Robotics Lab - 221 LIA 001
Assignment 2
Due: November 04, 2024, 2.00 pm IST

Instructions

1. All final code files to be pushed to your assignment repo
2. The questions below are to be answered serial order in a text file them pushed to your assignment repo as a **single file named <*your first name_ assignment2_ answers.txt* file**
3. Commit all files to the assignment git

1. **Battery state publisher-subscriber**
   You are building an autonomous mobile robot similar to the ROSbot 2R [1]. Write a rospy code to publish the following battery information (voltage, temperature, percentage, location (battery location eg, main battery), battery serial number) of the bot and subscribe it via a topic. The battery information is published every 0.25 seconds. The screenshot of the solution is shown in (figure 2)

Figure 1: Husarion ROSbot 2R [1]

   (a) List the currently running nodes
   (b) List the currently running topics
   (c) Run the rqt_graph tool and save the node graph as 'question1_rqt1.png'
   (d) Screencast the terminals, save the screencast as 'battery_your first name.webm' Save terminal screenshot as battery_your first name.png

2. **Unit conversion service**
   Multiple ultrasound sensors are mounted on an mobile robot for distance measurement. Create a ROS service that accepts the distance measured by the sensor (client) in Centimeters and responds with distance converted to Millimeters to the client.

   Run the service server node script and answer the questions below:

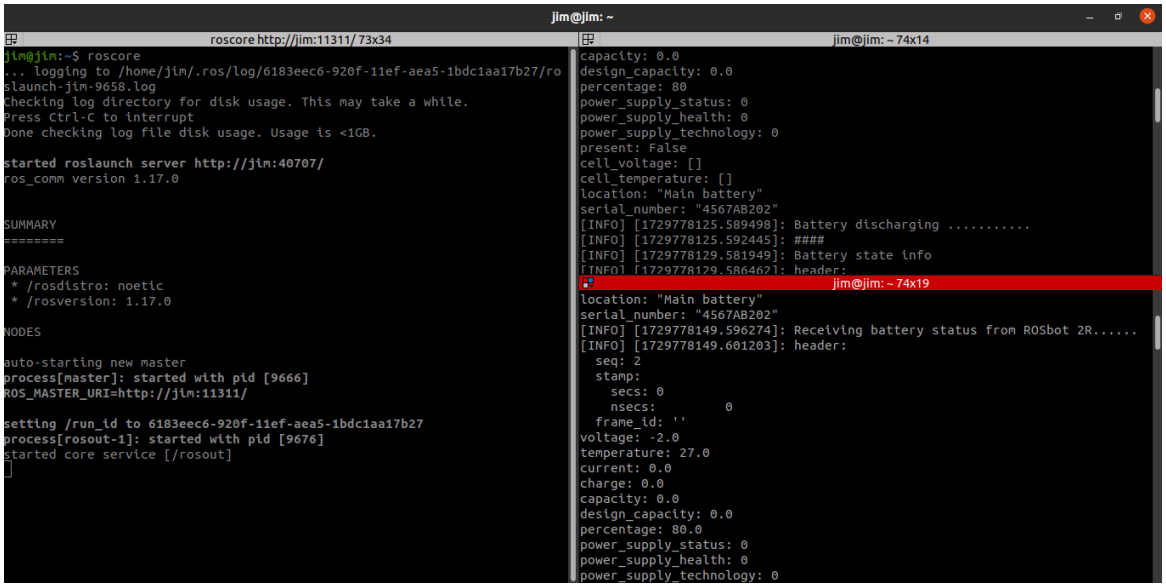


Figure 2: Question 1 solution running

(a) List the currently running nodes

(b) List the currently running topics

(c) List the currently running services

(d) Screencast the running terminals, save the screencast as 'ultrasound1_your first name.webm' and commit to git

(e) Call the service you created using the command `rosservice call <service1 name> <args>`. Save terminal screenshot as ultra_your first name.png

Run the service client node & service server node scripts and answer the questions below:

(a) List the currently running nodes

(b) List the currently running topics

(c) List the currently running services

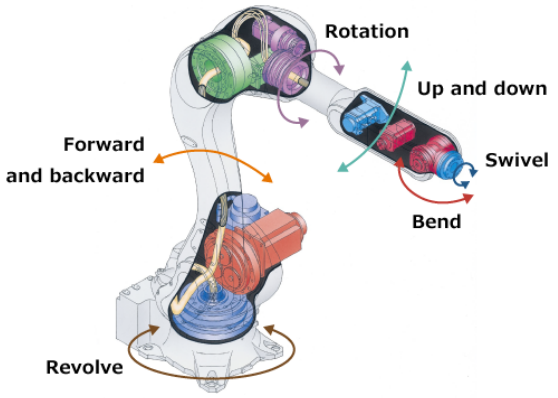
(d) Screencast the running terminals, save the screencast as 'ultrasound2_your first name.webm' and commit to git

3. **Fault diagnostic service**

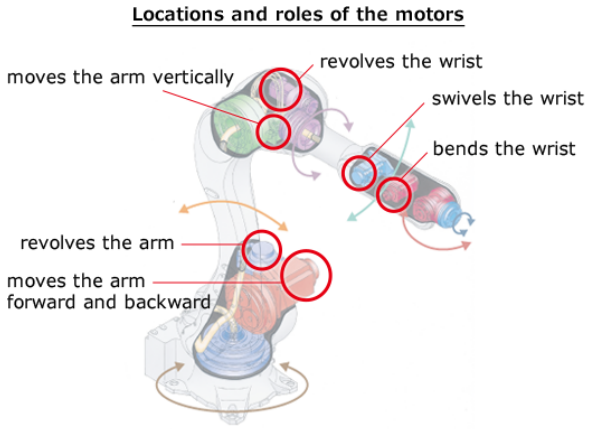
An industrial robotic arm similar to the one shown in figures 3a & 3b have a diagnostic code that checks on power up / restart whether all the components of the system are working properly.

In this assignment question we simulate the diagnostic code as a client node named *diagnostics* that request status from the robot joint motors.

- The three motor nodes (server nodes *motor1, motor2, motor3*) provide the response *'True'* or *'False'* to the *diagnostics* corresponding to whether the diagnostic test is passed by the motor or not. A string message for informational purpose is also passed to the *diagnostics*.



(a) Industrial robotic arm [2]



(b) Industrial robotic arm location of motors [2]

- *diagnostics* prints (on the terminal) response and the string message passed by the motor nodes. (see code execution video below)
- If all three motors pass the test, then the *diagnostics* node prints the message `'Joint motors check : PASS'` else the message `'Joint motors check : FAIL'`

(a) Realize the server nodes and client node. Run `rqt_graph` and paste the screenshot here

(b) List the running nodes

(c) List the running services

(d) Screencast the running terminals, save the screencast as 'motor1_your first name.webm' and commit to git

(e) Use `rospy.logerr` to generate an error message if any of the nodes fail. Screencast the error message displayed on terminal(s), save the screencast as 'motor2_your first name.webm' and commit to git

4. **Temperature monitoring**

On August 27 2023, the Indian Space Research Organisation (ISRO) released a graph of the temperature variation between the moon's surface and a point around 8 cm below as measured by an instrument named ChaSTE on board the lander module of the Chandrayaan-3 mission [3][4]. ChaSTE is a temperature probe that can be driven into the moon's surface using a motor to a depth of up to 10 cm. The temperature probe has 10 sensors.

The question 2 of assignment is inspired from the ChaSTE probe on-board the Vikram lander. Assuming that the above system is ROS 1 based, we simulate the temperature acquisition using ROS publisher-subscriber model involving two nodes 'temperature_sensor' and 'control_unit_01'. The 'temperature_sensor' node publishes temperature updates acquired by 'probe_01' on topic 'temperature_update' at rate of 1.0 Hz. The 'control_unit_01' node subscribes to the 'temperature_update' topic.

(a) List the currently running nodes

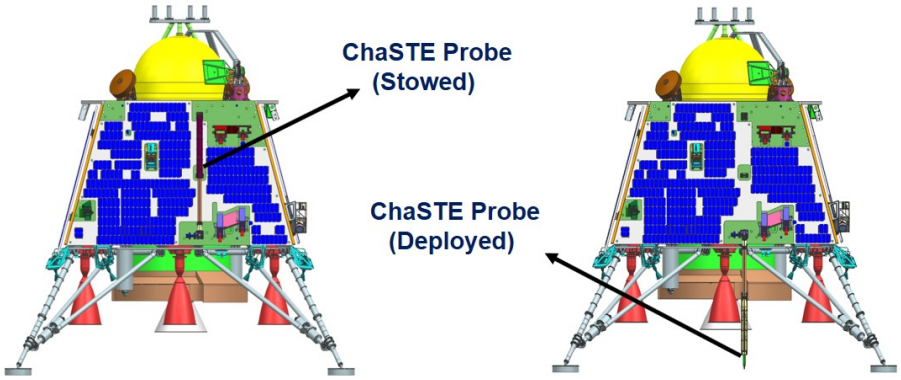


Figure 4: Chandra's Surface Thermophysical Experiment (ChaSTE) probe [3]

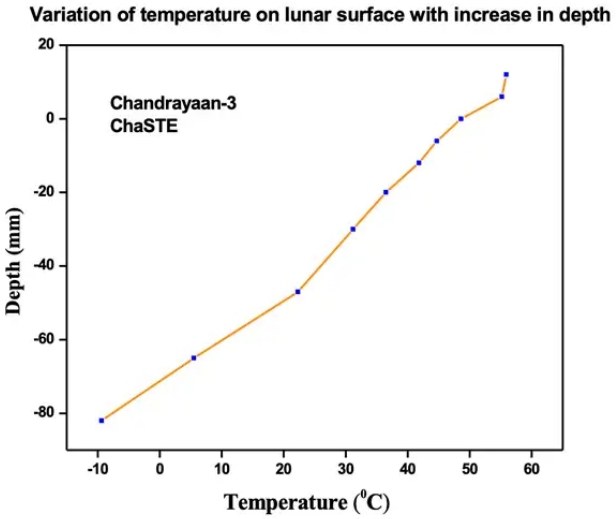


Figure 5: Variation of temperature on lunar surface with increase in depth [4]

(b) List the currently running topics

(c) Run the rqt_graph tool and paste the ros graph'

(d) Use the built-in screen recorder, and record a **35 second** of the terminals showing the nodes running. Save the file in *webm* format as vikram_your first name.webm as commit in the assignment submission.

(Refer this link on how to save videos using Ubuntu 20.04's built-in screen recorder)

Hints :

(a) Use suitable ROS message types from *sensor_msg* package to simulate the system

(b) The random temperature values can be generated using methods from *random* Python module like *random.randrange()* or *random.random()*

(c) Refer the documentation available at ROS Wiki

References

[1] @online Husarion ROSbot 2R, https://store.husarion.com/collections/robots Online; accessed 24-October-2024

[2] @online How Are Industrial Robots Built? A Guide on the Components and the Movement of Robot Arms, https://robotics.kawasaki.com/ja1/xyz/en/1804-03/ Online; accessed 30-October-2023

[3] @online Chandra's Surface Thermophysical Experiment (ChaSTE), https://www.prl.res.in/~pids/ChaSTE.html# Online; accessed 24-October-2024

[4] @online The first observations from the ChaSTE payload onboard Vikram Lander, https://www.isro.gov.in/Ch3_first_observation_ChaSTE_Vikram_Lander.html#:~:text=ChaSTE%20(Chandra's%20Surface%20Thermophysical%20Experiment,10%20cm%20beneath%20the%20surface. Online; accessed 24-October-2024

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