HIGH SPEED CAMERA USING A MOBILE MANIPULATOR

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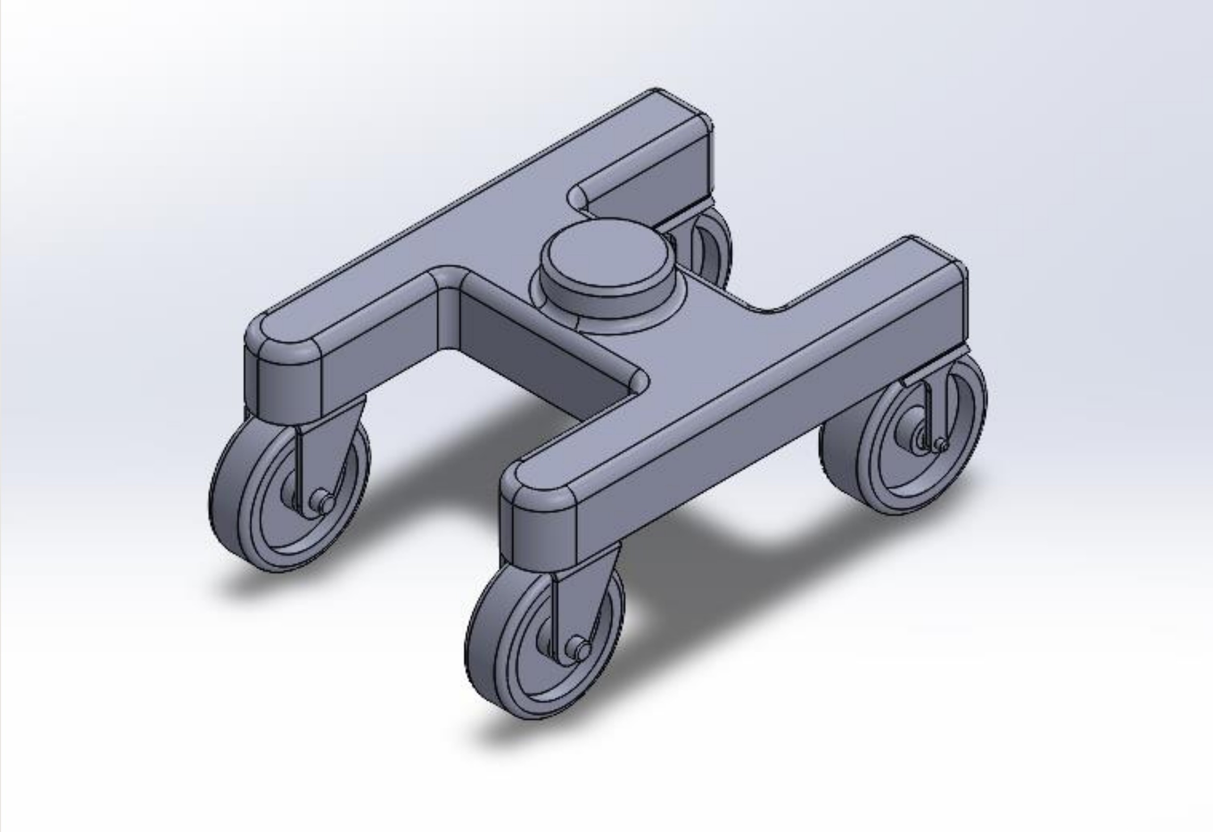
PROBLEM & MOTIVATION

- There are some complex camera movements which cannot be achieved by a cinematographer/director using hands or even stabilizing gimbals which are used by many studios for acquiring professional shots.
- A High-speed Robotic Camera can achieve such cinematic shots by programming the speed and providing an input to reach the desired target and orientation.
- Such robotic arm configurations can go from one position to another in a fraction of a second.
- The parameters can be pre-programmed and hence the robot can operate on its own.
- Recently, Apple INC. also shot their advertisement for their new iPhone 14 phone using a robotic cam and achieved very precise shots.

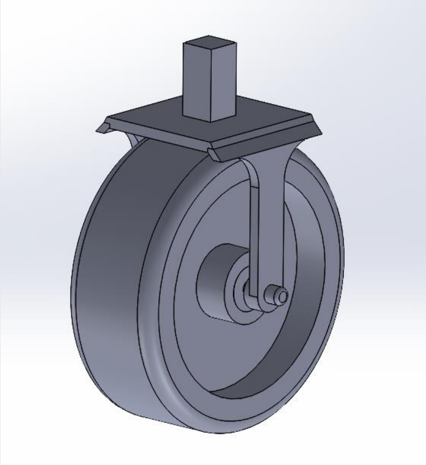
STEPS INVOLVED

1. Design and assemble a mobile platform for the UR3 manipulator in SolidWorks and exporting to URDF
2. Calculation and validation of Forward Kinematics and Inverse Kinematics of the manipulator
3. Build the ROS Package with controllers and writing scripts for the entire assembly to move the robot
4. Simulate and Visualize using Gazebo and RViz

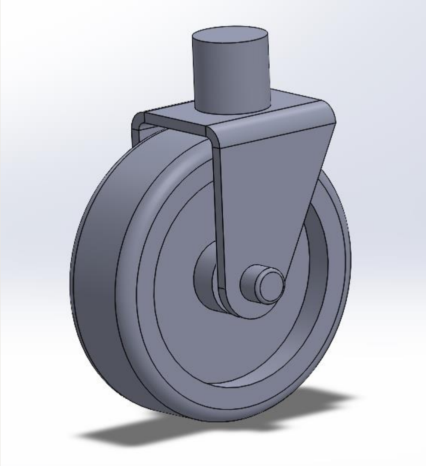
ROBOT DESIGN



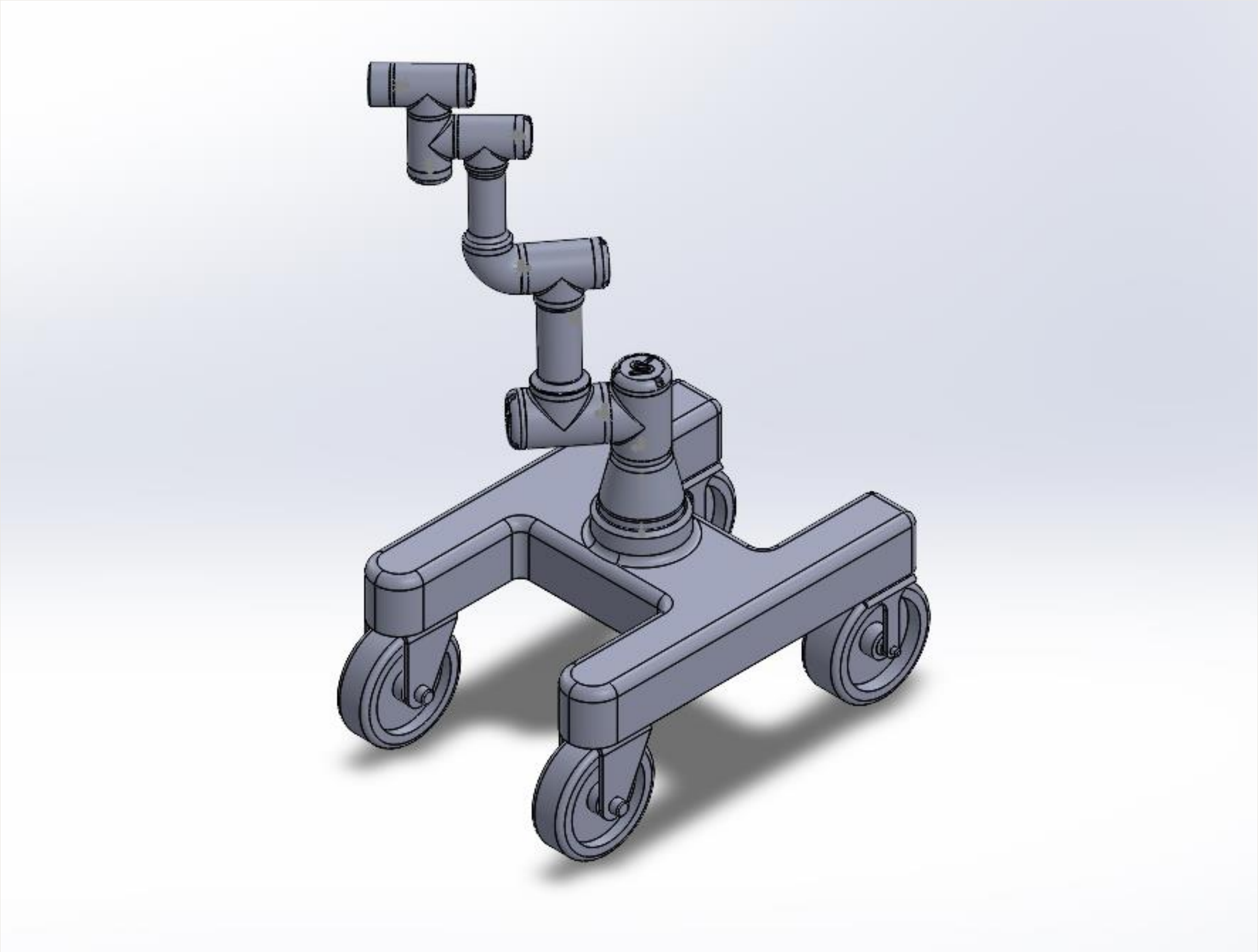
Chassis



Rear wheel Assembly

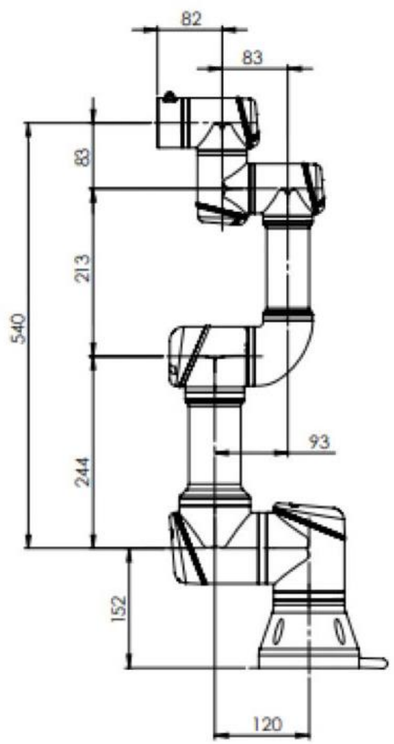


Front wheel Assembly

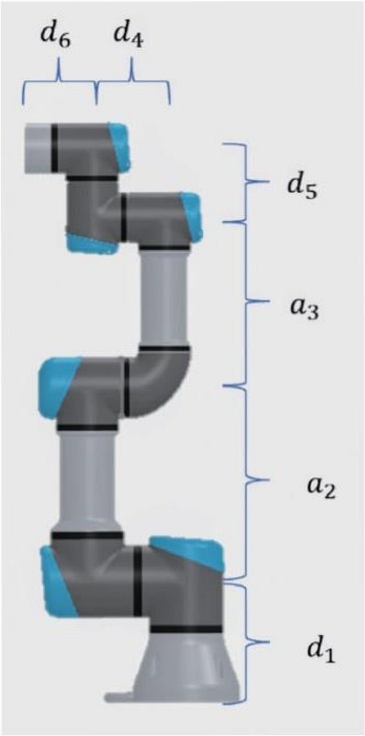


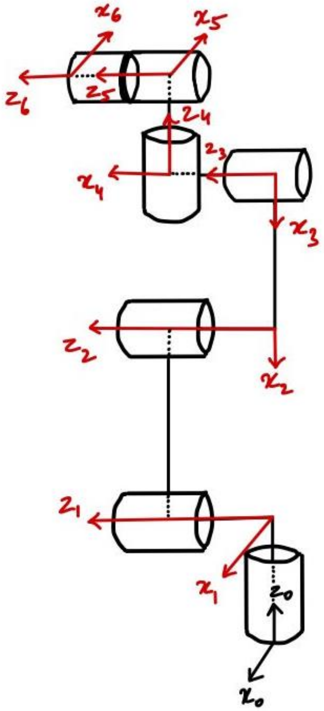
Mobile Manipulator Assembly

FORWARD KINEMATICS



All dimension is in mm

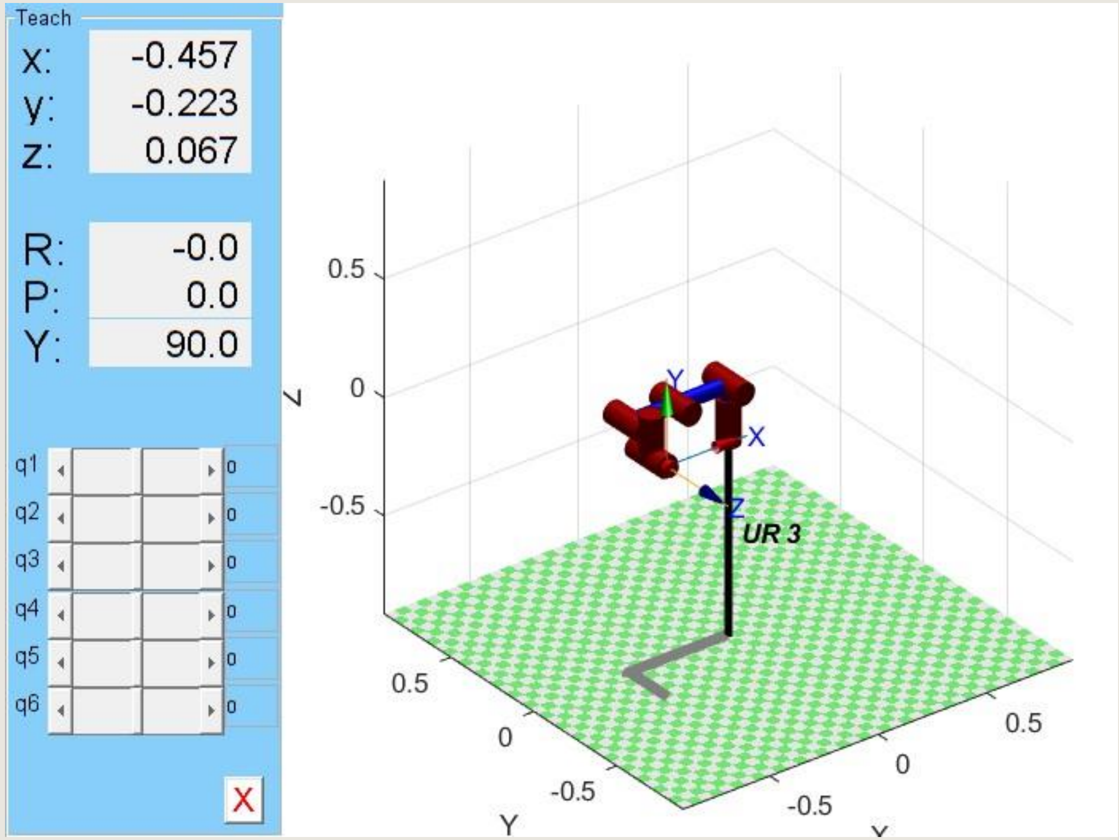


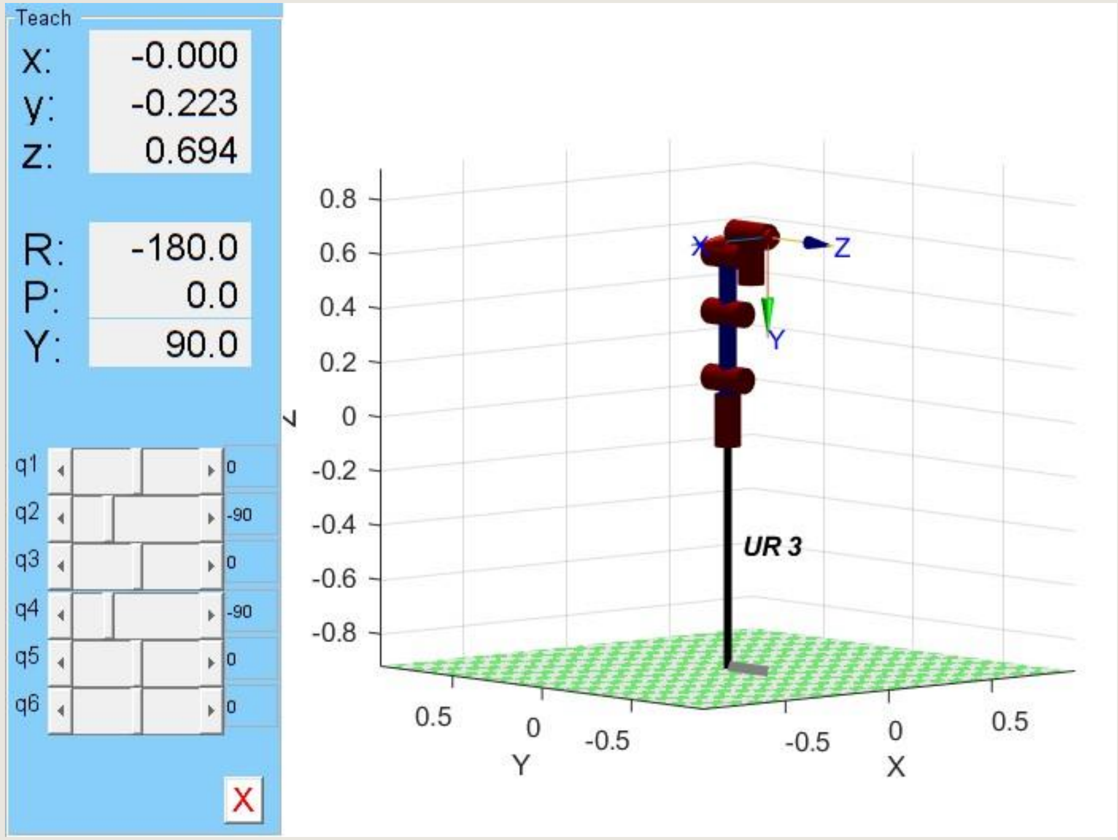


DH Table

Joint	a_i	d_i	α_i	θ_i	Offset
1	0	d_1	$\pi/2$	θ_1	0
2	a_2	0	0	θ_2	$-\pi/2$
3	a_3	0	0	θ_3	0
4	0	d_4	$\pi/2$	θ_4	$-\pi/2$
5	0	d_5	$-\pi/2$	θ_5	0
6	0	d_6	0	θ_6	0

Peter Corke's MATLAB Toolbox





INVERSE KINEMATICS

$$q_1 = atan2\,(d_4, \pm\sqrt{\left(d_6 a_y - p_y\right)^2 + \left(p_x - d_6 a_x\right)^2 - {d_4}^2}\,\Big) - atan2\left(d_6 a_y - p_y, p_x - d_6 a_x\right)$$

$$q_5 = atan2\left(\pm\sqrt{\left(n_x S_1 - n_y C_1\right)^2 + \left(o_x S_1 - o_y C_1\right)^2}, a_x S_1 - a_y C_1\right)$$

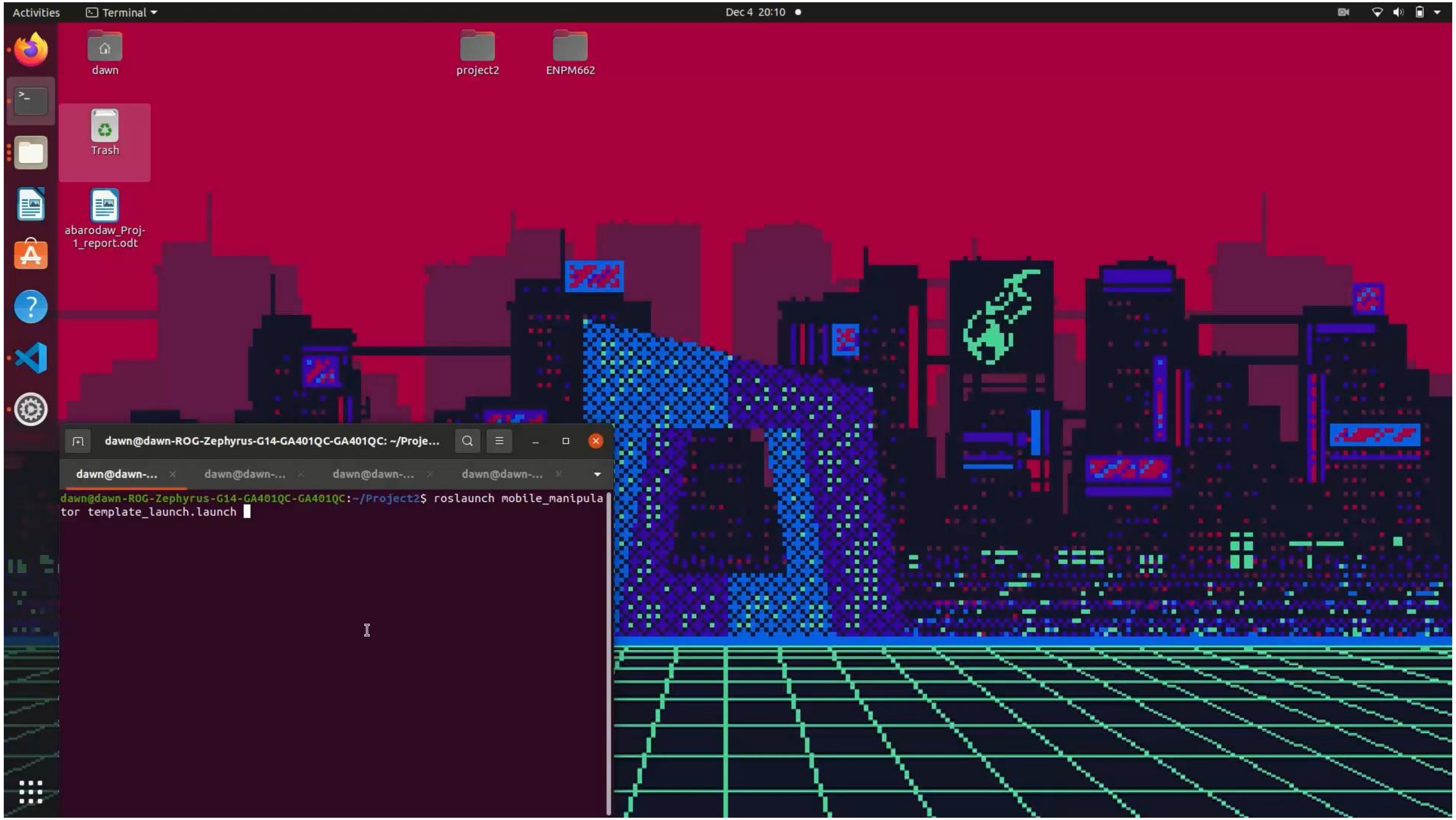
$$q_6 = atan2\left(\frac{-o_x S_1 - o_y C_1}{S_5}, \frac{n_x S_1 - n_y C_1}{S_5}\right)$$

$$q_3 = atan2\left(\pm\sqrt{1 - {P_3}^2}, P_3\right)$$

$$q_2 = atan2(r_2, r_1) - atan2(a_3 S_3 a_2 + a_3 C_3)$$

$$q_4 = atan2(n_2 C_5 c_6 - a_z S_5 - O_2 C_5 S_6, o_z C_6 + n_z S_6) - q_2 - q_3$$

SIMULATION


Activities
Terminal
Dec 4 20:10
dawn
project2
ENPM662
Trash
abarodaw_Proj-1_report.odt
dawn@dawn-ROG-Zephyrus-G14-GA401QC-GA401QC: ~/Proje...
dawn@dawn-...
dawn@dawn-ROG-Zephyrus-G14-GA401QC-GA401QC:~/Project2$ roslaunch mobile_manipulator template_launch.launch

CHALLENGES FACED

Design

1. Choosing an optimal design for the platform of the mobile manipulator.

2. Exporting to URDF and joint axes definition.

ROS & Visualization

1. Toppling of robot due to misalignment of center of mass of the mobile manipulator.

2. Choosing appropriate controllers for the smooth movement of arm joints.

3. Choosing the right position and orientation of the camera for the perfect view at the end effector.

INDIVIDUAL CONTRIBUTIONS

AAQIB

- Mobile platform design
- Forward kinematics
- Built ROS packages
- Integrated camera to the end effector

SANDEEP

- Defined Joint axes, origin and URDF export
- Inverse kinematics
- Added controllers for the robot arm
- Python script for moving the mobile robot

BOTH

- Gazebo and RViz visualization.
- Correct positioning and movement of the arm.

CONCLUSION

- With the help of mobile robotic camera, we can easily program the movements and achieve desired complex camera movements.
- By adding the platform, we can transport the robotic arm with ease.

REFERENCES

- UR3 CAD Model - https://www.traceparts.com/en/product/universal-robots-as-ur3-robot?Product=10-06032017-106400
- iPhone 14 ad BTS - https://youtube.com/shorts/hODFKkZD_nA?feature=share
- UR3 Image - https://www.semanticscholar.org/paper/Multiple-configurations-for-puncturing-robot-Abdelaziz-Luo/82bb0af4e8b5ea131aabc36b65dafeabd55c97aa

THANK YOU