

04. URDF

AI ROBOT

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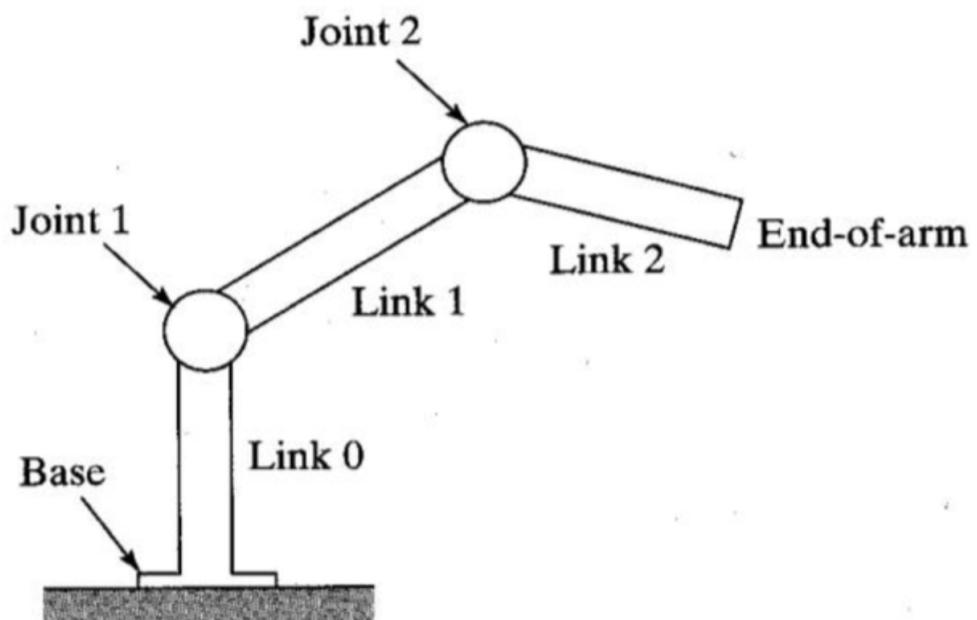
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1 URDF

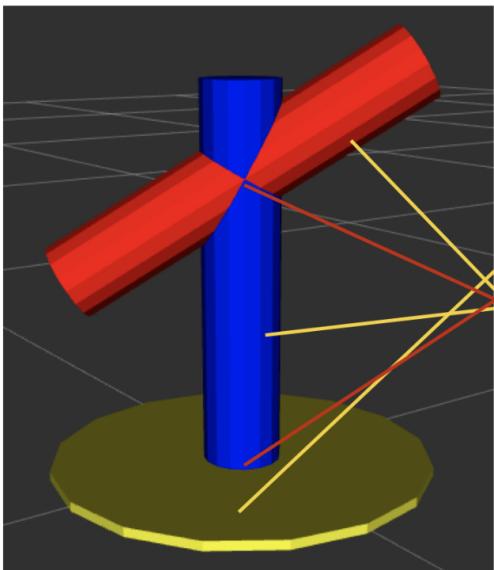
1.1 URDF - Unified Robot Description Format

- Unified Robot Description Format
- Kinematic and basic physics description of a robot
- XML format
- Kinematic tree structure

1.2 link와 joint의 개념



1.3 link와 joint의 개념 2



```
1  <?xml version="1.0"?>
2  <robot name="ex_urdf_pan_tilt">
3
4      <link name="base_link">...
5      </link>
6
7      <joint name="pan_joint" type="revolute">...
8      </joint>
9
10     <link name="pan_link">...
11     </link>
12
13     <joint name="tilt_joint" type="revolute">...
14     </joint>
15
16     <link name="tilt_link">...
17     </link>
18
19 </robot>
```

- 로봇, 부품, 관절 등을 설명하는 XML 포맷의 문서

1.4 sudo apt-get install liburdfdom-tools

```
pw@melodic:~$ sudo apt install liburdfdom-tools
Reading package lists... Done
Building dependency tree
Reading state information... Done
The following NEW packages will be installed:
  liburdfdom-tools
0 upgraded, 1 newly installed, 0 to remove and 0 not upgraded.
Need to get 12.5 kB of archives.
After this operation, 54.3 kB of additional disk space will be used.
Get:1 http://archive.ubuntu.com/ubuntu bionic-updates/universe amd64 liburdfdom-tools amd64 1.0.0-2u
buntu0.1 [12.5 kB]
Fetched 12.5 kB in 1s (11.4 kB/s)
Selecting previously unselected package liburdfdom-tools.
(Reading database ... 324053 files and directories currently installed.)
Preparing to unpack .../liburdfdom-tools_1.0.0-2ubuntu0.1_amd64.deb ...
Unpacking liburdfdom-tools (1.0.0-2ubuntu0.1) ...
Setting up liburdfdom-tools (1.0.0-2ubuntu0.1) ...
Processing triggers for man-db (2.8.3-2ubuntu0.1) ...
```

1.5 연습용 urdf_exam 패키지 생성

```
pw@melodic:~/ws/src$ catkin create pkg urdf_exam --catkin-deps std_msgs rospy urdf xacro  
Creating package "urdf_exam" in "/home/pw/ws/src"...  
Created file urdf_exam/package.xml  
Created file urdf_exam/CMakeLists.txt  
Created folder urdf_exam/src  
Successfully created package files in /home/pw/ws/src/urdf_exam.  
pw@melodic:~/ws/src$
```

- `catkin create pkg urdf_exam --catkin-deps std_msgs rospy urdf xacro`
 - 워크스페이스의 `src` 폴더에서 패키지 생성

1.6 urdf 폴더를 패키지 내에서 생성

```

pw@pwROS:~/catkin_ws/src$ ls
hello_world urdf_exam
pw@pwROS:~/catkin_ws/src$ cd urdf_exam/
catkin_ws
pw@pwROS:~/catkin_ws/src/urdf_exam$ ls
CMakeLists.txt package.xml src
CMakeLists.txt package.xml src urdf
pw@pwROS:~/catkin_ws/src/urdf_exam$ cd urdf/
pw@pwROS:~/catkin_ws/src/urdf_exam/urdf$ 

```

The terminal shows the creation of a directory named 'urdf' within the 'src/urdf_exam' directory. A file browser window is open in the background, showing the directory structure of the current workspace.

1.7 현시점 catkin_ws/src 폴더 내부 구조

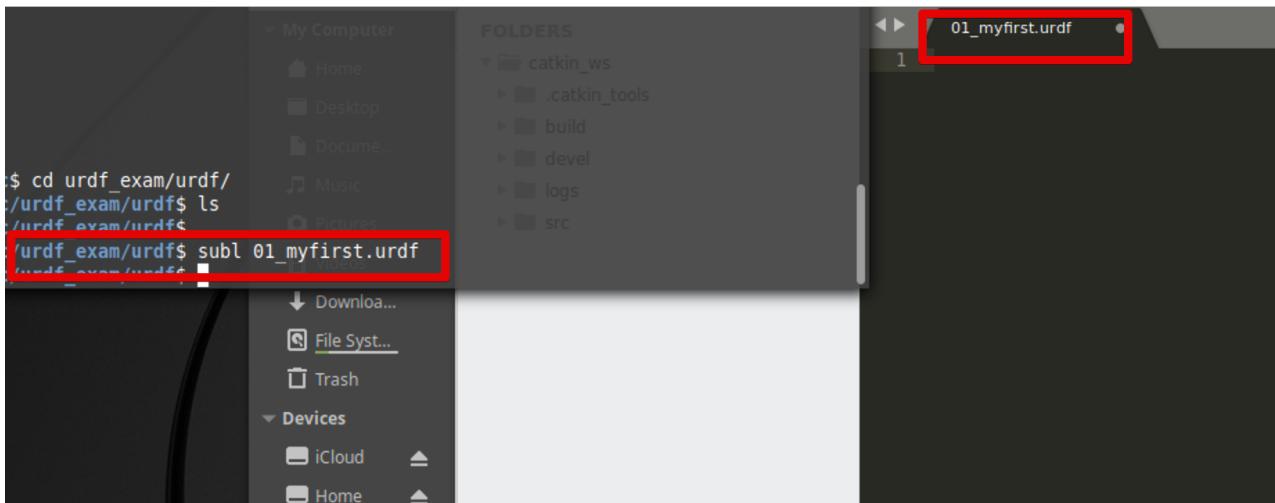
```

pw@pwROS:~/catkin_ws/src$ tree
.
├── hello_world
│   ├── 2019-09-18-00-43-21.bag
│   ├── CMakeLists.txt
│   ├── package.xml
│   └── scripts
│       ├── move_turtle.py
│       └── print_turtle_position.py
└── urdf_exam
    ├── CMakeLists.txt
    ├── package.xml
    └── src
        └── urdf

```

The terminal shows the output of the 'tree' command, displaying the directory structure of the 'src' folder. A file browser window is open in the background, showing the contents of the 'catkin_ws' workspace.

1.8 01_myfirst.urdf 생성



1.9 실습코드

```

1  <?xml version="1.0"?>
2  <robot name="myfirst">
3      <link name="base_link">
4          <visual>
5              <geometry>
6                  <cylinder length="0.6" radius="0.2"/>
7              </geometry>
8          </visual>
9      </link>
10 </robot>

```

1.10 check_urdf

```

pw@pwROS:~/catkin_ws/src/urdf_exam/urdf$ ls
pw@pwROS:~/catkin_ws/src/urdf_exam/urdf$ ls
01_myfirst.urdf
pw@pwROS:~/catkin_ws/src/urdf_exam/urdf$ check_urdf 01_myfirst.urdf
robot name is: myfirst
----- Successfully Parsed XML -----
root Link: base_link has 0 child(ren)
pw@pwROS:~/catkin_ws/src/urdf_exam/urdf$ 

```

1.11 urdf_to_graphiz

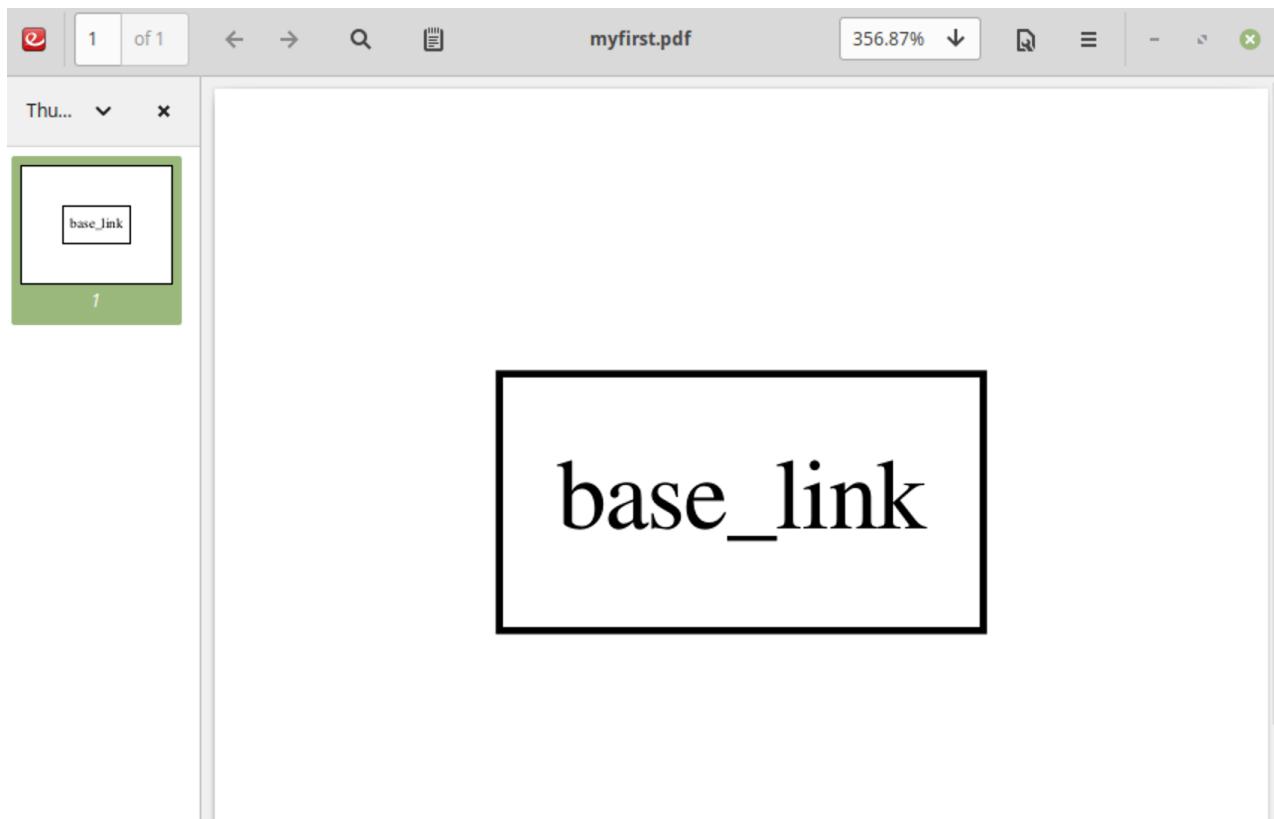
```
root:~/.ros/devel/lib/urdf/urdf_to_graphviz: line 1: base_link has 0 child(ren)
pw@pwROS:~/catkin_ws/src/urdf_exam/urdf$ urdf_to_graphviz 01_myfirst.urdf
Created file myfirst.gv
Created file myfirst.pdf
pw@pwROS:~/catkin_ws/src/urdf_exam/urdf$
```

1.12 sudo apt-get install evince

```
pw@pwROS:~/catkin_ws/src/urdf_exam/urdf$ sudo apt-get install evince
[sudo] password for pw:
Reading package lists... Done
Building dependency tree
Reading state information... Done
The following additional packages will be installed:
  evince-common libevdocument3-4 libevview3-3
Suggested packages:
  nautilus-sendto
The following NEW packages will be installed:
  evince evince-common libevdocument3-4 libevview3-3
0 upgraded, 4 newly installed, 0 to remove and 527 not upgraded.
Need to get 713 kB of archives.
After this operation, 3,708 kB of additional disk space will be used.
Do you want to continue? [Y/n] y
```

1.13 pdf 파일 open

```
pw@pwROS:~/catkin_ws/src/urdf_exam/urdf$ ls
01_myfirst.urdf  myfirst.gv  myfirst.pdf
pw@pwROS:~/catkin_ws/src/urdf_exam/urdf$ evince myfirst.pdf
pw@pwROS:~/catkin_ws/src/urdf_exam/urdf$
```



1.14 패키지 내에 launch 폴더를 만들고 display.launch 파일 생성

```
pw@pwROS:~/catkin_ws/src/urdf_exam$ tree
.
├── CMakeLists.txt
└── launch
    └── display.launch
├── package.xml
└── src
    └── urdf
        ├── 01_myfirst.urdf
        ├── myfirst.gv
        └── myfirst.pdf

3 directories, 6 files
```

1.15 display.launch

```

1 <?xml version="1.0"?>
2 <launch>
3   <arg name="model" />
4
5   <param name="robot_description" textfile="$(arg model)"/>
6   <node name="joint_state_publisher" pkg="joint_state_publisher" type="joint_state_publisher" />
7   <node name="robot_state_publisher" pkg="robot_state_publisher" type="state_publisher" />
8   <node name="rviz" pkg="rviz" type="rviz" args="-d $(find urdf_exam)/urdf.rviz" />
9 </launch>

```

- 아직 launch를 배우진 않았으니 가볍게 지나가요^^

1.16 워크스페이스에서 build

```

pw@melodic:~/ws$ catkin build
[...]
Profile:           default
Extending:        [cached] /opt/ros/melodic
Workspace:        /home/pw/ws
File Edit Selection Find View Goto Tools Project Preferences
Build Space:      [exists] /home/pw/ws/build
Devel Space:      [exists] /home/pw/ws/devel
Install Space:    [unused] /home/pw/ws/install
Log Space:        [exists] /home/pw/ws/logs
Source Space:     [exists] /home/pw/ws/src
DESTDIR:          [unused] None
Devel Space Layout: linked
[...]

```

move_turtle.py turtle_teleop.launch

```

1 <?xml version="1.0"?>
2 <launch>
3   <arg name="model" />
4   <param name="robot" />
5   <node name="joint_state_publisher" pkg="joint_state_publisher" type="joint_state_publisher" />
6   <node name="robot_state_publisher" pkg="robot_state_publisher" type="state_publisher" />

```

1.17 bashrc를 다시 읽고

```

pw@melodic:~/ws$ source ~/.bashrc
ROS1 is activated
pw@melodic:~/ws$ 
pw@melodic:~/ws$ 
pw@melodic:~/ws$ 

```

1.18 roslaunch 실행

```
pw@pwROS:~/catkin_ws/src/urdf_exam/urdf$  
pw@pwROS:~/catkin_ws/src/urdf_exam/urdf$ roslaunch urdf_exam display.launch model:=01_myfirst.urdf  
... logging to /home/pw/.ros/log/95bc3fd2-df58-11e9-a289-001c42f3af4f/roslaunch-pwROS-12531.log  
Checking log directory for disk usage. This may take awhile.  
Press Ctrl-C to interrupt  
Done checking log file disk usage. Usage is <1GB.  
  
started roslaunch server http://pwROS:40119/  
  
SUMMARY  
=====
```

PARAMETERS

- * /robot_description: <?xml version="1....

- roslaunch는 roscore가 실행중이 아니라면 자기가 실행한다

1.19 만약 입력인자인 model에서 pkg 경로를 인식시키고 싶다면

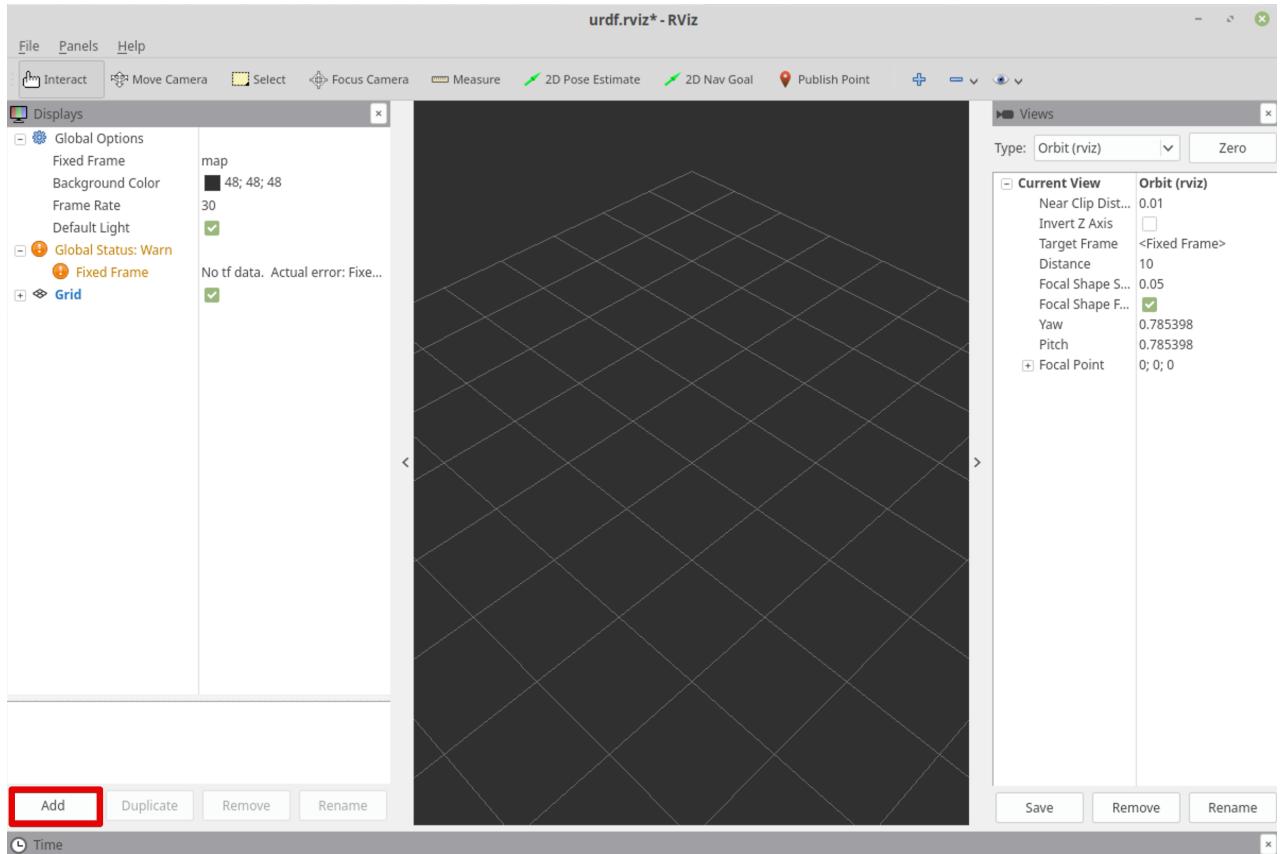
```
pw@melodic:~$ roslaunch urdf_exam display.launch model:=$(find urdf_exam)/urdf/01_myfirst.urdf  
... logging to /home/pw/.ros/log/e77a9ee8-9bb6-11ea-b077-001c420be203/roslaunch-melodic-4022.log  
Checking log directory for disk usage. This may take a while.  
Press Ctrl-C to interrupt  
Done checking log file disk usage. Usage is <1GB.  
  
started roslaunch server http://melodic:41469/  
  
SUMMARY  
=====
```

PARAMETERS

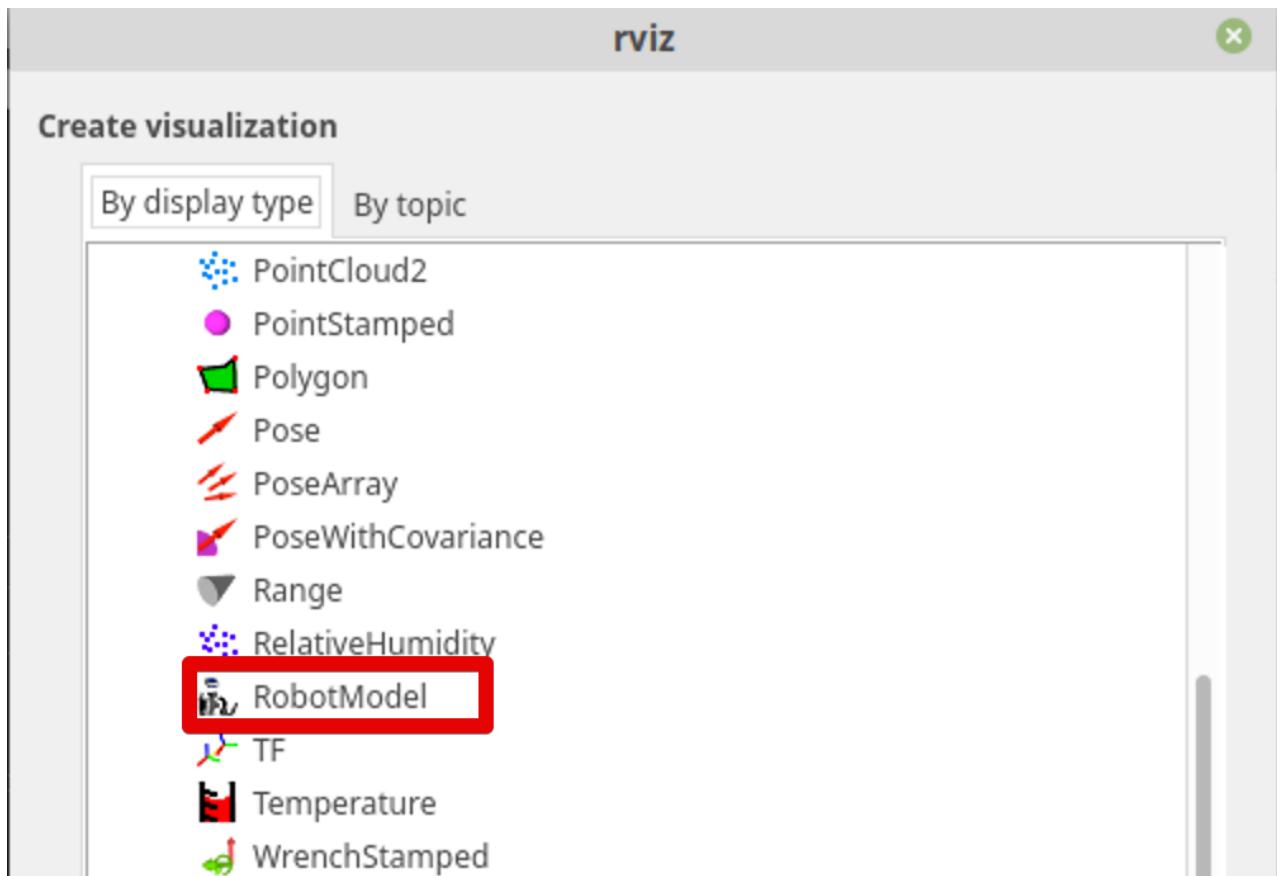
- * /robot_description: <?xml version="1....

- \$(find <pkg name>) 인자를 사용한다

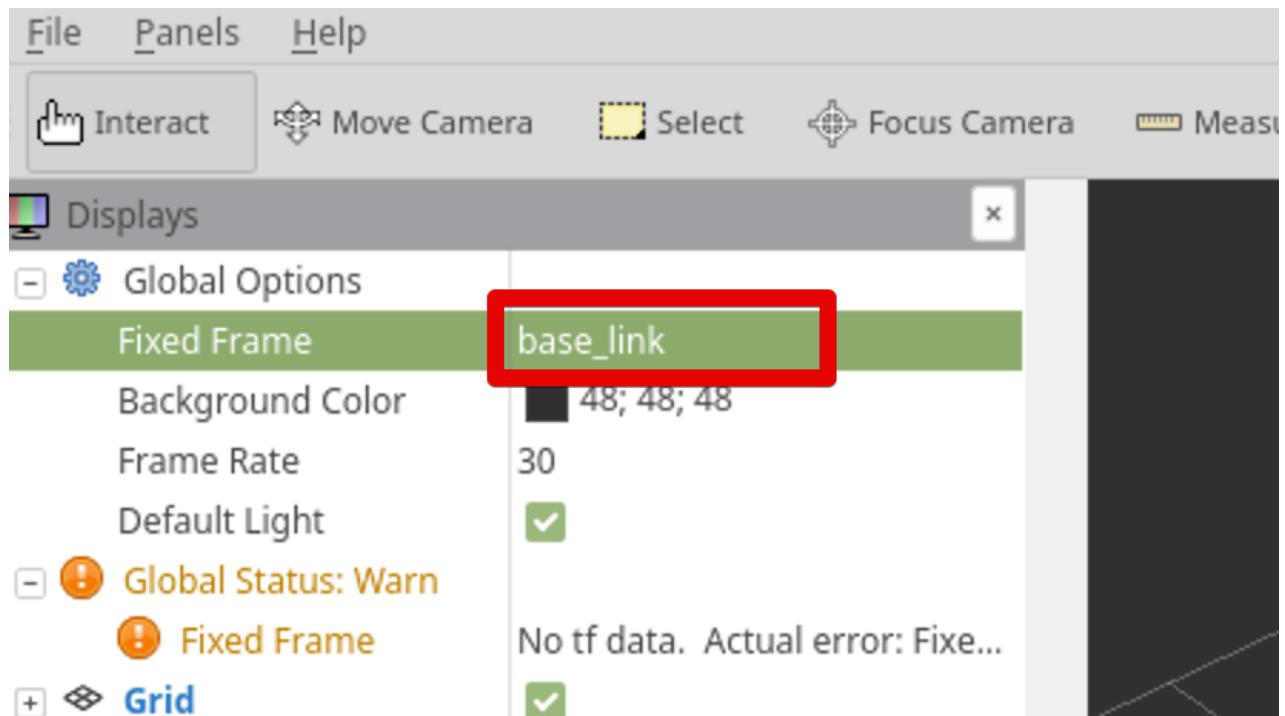
1.20 rviz가 실행되면 add를 누른다



1.21 RobotModel을 추가한다



1.22 Fixed Frame 옵션을 선택해서 base_link로 변경한다

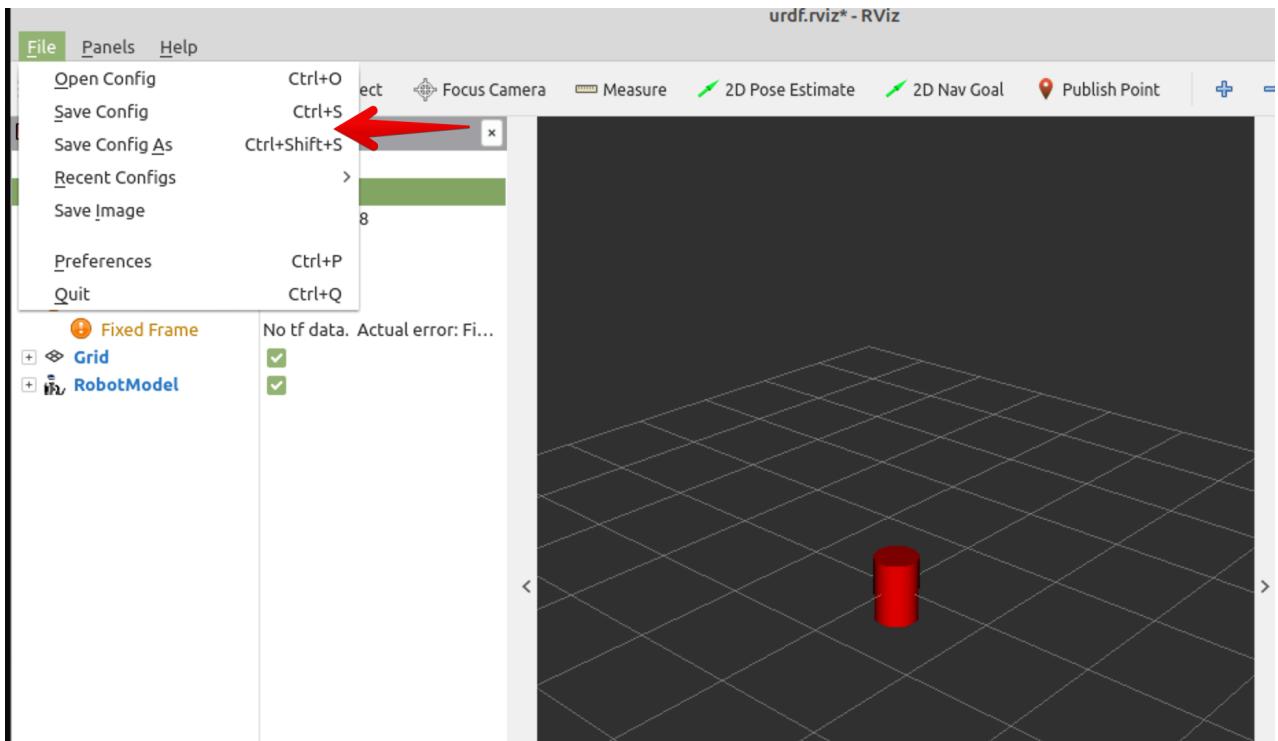


1.23 매번 이렇게 하기 싫다면

```
mira.urdf      x   display.launch      x
1 <?xml version="1.0"?>
2 <launch>
3   <arg name="model" />
4   <param name="robot_description" textfile="$(arg model)"/>
5   <node name="joint_state_publisher" pkg="joint_state_publisher" type="joint_state_publisher" />
6   <node name="robot_state_publisher" pkg="robot_state_publisher" type="robot_state_publisher" />
7   <node name="rviz" pkg="rviz" type="rviz" args="-d $(find urdf_exam)/urdf.rviz" />
8 </launch>
```

- display.launch에서 rviz를 실행할 때, 환경설정을 읽도록 설정해 두었다

1.24 rviz가 실행될 때



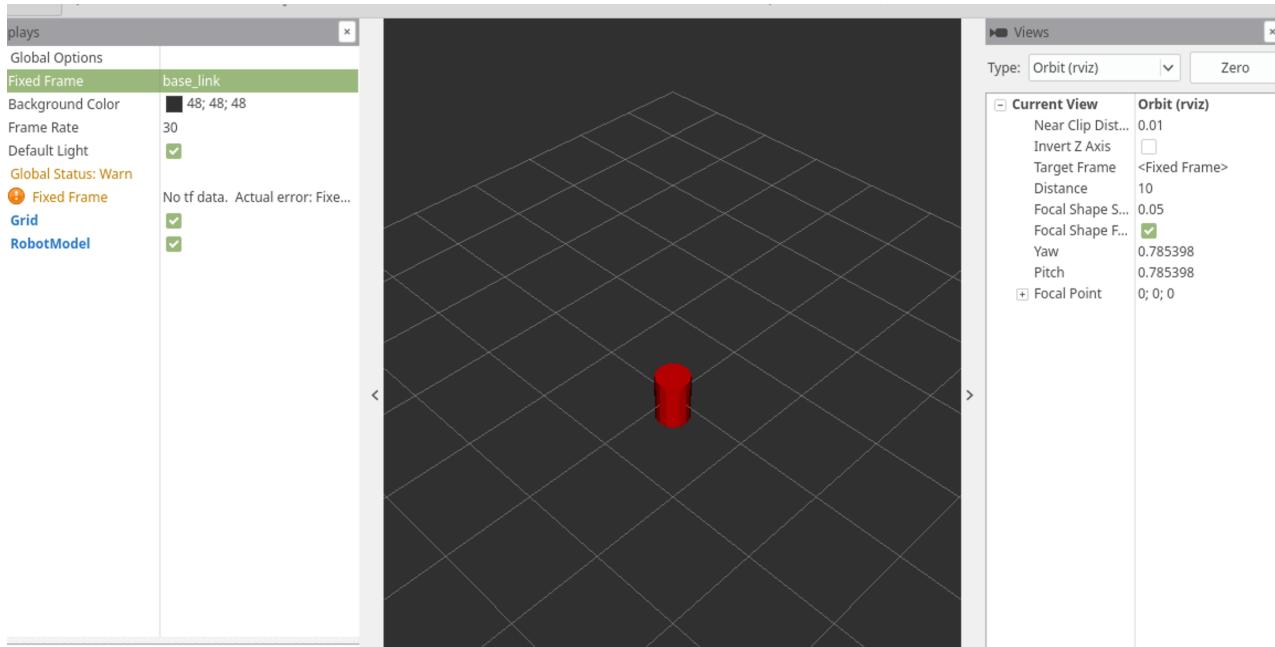
- config를 저장한다

1.25 rviz 확장명의 환경이 저장된 것이 보인다

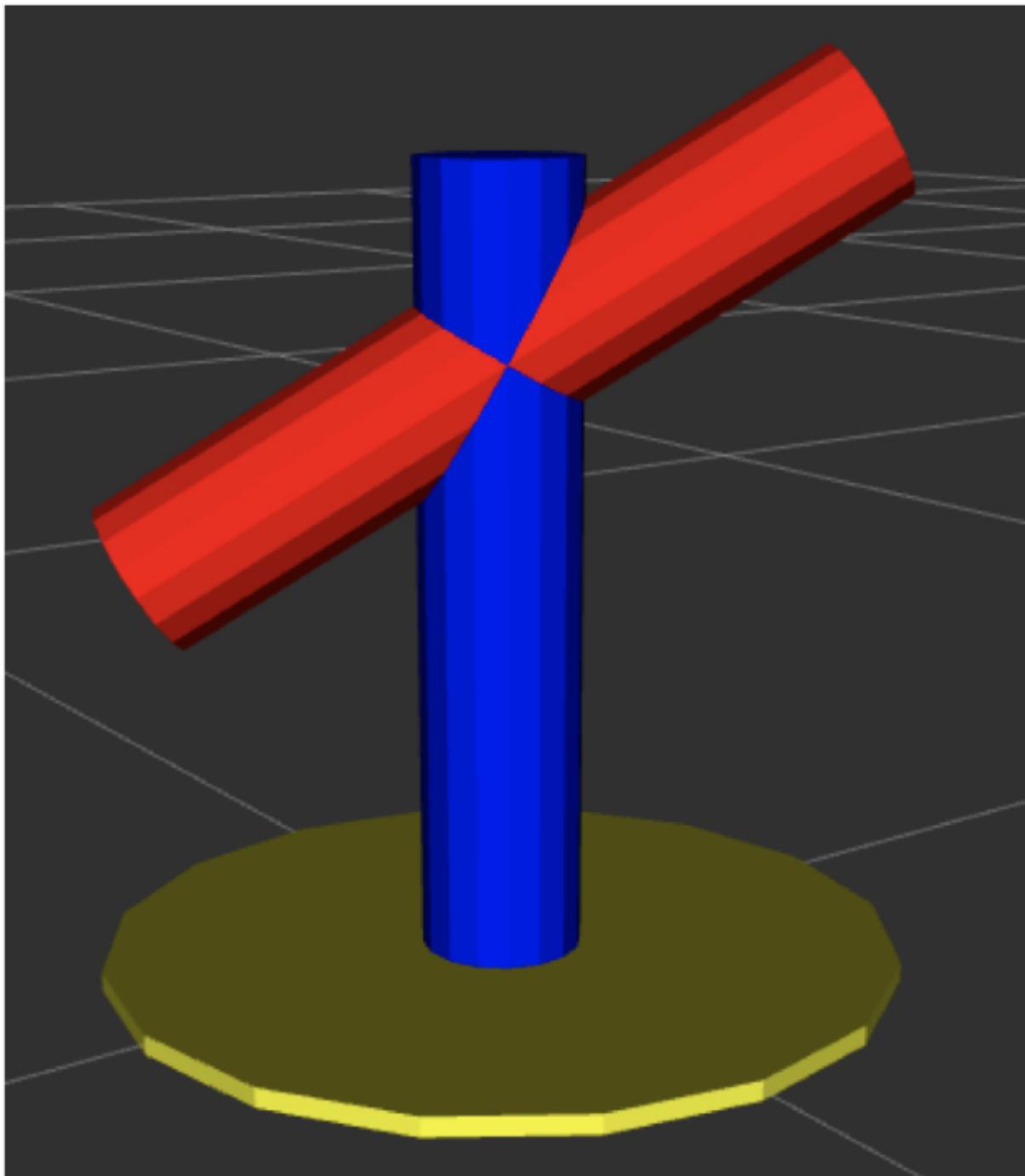
```
pw@melodic:~/ws/src/urdf_exam$ ls -l
total 32
-rw-r--r-- 1 pw pw 7072 May 21 23:43 CMakeLists.txt
drwxr-xr-x 2 pw pw 4096 May 21 23:49 launch
-rw-r--r-- 1 pw pw 2979 May 21 23:43 package.xml
drwxr-xr-x 2 pw pw 4096 May 21 23:43 src
drwxr-xr-x 2 pw pw 4096 May 22 07:15 urdfmental
-rw-r--r-- 1 pw pw 4685 May 22 08:02 urdf.rviz 31 fp
pw@melodic:~/ws/src/urdf_exam$
```

- 보통은 config나 config_rviz 폴더에 넣어 두는 경우가 많다
- 이제 다시 roslaunch를 실행해보면 편해진 것을 확인할 수 있다.

1.26 화면에 cylinder가 나타난다

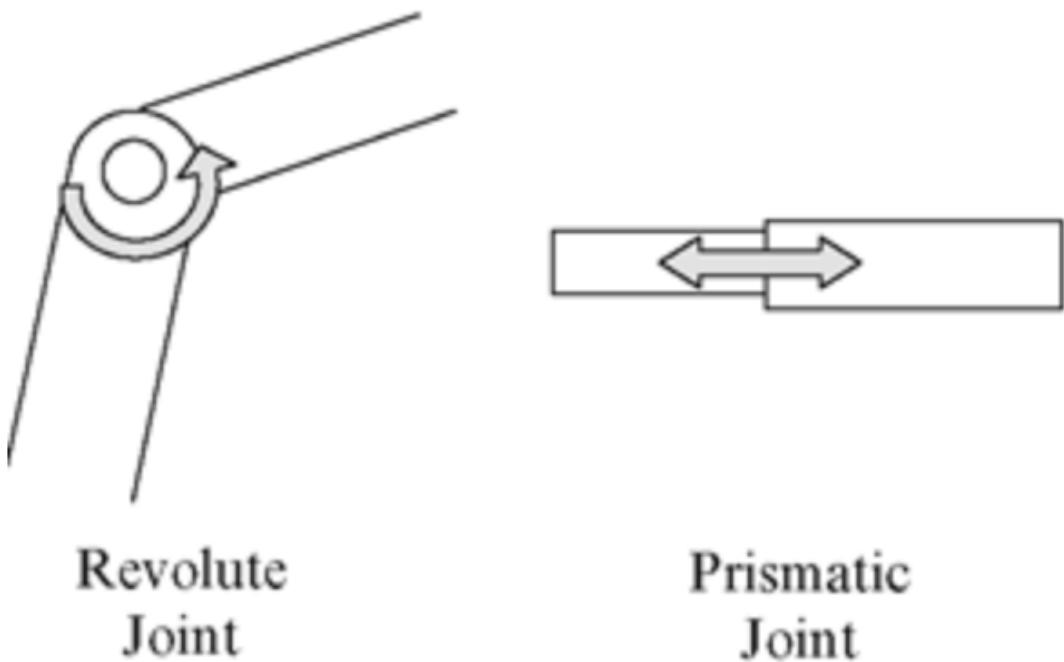


2 Pan/Tilt



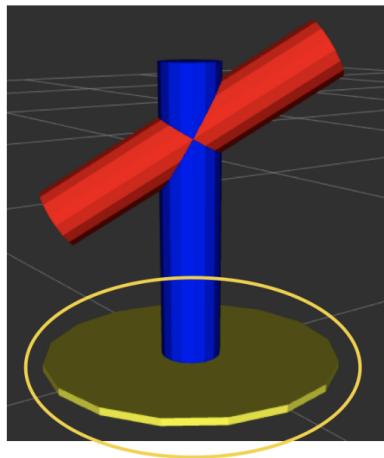
- Pan/tilt 시스템은 두 축으로 이뤄진 일종의 로봇암
- CCTV 등 다양한 분야를 가지고 있음

2.1 Robot Joint



- 가장 많이 사용하는 두 조인트

2.2 Base_link

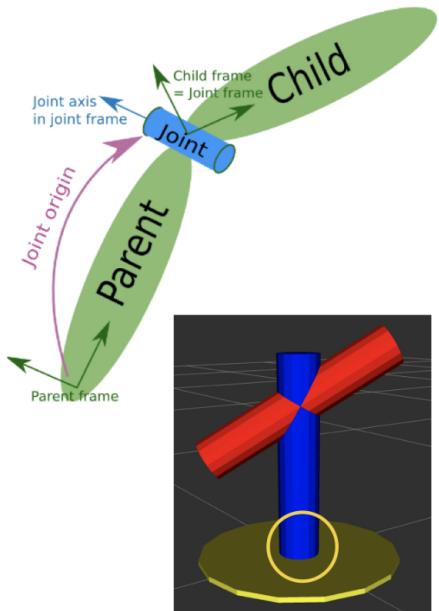


```

4 <link name="base_link">
5   <visual>
6     <geometry>
7       <cylinder length="0.01" radius="0.2"/>
8     </geometry>
9     <origin rpy="0 0 0" xyz="0 0 0"/>
0     <material name="yellow">
1       <color rgba="1 1 0 1"/>
2     </material>
3   </visual>
4
5   <collision>
6     <geometry>
7       <cylinder length="0.03" radius="0.2"/>
8     </geometry>
9     <origin rpy="0 0 0" xyz="0 0 0"/>
0   </collision>
1
2   <inertial>
3     <mass value="1"/>
4     <inertia ixx="1.0" ixy="0.0" ixz="0.0" iyy="1.0" iyz="0.0" izz="1.0"/>
5   </inertial>
6 </link>

```

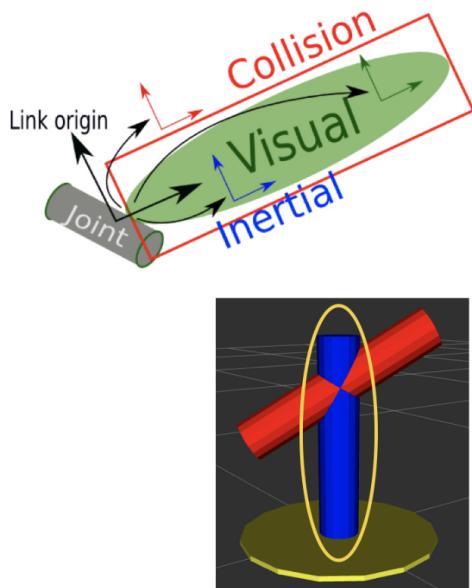
2.3 pan_joint



```
<joint name="pan_joint" type="revolute">
  <parent link="base_link"/>
  <child link="pan_link"/>
  <origin xyz="0 0 0.1" />
  <axis xyz="0 0 1" />
  <limit effort="300" velocity="0.1" lower="-3.14" upper="3.14" />
  <dynamics damping="50" friction="1" />
</joint>

<link name="pan_link">
```

2.4 pan_link



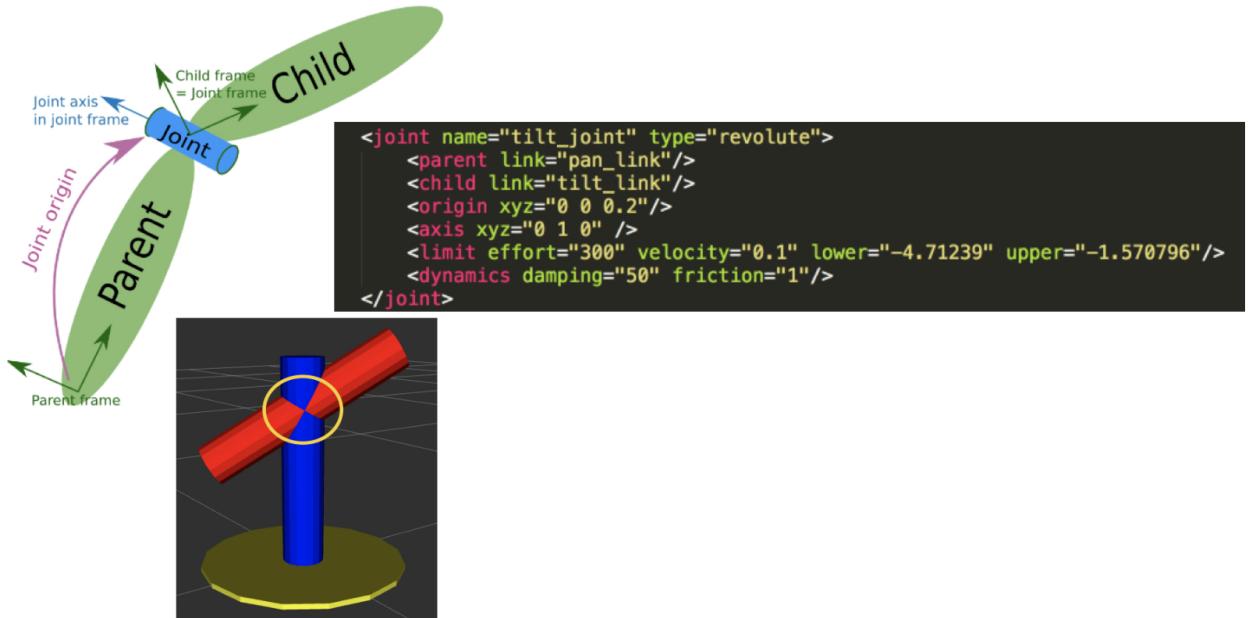
```
<link name="pan_link">
  <visual>
    <geometry>
      <cylinder length="0.4" radius="0.04"/>
    </geometry>
    <origin rpy="0 0 0" xyz="0 0 0.09"/>
    <material name="red">
      <color rgba="0 0 1 1"/>
    </material>
  </visual>

  <collision>
    <geometry>
      <cylinder length="0.4" radius="0.06"/>
    </geometry>
    <origin rpy="0 0 0" xyz="0 0 0.09"/>
  </collision>

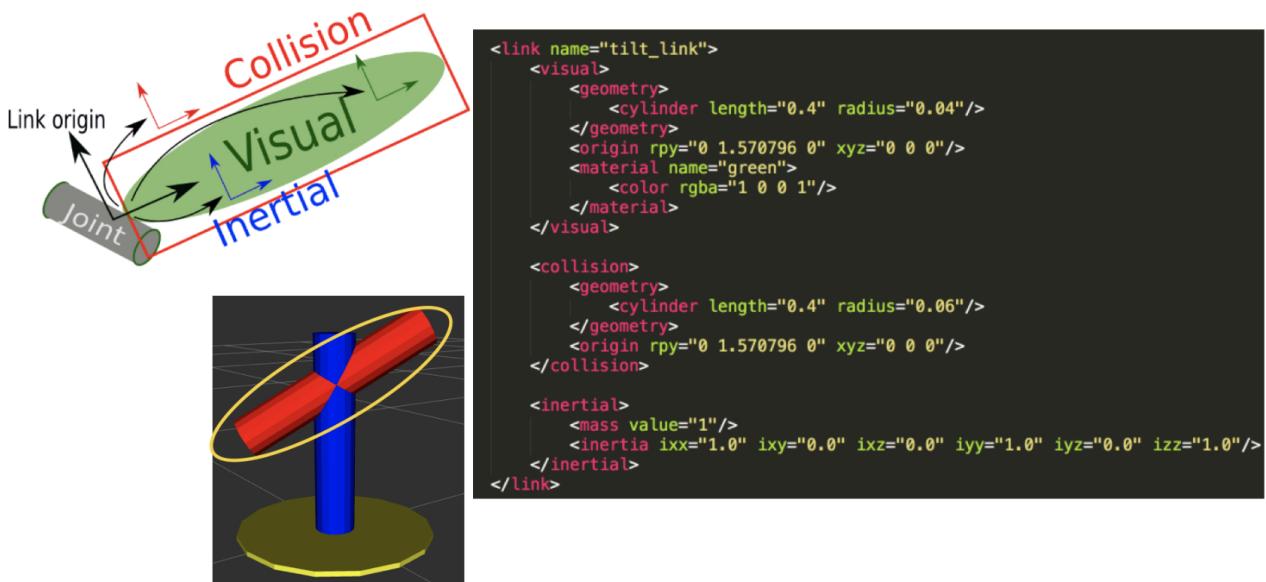
  <inertial>
    <mass value="1"/>
    <inertia ixx="1.0" ixy="0.0" ixz="0.0" iyy="1.0" iyz="0.0" izz="1.0" />
  </inertial>
</link>

<joint name="tilt_joint" type="revolute">
```

2.5 tilt_joint

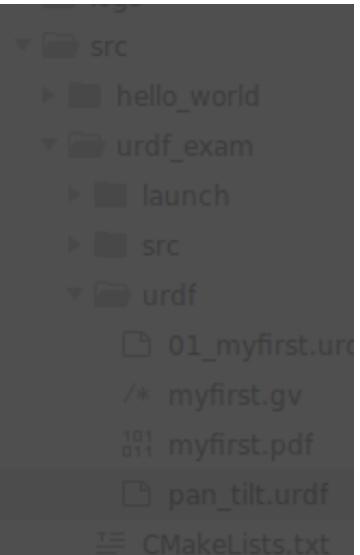


2.6 tilt_link



2.7 urdf 폴더에 pan_tilt.urdf 파일 생성

```
pw@pwROS:~/catkin_ws/src/urdf_exam$  
pw@pwROS:~/catkin_ws/src/urdf_exam$ tree  
.  
├── CMakeLists.txt  
└── launch  
    └── display.launch  
├── package.xml  
└── src  
    └── urdf  
        ├── 01_myfirst.urdf  
        ├── myfirst.gv  
        └── myfirst.pdf  
            └── pan_tilt.urdf  
  
3 directories, 7 files
```



- `subl pan_tilt.urdf`라는 명령을 `urdf_exam/urdf` 폴더안에서 실행하면 됨

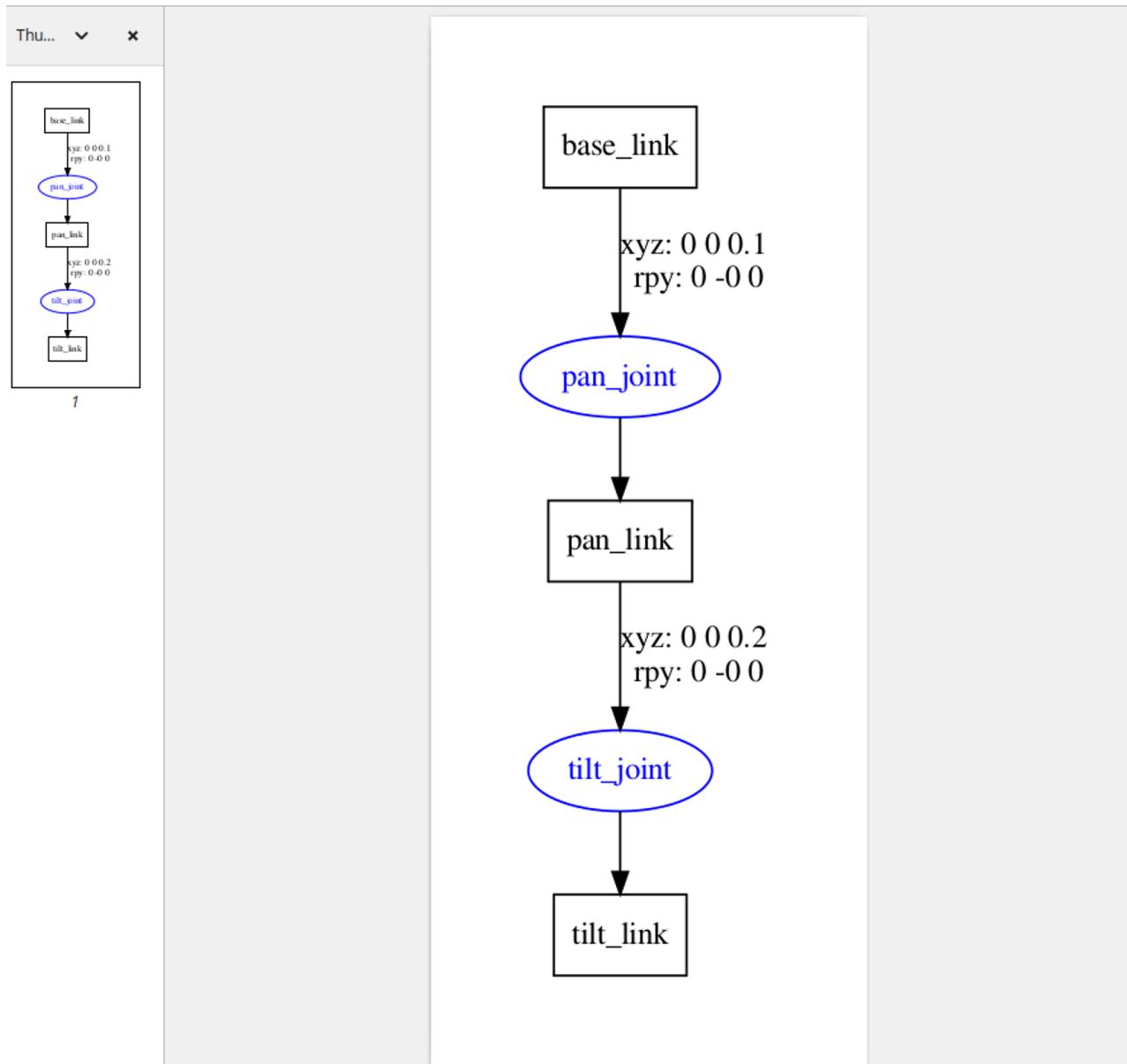
2.8 check_urdf

```
pw@pwROS:~/catkin_ws/src/urdf_exam/urdf$ check_urdf pan_tilt.urdf  
robot name is: ex_urdf_pan_tilt  
----- Successfully Parsed XML -----  
root Link: base_link has 1 child(ren)  
    child(1): pan_link  
        child(1): tilt_link
```

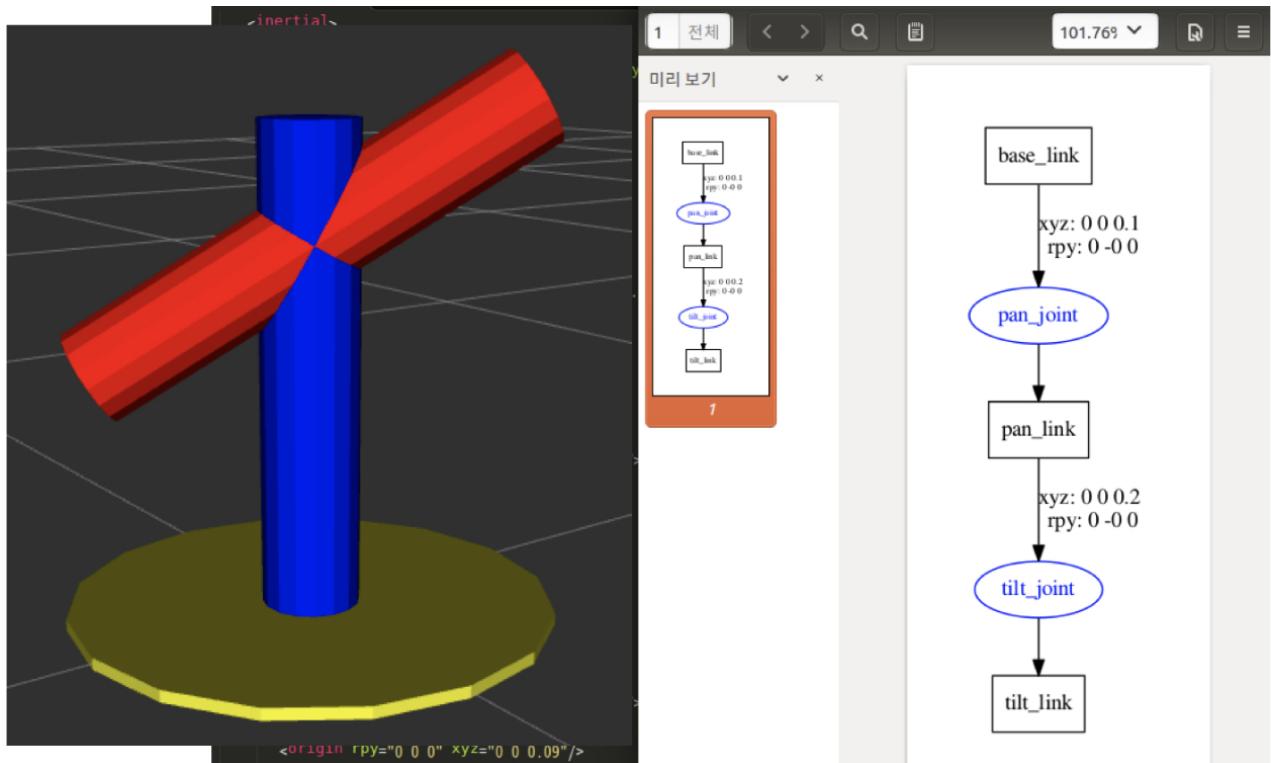
2.9 urdf_to_graphiz

```
pw@pwROS:~/catkin_ws/src/urdf_exam/urdf$ urdf_to_graphiz pan_tilt.urdf  
Created file ex_urdf_pan_tilt.gv  
Created file ex_urdf_pan_tilt.pdf  
pw@pwROS:~/catkin_ws/src/urdf_exam/urdf$ evince ex_urdf_pan_tilt.pdf
```

2.10 그레프로 urdf 확인



2.11 최종



2.12 launch 폴더에 display.launch 변경

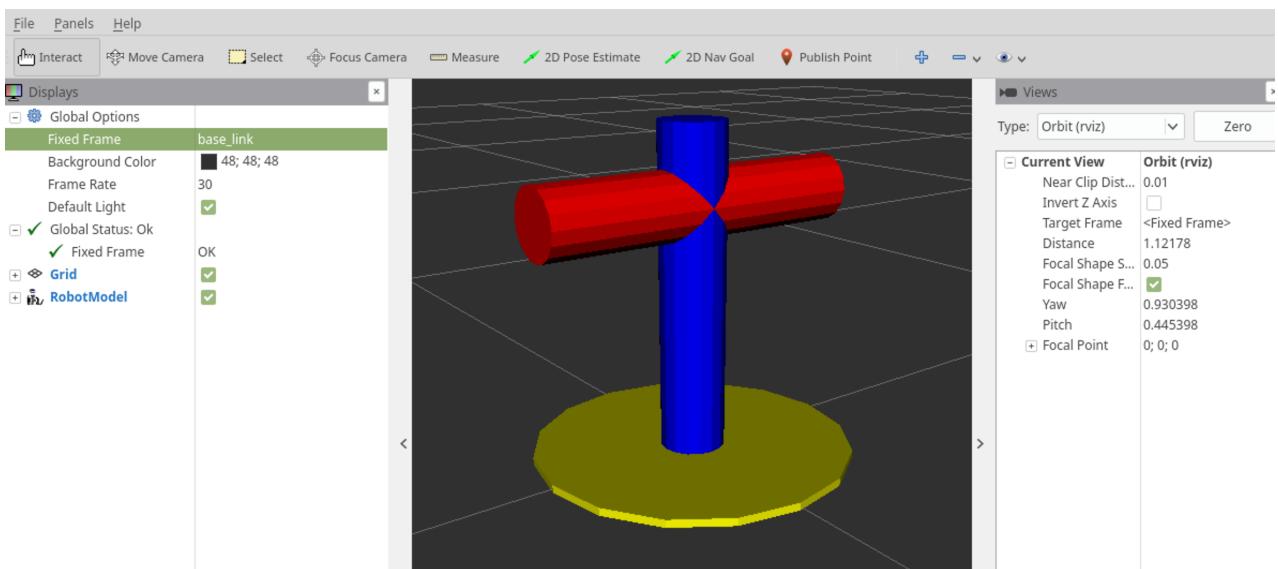
```

1  <?xml version="1.0"?>
2  <launch>
3      <arg name="model" />
4
5      <param name="robot_description" textfile="$(arg model)"/>
6      <param name="use_gui" value="true"/>
7      <node name="joint_state_publisher" pkg="joint_state_publisher" type="joint_state_publisher" />
8      <node name="robot_state_publisher" pkg="robot_state_publisher" type="state_publisher" />
9      <node name="rviz" pkg="rviz" type="rviz" args="-d $(find urdf_exam)/urdf.rviz" required="True" />
10     </launch>
  
```

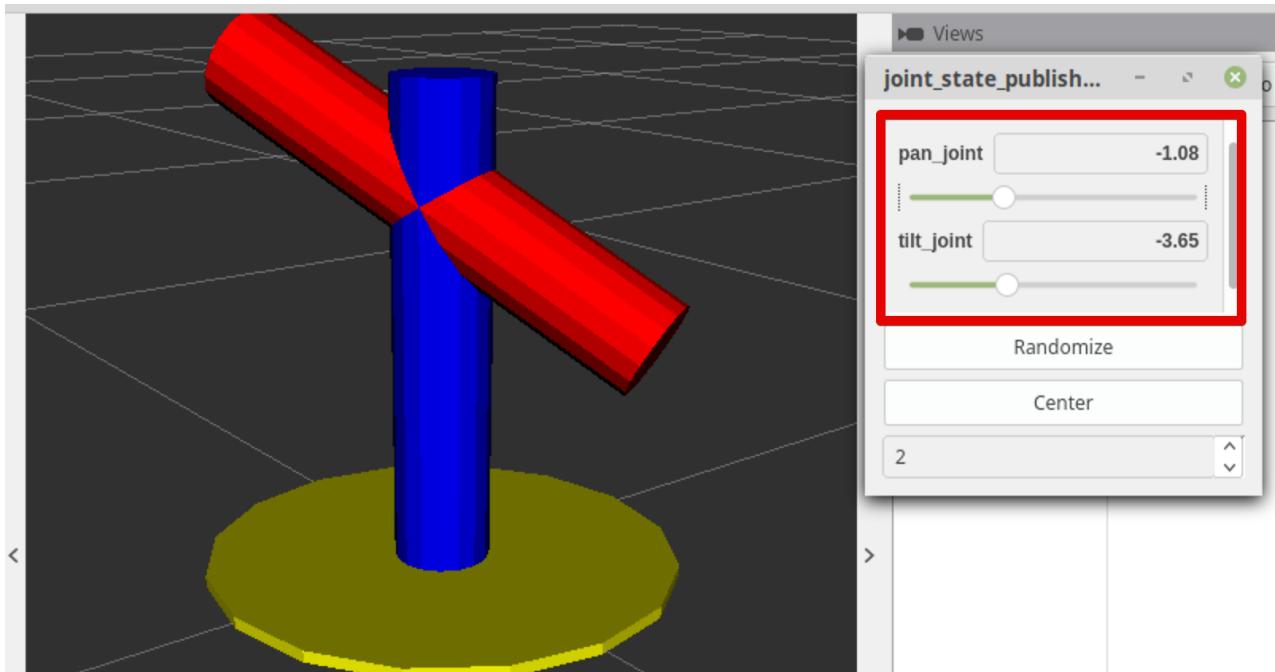
2.13 그리고 joint_state_publisher_gui를 설치

```
pw@melodic:~$ sudo apt install ros-melodic-joint-state-publisher
ros-melodic-joint-state-publisher      ros-melodic-joint-state-publisher-gui
pw@melodic:~$ sudo apt install ros-melodic-joint-state-publisher*
[sudo] password for pw:
Reading package lists... Done
Building dependency tree
Reading state information... Done
Note, selecting 'ros-melodic-joint-state-publisher' for glob 'ros-melodic-joint-state-publisher*'
Note, selecting 'ros-melodic-joint-state-publisher-gui' for glob 'ros-melodic-joint-state-publisher*'
'
ros-melodic-joint-state-publisher is already the newest version (1.12.15-1bionic.20200320.132142).
ros-melodic-joint-state-publisher set to manually installed.
The following NEW packages will be installed:
```

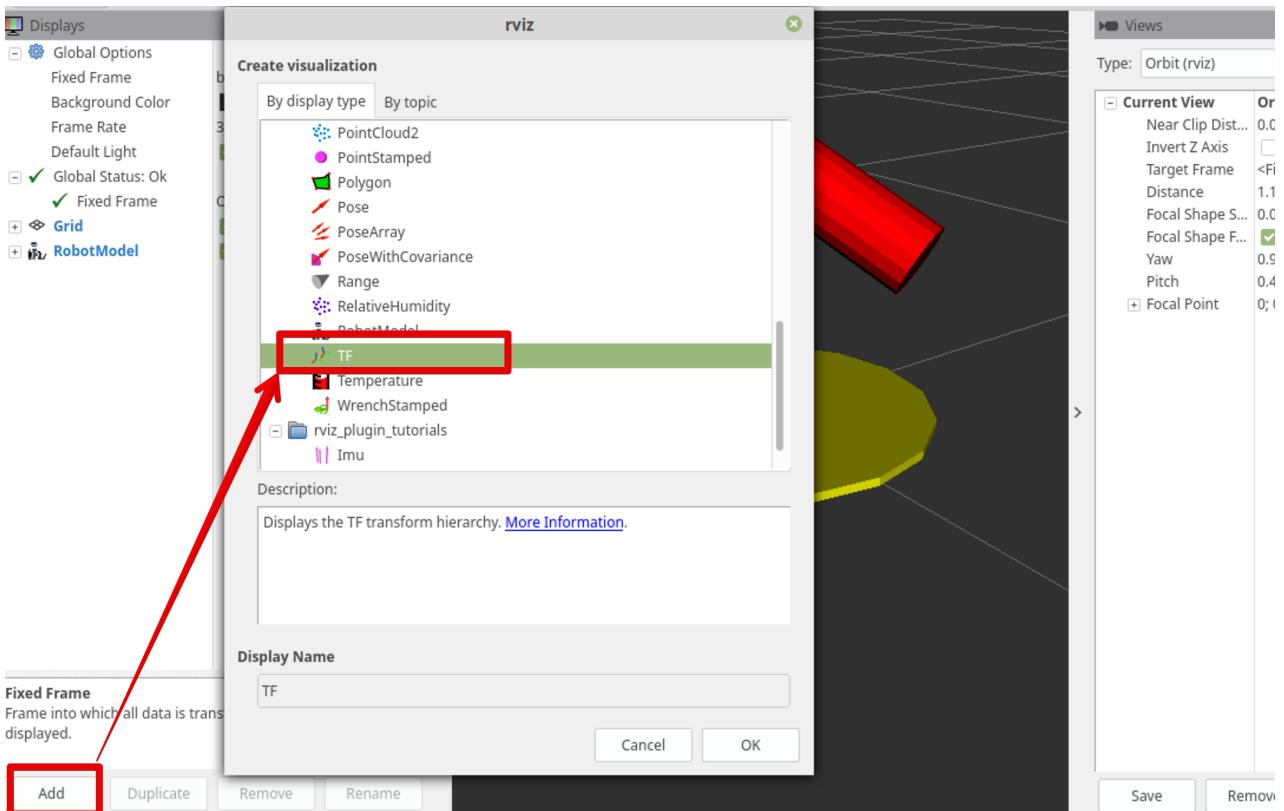
2.14 roslaunch urdf_exam display.launch model:=\$(find urdf_exam)/urdf/pan_tilt.urdf

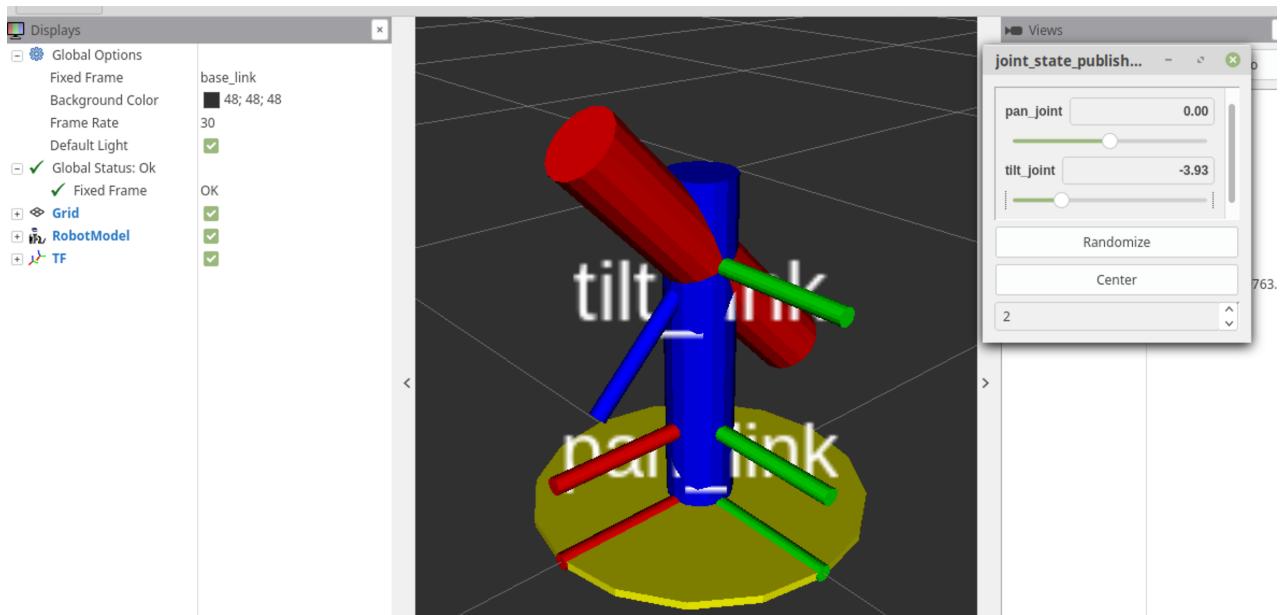


2.15 gui 조작하기



2.16 TF 추가





2.17 rqt_graph

