

*Technical Report from Mastering ROS*  
*Final Examination Robot Autonomy*



Oleh:

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## Chapter 1 – Introduction to ROS

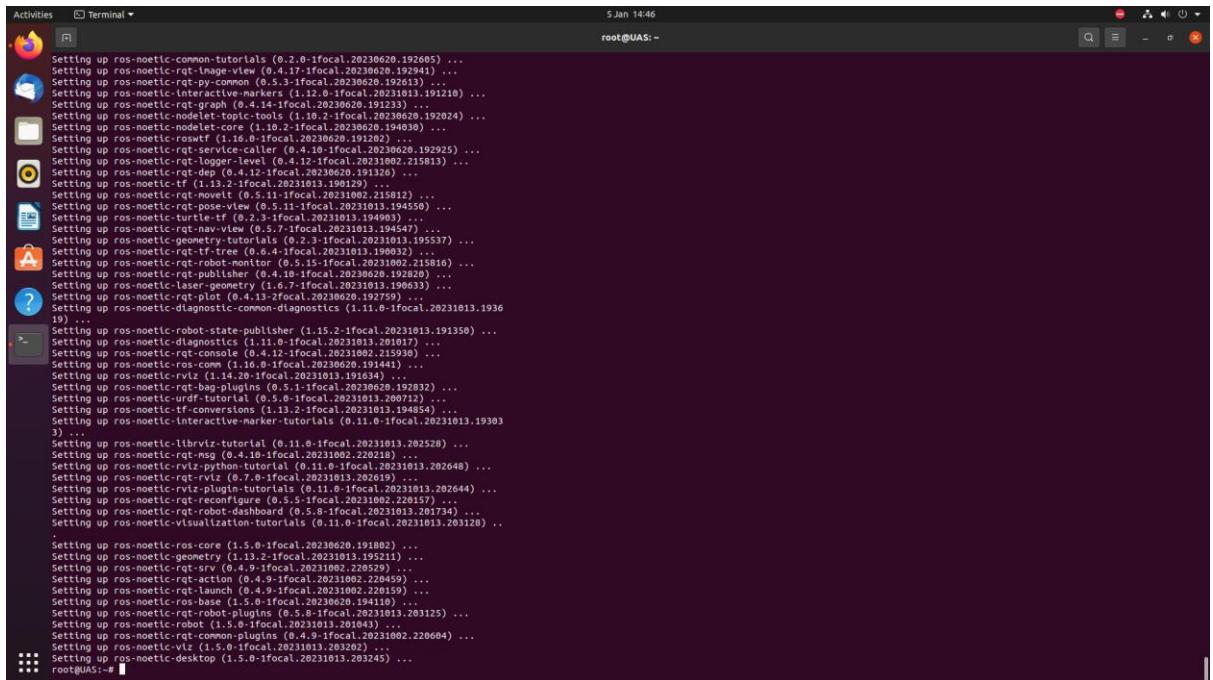
ROS (Robot Operating System) adalah kerangka kerja perangkat lunak sumber terbuka yang memfasilitasi pengembangan dan pengoperasian robot. Ubuntu 20.04 adalah versi sistem operasi Linux yang stabil dan banyak digunakan. Laporan ini membahas perkenalan singkat tentang ROS, Ubuntu 20.04, dan memberikan panduan instalasi ROS Noetic pada sistem operasi tersebut.

ROS dirancang dengan arsitektur distribusi yang memungkinkan komunikasi antar modul perangkat lunak yang disebut "nodes." Arsitektur ini memungkinkan pengembangan dan integrasi mudah dari berbagai komponen robotika.

Ubuntu 20.04, dengan kode nama Focal Fossa, merupakan versi LTS (Long Term Support) yang menawarkan stabilitas dan keamanan jangka panjang. Beberapa fiturnya meliputi kernel Linux 5.4, dukungan untuk Python 3.8, dan penggunaan lingkungan desktop GNOME 3.36.

Proses Instalasi ROS Noetic dilakukan sesuai dengan tahap-tahap yang ada pada <https://wiki.ros.org/noetic/Installation/Ubuntu>. Instalasi ini dilakukan pada sistem operasi Ubuntu 20.04 LTS/Debian, ROS dapat dukungan penuh dari Ubuntu 20.04 sehingga 2 hal tersebut merupakan kombinasi yang terbaik.

- **Instalasi ROS**



```
Setting up ros-noetic-common-tutorials (0.2.0-1focal.20230620.192605) ...
Setting up ros-noetic-rqt-image-view (0.4.17-1focal.20230620.192941) ...
Setting up ros-noetic-rqt-py-common (0.9.3-1focal.20230620.192613) ...
Setting up ros-noetic-interactive-marker-tutorials (0.1.0-1focal.20230620.193210) ...
Setting up ros-noetic-nodelet-topic-tools (1.10.2-1focal.20230620.192024) ...
Setting up ros-noetic-rosout (1.16.0-1focal.20230620.194038) ...
Setting up ros-noetic-rosoutf (1.16.0-1focal.20230620.191202) ...
Setting up ros-noetic-rqt-service-caller (0.4.10-1focal.20230620.192925) ...
Setting up ros-noetic-rqt-dep (0.4.17-1focal.20230620.191370) ...
Setting up ros-noetic-rqt-tf (1.13.2-1focal.20231013.190128) ...
Setting up ros-noetic-rqt-moveit (0.5.11-1focal.20231008.215812) ...
Setting up ros-noetic-rqt-poseview (0.5.1-1focal.20231013.194550) ...
Setting up ros-noetic-rqt-robot-monitor (0.5.0-1focal.20231002.215816) ...
Setting up ros-noetic-rqt-nav-view (0.5.7-1focal.20231013.194547) ...
Setting up ros-noetic-geometry-tutorials (0.2.3-1focal.20231013.195537) ...
Setting up ros-noetic-rqt-tf-tree (0.6.4-1focal.20231013.190032) ...
Setting up ros-noetic-ros-publisher (0.4.10-1focal.20230620.192880) ...
Setting up ros-noetic-laser-scanner (1.6.7-1focal.20231013.190503) ...
Setting up ros-noetic-rqt-plot (0.4.13-1focal.20230620.192759) ...
Setting up ros-noetic-diagnostic-common-diagnostics (1.11.0-1focal.20231013.193619) ...
Setting up ros-noetic-robot-state-publisher (1.15.2-1focal.20231013.191350) ...
Setting up ros-noetic-diagnostic (1.11.0-1focal.20231013.208107) ...
Setting up ros-noetic-rqt-console (0.4.12-1focal.20231002.215930) ...
Setting up ros-noetic-ros-comm (1.16.0-1focal.20230620.191441) ...
Setting up ros-noetic-rviz (1.14.28-1focal.20231013.191634) ...
Setting up ros-noetic-rqt-robot-monitor (0.5.0-1focal.20231002.192932) ...
Setting up ros-noetic-urdf-tutorial (0.1.0-1focal.20231013.200712) ...
Setting up ros-noetic-rqt-conversions (1.13.2-1focal.20231013.194684) ...
Setting up ros-noetic-interactive-marker-tutorials (0.11.0-1focal.20231013.193033) ...
Setting up ros-noetic-librviz-tutorial (0.11.0-1focal.20231013.202528) ...
Setting up ros-noetic-rqt-msg (0.4.18-1focal.20231002.220215) ...
Setting up ros-noetic-rviz-python-tutorial (0.11.0-1focal.20231013.202648) ...
Setting up ros-noetic-rqt-rviz (0.7.0-1focal.20231013.202619) ...
Setting up ros-noetic-rviz-plugin-tutorial (0.11.0-1focal.20231013.202644) ...
Setting up ros-noetic-rqt-reconfigure (0.5.5-1focal.20231002.220157) ...
Setting up ros-noetic-rqt-robot-dashboard (0.5.8-1focal.20231013.201734) ...
Setting up ros-noetic-visualization-tutorials (0.11.0-1focal.20231013.203128) ...
Setting up ros-noetic-ros-core (1.5.0-1focal.20230620.191802) ...
Setting up ros-noetic-geometry (1.11.0-1focal.20231013.195211) ...
Setting up ros-noetic-robot-state (0.9.14-1focal.20231002.215930) ...
Setting up ros-noetic-rqt-taction (0.4.9-1focal.20231002.220459) ...
Setting up ros-noetic-rqt-launch (0.4.9-1focal.20231002.220159) ...
Setting up ros-noetic-ros-base (1.5.0-1focal.20230620.194110) ...
Setting up ros-noetic-rqt-robot-plugin (0.5.8-1focal.20231013.203125) ...
Setting up ros-noetic-ros-control (1.5.0-1focal.20231002.220159) ...
Setting up ros-noetic-rqt-camera-plugin (0.4.9-1focal.20231002.220604) ...
Setting up ros-noetic-vt (1.5.0-1focal.20231013.203202) ...
Setting up ros-noetic-desktop (1.5.0-1focal.20231013.203245) ...
root@UAS:~#
```

- ROS environment setup

```

Activities Terminal 5 Jan 14:59
started rosnode server http://UAS:46669/
ros_com version 1.16.0

PARAMETERS
=====
* /rostdistro: noetic
* /rosversion: 1.16.0

NODES
=====
auto-starting new master
process[master]: started with pid [21435]
ROS_MASTER_URI=http://UAS:11311

[rosout-1] started with pid [21445]
started core service [/rosout]
<rosout> killing on exit
[master] killing on exit
shutting down processing monitor...
done
root@UAS:~# echo 'source /opt/ros/noetic/setup.bash' >> ~/.bashrc
root@UAS:~# gedit ~/.bashrc
<-
... logging to /root/.ros/log/55e27160-ab00-11ee-930c-f7095ec95b04/roslaunch-UAS-21699.log
Checking log directory for disk usage. This may take a while.
Press Ctrl-C to interrupt
done checking log file disk usage. Usage is <1GB.

started rosnode server http://UAS:46669
ros_com version 1.16.0

SUMMARY
=====

PARAMETERS
=====
* /rostdistro: noetic
* /rosversion: 1.16.0

NODES
=====
auto-starting new master
process[master]: started with pid [21707]
ROS_MASTER_URI=http://UAS:11311

[rosout-1] started with pid [21717]
started core service [/rosout]

```

- Isi environment ROS Noetic

```

Activities Terminal 5 Jan 15:07
root@UAS:~# cd /opt/
root@UAS:/opt# cd ros/
root@UAS:/opt/ros#
root@UAS:/opt/ros/noetic# ls
hostetc
root@UAS:/opt/ros/noetic# cd noetic/
root@UAS:/opt/ros/noetic# ls
bin  include  local_setup.sh  setup.sh      share
etc   lib       local_setup.zsh  _setup_util.py
etc   local_setup.bash  setup.bash  setup.zsh
root@UAS:/opt/ros/noetic# source /opt/ros/noetic/setup.bash
root@UAS:~# roscore
... logging to /root/.ros/log/a84d9412-ab0f-11ee-930c-f7095ec95b04/roslaunch-UAS-21424.log
... Checking log directory for disk usage. This may take a while.
Press Ctrl-C to interrupt
done checking log file disk usage. Usage is <1GB.

started rosnode server http://UAS:46669
ros_com version 1.16.0

SUMMARY
=====

PARAMETERS
=====
* /rostdistro: noetic
* /rosversion: 1.16.0

NODES
=====
auto-starting new master
process[master]: started with pid [21435]
ROS_MASTER_URI=http://UAS:11311

[rosout-1] started with pid [21445]
started core service [/rosout]
<rosout> killing on exit
[master] killing on exit
shutting down processing monitor...
done
root@UAS:~# echo 'source /opt/ros/noetic/setup.bash' >> ~/.bashrc
root@UAS:~# gedit ~/.bashrc
<-
... logging to /root/.ros/log/55e27160-ab00-11ee-930c-f7095ec95b04/roslaunch-UAS-21699.log
Checking log directory for disk usage. This may take a while.
Press Ctrl-C to interrupt
done checking log file disk usage. Usage is <1GB.

started rosnode server http://UAS:46669
ros_com version 1.16.0

SUMMARY
=====
```

- **Instalasi rosdep**

```

Activities Terminal 5 Jan 15:22
nathun@UAS: ~
Creating config file /etc/mercurial/hgext.rc with new version
Setting up mercurial-common (5.3.1-1ubuntu1) ...
Setting up mercurial (5.3.1-1ubuntu1) ...
Processing triggers for libc-bin (2.31-0ubuntu9.9) ...
Processing triggers for man-db (2.9.1-2) ...
Processing triggers for libcurl4-openssl-dev (0.24-1ubuntu3) ...
Processing triggers for gnome-support (3.64ubuntu1) ...
Processing triggers for gnome-menus (3.36.0-1ubuntu1) ...
nathun@UAS:~$ sudo apt install python3-rosdep
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
python3-rosdep is already the newest version (0.22.2-1).
0 to upgrade, 0 to newly install, 0 to remove and 252 not to upgrade.
nathun@UAS:~$ sudo rosdep init
Wrote /etc/ros/rosdep/sources.list.d/20-default.list
Recommended: please run
rosdep update
nathun@UAS:~$ rosdep update
reading in sources.list data from /etc/ros/rosdep/sources.list.d
Hit https://raw.githubusercontent.com/ros/rosdistro/master/rosdep/sx-homebrew.yaml
Hit https://raw.githubusercontent.com/ros/rosdistro/master/rosdep/base.yaml
Hit https://raw.githubusercontent.com/ros/rosdistro/master/rosdep/python.yaml
Hit https://raw.githubusercontent.com/ros/rosdistro/master/rosdep/ruby.yaml
Hit https://raw.githubusercontent.com/ros/rosdistro/master/releases/fuerte.yaml
Query rosdistro index https://raw.githubusercontent.com/ros/rosdistro/master/index-v4.yaml
Skip end-of-life distro "ardent"
Skip end-of-life distro "bouncy"
Skip end-of-life distro "crystal"
Skip end-of-life distro "diamond"
Skip end-of-life distro "elquent"
Skip end-of-life distro "foxy"
Skip end-of-life distro "galactic"
Skip end-of-life distro "groovy"
Skip end-of-life distro "hydro"
Skip end-of-life distro "indigo"
Add distro "iron"
Skip end-of-life distro "jade"
Skip end-of-life distro "kinetic"
Skip end-of-life distro "lunar"
Skip end-of-life distro "melodic"
Add distro "noetic"
Add distro "rolling"
update rosdep cache in /home/nathun/.ros/rosdep/sources.cache
nathun@UAS:~$ sudo rosdep init
ERROR: default sources list file already exists:
/etc/ros/rosdep/sources.list.d/20-default.list
Please delete if you wish to re-initialize
nathun@UAS:~$
```

- **Isi dari bashrc**

```

Activities Text Editor 5 Jan 15:11
*~.bashrc
Save
Open
File
Edit
Help
55 # If this is an xterm set the title to user@hostid:
56 case "$TERM" in
57 xterm*) title "${debian_chroot:+($debian_chroot)} \u001d${USER}@${HOSTNAME%%.*}";;
58 *) ;;
59 esac
60
61 # enable color support of ls and also add handy aliases
62 if [ -x /usr/bin/dircolors ]; then
63     test -r ~/.dircolors && eval "$(dircolors -b)" || eval "$(dircolors -b)"
64     alias ls='ls --color=auto'
65     alias dir='dir --color=auto'
66     alias grep='grep --color=auto'
67     alias fgrep='fgrep --color=auto'
68     alias egrep='egrep --color=auto'
69 fi
70
71 # colored GCC warnings and errors
72 export GCC_COLORS='error=1;31:warning=1;35:note=1;36:caret=1;32:locus=1;quote=1'
73
74 # some more ls aliases
75 alias ll='ls -alF'
76 alias la='ls -A'
77 alias l='ls -G'
78
79 # Add an "alert" alias for long running commands.  Use like so:
80 alias alert='notify-send --urgency=low -t " $(history|tail -n1|sed -e '\''s/^\s*\([0-9]\)\+\s*//;\$|[;]\)\$'\''" 2>/dev/null'
81
82 # Alias definitions.
83 # You may want to put all your additions into a separate file like
84 # $HOME/.bash_aliases, instead of adding them here directly.
85 # See /usr/share/doc/bash-doc/examples in the bash-doc package.
86
87 # For a . ~/.bash_aliases ); then
88 # . ./bash_aliases
89
90 # Alias definitions, overriding ones in /etc/bash.bashrc.
91 # You can also put functions here.
92 # Functions can be put in $HOME/.bash_completion
93 # See /usr/share/doc/bash-completion/bash_completion for examples.
94
95 # Alias definitions, overriding ones in /etc/bash.bashrc
96 # This is useful for enabling completion features you don't need to enable
97 # this, if it's already enabled in /etc/bash.bashrc and /etc/profile
98 # sources /etc/bash.bashrc.
99 # If you want to use the bash-completion package, you'll need to do this:
100 # If you want to use the bash-completion package, you'll need to do this:
101 # If you want to use the bash-completion package, you'll need to do this:
102 # If you want to use the bash-completion package, you'll need to do this:
103 # If you want to use the bash-completion package, you'll need to do this:
104 # If you want to use the bash-completion package, you'll need to do this:
105 # If you want to use the bash-completion package, you'll need to do this:
106 # If you want to use the bash-completion package, you'll need to do this:
107 # If you want to use the bash-completion package, you'll need to do this:
108 # If you want to use the bash-completion package, you'll need to do this:
109 # If you want to use the bash-completion package, you'll need to do this:
110 # If you want to use the bash-completion package, you'll need to do this:
111 # If you want to use the bash-completion package, you'll need to do this:
112 # If you want to use the bash-completion package, you'll need to do this:
113 # If you want to use the bash-completion package, you'll need to do this:
114 # If you want to use the bash-completion package, you'll need to do this:
115 # If you want to use the bash-completion package, you'll need to do this:
116 # If you want to use the bash-completion package, you'll need to do this:
117 # If you want to use the bash-completion package, you'll need to do this:
118 # If you want to use the bash-completion package, you'll need to do this:
119 source /opt/ros/noetic/setup.bash
```

- Melakukan run pada roscore

```

Activities Terminal 5 Jan 15:20
roscore http://UAS:11311/ nathan@UAS: ~
SUMMARY
=====
PARAMETERS
  * /rosdistro: noetic
  * /rosversion: 1.16.0
NODES
auto-starting new master
process[master]: started with pid [21435]
ROS_MASTER_URI=http://UAS:11311/
[A] setting /run_id to a84d9412-ab9f-11ee-930c-f7095ec95b04
process[rosout]: started with pid [21445]
started core service [/rosout]
<[rosout-1] killing on exit
[master] killing exit
shutting down processing monitor...
... shutting down processing monitor complete
root@UAS:~# echo "source /opt/ros/noetic/setup.bash" >> ~/.bashrc
root@UAS:~# gedit ~/.bashrc
```
logging to /root/.ros/log/55e27160-aba0-11ee-930c-f7095ec95b04/roslaun-UAS-21699.log
Checking log directory for disk usage. This may take a while.
Press Ctrl-C to interrupt
Done checking log file disk usage. Usage is <1GB.

started roslaunch server http://UAS:46607/
ros_comn version 1.16.0

SUMMARY
=====
PARAMETERS
  * /rosdistro: noetic
  * /rosversion: 1.16.0
NODES
auto-starting new master
process[master]: started with pid [21707]
ROS_MASTER_URI=http://UAS:11311/
setting /run_id to 55e27160-aba0-11ee-930c-f7095ec95b04
process[rosout-1]: started with pid [21717]
started core service [/rosout]
```

## *Chapter 2 – Getting Started with ROS Programming*

Laporan ini membahas langkah-langkah awal untuk memulai pemrograman ROS, termasuk pembuatan node dan workspace.

Dalam konteks ROS (Robot Operating System), sebuah "node" adalah proses perangkat lunak yang berjalan secara independen dan berkomunikasi dengan proses lainnya melalui sistem komunikasi yang disediakan oleh ROS. Node berperan sebagai entitas dasar yang memungkinkan modularitas dan distribusi dalam pengembangan perangkat lunak robotik. Sedangkan, sebuah "workspace" adalah direktori khusus yang berisi struktur file dan direktori yang diperlukan untuk mengembangkan, membangun, dan menyimpan paket-paket ROS. Workspace menyediakan lingkungan kerja untuk mengatur proyek-proyek pengembangan perangkat lunak robotika.

- Membuat paket ROS menggunakan catkin *build system*

```

Activities Terminal 5 Jan 19:40
nathun@UAS:~/catkin_ws$ cd ~/catkin_ws/src/$ catkin_init_workspace
nathun@UAS:~/catkin_ws$ cd ~/catkin_ws/src/CMakeLists.txt pointing to "/opt/ros/noetic/share/catkin/cmake/toplevel.cmake"
nathun@UAS:~/catkin_ws$ cd ~/catkin_ws
nathun@UAS:~/catkin_ws$ catkin_make
Base path: /home/nathun/catkin_ws
Source space: /home/nathun/catkin_ws/src
Build space: /home/nathun/catkin_ws/build
Devel space: /home/nathun/catkin_ws/devel
Install space: /home/nathun/catkin_ws/install
#####
## Running command: "cmake /home/nathun/catkin_ws/src -DCATKIN_DEVEL_PREFIX=/home/nathun/catkin_ws/devel -DCMAKE_INSTALL_PREFIX=/home/nathun/catkin_ws/install -G Unix Makefiles" in "/home/nathun/catkin_ws/build"
#####
-- The C compiler identification is GNU 9.4.0
-- The CXX compiler identification is GNU 9.4.0
-- Check for working C compiler: /usr/bin/cc
-- Check for working CXX compiler: /usr/bin/c++
-- Detecting C compiler ABI info
-- Detecting C compile features
-- Detecting CXX compiler ABI info - done
-- Detecting CXX compile features
-- Detecting CXX compile features - done
-- Check for working CXX compiler: /usr/bin/c++
-- Check for working CXX compiler: /usr/bin/c++ -- works
-- Detecting CXX compiler ABI info
-- Detecting CXX compiler ABI info - done
-- Detecting CXX compile features
-- Detecting CXX compile features - done
-- Using CMAKE_PREFIX_PATH: /opt/ros/noetic
-- This workspace overlays: /opt/ros/noetic
-- Found PythonEXECUTABLE: /usr/bin/python3 (found suitable version "3.8.10", minimum required is "3")
-- Using PYTHONEXECUTABLE: /usr/bin/python3
-- Using Python version: 3.8.10
-- Found Python dist-packages: /usr/lib/python3/dist-packages
-- Found PY_SON: /usr/lib/python3/dist-packages/_em.py
-- Using empty: /usr/lib/python3/dist-packages/_em.py
-- Using CATKIN_ENABLE_TESTING: ON
-- Call enable_testing()
-- Using CATKIN_RESULTS_DIR: /home/nathun/catkin_ws/build/test_results
-- Forcing gtest/gmock from source, though one was otherwise available.
-- Found gtest sources under '/usr/src/googletest': gtests will be built
-- Found gmock sources under '/usr/src/googletest': gmock will be built
-- Found PythonInterpreter: /usr/bin/python3 (found version "3.8.10")
-- Found Threads: TRUE
-- Using Python nosetests: /usr/bin/nosetests3
-- catkin 0.8.1
-- BUILD_SHARED_LIBS is on
BUILD_SHARED_LIBS is on
-- Using CATKIN_DEVEL_PREFIX: /home/nathun/catkin_ws/devel
-- Generating done
-- Build files have been written to: /home/nathun/catkin_ws/build
#####
## Running command: "make -j4 -l4" in "/home/nathun/catkin_ws/build"
#####
nathun@UAS:~/catkin_ws$
```

- Membuat workspace *mastering ros demo*

```

Activities Terminal 5 Jan 20:06
nathun@UAS:~/catkin_ws
[ 48%] Generating Lisp code from mastering_ros_demo_pkg/Demo_actionGoal.msg
[ 50%] Generating Lisp code from mastering_ros_demo_pkg/DemoActionResult.msg
[ 51%] Generating Python code from MSG mastering_ros_demo_pkg/Demo_actionGoal
[ 53%] Generating Lisp code from mastering_ros_demo_pkg/Demo_actionFeedback.msg
[ 54%] Generating Python code from MSG mastering_ros_demo_pkg/Demo_actionFeedback
[ 54%] Built target mastering_ros_demo_pkg_generate_messages_lisp
Scanning dependencies of target mastering_ros_demo_pkg_generate_messages_eus
[ 56%] Generating EusLisp code from mastering_ros_demo_pkg/demo_msg.msg
[ 57%] Generating Python code from MSG mastering_ros_demo_pkg/DemoActionResult
[ 58%] Generating EusLisp code from MSG mastering_ros_demo_pkg/Demo_actionGoal.msg
[ 58%] Generating EusLisp code from MSG mastering_ros_demo_pkg/Demo_actionFeedback.msg
[ 59%] Linking CXX executable /home/nathun/catkin_ws/devel/lib/mastering_ros_demo_pkg/demo_topic_publisher
[ 64%] Generating Python code from MSG mastering_ros_demo_pkg/Demo_actionFeedback
[ 65%] Generating EusLisp code from mastering_ros_demo_pkg/Demo_actionActionResult.msg
[ 65%] Generating EusLisp code from mastering_ros_demo_pkg/Demo_actionFeedback.msg
[ 67%] Built target demo_topic_publisher
Scanning dependencies of target demo_msg_subscriber
[ 68%] Building CXX object mastering_ros_demo_pkg/CMakeFiles/demo_msg_subscriber.dir/src/demo_msg_subscriber.cpp.o
[ 70%] Generating Python code from SRV mastering_ros_demo_pkg/demo_srv
[ 71%] Generating EusLisp code from masterin_ros_demo_pkg/Demo_actionGoal.msg
[ 73%] Generating EusLisp code from masterin_ros_demo_pkg/Demo_actionFeedback.msg
[ 75%] Generating Python msg_int_.py for mastering_ros_demo_pkg
[ 76%] Generating EusLisp code from mastering_ros_demo_pkg/Demo_actionFeedback.msg
[ 78%] Generating EusLisp code from mastering_ros_demo_pkg/demo_srv.srv
[ 78%] Generating EusLisp code from masterin_ros_demo_pkg/Demo_actionFeedback
[ 79%] Linking CXX executable /home/nathun/catkin_ws/devel/lib/mastering_ros_demo_pkg/demo_topic_subscriber
[ 81%] Built target demo_topic_subscriber
Scanning dependencies of target demo_service_server
[ 84%] Building CXX object mastering_ros_demo_pkg/CMakeFiles/demo_service_server.dir/src/demo_service_server.cpp.o
[ 84%] Built target demo_service_server
Scanning dependencies of target demo_action_server
[ 85%] Building CXX object mastering_ros_demo_pkg/Demo_action_server.dir/src/demo_action_server.cpp.o
[ 85%] Built target mastering_ros_demo_pkg_generate_messages_eus
Scanning dependencies of target demo_action_client
[ 87%] Building CXX object mastering_ros_demo_pkg/CMakeFiles/demo_action_client.dir/src/demo_action_client.cpp.o
[ 88%] Built target demo_action_client
Scanning dependencies of target demo_service_client
[ 89%] Building CXX object mastering_ros_demo_pkg/CMakeFiles/demo_service_client.dir/src/demo_service_client.cpp.o
[ 89%] Built target demo_service_client
Scanning dependencies of target demo_msg_publisher
[ 93%] Building CXX object mastering_ros_demo_pkg/Demo_msg_publisher.dir/src/demo_msg_publisher.cpp.o
Scanning dependencies of target mastering_ros_demo_pkg_generate_messages
[ 95%] Built target mastering_ros_demo_pkg_generate_messages
[ 96%] Linking CXX executable /home/nathun/catkin_ws/devel/lib/mastering_ros_demo_pkg/demo_action_server
[ 98%] Linking CXX executable /home/nathun/catkin_ws/devel/lib/mastering_ros_demo_pkg/demo_msg_publisher
[ 98%] Built target demo_action_server
[ 98%] Built target demo_msg_publisher
[100%] Linking CXX executable /home/nathun/catkin_ws/devel/lib/mastering_ros_demo_pkg/demo_action_client
[100%] Built target demo_action_client
*** nathun@UAS:~/catkin_ws ***
```

- **Instalasi paket**

```

Activities Terminal 5 Jan 19:42
nathan@UAS: ~/catkin_ws

## The C compiler identification is GNU 9.4.0
## The CXX compiler identification is GNU 9.4.0
## Check for working C compiler: /usr/bin/cc -- works
Detecting C compiler ABI info
Detected C compiler ABI info
-- Detecting C compile features
-- Detecting C compile features - done
-- Detecting CXX compiler ABI info - done
-- Detecting CXX compile features
-- Detecting CXX compile features - done
-- Using CATKIN_DEVEL_PREFIX /home/nathan/catkin_ws/devel
-- Using CMAKE_PREFIX_PATH /opt/ros/noetic
-- This workspace overlays: /opt/ros/noetic
  Found PythonInterp: /usr/bin/python3 (found suitable version "3.8.10", minimum required is "3")
-- Using PYTHON_EXECUTABLE: /usr/bin/python3
-- Using Debian Python package layout
  Found PY_VENV_DISABLE: /usr/bin/python3/dist-packages/em.py
  Found PY_VENV_VIA_VENV: /usr/bin/python3/dist-packages/em.py
  Using CATKIN_ENABLE_TESTING: ON
-- Call enable_testing()
-- Using CATKIN_TEST_RESULTS_DIR: /home/nathan/catkin_ws/build/test_results
  Forcing gtest to use the system's gtest instead of building its own
-- Using gtest sources under: /usr/src/googletest; gtests will be built
  Found gmock sources under: /usr/src/googletest; gmock will be built
  Found PythonInterp: /usr/bin/python3 (found version "3.8.10")
-- Found Threads: TRUE
-- Using nosetests: /usr/bin/nosetests3
-- catkin 0.9.10
-- BUILD_SHARED_LIBS is on
-- BUILD_SHARED_LIBS is on
-- Configuring done
-- Generating done
-- Build files have been written to: /home/nathan/catkin_ws/build
#####
#### Running command: "make -j4 -l4" in "/home/nathan/catkin_ws/build"
#####
nathan@UAS:~/catkin_ws$ echo '$source ~/catkin_ws/devel/setup.bash' >> ~/.bashrc
nathan@UAS:~/catkin_ws$ catkin_create_pkgs package_name [dependency1] [dependency2]
Created file package_name/CMakeLists.txt
Successfully created file package_name/CMakeLists.txt
Created file package_name/package.xml
Successfully created file package_name/package.xml. Please adjust the values in package.xml.
Created file mastering_ros_demo_pkg/CMakeLists.txt
Created file mastering_ros_demo_pkg/package.xml
Created file mastering_ros_demo_pkg/include/mastering_ros_demo_pk
Created folder mastering_ros_demo_pkgs/include/mastering_ros_demo_pk
Successfully created folder /home/nathan/catkin_ws/mastering_ros_demo_pkgs. Please adjust the values in package.xml.
nathan@UAS:~/catkin_ws$ actionlib.actionlib_ngsp

```

- **Menjalankan code node pertama**

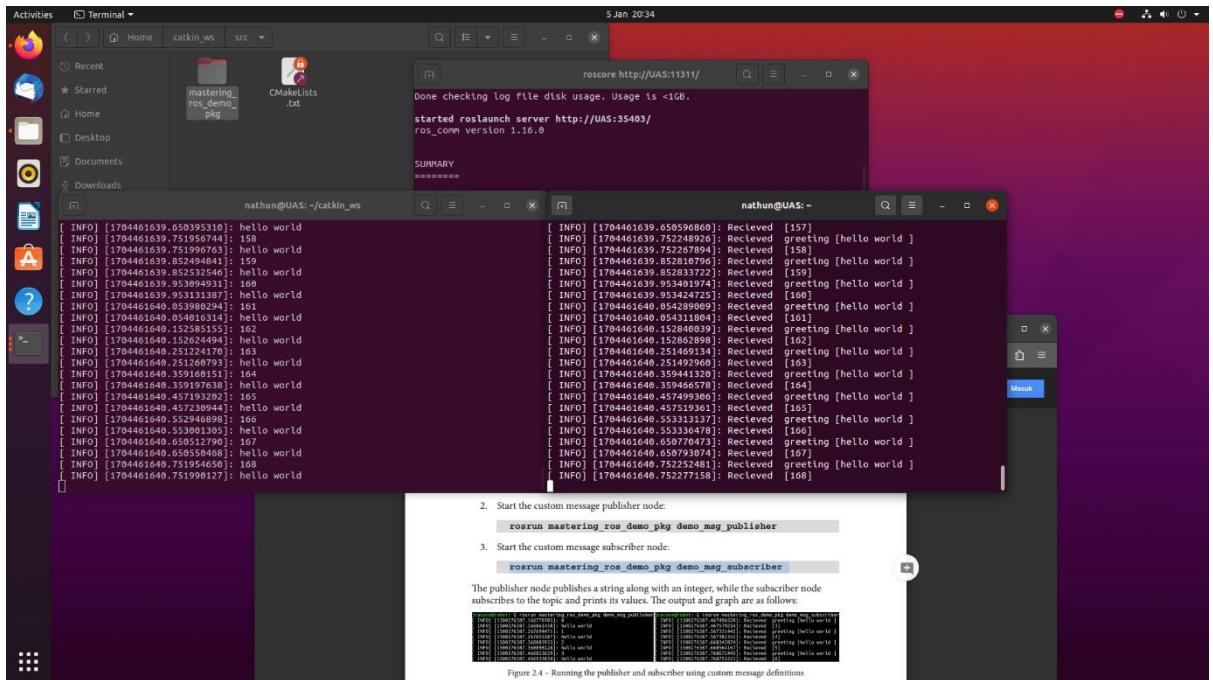
```

Activities Terminal 5 Jan 20:29
nathan@UAS: ~/catkin_ws

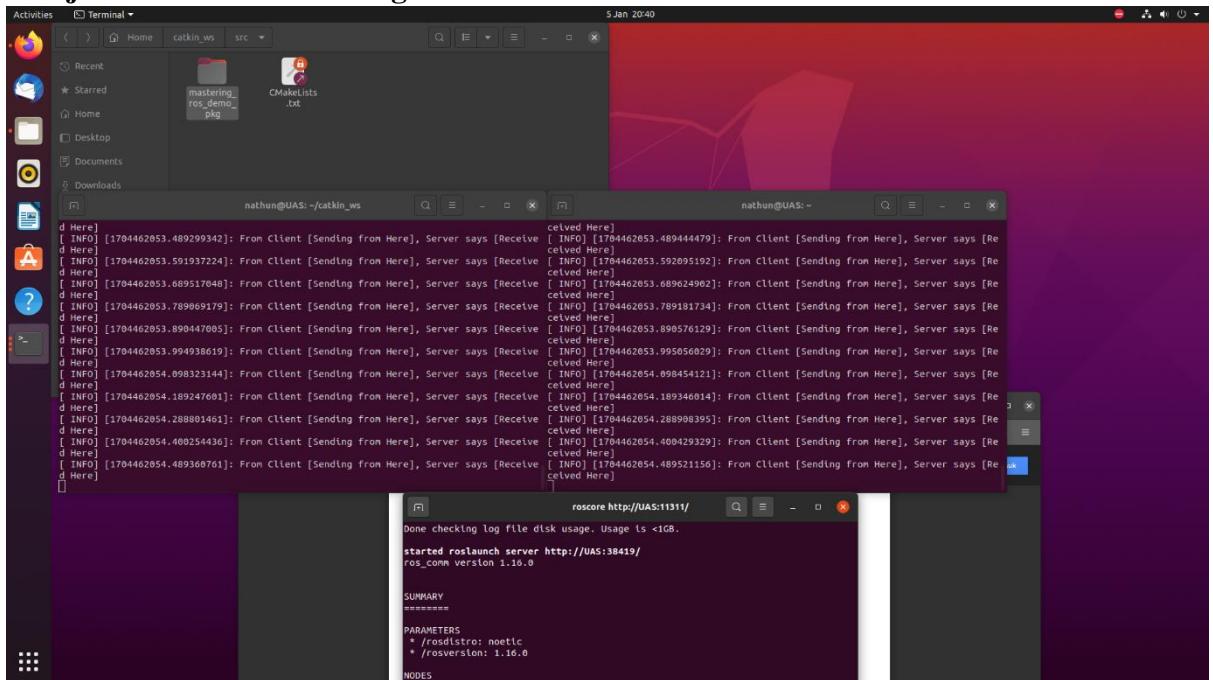
Press Ctrl-C to interrupt
Done checking log file disk usage. Usage is <1GB.
started roslaunch server http://UAS:42653/
ros_comm version 1.16.0

SUMMARY
=====
[ INFO] [1704461389.347416761]: Received [411]
[ INFO] [1704461389.469385800]: Received [412]
[ INFO] [1704461389.504964490]: Received [413]
[ INFO] [1704461389.647200006]: Received [414]
[ INFO] [1704461389.769670156]: Received [415]
[ INFO] [1704461389.847155555]: Received [416]
[ INFO] [1704461389.948470692]: Received [417]
[ INFO] [1704461390.067553524]: Received [418]
[ INFO] [1704461390.186500008]: Received [419]
[ INFO] [1704461390.249249222]: Received [420]
[ INFO] [1704461390.347883347]: Received [421]
[ INFO] [1704461390.452293171]: Received [422]
[ INFO] [1704461390.551946626]: Received [423]
[ INFO] [1704461390.665680767]: Received [424]
[ INFO] [1704461390.758223572]: Received [425]
[ INFO] [1704461390.852853371]: Received [426]
[ INFO] [1704461390.947863142]: Received [427]
[ INFO] [1704461391.051827423]: Received [428]
[ INFO] [1704461391.168267248]: Received [429]
[ INFO] [1704461391.246966993]: Received [430]
[ INFO] [1704461391.351696024]: Received [431]
[ INFO] [1704461391.448294384]: Received [432]
[ INFO] [1704461391.547110799]: Received [433]

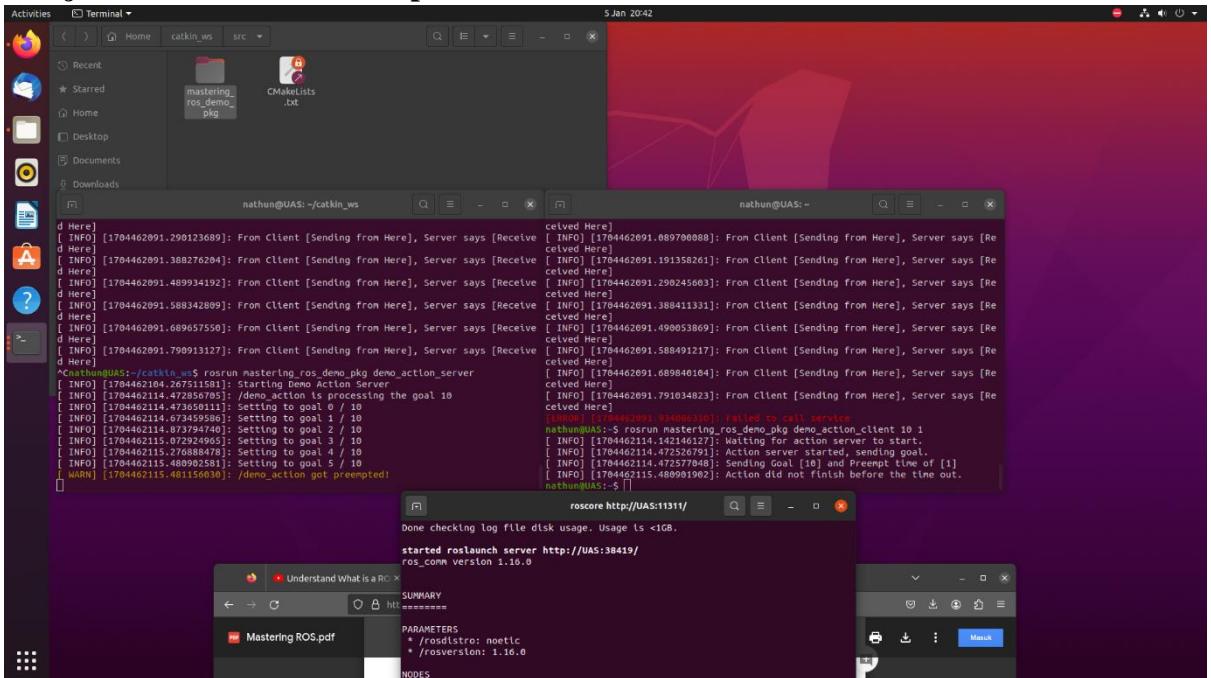
Now run both commands in two shells. In the running publisher, run the following command:
rosrun mastering_ros_demo_package demo_topic_publisher
In the running subscriber, run the following command:
rosrun mastering_ros_demo_package demo_topic_subscriber
We will see the following output:
[INFO] [1704461391.570865145]: Recv from topic demo_topic_publisher
[INFO] [1598071515.717085151]: 0
[INFO] [1598071515.717085151]: 1
[INFO] [1598071515.717085151]: 2
[INFO] [1598071515.717085151]: 3
[INFO] [1598071515.717085151]: 4
[INFO] [1598071515.717085151]: 5
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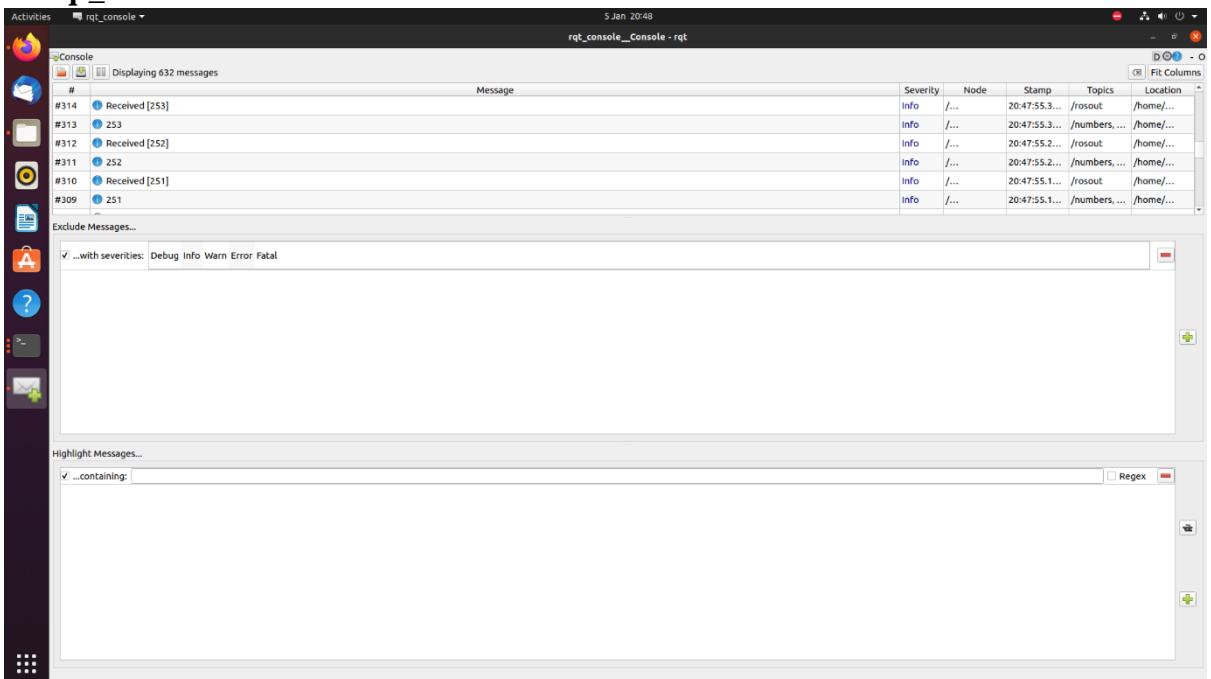
- Menjalankan code node ketiga



- Menjalankan code node keempat



- Isi rqt\_console



*Chapter 3 – Working with ROS for 3D Modeling*

Pemodelan 3D menjadi aspek kunci dalam pengembangan robotika, simulasi, dan pengolahan data citra. ROS (Robot Operating System) menyediakan alat dan library yang kuat untuk bekerja dengan model 3D, memungkinkan pengembang untuk mengintegrasikan dan mengelola informasi ruang tiga dimensi. Model geometris 3D merepresentasikan objek dalam ruang tiga dimensi menggunakan koordinat x, y, dan z.

- ROS menggunakan RViz (ROS Visualization) sebagai alat bantu visualisasi utama untuk pemodelan 3D.
  - URDF (Unified Robot Description Format) digunakan untuk mendefinisikan model robot dalam lingkungan simulasi ROS.

Berikut merupakan langkah-langkah yang dijalankan:

- Pembuatan ROS package untuk *3d modeling*

```
Activities Terminal 5 Jan 22:09
nathan@UAS:~
```

bash: source-/catkin\_ws/devel/setup.bash: No such file or directory  
nathan@UAS:~\$ cd  
nathan@UAS:~\$ catkin\_create\_pkg mastering\_ros\_robot\_description\_pkg roscpp tf  
Created file mastering\_ros\_robot\_description\_pkg/package.xml  
Created file mastering\_ros\_robot\_description\_pkg/CMakeLists.txt  
Created Folder mastering\_ros\_robot\_description\_pkg/include/mastering\_ros\_robot\_description\_pkg  
Created file mastering\_ros\_robot\_description\_pkg/src  
Successfully created files in /home/nathan/mastering\_ros\_robot\_description\_pkg. Please adjust the values in package.xml.  
nathan@UAS:~\$ geometry\_msgs urdf rviz xacro  
geometry\_msgs: command not found  
nathan@UAS:~\$ catkin\_create\_pkg mastering\_ros\_robot\_description\_pkg roscpp tf  
usage: catkin\_create\_pkg [OPTIONS] [NAME] [SVS DEPS [SVS DEPS ...]]  
 [-b [BOOST COMPS [BOOST COMPS ...]]] [-V PKG\_VERSION]  
 [-D DESCRIPTION] [-l LICENSE] [-a AUTHOR]  
 [-m MAINTAINER] [-r rostdistro ROSDISTRO]  
 [-n NAME] [-d DEPENDENCIES [DEPENDENCIES ...]]  
catkin\_create\_pkg: error: file exists: /home/nathan/mastering\_ros\_robot\_description\_pkg/package.xml  
[sudo] password for nathan:  
Reading package lists... Done  
Building dependency tree  
Reading state information... Done  
ros-noetic-urdf is already the newest version (1.13.2-1focal.20230620.185459).  
ros-noetic-urdf set to manually installed.  
0 to upgrade, 0 to newly install, 0 to remove and 252 not to upgrade.  
> ros-noetic-xacro  
[sudo] password for nathan:  
Reading package lists... Done  
Building dependency tree  
Reading state information... Done  
ros-noetic-xacro is already the newest version (1.14.16-1focal.20230620.185428).  
ros-noetic-xacro set to manually installed.  
0 to upgrade, 0 to newly install, 0 to remove and 252 not to upgrade.  
nathan@UAS:~\$

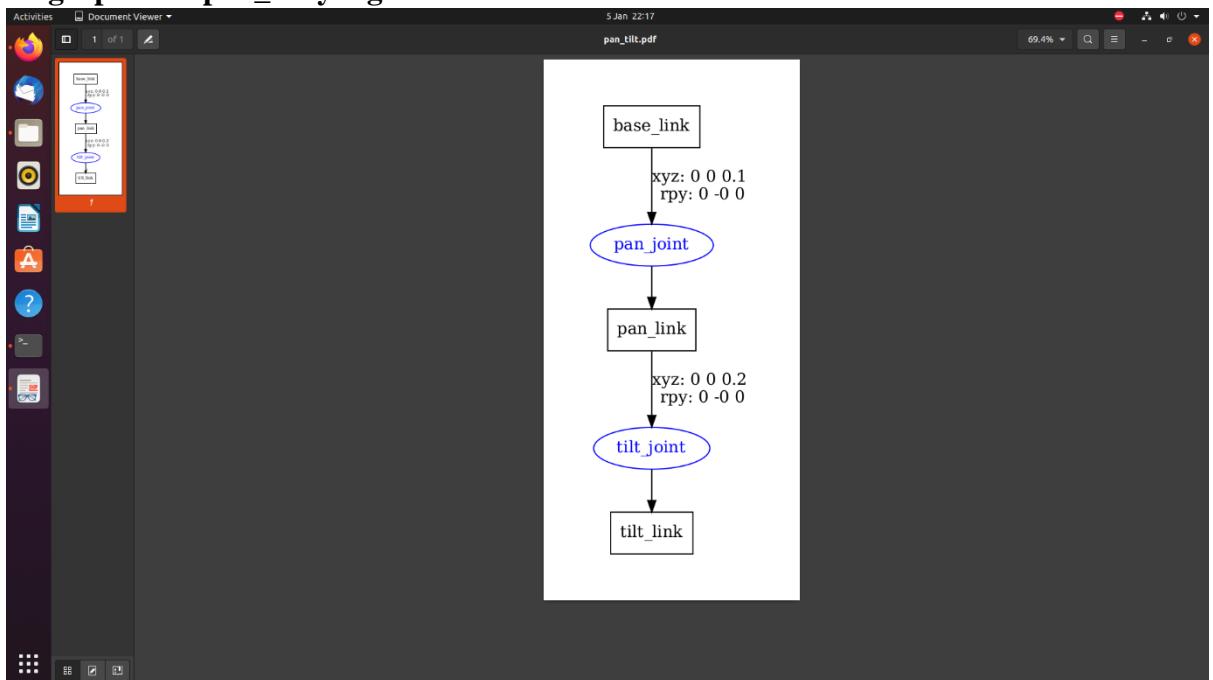
- Melakukan pemeriksaan pada file pan\_tilt.urdf

```

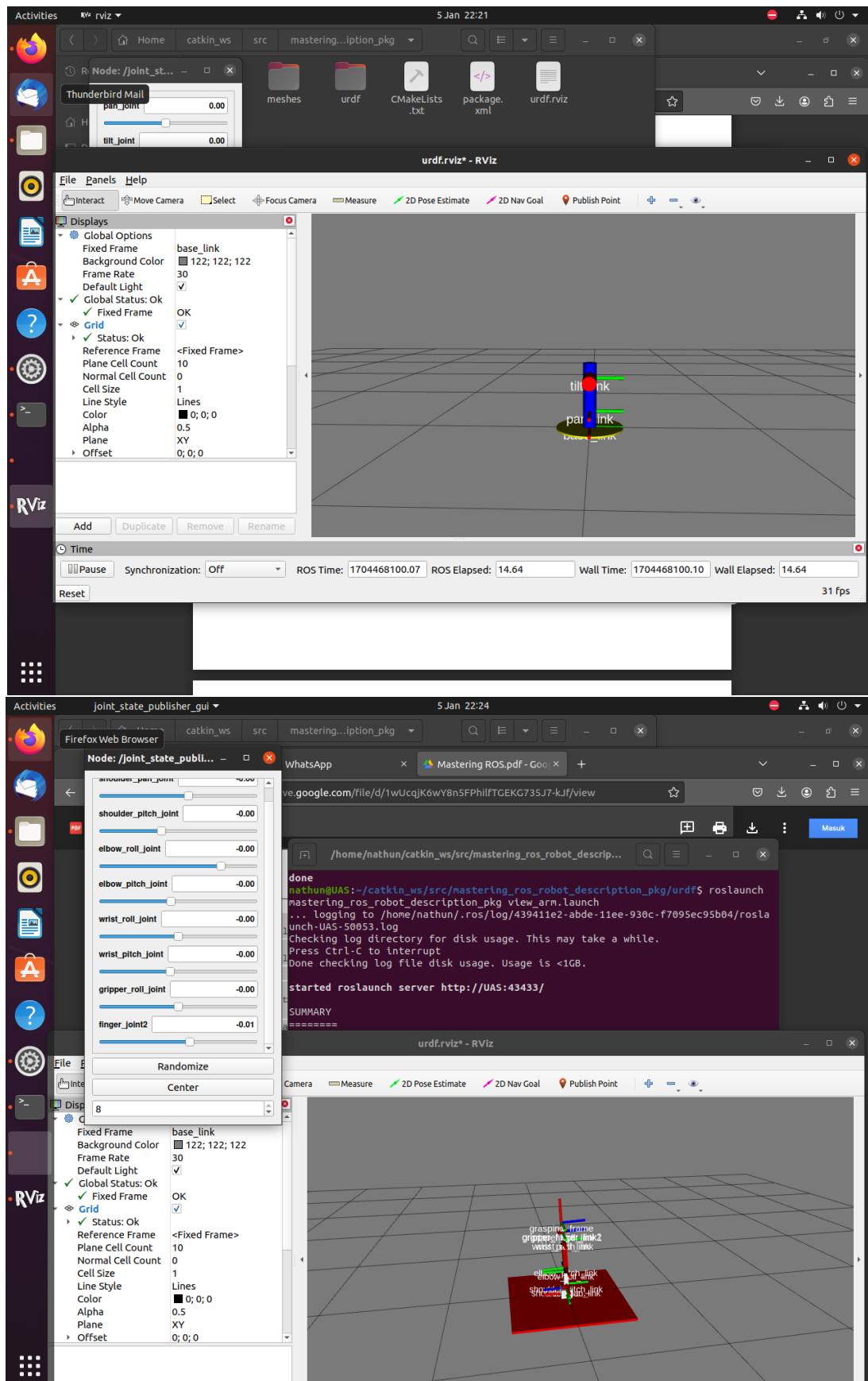
nathan@UAS:~/catkin_ws/src/mastering_ros_robot_description_pkg$ cd
nathan@UAS:~/catkin_ws$ cd src/mastering_ros_robot_description_pkg$ urdf
nathan@UAS:~/catkin_ws$ cd catkin_ws
nathan@UAS:~/catkin_ws$ cd src
nathan@UAS:~/catkin_ws$ cd mastering_ros_robot_description_pkg$ urdf
nathan@UAS:~/catkin_ws$ cd ~/catkin_ws/src/mastering_ros_robot_description_pkg$ urdf
nathan@UAS:~/catkin_ws$ check_urdf pan_tilt.urdf
robot name is: pan_tilt
----- Successfully Parsed XML -----
root link: base_link has 1 child(ren)
    child(0): pan_link
        child(0): tilt_link
nathan@UAS:~/catkin_ws$ cd ~/catkin_ws/src/mastering_ros_robot_description_pkg$ urdf

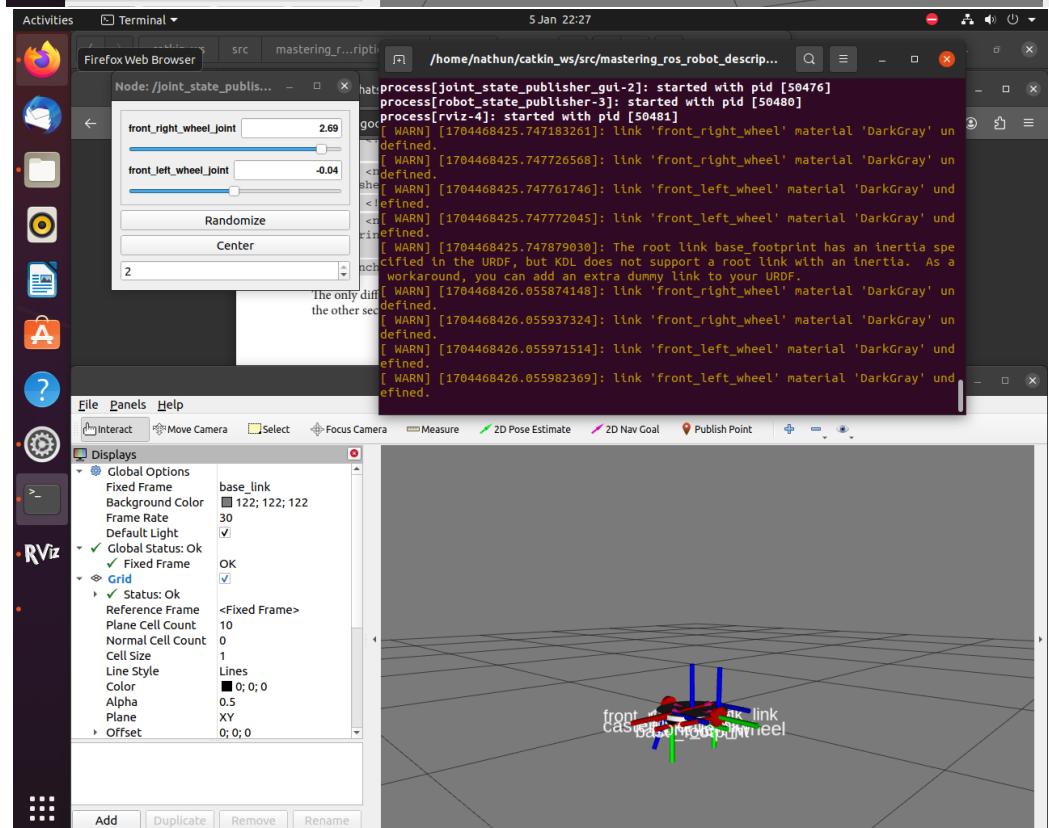
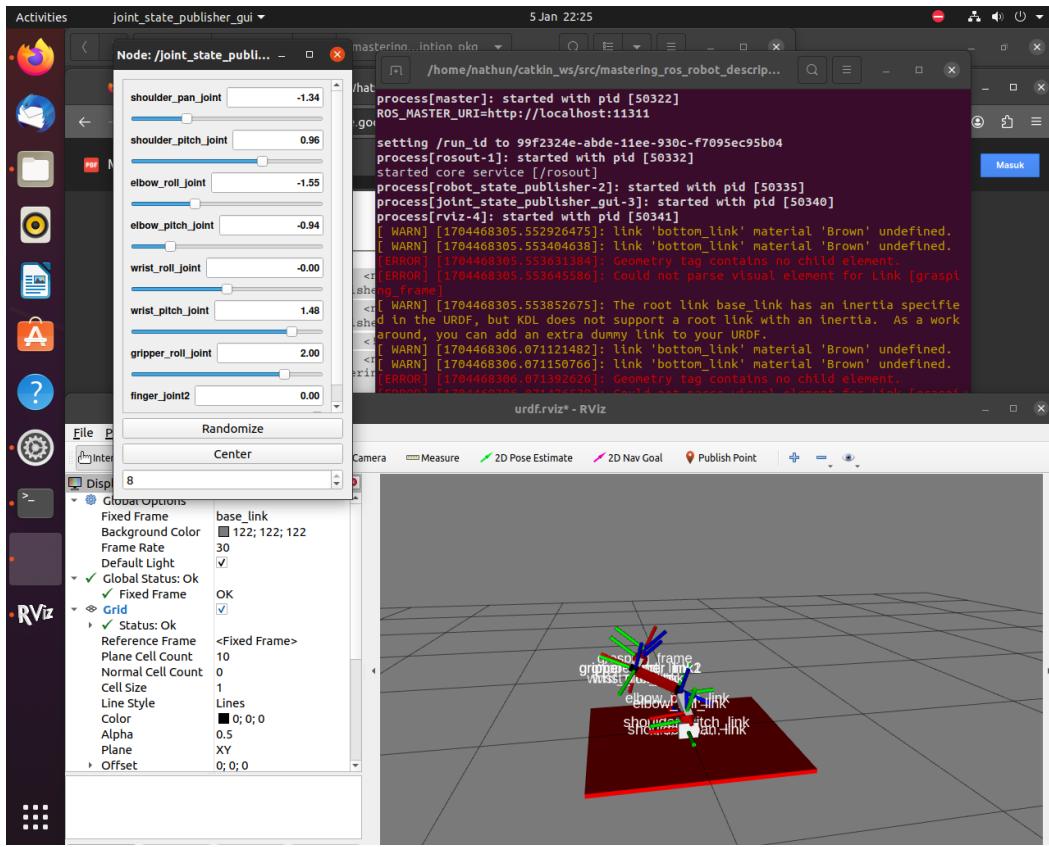
```

- Isi graph dari pan\_tilt yang sudah di konversi format



- Menjalankan *file demo robot menggunakan Rviz*



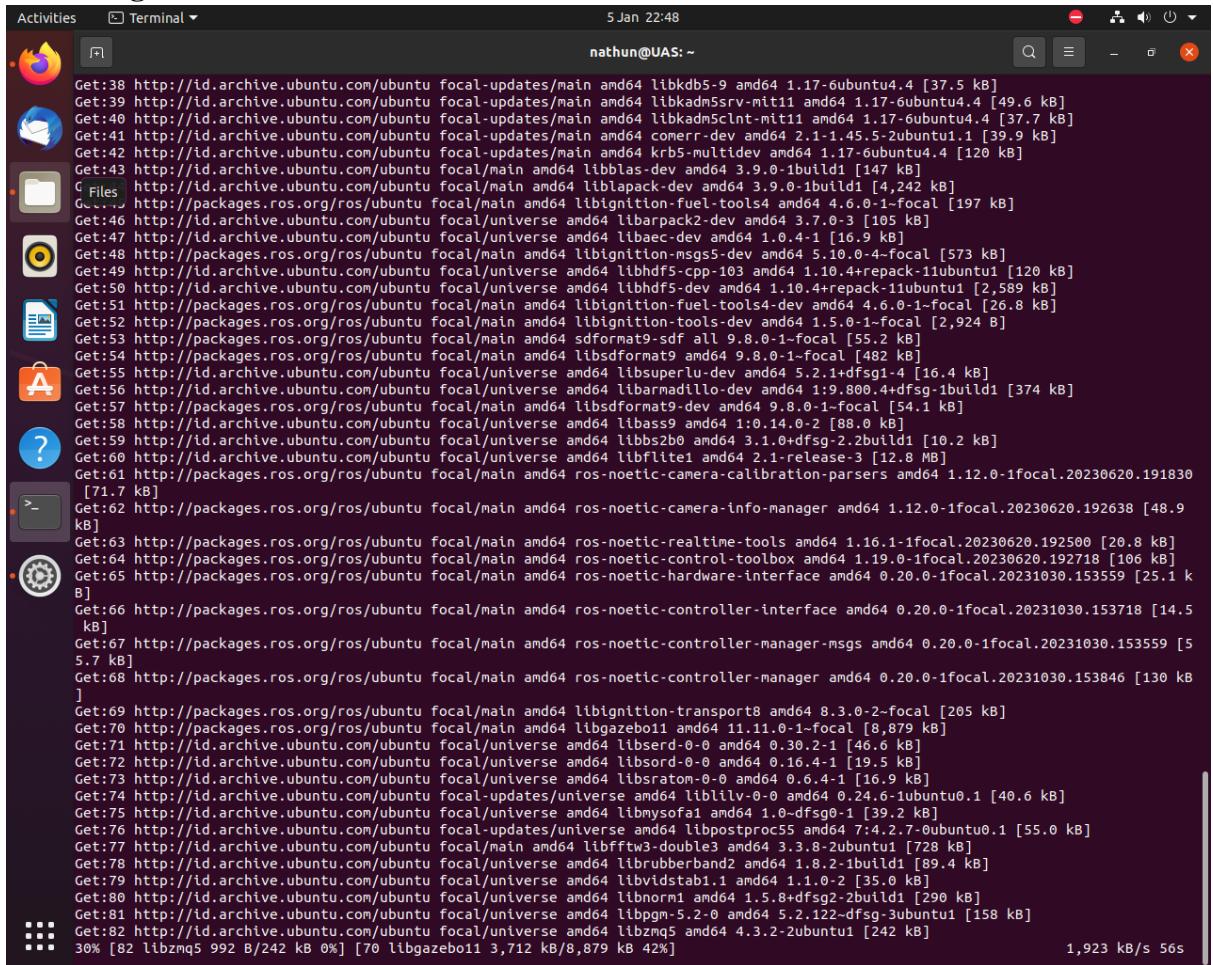


## Chapter 4 – Simulating Robots Using ROS and Gazebo

Simulasi robotika memainkan peran penting dalam pengembangan, pengujian, dan pemahaman perilaku robot. ROS (Robot Operating System) dan Gazebo adalah kombinasi kuat untuk membuat simulasi robot yang realistik dan berinteraksi dengan lingkungan simulasi. Jika sebelumnya berfokus pada instalasi dan juga mencoba menjalankan *file demo* di Rviz, maka pada *chapter* ini lebih berfokus pada memanfaatkan gazebo untuk menjalankan robot. Pada *chapter* ini juga seharusnya dapat mengubah nilai dari variable robot lewat terminal, tetapi terdapat beberapa masalah yang membuatnya tidak terjadi perubahan dan robot tetap pada posisi awal.

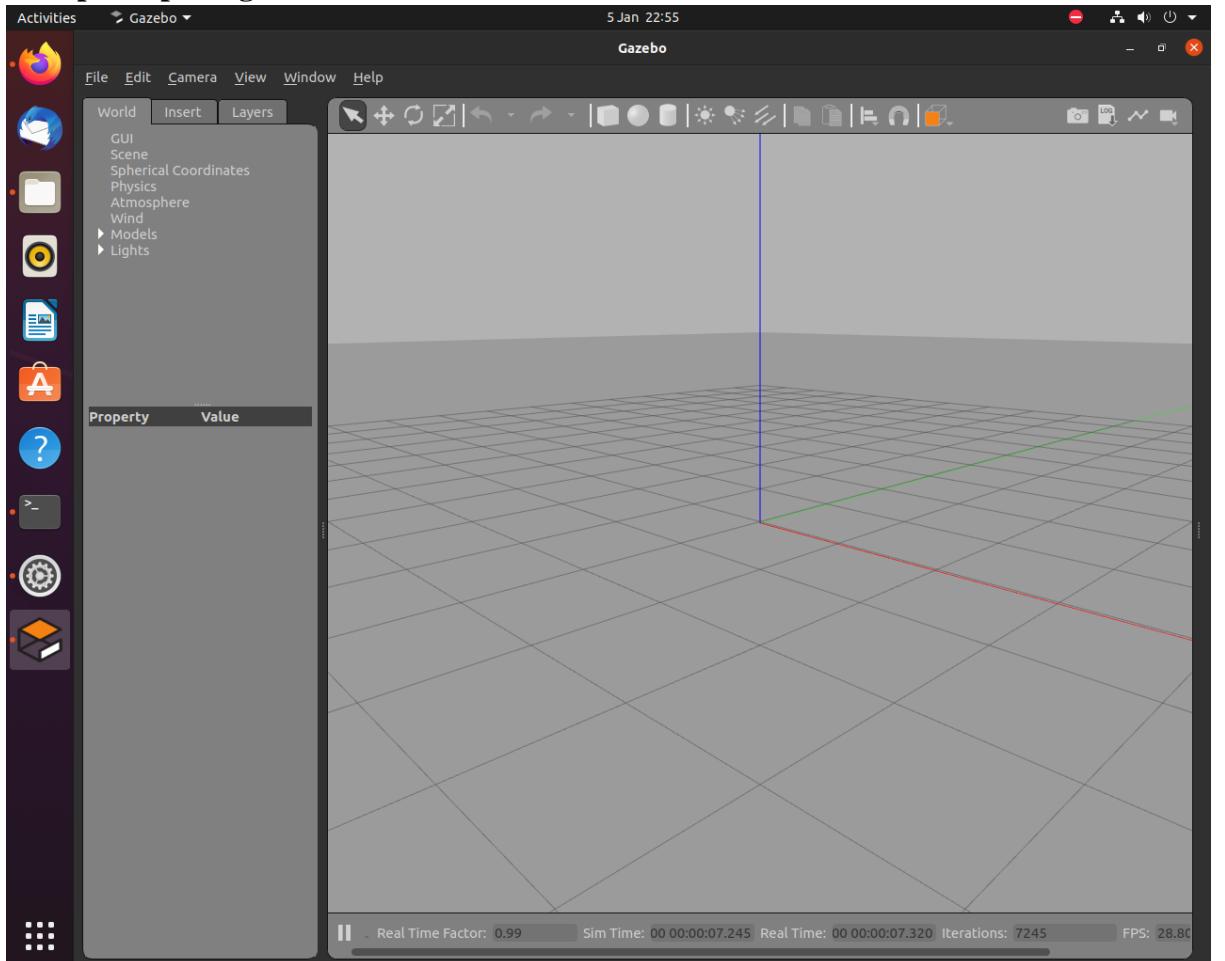
Langkah yang dijalankan adalah sebagai berikut:

- **Instalasi gazebo**

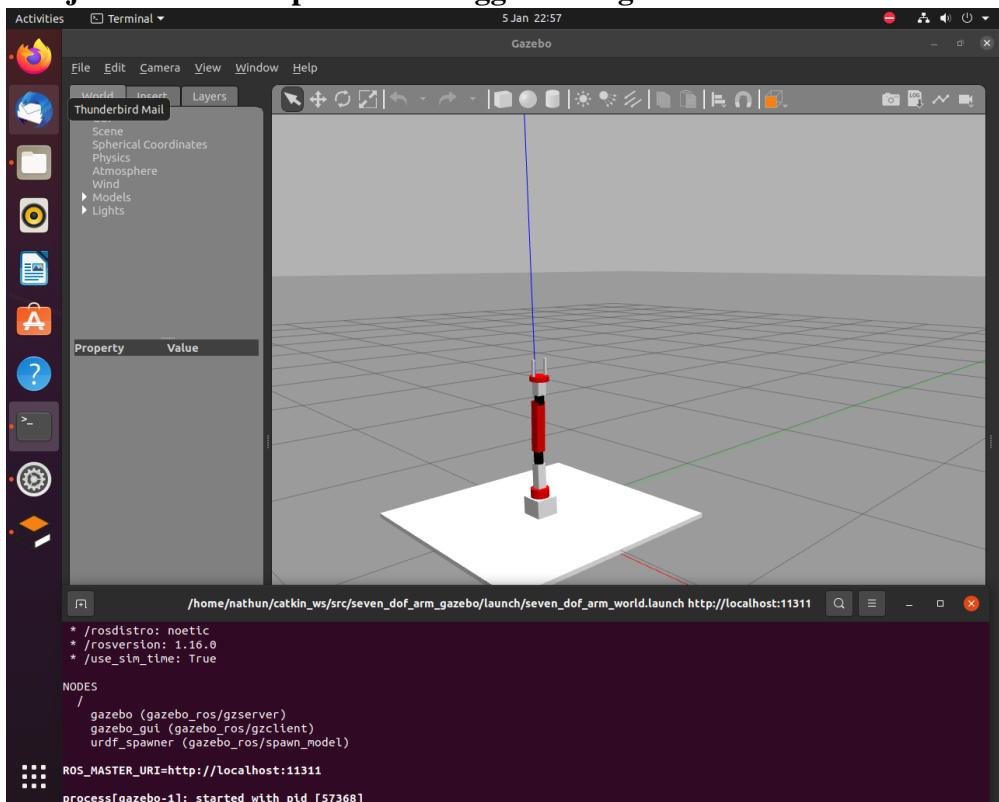


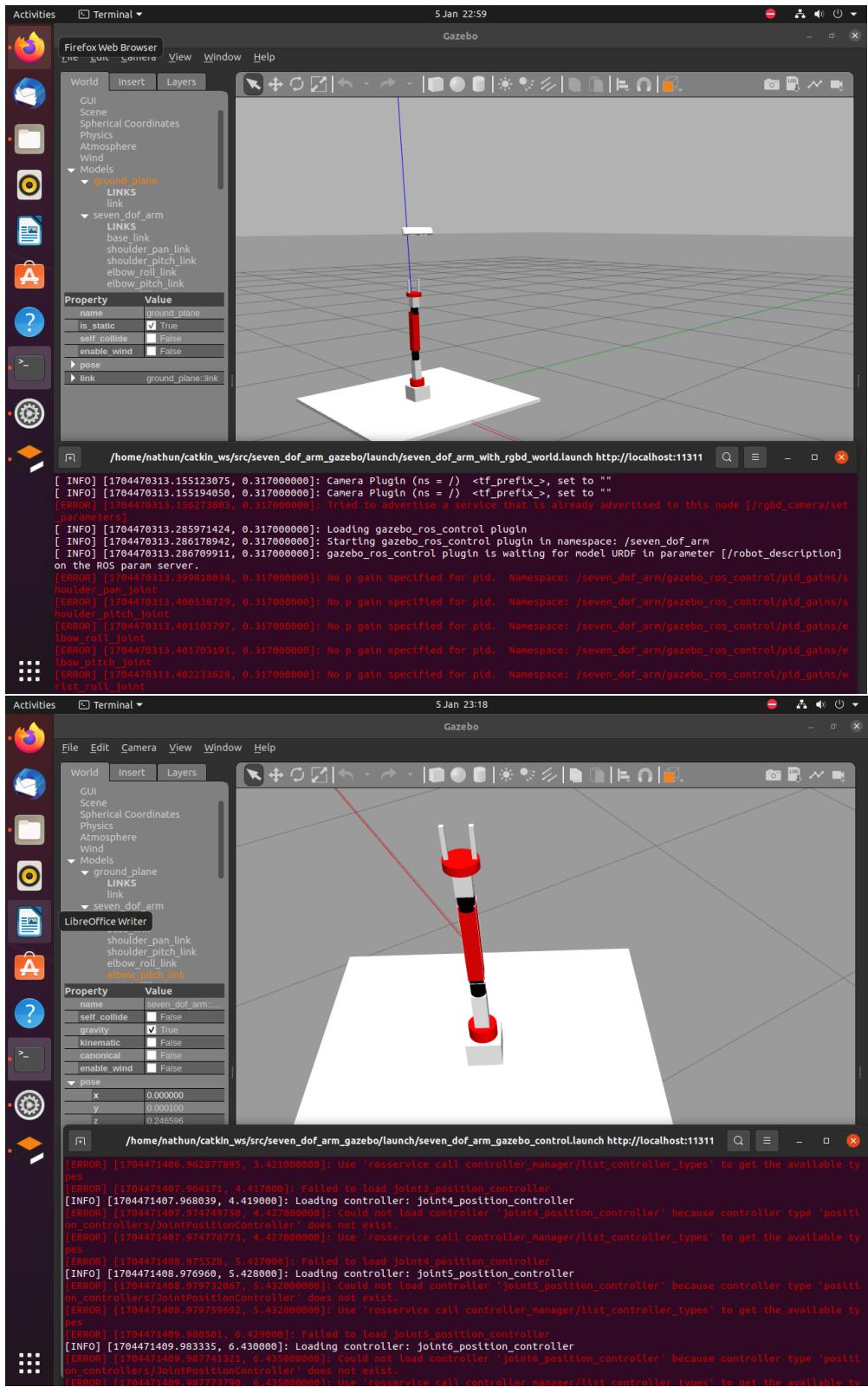
```
Activities Terminal 5 Jan 22:48
nathan@UAS: ~
Get:38 http://id.archive.ubuntu.com/ubuntu focal-updates/main amd64 libkdb5-9 amd64 1.17-6ubuntu4.4 [37.5 kB]
Get:39 http://id.archive.ubuntu.com/ubuntu focal-updates/main amd64 libkadm5srv-mit11 amd64 1.17-6ubuntu4.4 [49.6 kB]
Get:40 http://id.archive.ubuntu.com/ubuntu focal-updates/main amd64 libkadm5clnt-mit11 amd64 1.17-6ubuntu4.4 [37.7 kB]
Get:41 http://id.archive.ubuntu.com/ubuntu focal-updates/main amd64 comerr-dev amd64 2.1-1.45.5-2ubuntu1.1 [39.9 kB]
Get:42 http://id.archive.ubuntu.com/ubuntu focal-updates/main amd64 krb5-multidev amd64 1.17-6ubuntu4.4 [120 kB]
Get:43 http://id.archive.ubuntu.com/ubuntu focal/main amd64 libblas-dev amd64 3.9.0-1build1 [147 kB]
Get:44 http://id.archive.ubuntu.com/ubuntu focal/main amd64 liblapack-dev amd64 4.6.0-1-focal [4,242 kB]
Get:45 http://packages.ros.org/ros/ubuntu focal/universe amd64 libbarpack-fuel-tools4 amd64 4.6.0-1-focal [197 kB]
Get:46 http://id.archive.ubuntu.com/ubuntu focal/universe amd64 libbarpack2-dev amd64 3.7.0-3 [105 kB]
Get:47 http://id.archive.ubuntu.com/ubuntu focal/universe amd64 libbaec-dev amd64 1.0.4-1 [16.9 kB]
Get:48 http://packages.ros.org/ros/ubuntu focal/main amd64 libignition-msgs5-dev amd64 5.10.0-4-focal [573 kB]
Get:49 http://id.archive.ubuntu.com/ubuntu focal/universe amd64 libhdf5-cpp-103 amd64 1.10.4+repack-11ubuntu1 [120 kB]
Get:50 http://id.archive.ubuntu.com/ubuntu focal/universe amd64 libhdf5-dev amd64 1.10.4+repack-11ubuntu1 [2,589 kB]
Get:51 http://packages.ros.org/ros/ubuntu focal/main amd64 libignition-fuel-tools4-dev amd64 4.6.0-1-focal [26.8 kB]
Get:52 http://packages.ros.org/ros/ubuntu focal/main amd64 libignition-tools-dev amd64 1.5.0-1-focal [2,924 kB]
Get:53 http://packages.ros.org/ros/ubuntu focal/main amd64 sdformat9-sdf all 9.8.0-1-focal [55.2 kB]
Get:54 http://packages.ros.org/ros/ubuntu focal/main amd64 libsdformat9 amd64 9.8.0-1-focal [482 kB]
Get:55 http://id.archive.ubuntu.com/ubuntu focal/universe amd64 libsuperlu-dev amd64 5.2.1+dfsg1-4 [16.4 kB]
Get:56 http://id.archive.ubuntu.com/ubuntu focal/universe amd64 libmadillo-dev amd64 1.9.800.4+dfsg-1build1 [374 kB]
Get:57 http://packages.ros.org/ros/ubuntu focal/main amd64 libsdformat9-dev amd64 9.8.0-1-focal [54.1 kB]
Get:58 http://id.archive.ubuntu.com/ubuntu focal/universe amd64 liblass9 amd64 1:0.14.0-2 [88.0 kB]
Get:59 http://id.archive.ubuntu.com/ubuntu focal/universe amd64 libbsz2b0 amd64 3.1.0+dfsg-2.2build1 [10.2 kB]
Get:60 http://id.archive.ubuntu.com/ubuntu focal/universe amd64 libflite1 amd64 2.1-release-3 [12.8 MB]
Get:61 http://packages.ros.org/ros/ubuntu focal/main amd64 ros-noetic-camera-calibration-parsers amd64 1.12.0-1focal.20230620.191830 [71.7 kB]
Get:62 http://packages.ros.org/ros/ubuntu focal/main amd64 ros-noetic-camera-info-manager amd64 1.12.0-1focal.20230620.192638 [48.9 kB]
Get:63 http://packages.ros.org/ros/ubuntu focal/main amd64 ros-noetic-realtime-tools amd64 1.16.1-1focal.20230620.192500 [20.8 kB]
Get:64 http://packages.ros.org/ros/ubuntu focal/main amd64 ros-noetic-control-toolbox amd64 1.19.0-1focal.20230620.192718 [106 kB]
Get:65 http://packages.ros.org/ros/ubuntu focal/main amd64 ros-noetic-hardware-interface amd64 0.20.0-1focal.20231030.153559 [25.1 kB]
Get:66 http://packages.ros.org/ros/ubuntu focal/main amd64 ros-noetic-controller-interface amd64 0.20.0-1focal.20231030.153718 [14.5 kB]
Get:67 http://packages.ros.org/ros/ubuntu focal/main amd64 ros-noetic-controller-manager-msgs amd64 0.20.0-1focal.20231030.153559 [5.7 kB]
Get:68 http://packages.ros.org/ros/ubuntu focal/main amd64 ros-noetic-controller-manager amd64 0.20.0-1focal.20231030.153846 [130 kB]
Get:69 http://packages.ros.org/ros/ubuntu focal/main amd64 libignition-transport8 amd64 8.3.0-2-focal [205 kB]
Get:70 http://packages.ros.org/ros/ubuntu focal/main amd64 libgazebo11 amd64 11.11.0-1-focal [8,879 kB]
Get:71 http://id.archive.ubuntu.com/ubuntu focal/universe amd64 libserd-0-0 amd64 0.30.2-1 [46.6 kB]
Get:72 http://id.archive.ubuntu.com/ubuntu focal/universe amd64 libssord-0-0 amd64 0.16.4-1 [19.5 kB]
Get:73 http://id.archive.ubuntu.com/ubuntu focal/universe amd64 libsratom-0-0 amd64 0.6.4-1 [16.9 kB]
Get:74 http://id.archive.ubuntu.com/ubuntu focal-updates/universe amd64 liblillv-0-0 amd64 0.24.6-1ubuntu0.1 [40.6 kB]
Get:75 http://id.archive.ubuntu.com/ubuntu focal/universe amd64 libmysofa1 amd64 1.0-dfs9g-1 [39.2 kB]
Get:76 http://id.archive.ubuntu.com/ubuntu focal-updates/universe amd64 libpostproc55 amd64 7:4.2.7-0ubuntu0.1 [55.0 kB]
Get:77 http://id.archive.ubuntu.com/ubuntu focal/main amd64 libfftw3-double3 amd64 3.3.8-2ubuntu1 [728 kB]
Get:78 http://id.archive.ubuntu.com/ubuntu focal/universe amd64 librubberband2 amd64 1.8.2-1build1 [89.4 kB]
Get:79 http://id.archive.ubuntu.com/ubuntu focal/universe amd64 libvidstab1.1 amd64 1.1.0-2 [35.0 kB]
Get:80 http://id.archive.ubuntu.com/ubuntu focal/universe amd64 libnorm1 amd64 1.5.8+dfsg2-zbuild1 [290 kB]
Get:81 http://id.archive.ubuntu.com/ubuntu focal/universe amd64 libpgm-5.2-0 amd64 5.2.122-dfsg-3ubuntu1 [158 kB]
Get:82 http://id.archive.ubuntu.com/ubuntu focal/universe amd64 libzmq5 amd64 4.3.2-2ubuntu1 [242 kB]
30% [82 libzmq5 992 B/242 kB 0%] [70 libgazebo11 3,712 kB/8,879 kB 42%]
```

- **Mempersiapkan gazebo**



- **Menjalankan beberapa robot menggunakan gazebo**

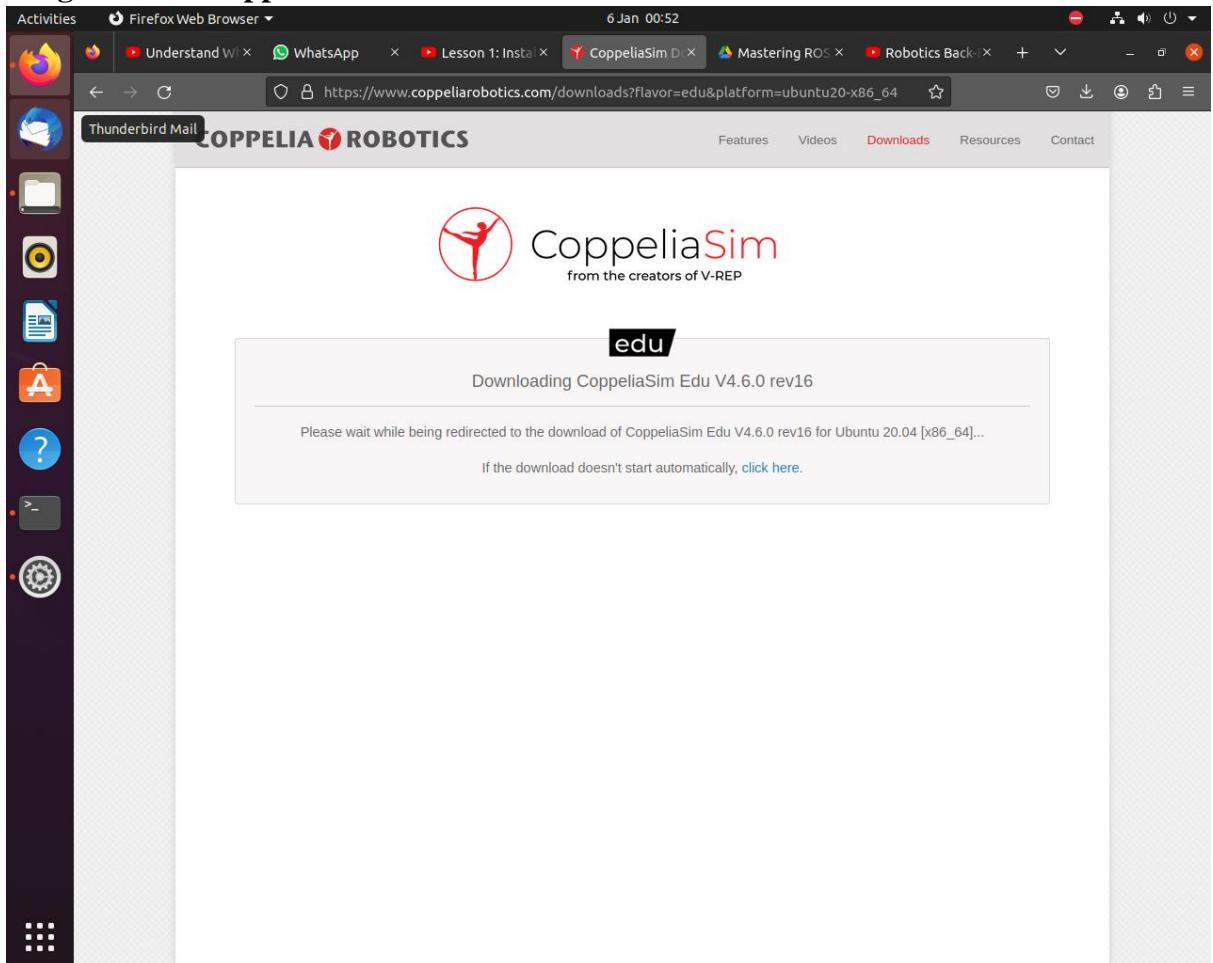




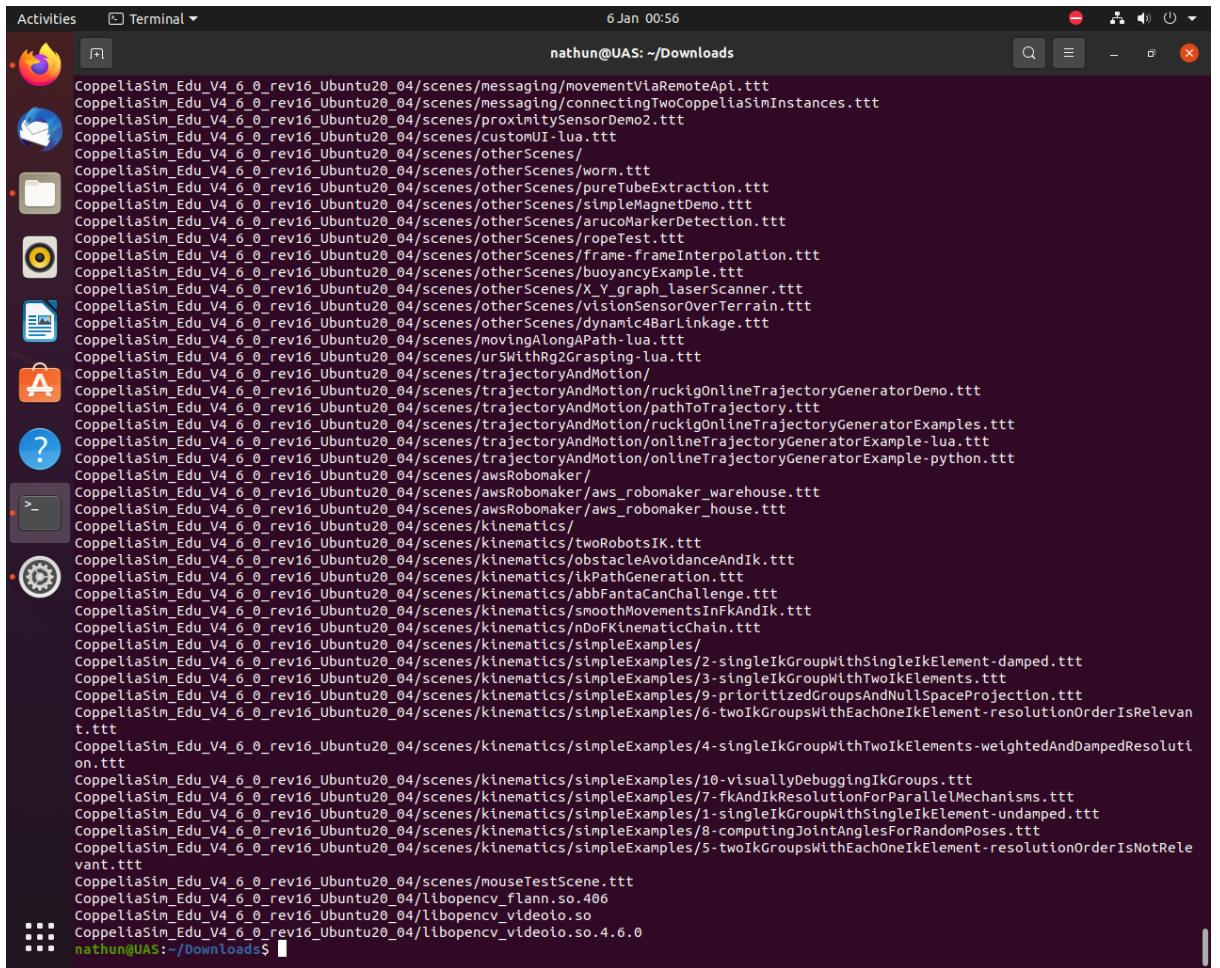
## ***Chapter 5 – Simulating Robots Using ROS, CoppeliaSim, and Webots***

Simulasi robotika adalah komponen krusial dalam pengembangan robot dan algoritma kontrolnya. Kombinasi ROS (Robot Operating System), CoppeliaSim, dan Webots memberikan solusi lengkap untuk mensimulasikan dan menguji robot dalam lingkungan virtual sebelum implementasi fisiknya. Pada *chapter* ini akan berfokus pada instalasi CoppeliaSim dan penggunaannya, serta instalasi Webots dan penggunaannya. Langkah yang dijalankan adalah sebagai berikut:

- **Pengunduhan CoppeliaSim**



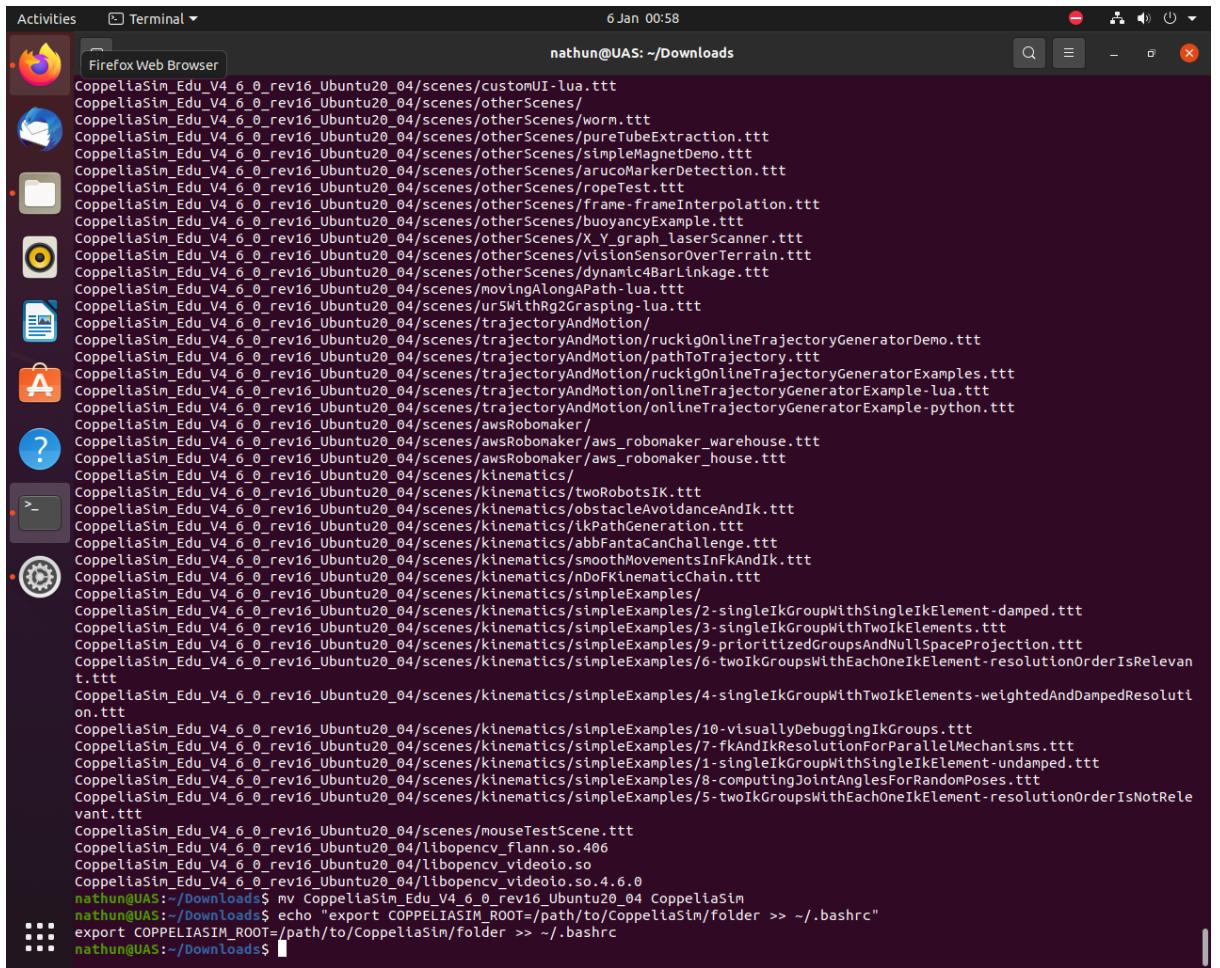
- **Instalasi CoppeliaSim**



A screenshot of a Linux desktop environment, likely Ubuntu, showing a terminal window. The terminal window has a dark background and displays a list of files from the directory `~/Downloads`. The files are all named `CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/` followed by various scene names. The terminal window is titled "Terminal" and shows the date and time as "6 Jan 00:56". The user's name is "nathun@UAS: ~/Downloads". The terminal window has a standard Linux-style title bar with icons for minimize, maximize, and close.

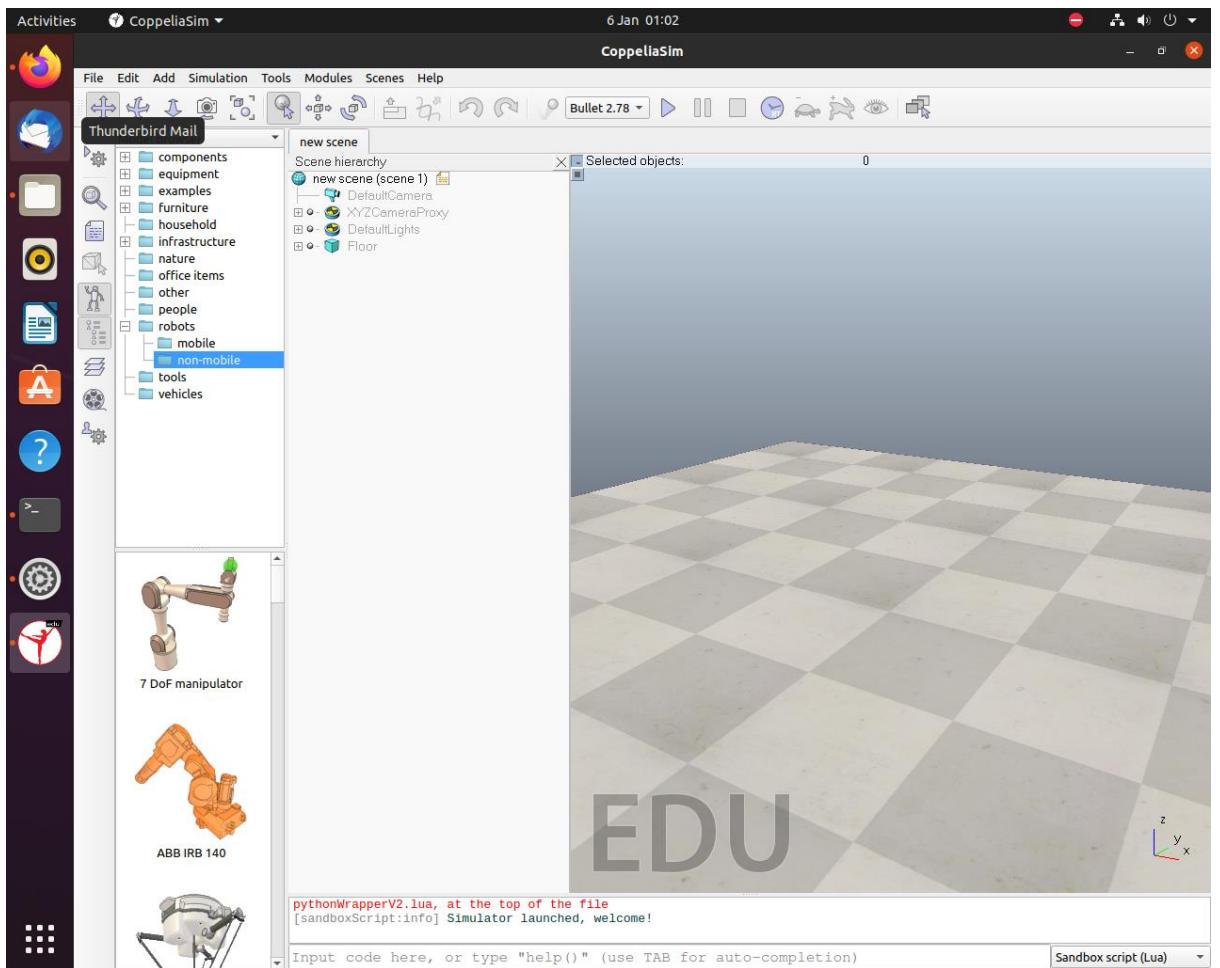
```
nathun@UAS: ~/Downloads
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/messaging/movementViaRemoteApi.ttt
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/messaging/connectingTwoCoppeliaSimInstances.ttt
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/proximitySensorDemo2.ttt
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/customUI-lua.ttt
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/otherScenes/
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/otherScenes/worm.ttt
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/otherScenes/pureTubeExtraction.ttt
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/otherScenes/simpleMagnetDemo.ttt
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/otherScenes/arucoMarkerDetection.ttt
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/otherScenes/ropeTest.ttt
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/otherScenes/frameInterpolation.ttt
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/otherScenes/buoyancyExample.ttt
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/otherScenes/X_Y_graph_laserScanner.ttt
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/otherScenes/visionsensorOverTerrain.ttt
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/otherScenes/dynamic4Barlinkage.ttt
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/movingAlongAPath-lua.ttt
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/ur5WithRg2Grasping-lua.ttt
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/trajectoryAndMotion/
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/trajectoryAndMotion/ruckigOnlineTrajectoryGeneratorDemo.ttt
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/trajectoryAndMotion/pathToTrajectory.ttt
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/trajectoryAndMotion/ruckigOnlineTrajectoryGeneratorExamples.ttt
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/trajectoryAndMotion/onlineTrajectoryGeneratorExample-lua.ttt
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/trajectoryAndMotion/onlineTrajectoryGeneratorExample-python.ttt
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/awsRobomaker/
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/awsRobomaker/aws_robomaker_warehouse.ttt
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/awsRobomaker/aws_robomaker_house.ttt
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/kinematics/
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/kinematics/twoRobotsIK.ttt
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/kinematics/obstacleAvoidanceAndIk.ttt
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/kinematics/ikPathGeneration.ttt
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/kinematics/abbFantaCanChallenge.ttt
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/kinematics/smoothMovementsInFkAndIk.ttt
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/kinematics/nDoFKinematicChain.ttt
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/kinematics/simpleExamples/
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/kinematics/simpleExamples/2-singleIkGroupWithSingleIkElement-damped.ttt
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/kinematics/simpleExamples/3-singleIkGroupWithTwoIkElements.ttt
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/kinematics/simpleExamples/9-prioritizedGroupsAndNullspaceProjection.ttt
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/kinematics/simpleExamples/6-twoIkGroupsWithEachOneIkElement-resolutionOrderIsRelevant.ttt
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/kinematics/simpleExamples/4-singleIkGroupWithTwoIkElements-weightedAndDampedResolution.ttt
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/kinematics/simpleExamples/10-visuallyDebuggingIkGroups.ttt
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/kinematics/simpleExamples/7-fkAndIkResolutionForParallelMechanisms.ttt
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/kinematics/simpleExamples/1-singleIkGroupWithSingleIkElement-undamped.ttt
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/kinematics/simpleExamples/8-computingJointAnglesForRandomPoses.ttt
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/kinematics/simpleExamples/5-twoIkGroupsWithEachOneIkElement-resolutionOrderIsNotRelevant.ttt
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/mouseTestScene.ttt
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/libopencv_flann.so.406
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/libopencv_videoto.so
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/libopencv_videoto.so.4.6.0
nathun@UAS: ~/Downloads$
```

- **Memindahkan dan Ekstraksi CoppeliaSim**

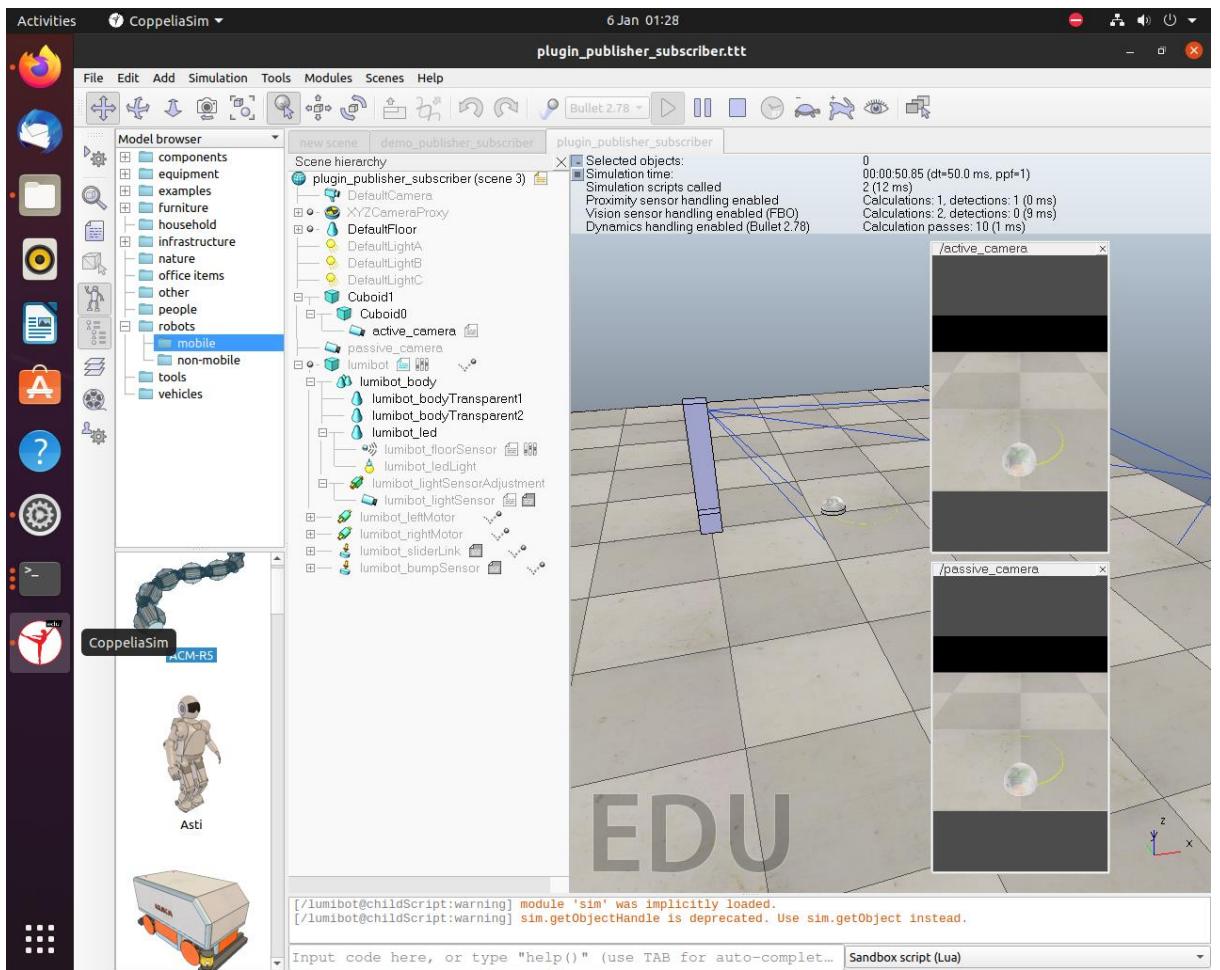


```
Activities Terminal 6 Jan 00:58
Firefox Web Browser nathun@UAS: ~/Downloads
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/customUI-lua.ttt
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/otherScenes/
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/otherScenes/worm.ttt
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/otherScenes/pureTubeExtraction.ttt
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/otherScenes/simpleMagnetDemo.ttt
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/otherScenes/arucoMarkerDetection.ttt
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/otherScenes/ropeTest.ttt
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/otherScenes/frameInterpolation.ttt
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/otherScenes/buoyancyExample.ttt
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/otherScenes/X_Y_graph_laserScanner.ttt
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/otherScenes/visionSensorOverTerrain.ttt
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/otherScenes/dynamic4BarLinkage.ttt
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/movingAlongAPath-lua.ttt
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/ur5WithRg2Grasping-lua.ttt
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/trajectoryAndMotion/
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/trajectoryAndMotion/ruckigOnlineTrajectoryGeneratorDemo.ttt
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/trajectoryAndMotion/pathToTrajectory.ttt
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/trajectoryAndMotion/ruckigOnlineTrajectoryGeneratorExamples.ttt
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/trajectoryAndMotion/onlineTrajectoryGeneratorExample-lua.ttt
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/trajectoryAndMotion/onlineTrajectoryGeneratorExample-python.ttt
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/awsRobomaker/
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/awsRobomaker/aws_robomaker_warehouse.ttt
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/awsRobomaker/aws_robomaker_house.ttt
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/kinematics/
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/kinematics/twoRobotsIK.ttt
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/kinematics/obstacleAvoidanceAndIk.ttt
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/kinematics/ikPathGeneration.ttt
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/kinematics/abbFantaCanChallenge.ttt
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/kinematics/smoothMovementsInIkAndIk.ttt
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/kinematics/noDofKinematicChain.ttt
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/kinematics/simpleExamples/
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/kinematics/simpleExamples/2-singleIkGroupWithSingleIkElement-damped.ttt
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/kinematics/simpleExamples/3-singleIkGroupWithTwoIkElements.ttt
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/kinematics/simpleExamples/9-prioritizedGroupsAndNullSpaceProjection.ttt
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/kinematics/simpleExamples/6-twoIkGroupsWithEachOneIkElement-resolutionOrderIsRelevant.ttt
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/kinematics/simpleExamples/4-singleIkGroupWithTwoIkElements-weightedAndDampedResolution.ttt
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/kinematics/simpleExamples/10-visuallyDebuggingIkGroups.ttt
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/kinematics/simpleExamples/7-fkAndIkResolutionForParallelMechanisms.ttt
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/kinematics/simpleExamples/1-singleIkGroupWithSingleIkElement-undamped.ttt
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/kinematics/simpleExamples/8-computingJointAnglesForRandomPoses.ttt
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/kinematics/simpleExamples/5-twoIkGroupsWithEachOneIkElement-resolutionOrderIsNotRelevant.ttt
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/scenes/mouseTestScene.ttt
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/libopencv_flann.so.406
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/libopencv_videoio.so
CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04/libopencv_videoio.so.4.6.0
nathun@UAS:~/Downloads$ mv CoppeliaSim_Edu_V4_6_0_rev16_Ubuntu20_04 CoppeliaSim
nathun@UAS:~/Downloads$ echo "export COPPELIASIM_ROOT=/path/to/CoppeliaSim/folder >> ~/.bashrc"
export COPPELIASIM_ROOT=/path/to/CoppeliaSim/folder >> ~/.bashrc
nathun@UAS:~/Downloads$
```

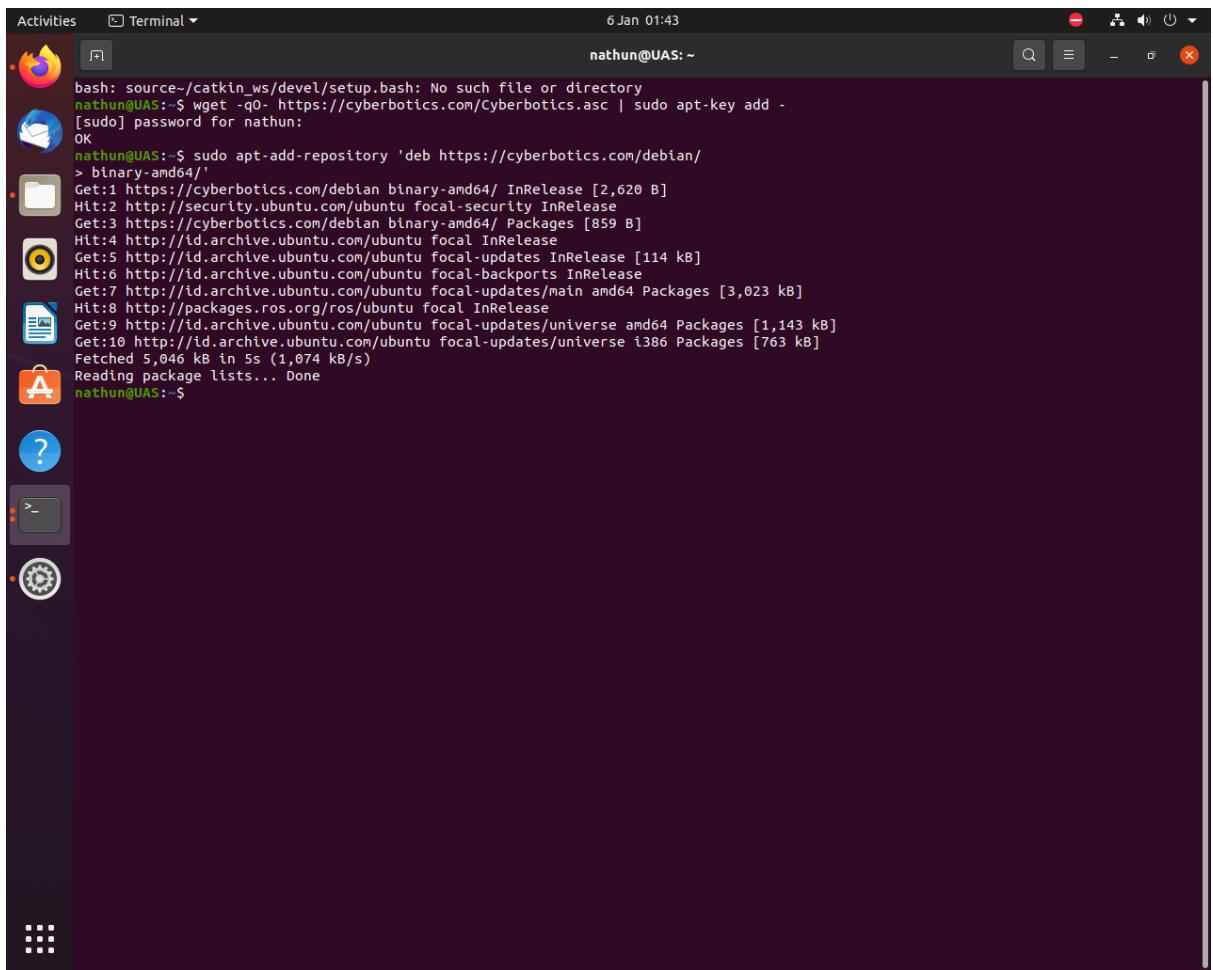
- Menjalankan dan Mempersiapkan CoppeliaSim



- Membuka file robot di CoppeliaSim serta menjalankannya



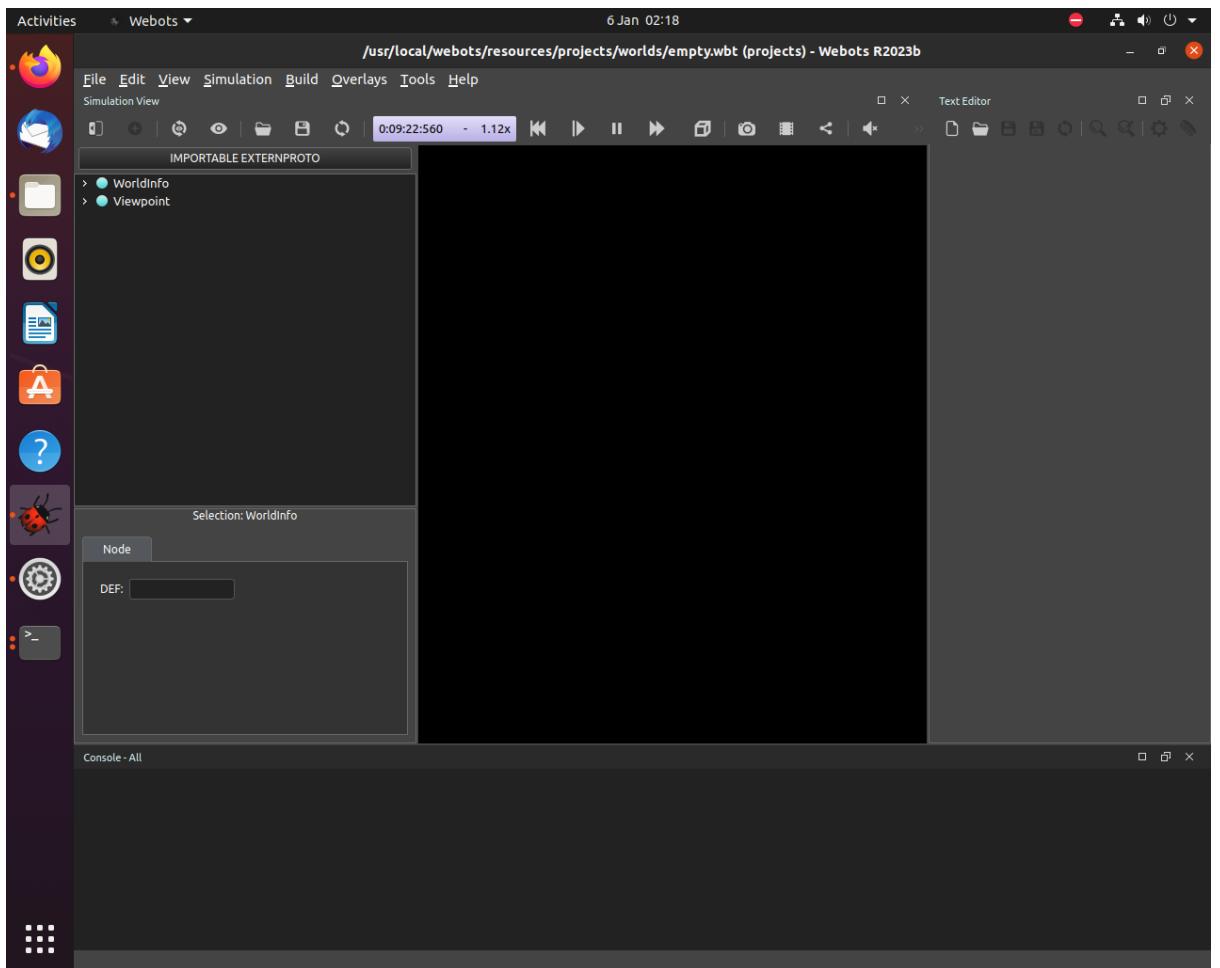
- Mendambahkan cyberbotic respository untuk Webots



A screenshot of a Ubuntu desktop environment. On the left is the Unity Dash, which includes icons for the Dash, Home, Activities, and a search bar. The main area shows a terminal window titled 'Terminal' with the command 'nathun@UAS:~\$'. The terminal displays the following output:

```
6 Jan 01:43
nathun@UAS:~$ bash: source~/catkin_ws/devel/setup.bash: No such file or directory
nathun@UAS:~$ wget -qO- https://cyberbotics.com/Cyberbotics.asc | sudo apt-key add -
[sudo] password for nathun:
OK
nathun@UAS:~$ sudo apt-add-repository 'deb https://cyberbotics.com/debian/
> binary-amd64'
Get:1 https://cyberbotics.com/debian binary-amd64/ InRelease [2,620 B]
Hit:2 http://security.ubuntu.com/ubuntu focal-security InRelease
Get:3 https://cyberbotics.com/debian binary-amd64/ Packages [859 B]
Hit:4 http://td.archive.ubuntu.com/ubuntu focal InRelease
Get:5 http://td.archive.ubuntu.com/ubuntu focal-updates InRelease [114 kB]
Hit:6 http://td.archive.ubuntu.com/ubuntu focal-backports InRelease
Get:7 http://td.archive.ubuntu.com/ubuntu focal-updates/main amd64 Packages [3,023 kB]
Hit:8 http://packages.ros.org/ros/ubuntu focal InRelease
Get:9 http://td.archive.ubuntu.com/ubuntu focal-updates/universe amd64 Packages [1,143 kB]
Get:10 http://td.archive.ubuntu.com/ubuntu focal-updates/universe i386 Packages [763 kB]
Fetched 5,046 kB in 5s (1,074 kB/s)
Reading package lists... Done
nathun@UAS:~$
```

- **Instalasi Webots menggunakan kode**  
sudo apt-get install webots
- **Menjalankan dan mempersiapkan aplikasi Webots**



Webots yang terpasang tampak berbeda dengan yang ada pada buku, pada webots yang terpasang tidak ada menu **Wizard** pada bar diatas, tetapi pada buku terdapat menu **Wizard** sehingga tidak bisa dilakukan pembuatan *directory project* baru.