Write a script to perform simple motions using Stretch's API.

5. Write a script to perform simple motions using ROS commands.

What you will submit

1. Your completed code files (.py) for parts #4 and #5 (see previous slide)
    - Part #4: `stretch_api.py`
    - Part #5: `ros2.py`
2. An screenshot of rviz (.jpg or .png)
3. Two videos (.mp4) showing the robot motion for parts #4 and #5. `stretch_api.mp4` and `ros2.mp4`

Lab 1 is Solo (no teams)

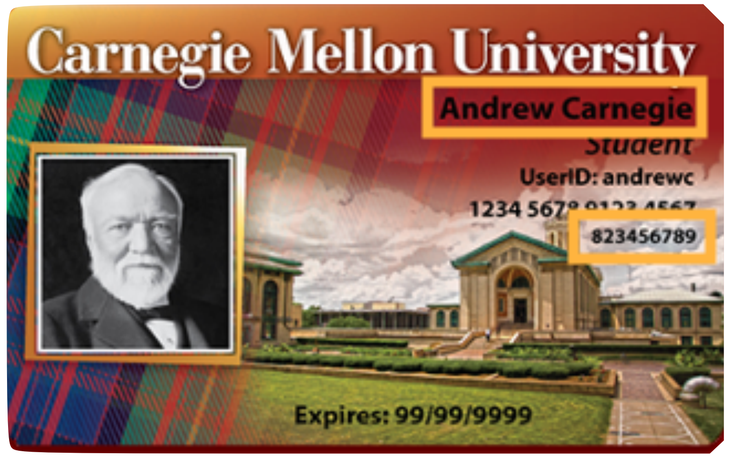
- Due Date: **Wednesday, February 4th** (2 weeks from now)
- If you don’t finish in class today, both robots will be available in the AI Maker Space (basement floor of Tepper).

Teams for Future Labs and Course project

- Teams of 3 students
- Use **Canvas Discussions** to find team members, or look for team members **today (in-person)**!
- Discussions Link: https://canvas.cmu.edu/courses/52596/discussion_topics/796930
- Once you find a team, please have one member submit the team member names: https://forms.gle/nNzqL7iCRX6jCxUj9

Send your IDs to me

- To get access to the AI Maker Space.
- 9 digit ID on front of your CMU card. (e.g. 822500909)
- Not your Andrew ID.



https://forms.gle/5LavZWFW6xp9Fuif7

Setup a folder on the robot for your own code

```
cd 16762/
mkdir your_name
cd your_name

# Create a Python virtual env (that way your pip installs don't break other people's code)
python3 -m venv env
source env/bin/activate
pip3 install --upgrade pip
pip3 install hello-robot-stretch-body
pip3 install numpy==1.26.4 opencv-contrib-python==4.10.0.84 opencv-python==4.11.0.86

# Create your own GitHub repo.
git clone https://github.com/YourUserName/YourRepoName.git
```

When you turn on the robot

Put the battery into **SUPPLY** mode.

Run:

```
cd 16762/your_name
source env/bin/activate
stretch_robot_home.py
```

Some helpful functions

Stretch API:

```
robot.stow()
```

ROS 2 API:

https://docs.hello-robot.com/0.3/ros2/intro_to_hellonode/

```
node.stow_the_robot()

node.move_to_pose({'joint_arm': 0.7}, blocking=True)

node.move_to_pose({‘joint_wrist_yaw':
            node.joint_state.position[node.joint_state.name.index(‘joint_wrist_yaw')] +
            np.radians(45)}, blocking=True)
```

Joint names

ROS 2 API:

https://docs.hello-robot.com/0.3/ros2/intro_to_hellonode/

```
joint_arm
joint_lift
joint_wrist_yaw
joint_wrist_pitch
joint_wrist_roll
joint_gripper_finger_left or joint_gripper_finger_right
joint_head_pan
joint_head_tilt
translate_mobile_base
rotate_mobile_base
```

How to edit code on robot? Try VIM

`vim ros2.py`

Use arrow keys to move cursor to where you want.

Press `i` to enter edit mode. Type out your changes.

Press `Ctrl+c` to exit edit mode.

Press `:` then press `w` then press `Enter/Return` to write (save) the file.

Press `:` then `q` then `Enter/Return` to exit VIM.

How to connect into the robot

- We have two robots — 3159 and 3160. These numbers are on the back of the robot near the on/off switch.
- Username: hello-robot
- Password: 16762cmu!
- stretch-se3-3159:
    - **SSH**: ssh -X hello-robot@stretch3159.wifi.local.cmu.edu
    - **Anydesk**: 1943010008
- stretch-se3-3160:
    - **SSH**: ssh -X hello-robot@stretch3160.wifi.local.cmu.edu
    - **Anydesk**: 1424568870

Scheduling time with the robot

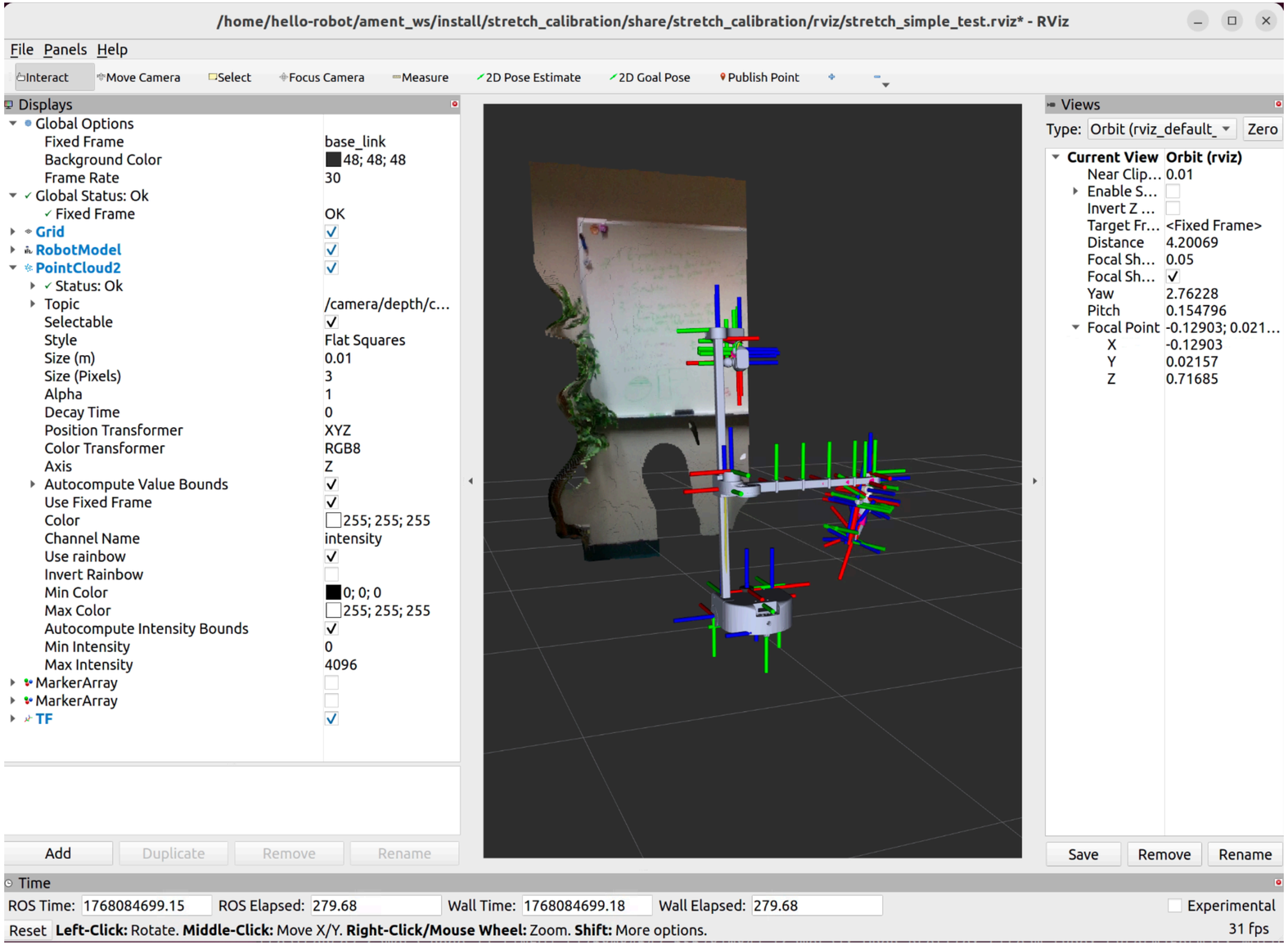
- We have a Google Calendar for each robot, which you have all been added to.
- For this lecture you can reserve max 10 minutes on the robot.
- In the AI Maker Space, max 1 hour time block, then let another student use the robot.

  (The maximum allowed time will increase once we have teams)
- **Be courteous**, don't hog the robot, let someone else use it and come back in an hour.

Part #3: Rviz

Launch Rviz, display the robot, all of the TF2 coordinate frames and the colored point cloud from the robot's RealSense camera. Take a screenshot and upload with your submission.

Solution


/home/hello-robot/ament_ws/install/stretch_calibration/share/stretch_calibration/rviz/stretch_simple_test.rviz* - RViz
File Panels Help
Interact
Move Camera
Select
Focus Camera
Measure
2D Pose Estimate
2D Goal Pose
Publish Point
Displays
Global Options
Fixed Frame base_link
Background Color 48; 48; 48
Frame Rate 30
Global Status: Ok
Fixed Frame OK
Grid
RobotModel
PointCloud2
Status: Ok
Topic /camera/depth/c...
Selectable
Style Flat Squares
Size (m) 0.01
Size (Pixels) 3
Alpha 1
Decay Time 0
Position Transformer XYZ
Color Transformer RGB8
Axis Z
Autocompute Value Bounds
Use Fixed Frame
Color 255; 255; 255
Channel Name intensity
Use rainbow
Invert Rainbow
Min Color 0; 0; 0
Max Color 255; 255; 255
Autocompute Intensity Bounds
Min Intensity 0
Max Intensity 4096
MarkerArray
MarkerArray
TF
Add
Duplicate
Remove
Rename
Views
Type: Orbit (rviz_default_
Zero
Current View Orbit (rviz)
Near Clip... 0.01
Enable S...
Invert Z ...
Target Fr... <Fixed Frame>
Distance 4.20069
Focal Sh... 0.05
Focal Sh...
Yaw 2.76228
Pitch 0.154796
Focal Point -0.12903; 0.021...
X -0.12903
Y 0.02157
Z 0.71685
Save
Remove
Rename
Time
ROS Time: 1768084699.15
ROS Elapsed: 279.68
Wall Time: 1768084699.18
Wall Elapsed: 279.68
Experimental
Reset
Left-Click: Rotate. Middle-Click: Move X/Y. Right-Click/Mouse Wheel: Zoom. Shift: More options.
31 fps

Part #4: Stretch API

Move the arm and gripper back to it's 'stow' position. This can be done with a single line of code.

Make sure there is sufficient free space around the robot so it doesn't collide with things as it moves.

Extend the telescoping arm all the way out and raise the lift all the way up at the same time. Once lifted, move all three of the wrist motors, one at a time (not all at once). Any rotation amount is fine as long as it is visible. Then open the gripper and close it. Then rotate both of the two motors connected to the RealSense (head camera). Then reset everything back to the 'stow' position.

Once in stow, drive the robot forward 0.5 meters, rotate 180 degrees, then drive 0.5 meters forward (back to the starting position).

ROS API

Repeat all of the motions from the previous slide, but using ROS 2 commands.

Solution