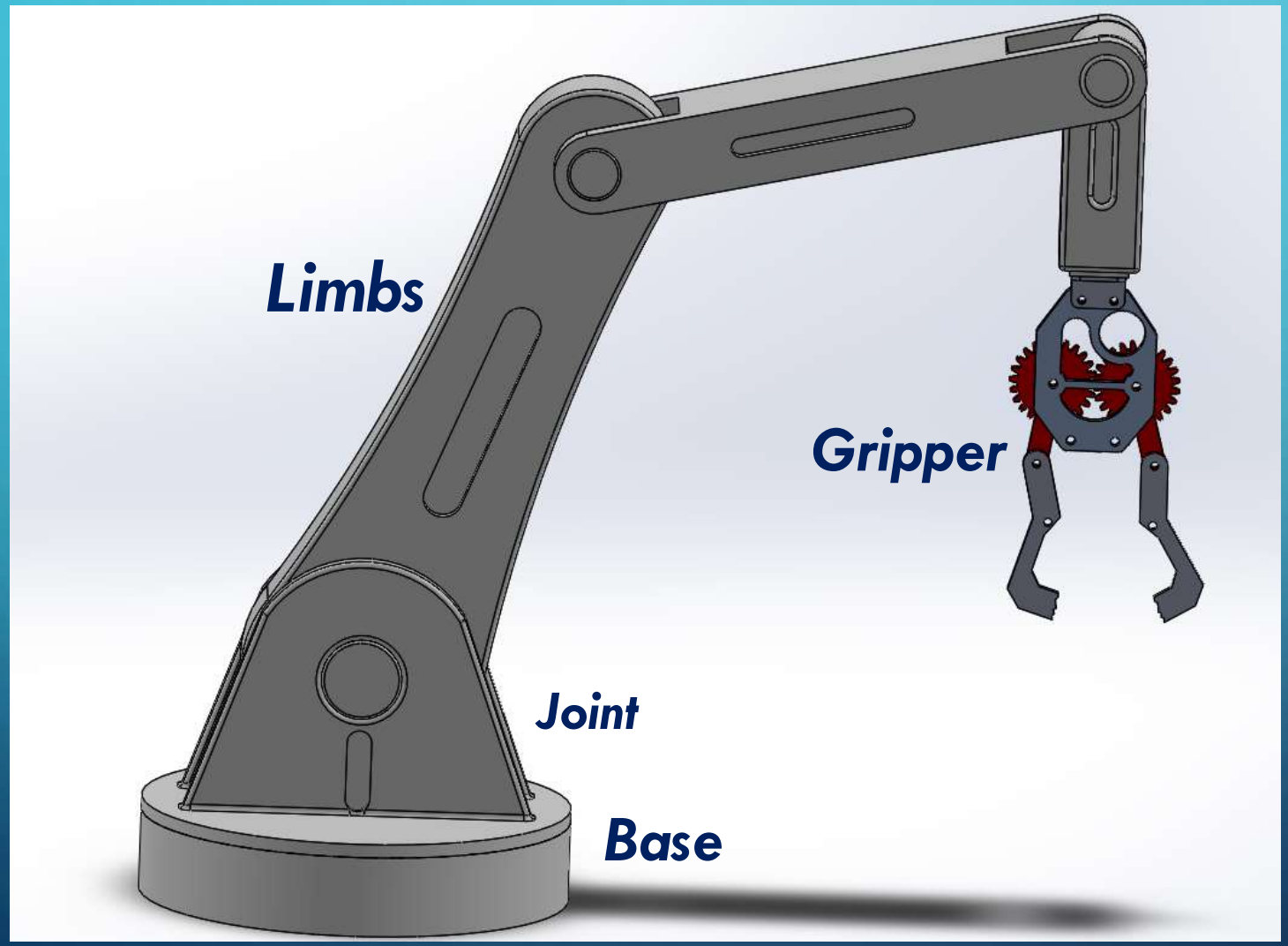
MARS OPEN PROJECT'22

ROBOTIC ARM SIMULATION

AJAY KR. SONWANI
HARSH KUMAR
AVIRAL JAIN
SAKSHAM JAISWAL

MENTORS-
HARSHINI MAM
DIWAHAR SIR

ROBOTIC ARM



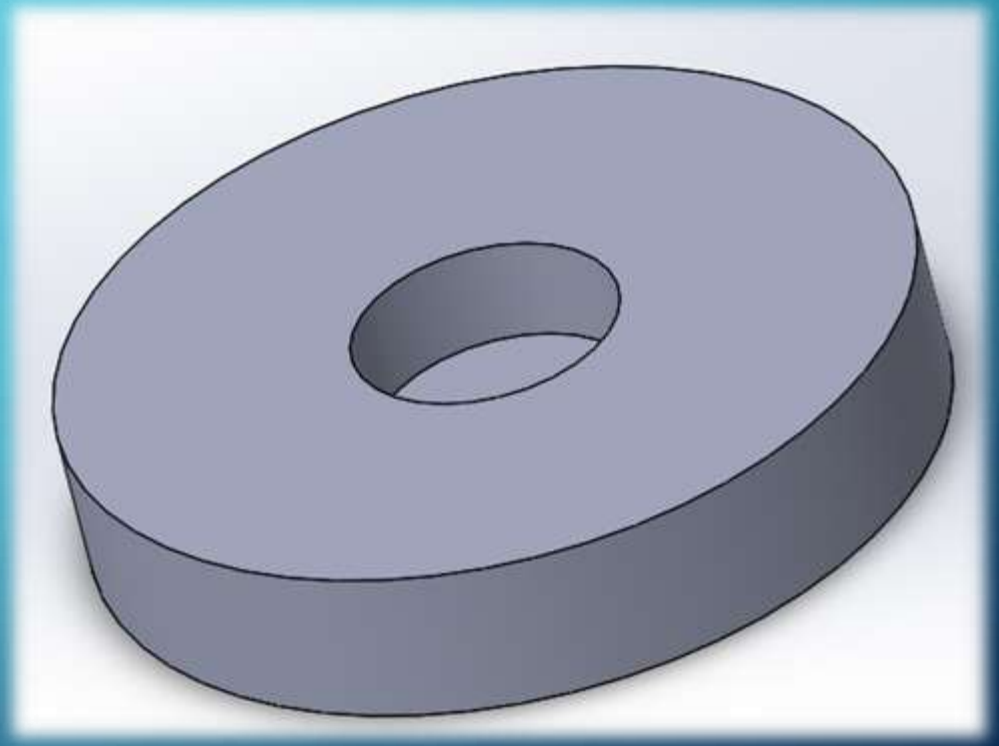
Designed in- Solidworks

Designed by-
Ajay Kr. Sonwani
Saksham Jaiswal

BASE

FEATURES OF SOLIDWORKS USED

1. Extruded Boss/Base
2. Extruded Cut
3. Smart Dimension.

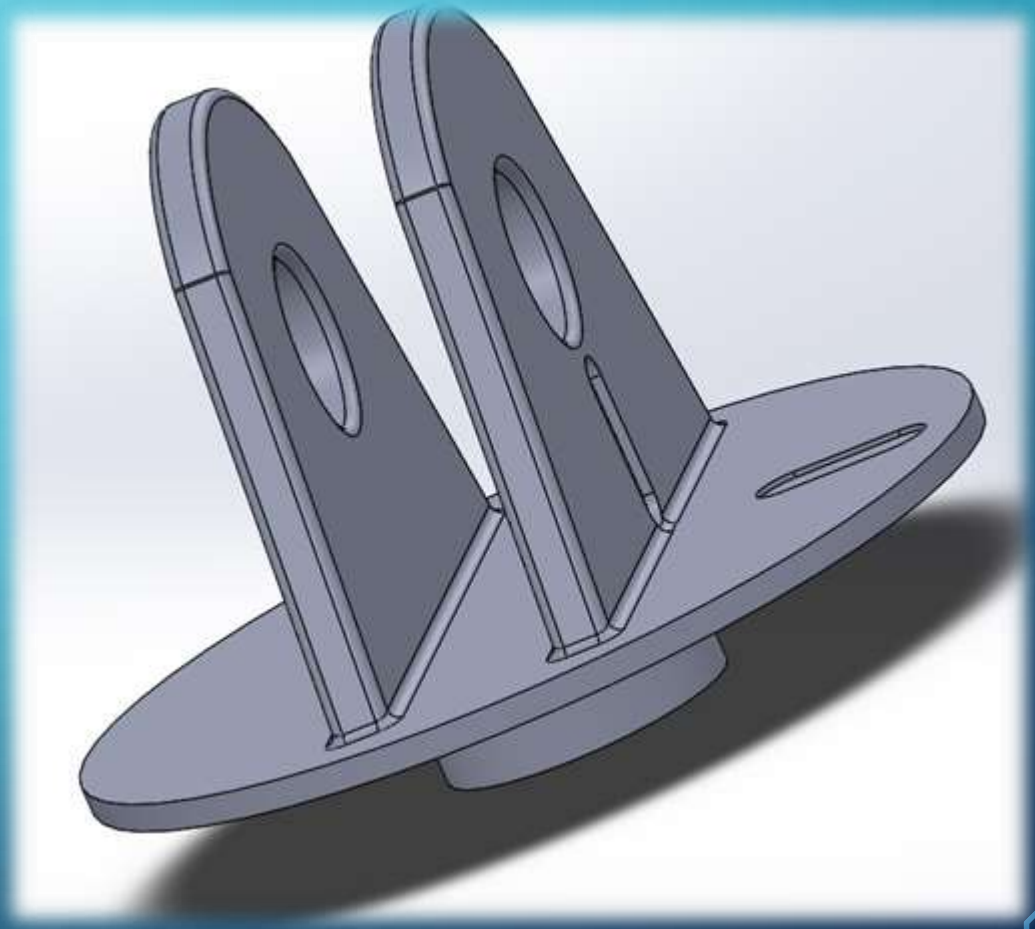


It is the stand of the robotic arm.

JOINT

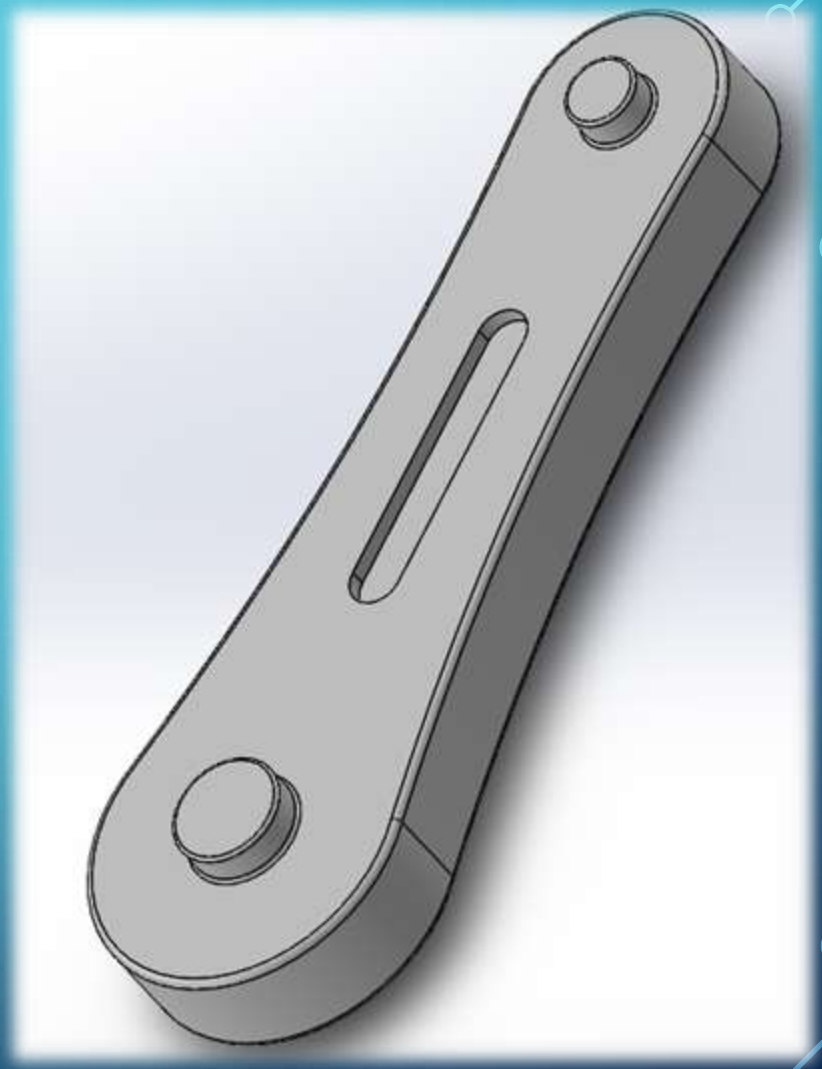
FEATURES USED

1. Extruded Boss/base
2. Extruded Cut
3. Mirror
4. Fillet
5. Smart Dimension



IT IS USED TO JOIN THE BASE AND THE LIMB.

LINK-1



FEATURES USED

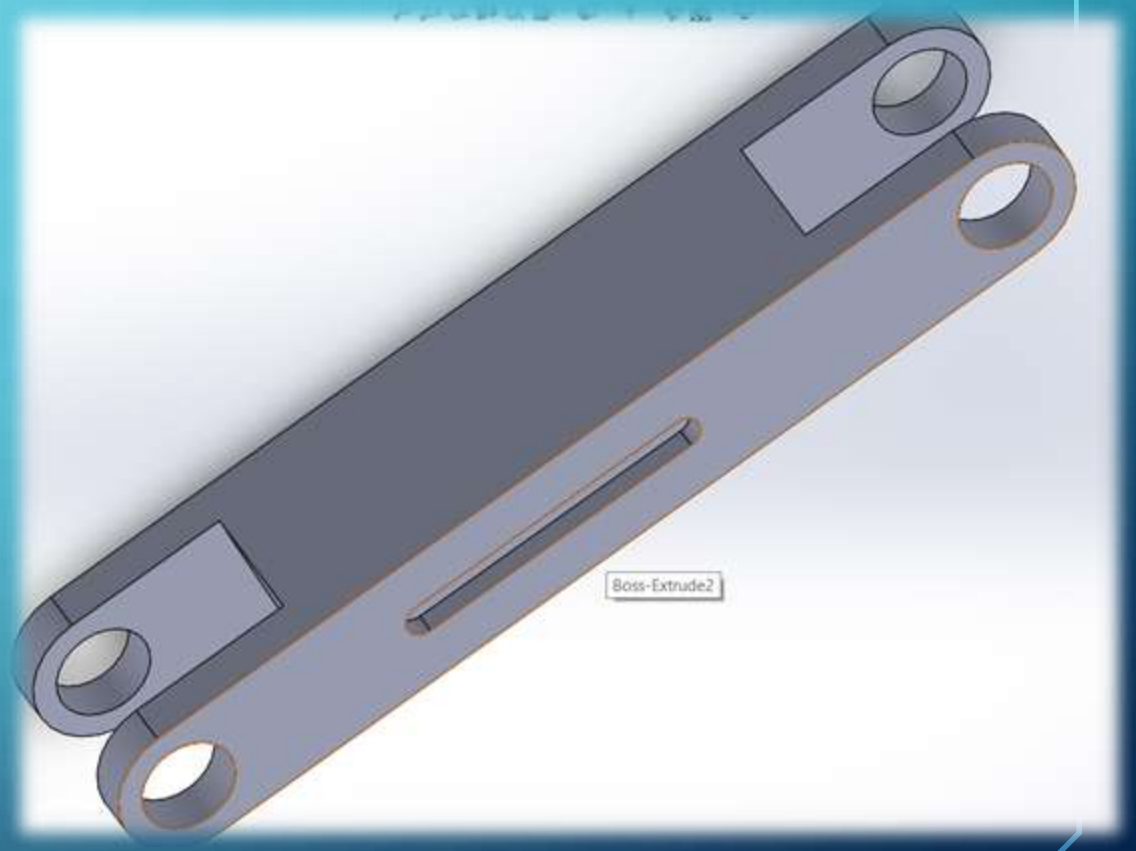
1. Extruded Boss/base
2. Extruded Cut
3. Mirror
4. Fillet
5. Smart Dimension

IT IS THE MOVING PART OF THE ROBOT.

LINK-2

FEATURES USED

1. Extruded Boss/base
2. Extruded Cut
3. Mirror
4. Fillet
5. Smart Dimension

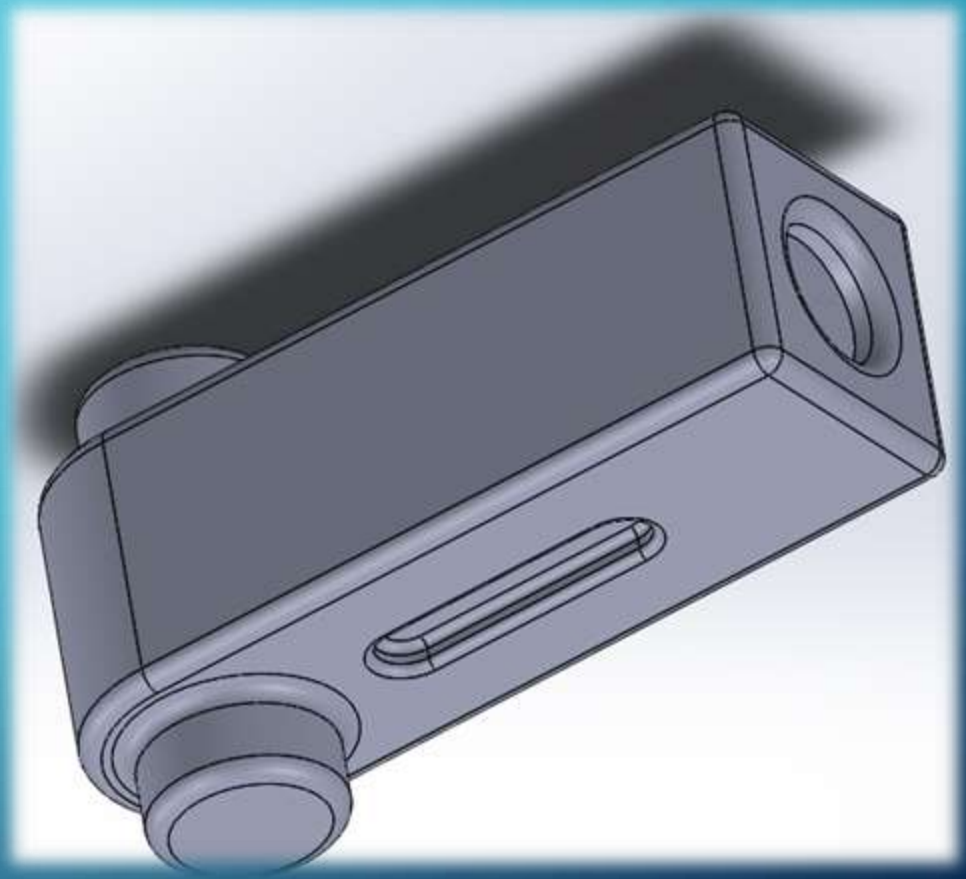


IT IS THE MOVING PART OF THE ROBOT.

LINK_3

FEATURES USED

1. Extruded Boss/base
2. Extruded Cut
3. Mirror
4. Fillet
5. Smart Dimension

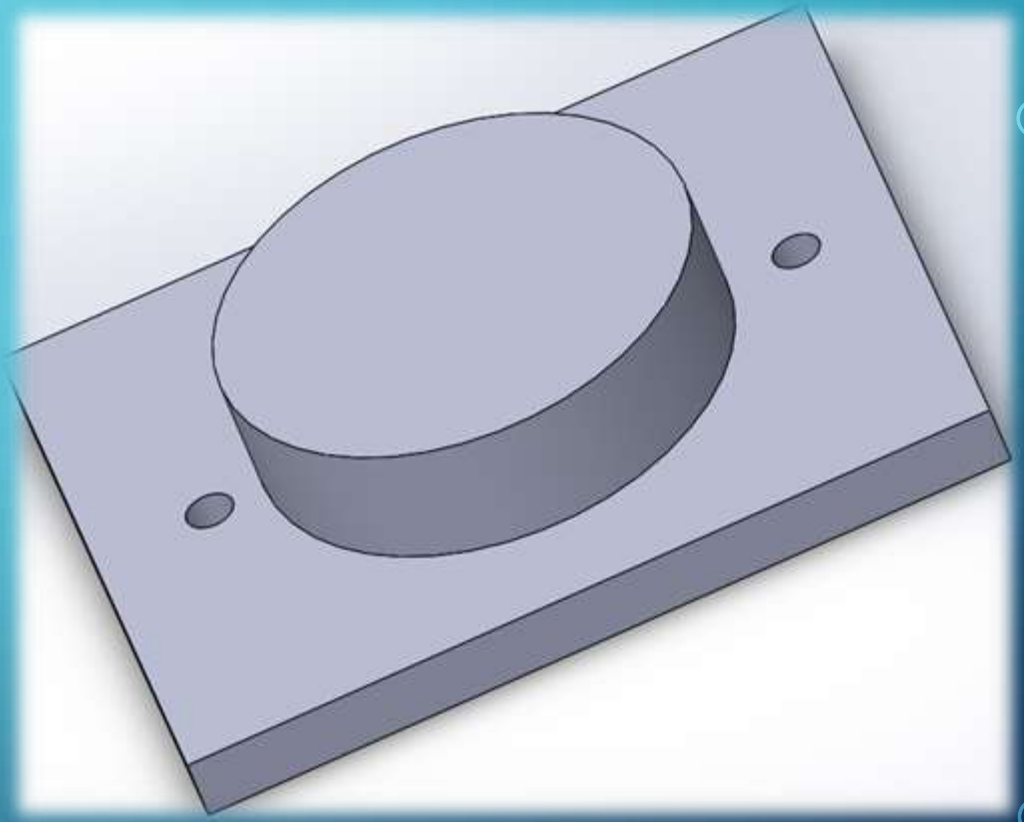


It is the moving part of the robot.

LINK-4

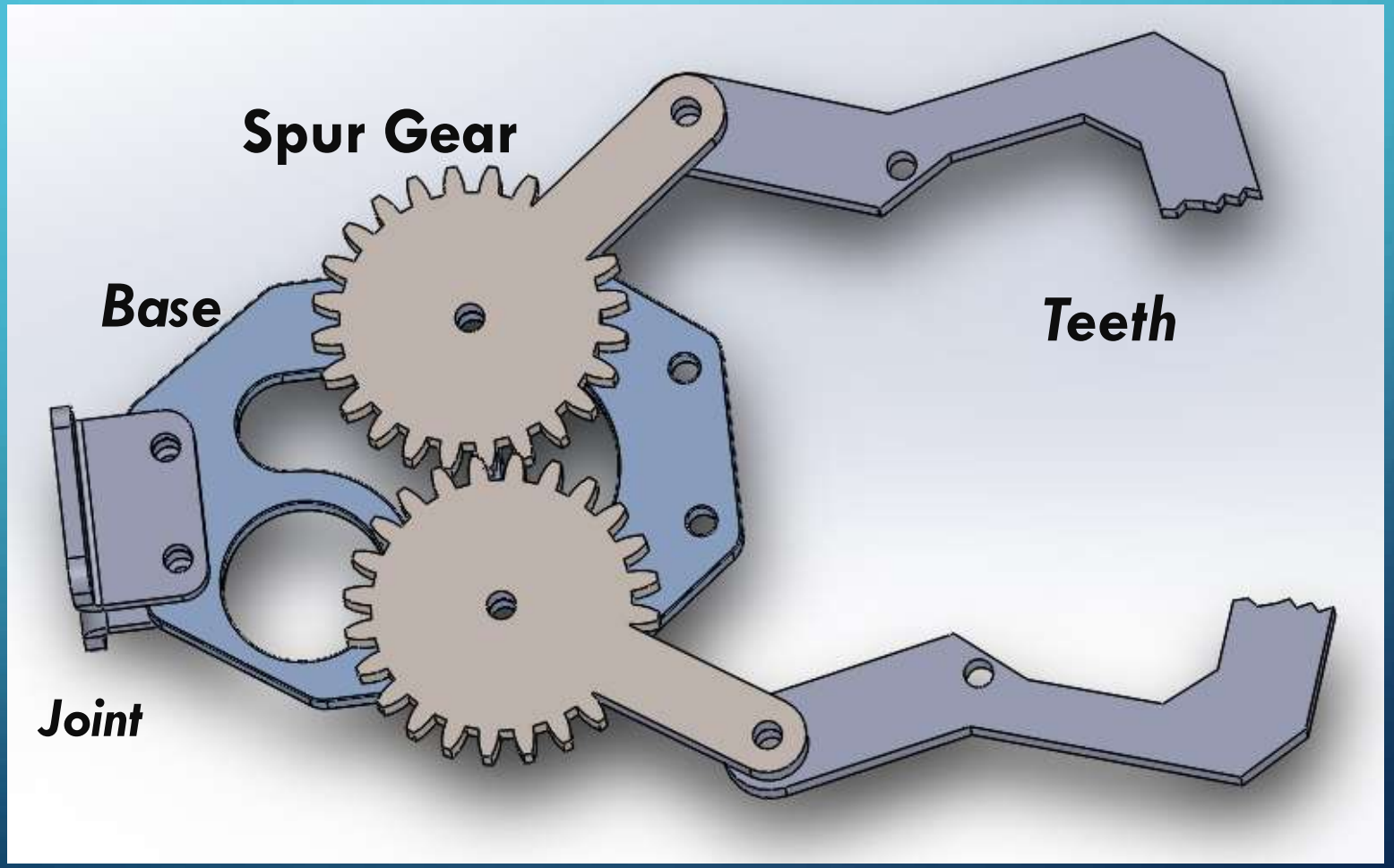
FEATURES USED

1. EXTRUDED BOSS/BASE
2. EXTRUDED CUT
3. SMART DIMENSION.



It is used to join the gripper with the limbs.

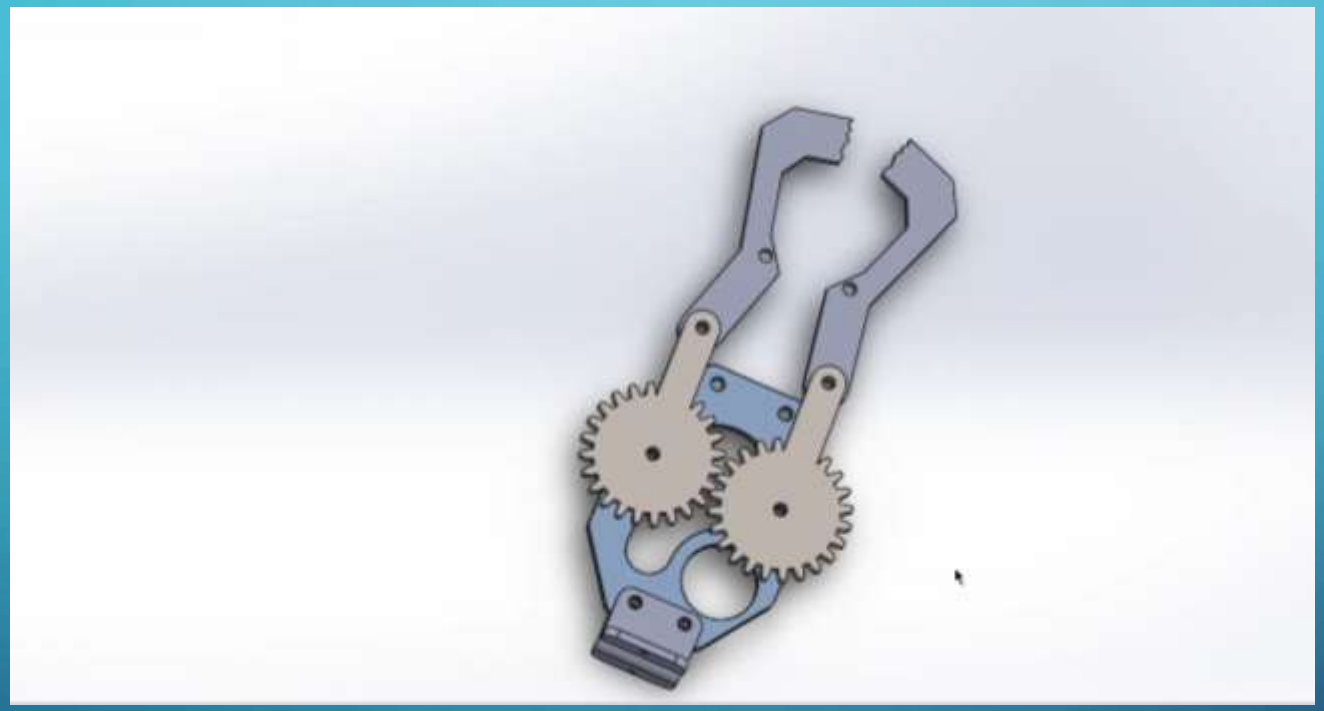
GRIPPER



FEATURES USED TO MAKE GRIPPER

1. SPUR GEAR
2. EXTRUDED BOSS/BASE
3. EXTRUDED CUT
4. SHEET METAL
5. BASE-FLANGE
6. FILLET
7. SMART DIMENSION

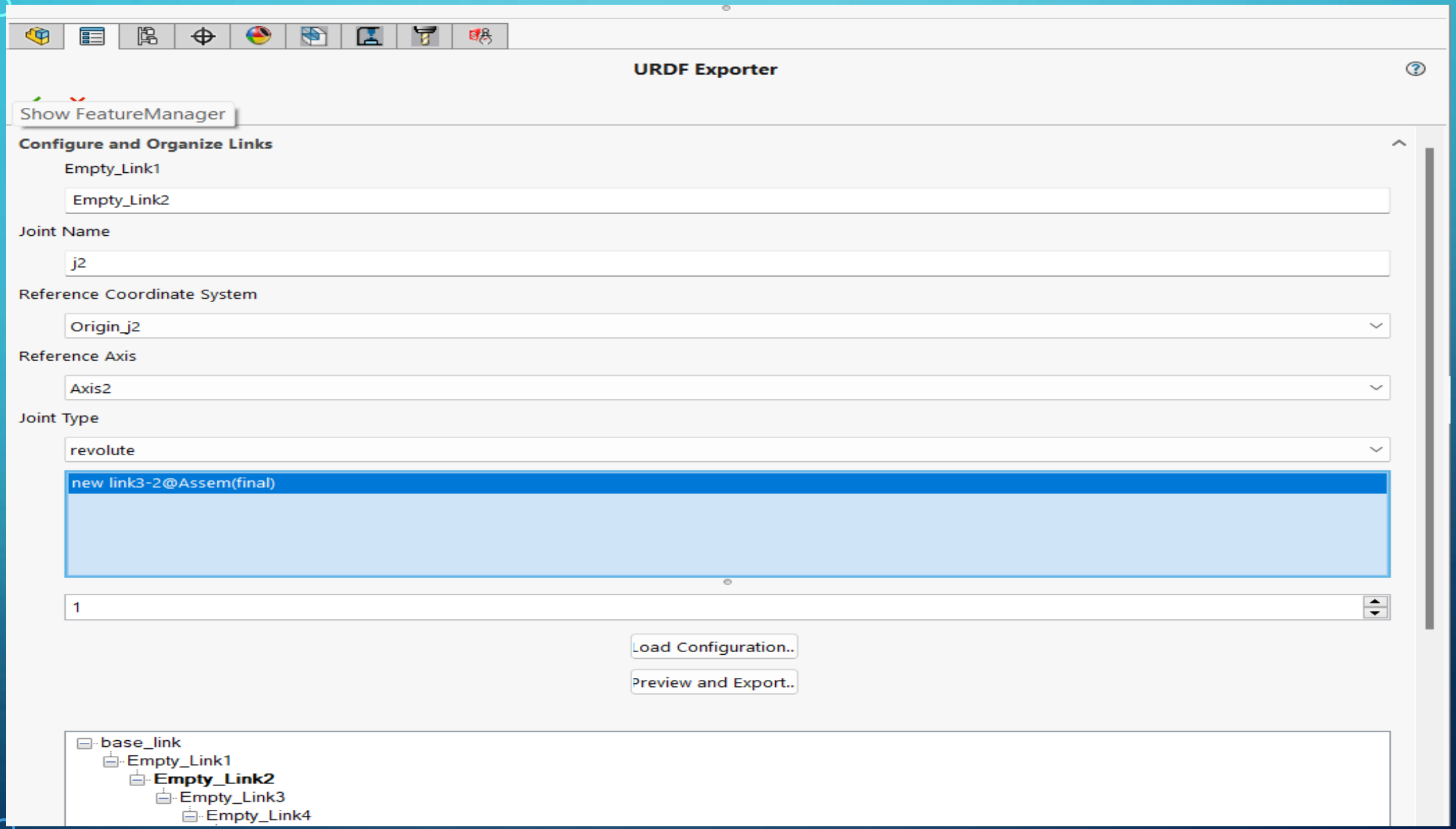
WORKING OF GRIPPER

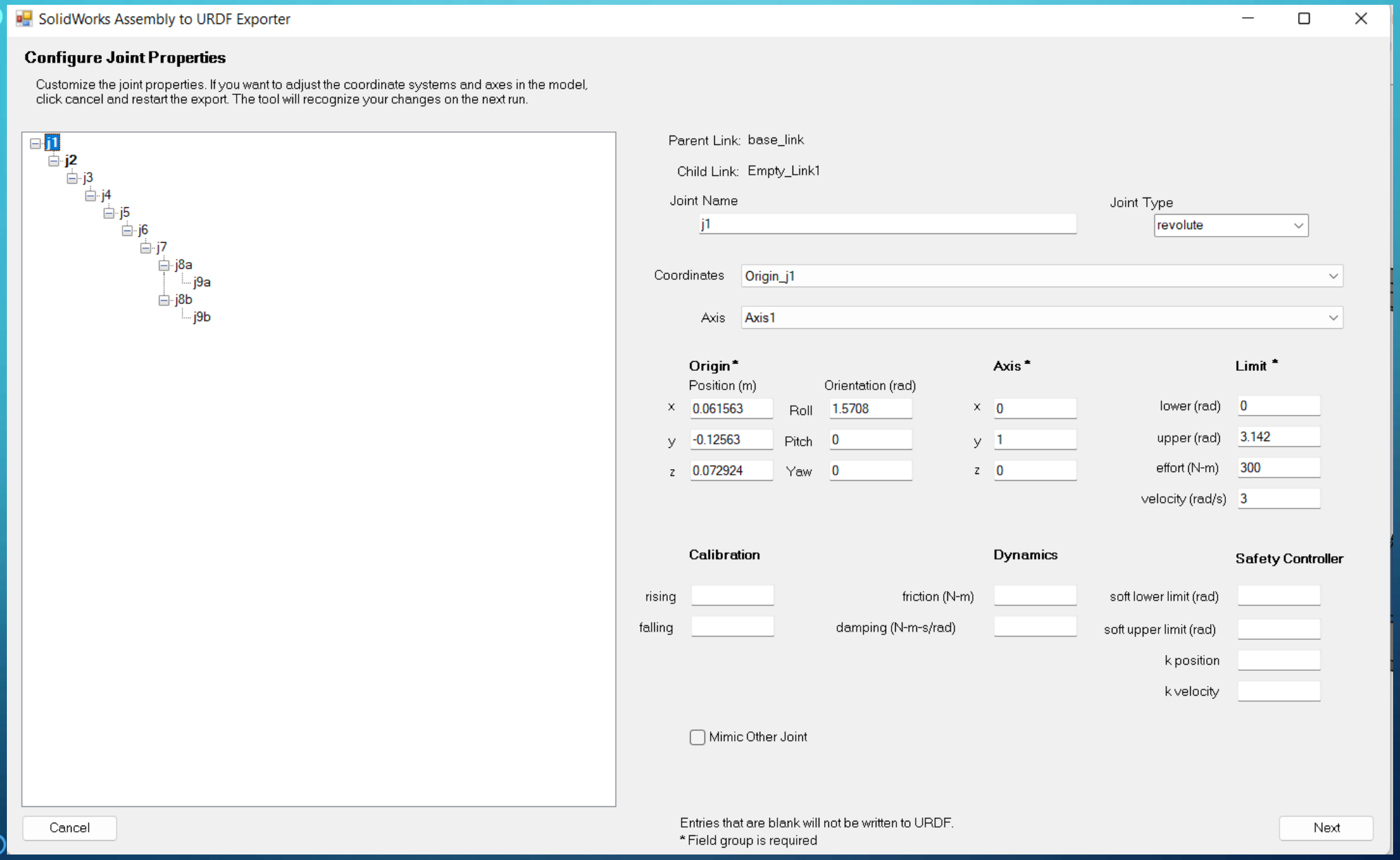


SOLID WORKS FILE TO URDF

STEPS-

1) Create mates to specify the reference position of each link and then suppress them.
2) Create axis for each joint around which the link will move.
3) Give name, reference axis , joint type and number of child links.
4) Click preview and export.
5) Then give lower and upper limits for the movements of the specific part with respect to its reference axis ,effort and velocity for the movement.
6) Then make sure that each part is having a positive mass and then export.


URDF Exporter
Show FeatureManager
Configure and Organize Links
Empty_Link1
Empty_Link2
Joint Name
j2
Reference Coordinate System
Origin_j2
Reference Axis
Axis2
Joint Type
revolute
new link3-2@Assem(final)
1
Load Configuration..
Preview and Export..
base_link
Empty_Link1
Empty_Link2
Empty_Link3
Empty_Link4

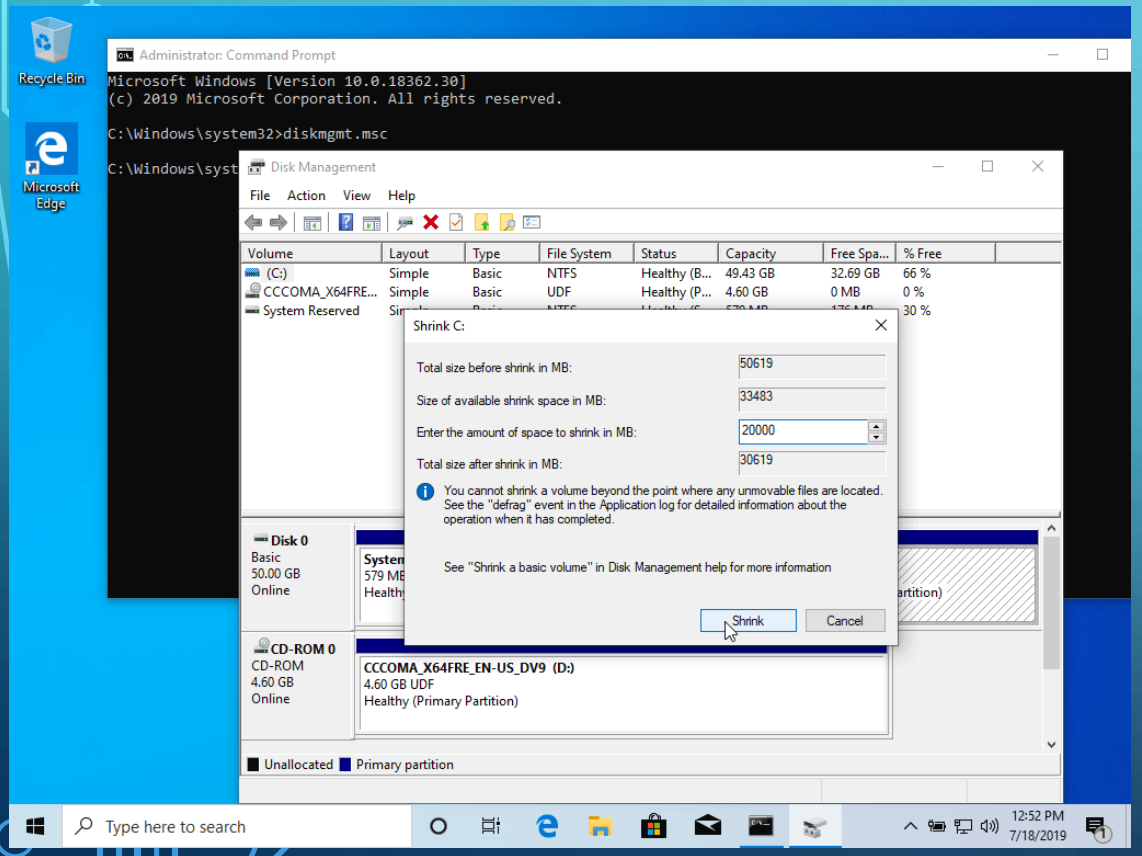

SolidWorks Assembly to URDF Exporter
Configure Joint Properties
Customize the joint properties. If you want to adjust the coordinate systems and axes in the model, click cancel and restart the export. The tool will recognize your changes on the next run.
j1
j2
j3
j4
j5
j6
j7
j8a
j9a
j8b
j9b
Parent Link: base_link
Child Link: Empty_Link1
Joint Name
j1
Joint Type
revolute
Coordinates
Origin_j1
Axis
Axis1
Origin *
Position (m)
Orientation (rad)
x 0.061563
y -0.12563
z 0.072924
Roll 1.5708
Pitch 0
Yaw 0
Axis *
x 0
y 1
z 0
Limit *
lower (rad) 0
upper (rad) 3.142
effort (N-m) 300
velocity (rad/s) 3
Calibration
rising
falling
Dynamics
friction (N-m)
damping (N-m-s/rad)
Safety Controller
soft lower limit (rad)
soft upper limit (rad)
k position
k velocity
Mimic Other Joint
Cancel
Entries that are blank will not be written to URDF.
* Field group is required
Next

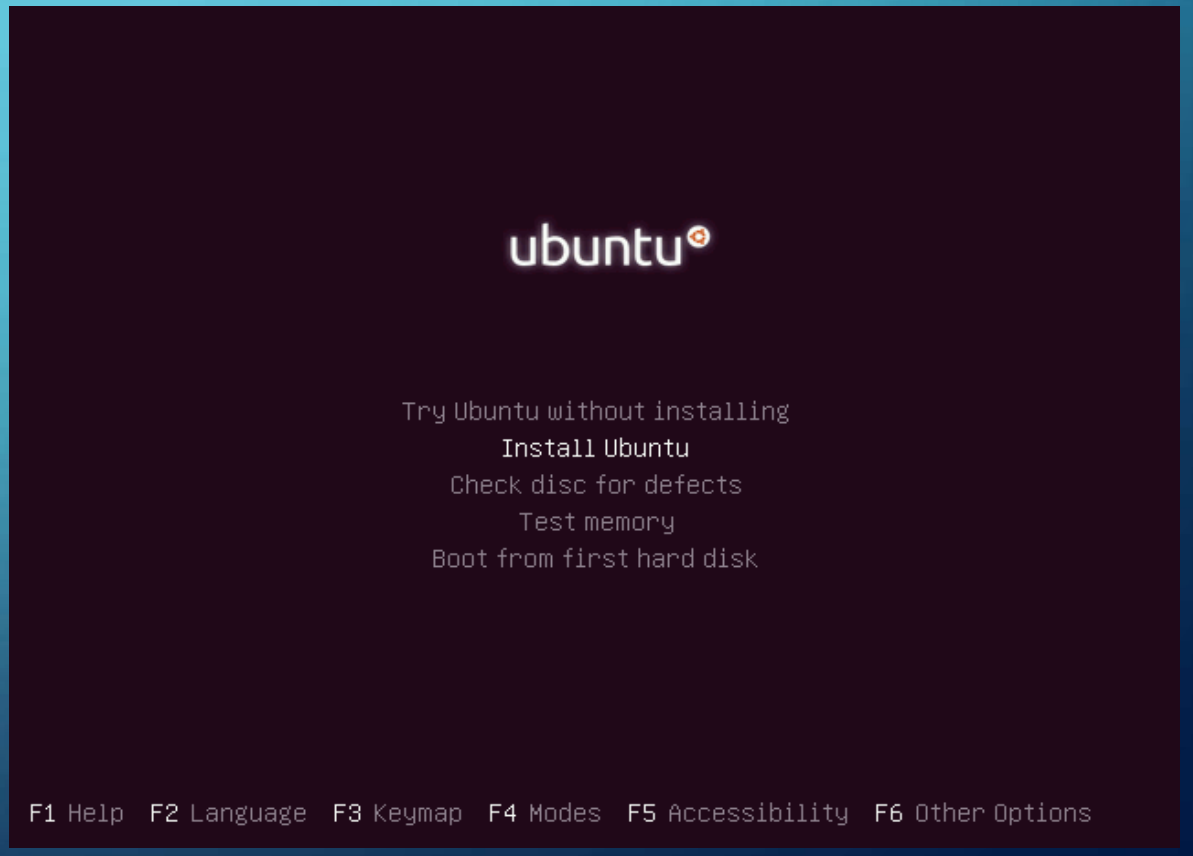
TAGS IN URDF

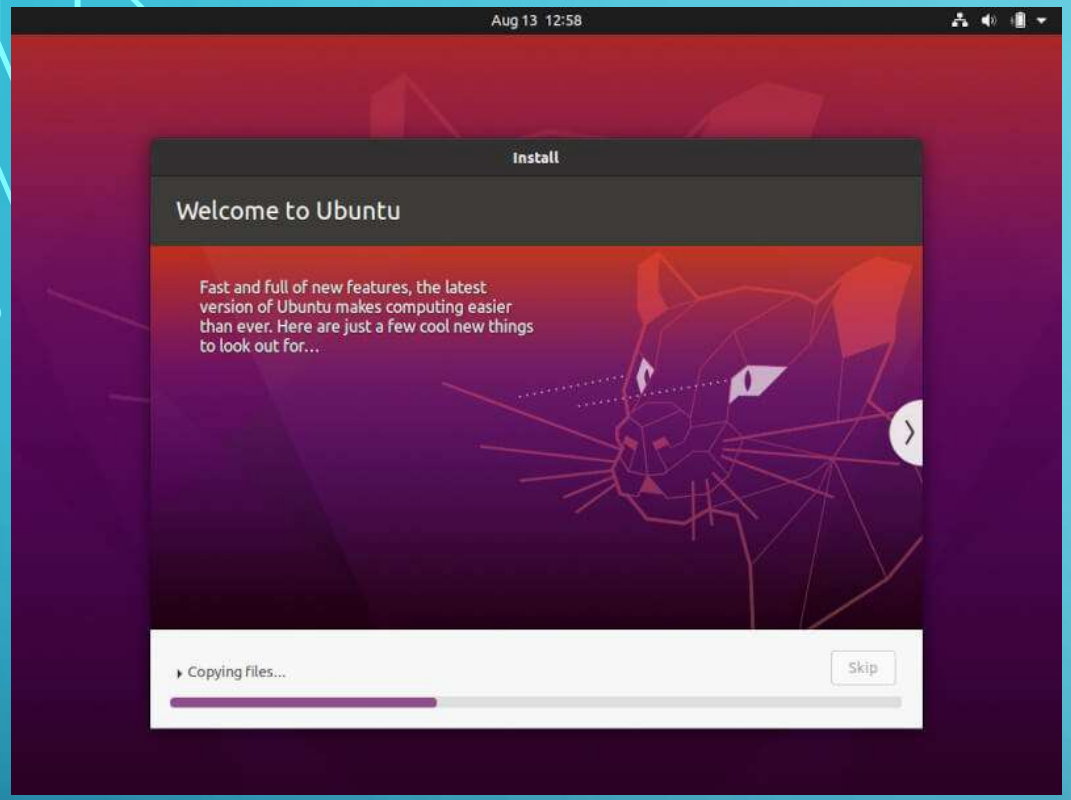
- Robot tag- A proper XML file should have an XML declaration/prolog in the first line, and then after that will be a single tag (called the root tag), which ALL the other tags live inside of. For a URDF file, this root tag will be the robot tag, and the only thing to note here for now is that we can set the name attribute which lets us (unsurprisingly) specify the name of our robot.
- Link tag- A link tag lets us firstly specify the name of a link, as well as some additional characteristics - the visual, collision, and inertial properties. These additional tags are generally optional, however they will be required for certain situations such as simulations (which we'll cover in a later tutorial).
- Joint tag- the joints are actually where all the detail is in terms of the robot's structure, as they define the link locations, and how they move relative to each other

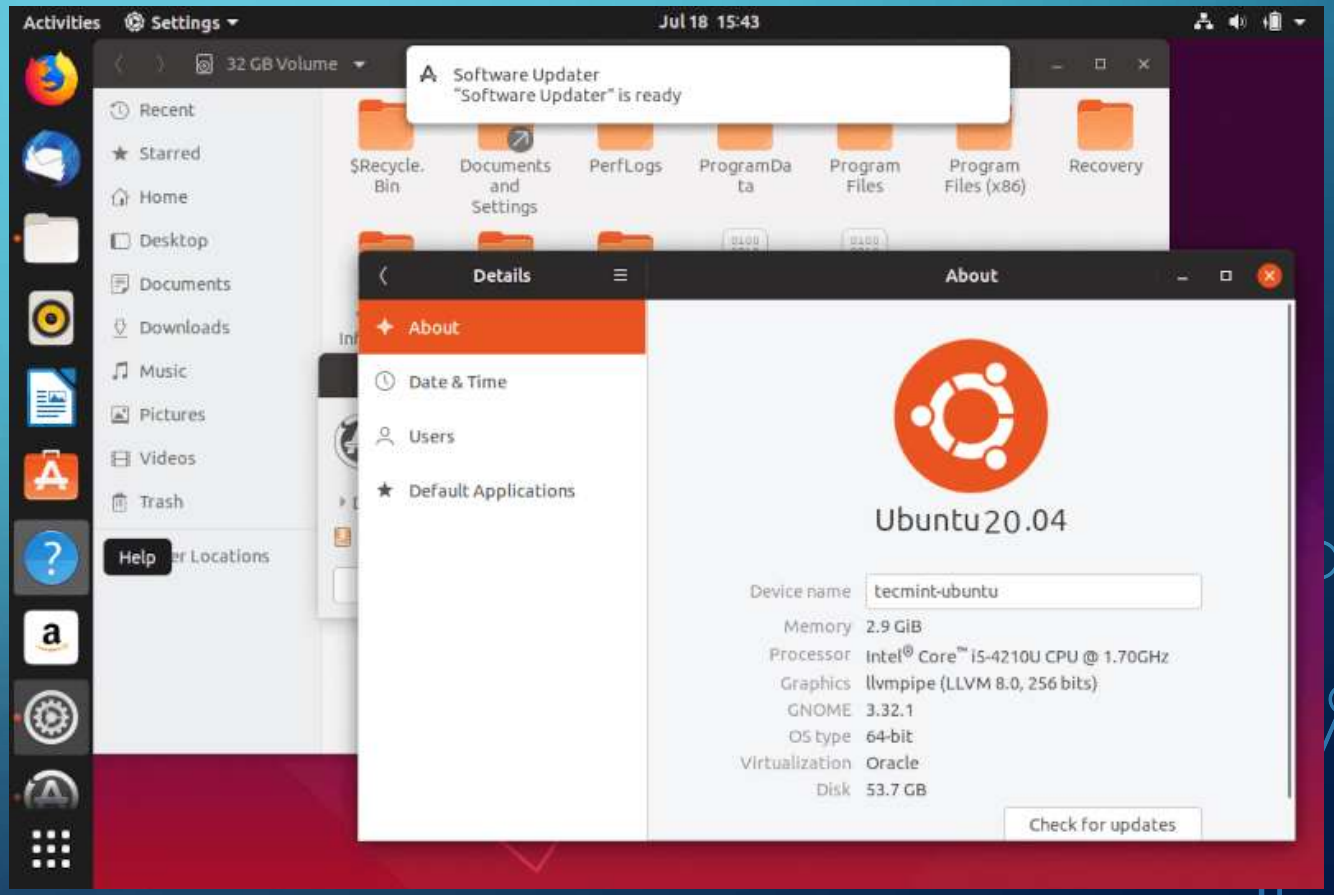
DUAL BOOT TO UBUNTU

1. THE FIRST THING YOU NEED TO TAKE CARE OF IS TO CREATE FREE SPACE ON THE COMPUTER HARD DISK IN CASE THE SYSTEM IS INSTALLED ON A SINGLE PARTITION.






Aug 13 12:58
Install
Welcome to Ubuntu
Fast and full of new features, the latest version of Ubuntu makes computing easier than ever. Here are just a few cool new things to look out for...
Copying files...
Skip


Activities
Settings
Jul 18 15:43
32 GB Volume
Software Updater
"Software Updater" is ready
Recent
Starred
Home
Desktop
Documents
Downloads
Music
Pictures
Videos
Trash
Help
$Recycle.Bin
Documents and Settings
PerfLogs
ProgramData
Program Files
Program Files (x86)
Recovery
Details
About
Date & Time
Users
Default Applications
Ubuntu 20.04
Device name tecmint-ubuntu
Memory 2.9 GiB
Processor Intel® Core™ i5-4210U CPU @ 1.70GHz
Graphics llvmpipe (LLVM 8.0, 256 bits)
GNOME 3.32.1
OS type 64-bit
Virtualization Oracle
Disk 53.7 GB
Check for updates

BASIC LINUX COMMANDS

Linux command	Description	Linux command example
cd	Change directory with a specified path	cd */path/directory1*
clear	Clear the screen	clear
cp	Copy file(s)	cp */path1/file1 /path2/file1*
diff	Compare the contents of files	diff *file1 file2*
exit	Log out of Linux	exit
grep	Find a string of text in a file	grep "word or phrase" *file1*
head	Display beginning of a file	head *file1*
less	View a file	less *file1*
ls	List contents of a directory	ls */path/directory1*
mv	Move file(s) or rename file(s)	mv */path1/file1 /path2/file2*
mkdir	Create a directory	mkdir *directory*
rm	Delete file(s)	rm *file1*
rmdir	Remove a directory	rmdir *directory*
tail	Display end of a file	tail *file1*
tar	Store, list or extract files in an archive	tar *file1*
vi	Edit file(s) with simple text editor	vi *file1*

ROS(ROBOT OPERATING SYSTEM)

- ROS IS AN OPEN-SOURCE, META-OPERATING SYSTEM FOR YOUR ROBOT. IT PROVIDES THE SERVICES YOU WOULD EXPECT FROM AN OPERATING SYSTEM, INCLUDING HARDWARE ABSTRACTION, LOW-LEVEL DEVICE CONTROL, IMPLEMENTATION OF COMMONLY-USED FUNCTIONALITY, MESSAGE-PASSING BETWEEN PROCESSES, AND PACKAGE MANAGEMENT.
- ROS ALLOWS DEVELOPERS TO EASILY SIMULATE THEIR ROBOT IN ANY ENVIRONMENT, BEFORE DEPLOYING ANYTHING IN THE REAL WORLD. TOOLS LIKE GAZEBO EVEN ALLOW YOU TO CREATE SIMULATIONS WITH ROBOTS YOU DON'T POSSESS.

LIST OF ROS DISTRIBUTIONS

- ROS NOETIC (RECOMMENDED)
- ROS MELODIC
- ROS KINETIC
- ROS INDIGO

ROS INSTALLATION

SETUP YOUR SOURCES.LIST

```
sudo sh -c 'echo "deb http://packages.ros.org/ros/ubuntu $(lsb_release -sc) main" > /etc/apt/sources.list.d/ros-latest.list'
```

SETUP YOUR KEYS

```
sudo apt install curl # if you haven't already installed curl
curl -s https://raw.githubusercontent.com/ros/rosdistro/master/ros.asc | sudo apt-key add -
```

DESKTOP FULL INSTALL

```
sudo apt install ros-noetic-desktop-full
```

ENVIRONMENT SETUP

```
source /opt/ros/noetic/setup.bash
```

CREATING A WORKSPACE

- A workspace is folder where you modify, build and install packages.
- Commands for creating a workspace

```
$ mkdir -p ~/catkin_ws/src
$ cd ~/catkin_ws/
$ catkin_make
```

ROS PACKAGES : They are the main unit for organizing software in ros.

ROS NODES : They are processes that perform computation.

ROS TOPICS : It is a name that is used to identify content of a message.

ROS SERVICES : They are pair of message structure each for request and reply

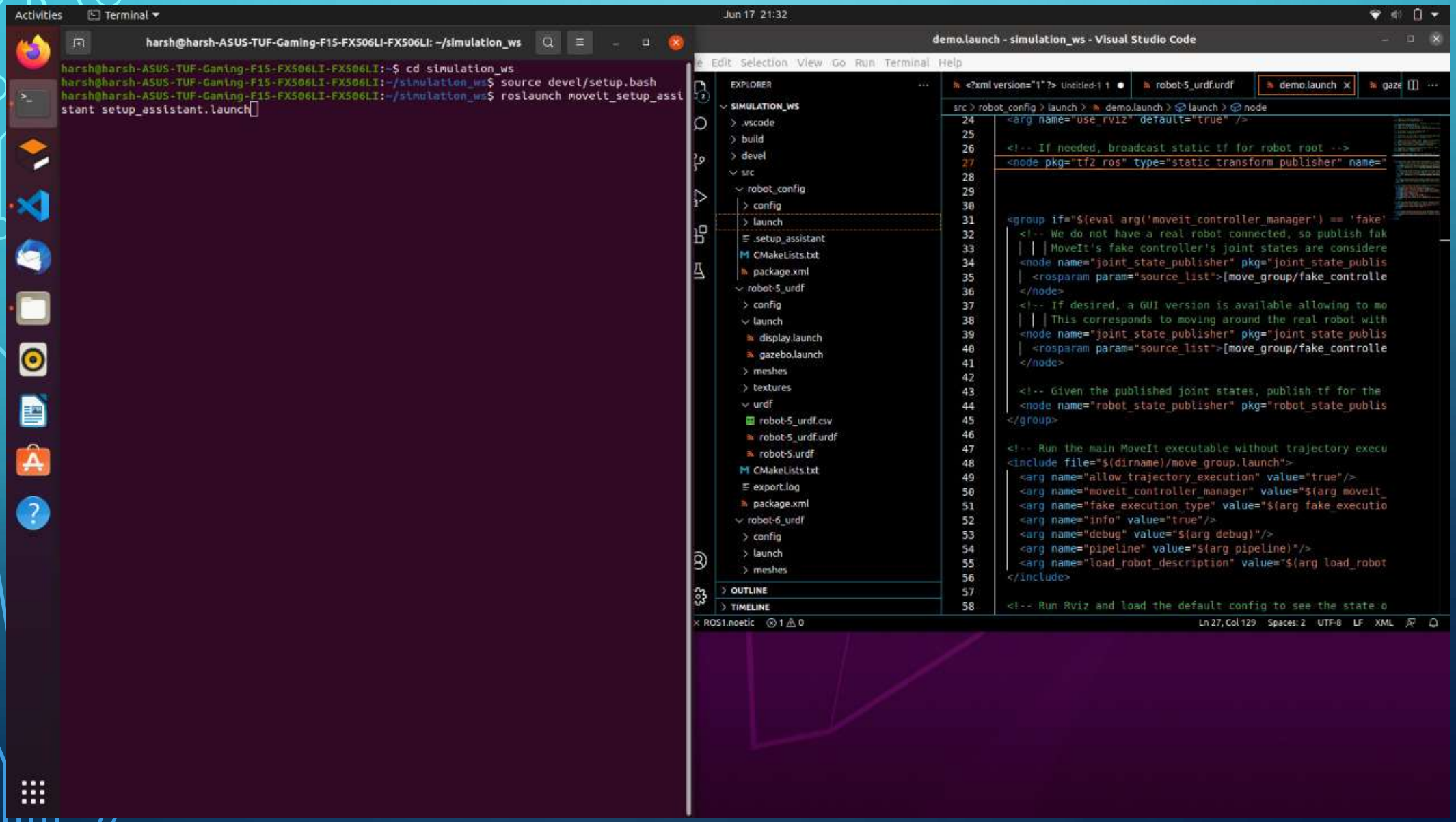
MOVEIT

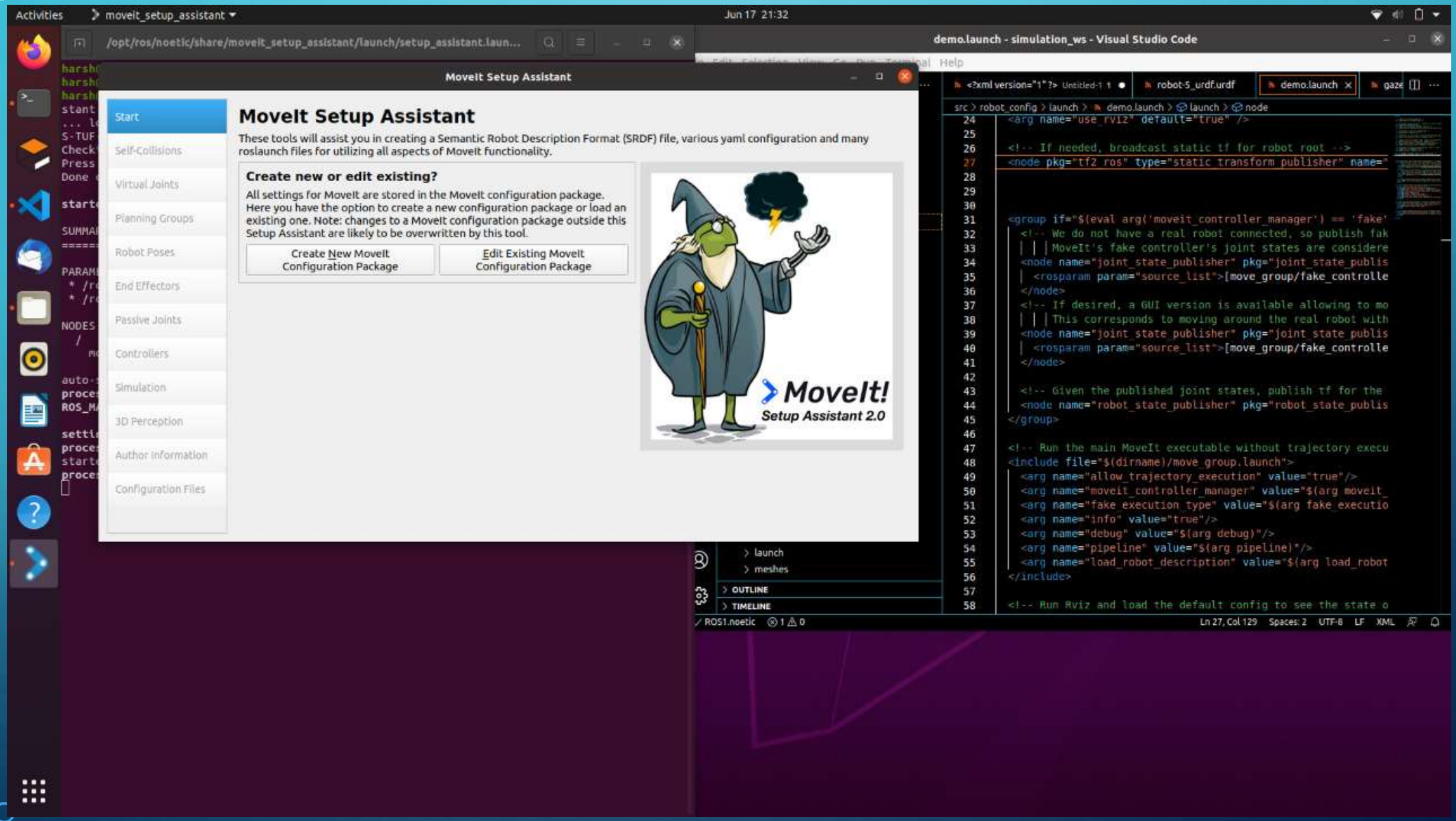
MOVEIT IS A MOTION PLANNING FRAMEWORK WHERE WE CAN LAUNCH OUR MODEL'S URDF FILE AND SIMULATE IT.

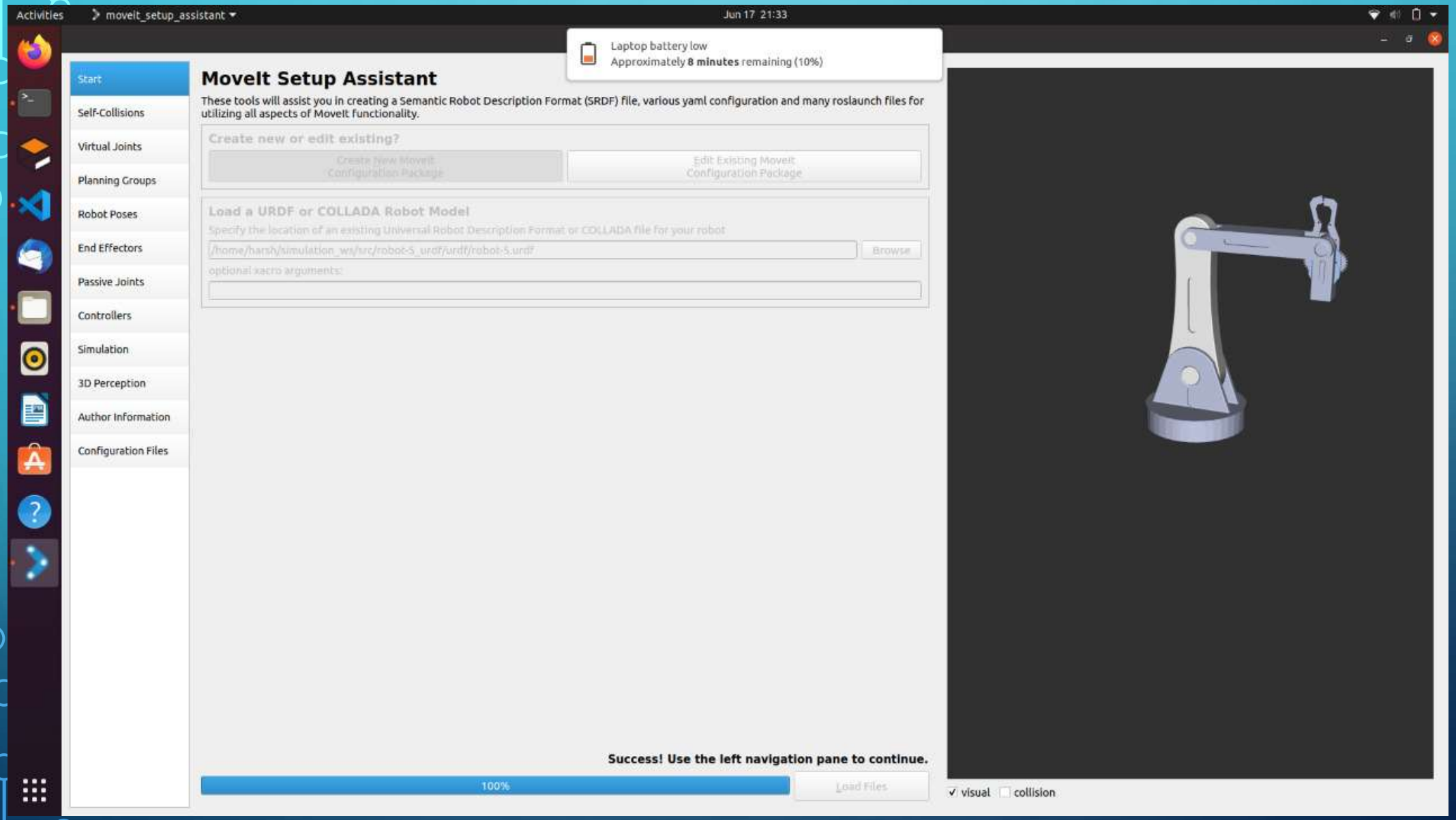
PERKS OF INSTALLING MOVEIT IN ROS

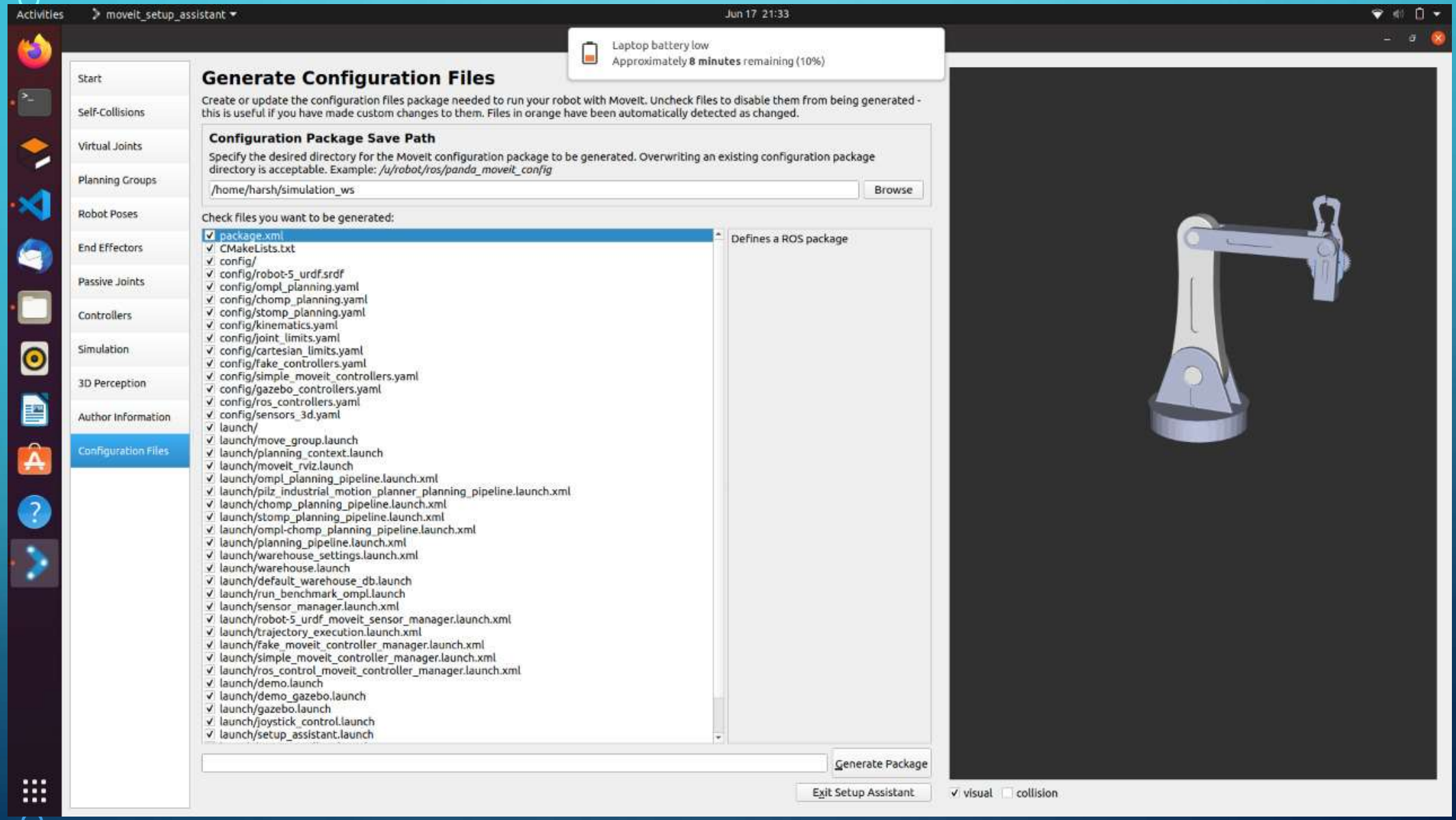
- IT CREATES COLLISION MATRIX WHICH DETECTS POSSIBILITIES OF COLLISION DURING MOTION
- IT HELPS US TO ADD VIRTUAL JOINTS AND END EFFECTORS IN OUR MODEL.
- IT HELPS TO PLAN OUR ROBOT MOVEMENT AND THEN EXECUTE IT IN OTHER SIMULATING ENVIRONMENTS LIKE GAZEBO.
- IT CREATES SEVERAL CONFIGURATION FILES SUCH AS LAUNCH AND CONTROLLER FILES.

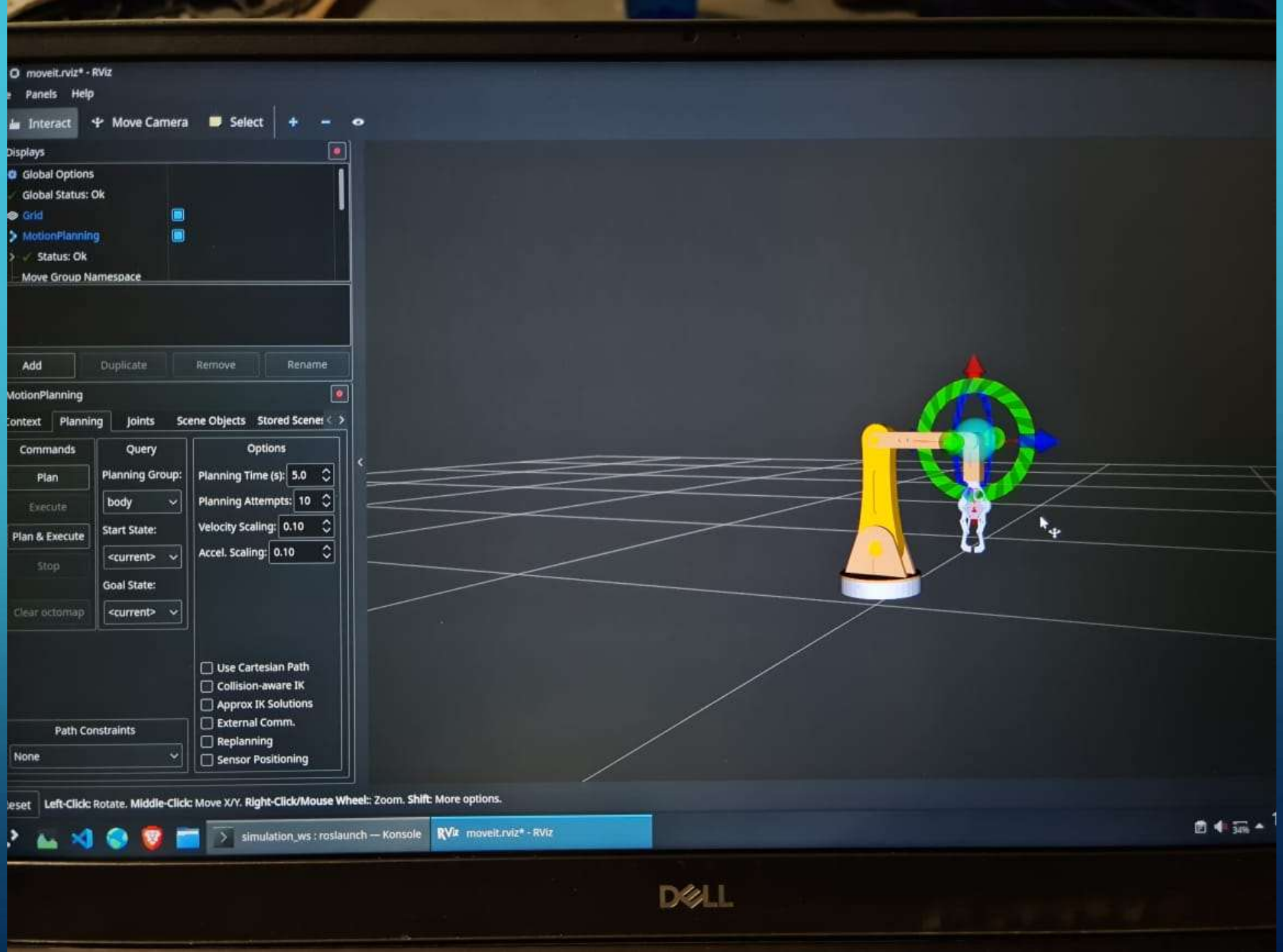
MOVEIT ASSISTANT




Activities
moveit_setup_assistant
Jun 17 21:32
/opt/ros/noetic/share/moveit_setup_assistant/launch/setup_assistant.laun...
MoveIt Setup Assistant
Start
Self-Collisions
Virtual Joints
Planning Groups
Robot Poses
End Effectors
Passive Joints
Controllers
Simulation
3D Perception
Author Information
Configuration Files
MoveIt Setup Assistant
These tools will assist you in creating a Semantic Robot Description Format (SRDF) file, various yaml configuration and many roslaunch files for utilizing all aspects of MoveIt functionality.
Create new or edit existing?
All settings for MoveIt are stored in the MoveIt configuration package. Here you have the option to create a new configuration package or load an existing one. Note: changes to a MoveIt configuration package outside this Setup Assistant are likely to be overwritten by this tool.
Create New MoveIt Configuration Package
Edit Existing MoveIt Configuration Package
MoveIt!
Setup Assistant 2.0
demo.launch - simulation_ws - Visual Studio Code
robot-5_urdf.urdf
demo.launch
launch
meshes
OUTLINE
TIMELINE
ROS1.noetic
Ln 27, Col 129
Spaces: 2
UTF-8
LF
XML


Activities
moveit_setup_assistant
Jun 17 21:33
Laptop battery low
Approximately 8 minutes remaining (10%)
Start
Self-Collisions
Virtual Joints
Planning Groups
Robot Poses
End Effectors
Passive Joints
Controllers
Simulation
3D Perception
Author Information
Configuration Files
MoveIt Setup Assistant
These tools will assist you in creating a Semantic Robot Description Format (SRDF) file, various yaml configuration and many roslaunch files for utilizing all aspects of MoveIt functionality.
Create new or edit existing?
Create New MoveIt Configuration Package
Edit Existing MoveIt Configuration Package
Load a URDF or COLLADA Robot Model
Specify the location of an existing Universal Robot Description Format or COLLADA file for your robot
/home/harsh/simulation_ws/src/robot-5_urdf/urdf/robot-5.urdf
Browse
optional xacro arguments:
Success! Use the left navigation pane to continue.
100%
Load Files
visual
collision


Activities
moveit_setup_assistant
Jun 17 21:33
Laptop battery low
Approximately 8 minutes remaining (10%)
Start
Self-Collisions
Virtual Joints
Planning Groups
Robot Poses
End Effectors
Passive Joints
Controllers
Simulation
3D Perception
Author Information
Configuration Files
Generate Configuration Files
Create or update the configuration files package needed to run your robot with MoveIt. Uncheck files to disable them from being generated - this is useful if you have made custom changes to them. Files in orange have been automatically detected as changed.
Configuration Package Save Path
Specify the desired directory for the MoveIt configuration package to be generated. Overwriting an existing configuration package directory is acceptable. Example: /u/robot/ros/panda_moveit_config
/home/harsh/simulation_ws
Browse
Check files you want to be generated:
package.xml
CMakeLists.txt
config/
config/robot-5_urdf.srdf
config/ompl_planning.yaml
config/chomp_planning.yaml
config/stomp_planning.yaml
config/kinematics.yaml
config/joint_limits.yaml
config/cartesian_limits.yaml
config/fake_controllers.yaml
config/simple_moveit_controllers.yaml
config/gazebo_controllers.yaml
config/ros_controllers.yaml
config/sensors_3d.yaml
launch/
launch/move_group.launch
launch/planning_context.launch
launch/moveit_rviz.launch
launch/ompl_planning_pipeline.launch.xml
launch/pilz_industrial_motion_planner_planning_pipeline.launch.xml
launch/chomp_planning_pipeline.launch.xml
launch/stomp_planning_pipeline.launch.xml
launch/ompl-chomp_planning_pipeline.launch.xml
launch/planning_pipeline.launch.xml
launch/warehouse_settings.launch.xml
launch/warehouse.launch
launch/default_warehouse_db.launch
launch/run_benchmark_ompl.launch
launch/sensor_manager.launch.xml
launch/robot-5_urdf_moveit_sensor_manager.launch.xml
launch/trajectory_execution.launch.xml
launch/fake_moveit_controller_manager.launch.xml
launch/simple_moveit_controller_manager.launch.xml
launch/ros_control_moveit_controller_manager.launch.xml
launch/demo.launch
launch/demo_gazebo.launch
launch/gazebo.launch
launch/joystick_control.launch
launch/setup_assistant.launch
Defines a ROS package
Generate Package
Exit Setup Assistant
visual
collision


moveit.rviz* - RViz
Panels
Help
Interact
Move Camera
Select
Displays
Global Options
Global Status: Ok
Grid
MotionPlanning
Status: Ok
Move Group Namespace
Add
Duplicate
Remove
Rename
MotionPlanning
Context
Planning
Joints
Scene Objects
Stored Scene
Commands
Plan
Execute
Plan & Execute
Stop
Clear octomap
Query
Planning Group:
body
Start State:
<current>
Goal State:
<current>
Options
Planning Time (s): 5.0
Planning Attempts: 10
Velocity Scaling: 0.10
Accel. Scaling: 0.10
Use Cartesian Path
Collision-aware IK
Approx IK Solutions
External Comm.
Replanning
Sensor Positioning
Path Constraints
None
Left-Click: Rotate. Middle-Click: Move X/Y. Right-Click/Mouse Wheel:: Zoom. Shift: More options.
simulation_ws : roslaunch — Konsole
moveit.rviz* - RViz
DELL


THANK YOU