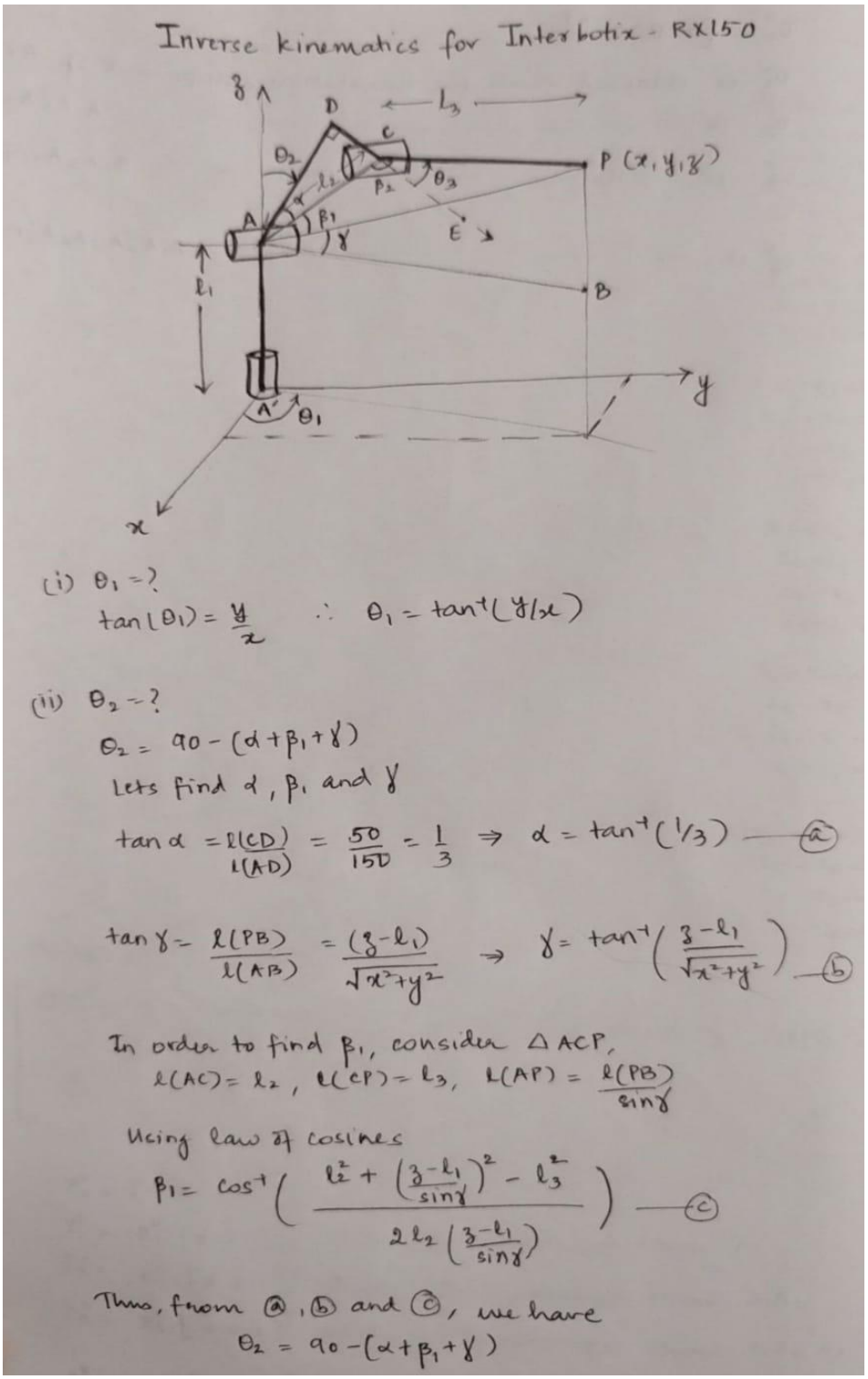
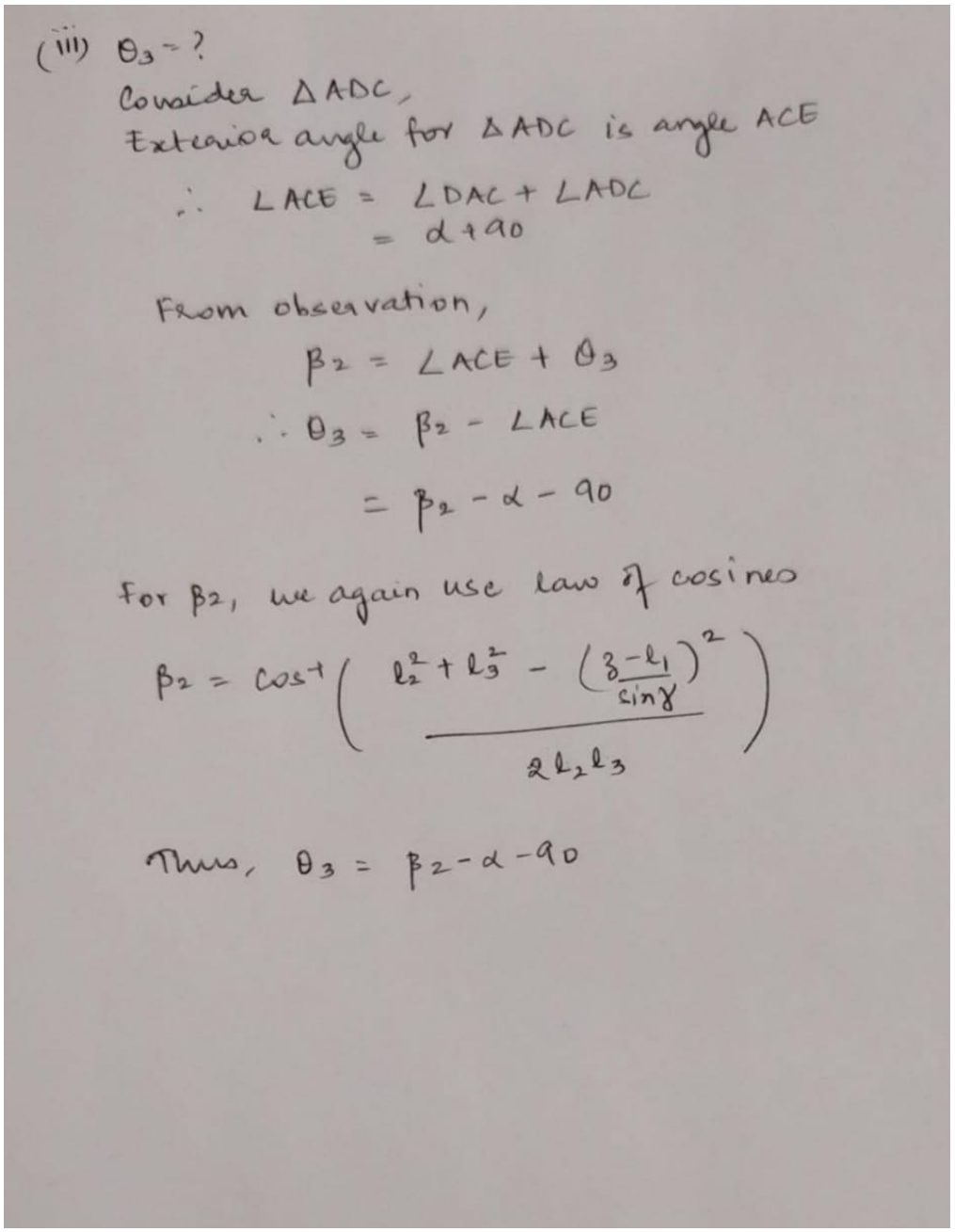
ROS Assignment 3 Report

The inverse kinematics of the Interbotix RX-150 manipulator were calculated after carefully studying the schematic diagram for lengths and angles. The following image shows the derivation of the joint angles using geometry on the basis of which the *inverse_kinematics.py* script works.





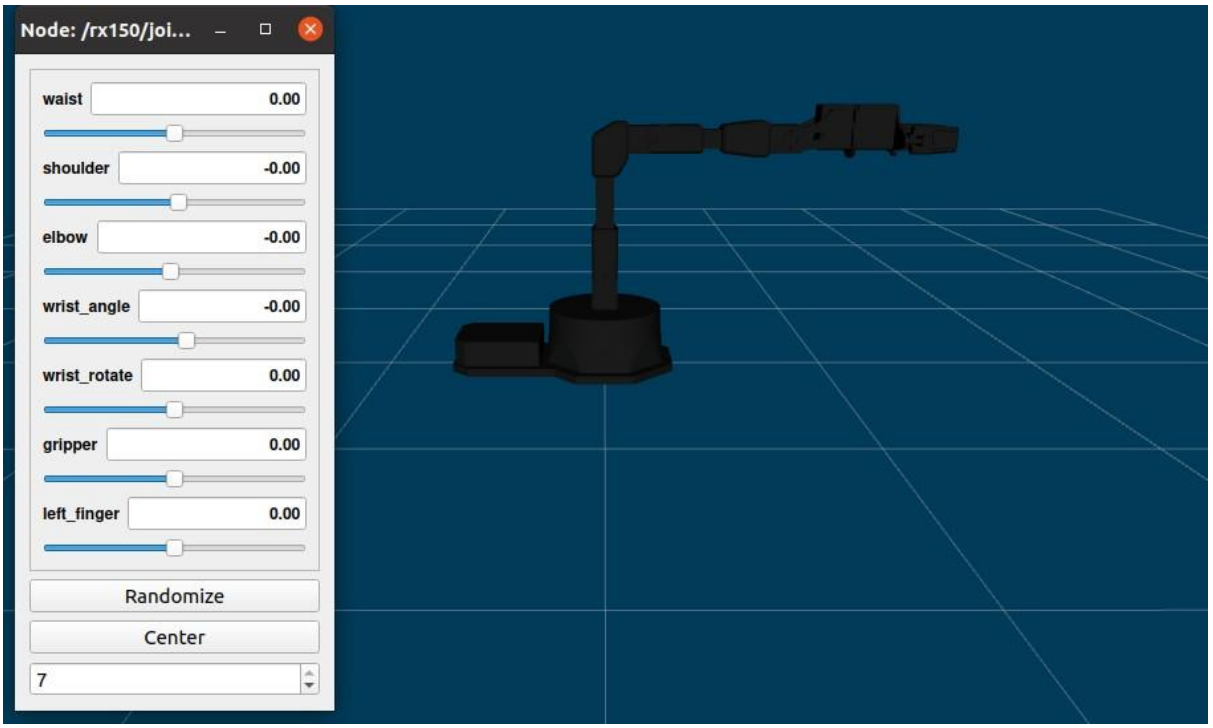
How does the script work?

- Defines a function to calculate the angle using the Law **of cosines**.
- Defines expressions for the joint angles and the intermediate angles and lengths
- Takes the position of the end-effector as argument and returns the joint angles

Note: The screenshots of results for the various test cases have been attached in the pages to follow.

Test case 1:

RViz:



tf_echo:

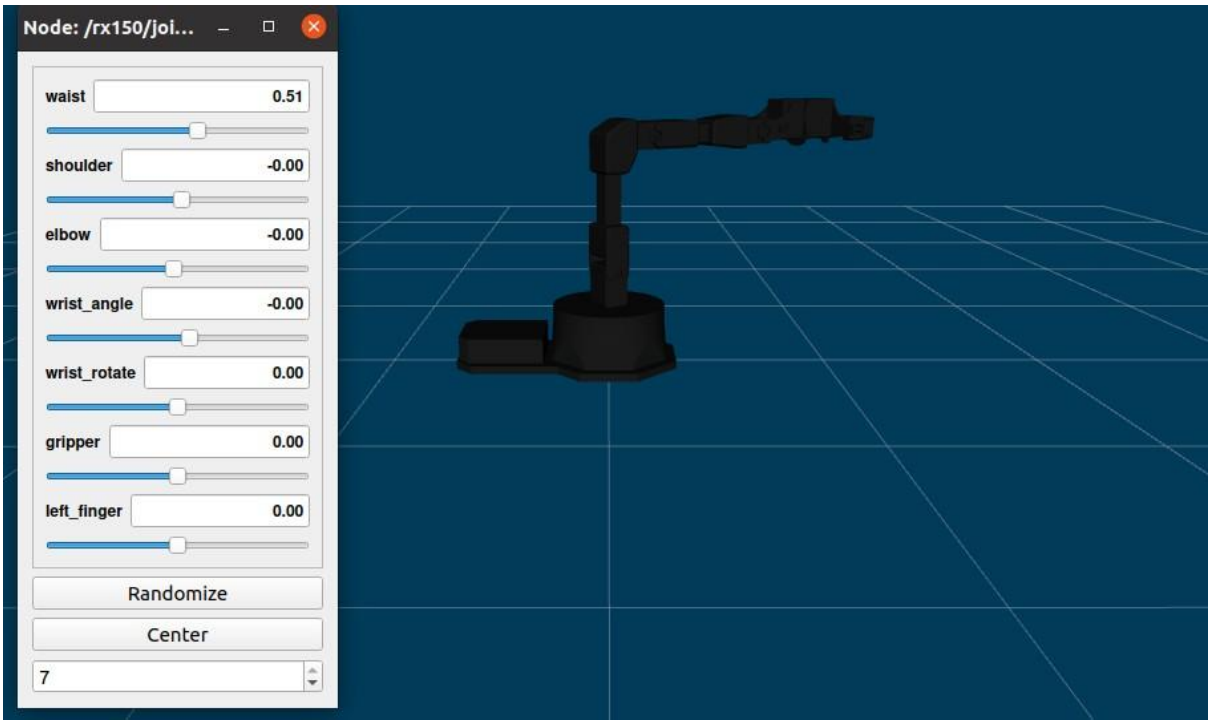
```
At time 1645837292.339
- Translation: [0.200, 0.000, 0.254]
- Rotation: in Quaternion [1.000, 0.000, 0.000, 0.000]
            in RPY (radian) [3.142, -0.001, 0.000]
            in RPY (degree) [180.000, -0.044, 0.000]
At time 1645837293.385
- Translation: [0.200, 0.000, 0.254]
- Rotation: in Quaternion [1.000, 0.000, 0.000, 0.000]
            in RPY (radian) [3.142, -0.001, 0.000]
            in RPY (degree) [180.000, -0.044, 0.000]
```

script:

```
radha@radha-hp-nb:~/WPI/RBE-500/rbe500_ros$ python src/inverse_kinematics/script
s/test_inverse_kinematics.py
[INFO] [1645837220.386232]: Press Ctrl + C to terminate
joint angles (rad) =  [0.    0.    0.001]
joint angles (deg) =  [0.    0.017 0.061]
target position (m) =  [0.2   0.    0.254]
```

Test case 2:

RViz:



tf_echo:

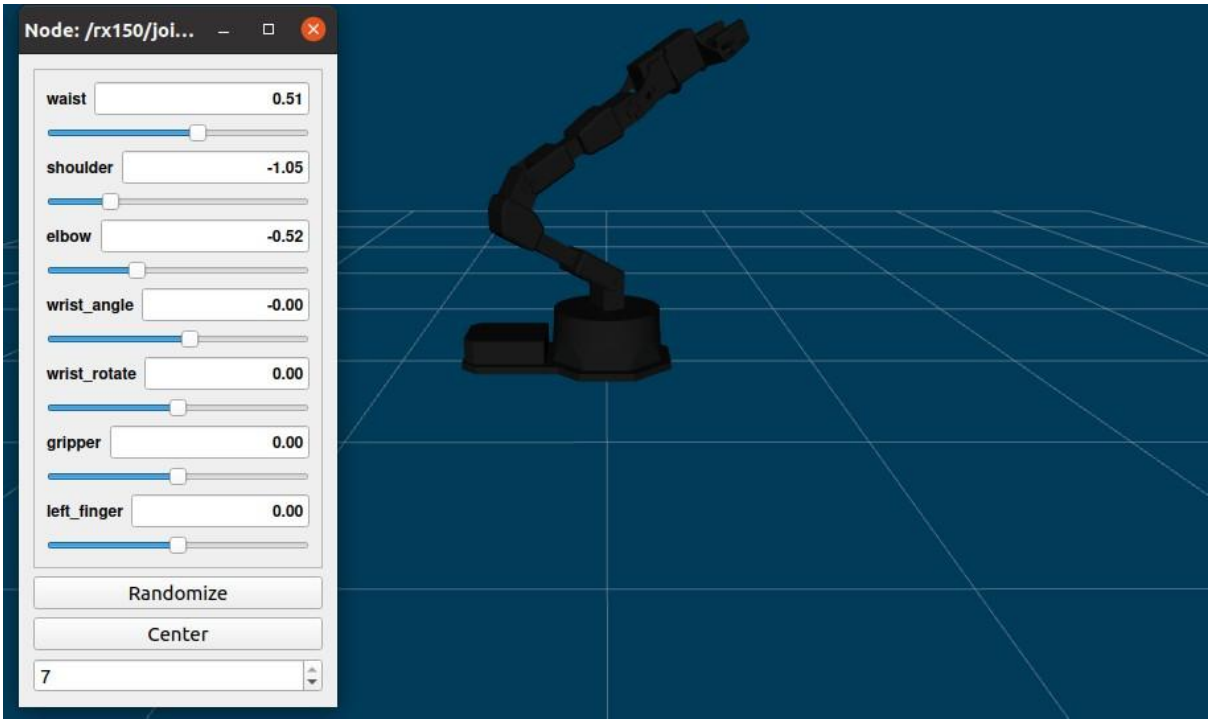
```
At time 1645838060.399
- Translation: [0.173, 0.100, 0.254]
- Rotation: in Quaternion [0.966, 0.259, 0.000, -0.000]
            in RPY (radian) [3.142, -0.000, 0.524]
            in RPY (degree) [180.000, -0.009, 30.001]
At time 1645838061.385
- Translation: [0.173, 0.100, 0.254]
- Rotation: in Quaternion [0.966, 0.259, 0.000, -0.000]
            in RPY (radian) [3.142, -0.000, 0.524]
            in RPY (degree) [180.000, -0.009, 30.001]
```

script:

```
radha@radha-hp-nb:~/WPI/RBE-500/rbe500_ros$ python src/inverse_kinematics/script
s/test_inverse_kinematics.py
[INFO] [1645837997.642176]: Press Ctrl + C to terminate
joint angles (rad) =  [0.524 0.    0.   ]
joint angles (deg) =  [30.001  0.015  0.024]
target position (m) =  [0.173 0.1   0.254]
```

Test case 3:

RViz:



tf_echo:

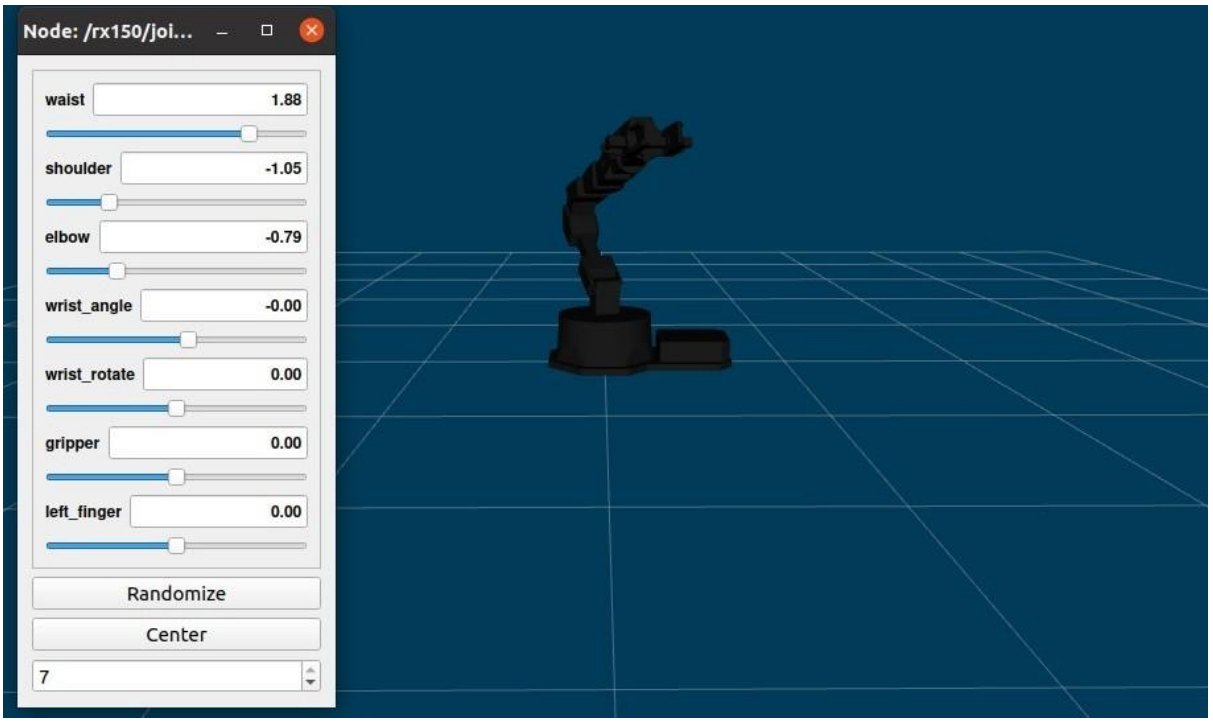
```
At time 1645838452.378
- Translation: [0.022, 0.013, 0.297]
- Rotation: in Quaternion [0.933, 0.250, 0.250, -0.067]
            in RPY (radian) [3.142, -0.524, 0.524]
            in RPY (degree) [180.000, -30.008, 30.001]
At time 1645838453.365
- Translation: [0.022, 0.013, 0.297]
- Rotation: in Quaternion [0.933, 0.250, 0.250, -0.067]
            in RPY (radian) [3.142, -0.524, 0.524]
            in RPY (degree) [180.000, -30.008, 30.001]
```

script:

```
radha@radha-hp-nb:~/WPI/RBE-500/rbe500_ros$ python src/inverse_kinematics/script
s/test_inverse_kinematics.py
[INFO] [1645838436.628388]: Press Ctrl + C to terminate
joint angles (rad) =  [ 0.524 -1.047 -0.523]
joint angles (deg) =  [ 30.001 -59.984 -29.976]
target position (m) =  [0.022 0.012 0.297]
```

Test case 4:

RViz:



tf_echo:

```
At time 1645836332.379
- Translation: [-0.012, 0.038, 0.261]
- Rotation: in Quaternion [0.586, 0.800, 0.077, -0.106]
            in RPY (radian) [3.142, -0.262, 1.877]
            in RPY (degree) [180.000, -15.037, 107.526]
At time 1645836333.387
- Translation: [-0.012, 0.038, 0.261]
- Rotation: in Quaternion [0.586, 0.800, 0.077, -0.106]
            in RPY (radian) [3.142, -0.262, 1.877]
            in RPY (degree) [180.000, -15.037, 107.526]
```

script:

```
radha@radha-hp-nb:~/WPI/RBE-500/rbe500_ros$ python src/inverse_kinematics/script
s/test_inverse_kinematics.py
[INFO] [1645836399.028190]: Press Ctrl + C to terminate
joint angles (rad) =  [ 1.877 -1.048 -0.786]
joint angles (deg) =  [107.526 -60.043 -45.006]
target position (m) =  [-0.012  0.038  0.261]
```