

my_kuka_robot

```
roslaunch (ssh) #1 x ~/qiuliu (zsh) #2 x ..my_kuka_robot (zsh) #3 x ..my_kuka_robot (zsh) #4 x python3 (Python) #1 x ..my_kuka_robot (ssh) #2
~/ee543/coding/catkin_ws/src/my_kuka_robot/scripts # master ● roslaunch my_kuka_robot my_kuka_s
server.launch
... logging to /home/nansong/.ros/log/42837672-2861-11e9-9881-a0c58955878c/roslaunch-nansong-15048.1
og
Checking log directory for disk usage. This may take awhile.
Press Ctrl-C to interrupt
Done checking log file disk usage. Usage is <16B.

started roslaunch server http://nansong:34403/

SUMMARY
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PARAMETERS
 * /roscdistro: kinetic
 * /rosversion: 1.12.14

NODES
 /
  my_kuka (my_kuka_robot/my_kuka.py)

auto-starting new master
process[master]: started with pid [15058]
ROS_MASTER_URI=http://localhost:11311

setting /run_id to 42837672-2861-11e9-9881-a0c58955878c
process[rosout-1]: started with pid [15071]
started core service [/rosout]
process[my_kuka-2]: started with pid [15075]
Step 1: initializing my_kuka solver...
Matrix([[0, 0, 1, 0], [0, -1, 0, 0], [1, 0, 0, 0], [0, 0, 0, 1]])
debug02
debug03
debug04
debug05
debug06
debug06
debug R_corr2
debug 36.1
debug 36.2
Step 2: creating a callable proxy to a service
Step 3: ready to receive requests
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~/ee543/coding/catkin_ws/src/my_kuka_robot # master ● ls
CMakeLists.txt launch package.xml scripts srv
~/ee543/coding/catkin_ws/src/my_kuka_robot # master ● roslaunch my_kuka_robot FK_test.launch █
```

FK_test

```
X roslaunch (ssh) #1 X ~/qiujie (zsh) #2 X ..my_kuka_rob... #3 X ..my_kuka_rob... #4
EE URDF position: [[0.400118435142705], [-0.504905722168419], [3.53629178745
625], [1.000000000000000]]
EE URDF orientation: [-0.44673751 0.59084094 -0.589512 0.32219277]

processing point 1
Link 2 position : [[0.105549765742401], [-0.333705329522506], [0.7500000000
00000], [1.000000000000000]]
Link 3 position : [[0.363014415108960], [-1.14770358951816], [1.66302726522
848], [1.000000000000000]]
Link 5/Wrist Center position : [[0.814780671084071], [-2.57600431815504], [
1.75673040571802], [1.000000000000000]]
Gripper/End Effector position : [[0.594341387981789], [-2.69863579095321],
[1.58887021286485], [1.000000000000000]]
EE URDF position: [[0.594341387981789], [-2.69863579095321], [1.588870212864
85], [1.000000000000000]]
EE URDF orientation: [-0.3201467 0.10204011 0.92376891 -0.18369785]

processing point 2
Link 2 position : [[-0.208128252137825], [-0.281394084269826], [0.750000000
000000], [1.000000000000000]]
Link 3 position : [[-0.939989169575733], [-1.27088652731854], [0.9685962091
99582], [1.000000000000000]]
Link 5/Wrist Center position : [[-1.83136153127426], [-2.47604203545921], [
0.891320637391945], [1.000000000000000]]
Gripper/End Effector position : [[-1.72973763058783], [-2.52158948897535],
[1.17311313602786], [1.000000000000000]]
EE URDF position: [[-1.72973763058783], [-2.52158948897535], [1.173113136027
86], [1.000000000000000]]
EE URDF orientation: [-0.11738398 -0.54995609 -0.17277758 0.80865147]

processing point 3
Link 2 position : [[0.214674278280830], [0.276432549177199], [0.75000000000
0000], [1.000000000000000]]
Link 3 position : [[0.740294081501438], [0.953264553765171], [1.66001223070
229], [1.000000000000000]]
Link 5/Wrist Center position : [[1.54926824285643], [1.99496732054613], [2.
3764842482536], [1.000000000000000]]
Gripper/End Effector position : [[1.25484902564630], [2.01473555103258], [2.
44529951982513], [1.000000000000000]]
EE URDF position: [[1.25484902564630], [2.01473555103258], [2.44529951982513
], [1.000000000000000]]
EE URDF orientation: [ 0.11422283 0.53067693 0.83917954 -0.03335946]

processing point 4
Link 2 position : [[-0.147693961686734], [0.317311351327490], [0.7500000000
00000], [1.000000000000000]]
Link 3 position : [[-0.00198949498254514], [0.00427430704790529], [1.951365
06412129], [1.000000000000000]]
Link 5/Wrist Center position : [[-0.368461280739306], [0.791616296076028],
[3.17558196588237], [1.000000000000000]]
Gripper/End Effector position : [[-0.0713457461672590], [0.750904677183172],
[3.21887080050620], [1.000000000000000]]
EE URDF position: [[-0.0713457461672590], [0.750904677183172], [3.2188708005
0620], [1.000000000000000]]
EE URDF orientation: [ 0.98658723 -0.07631695 0.06233829 0.1301357 ]

RESPONDED TO "my_kuka_FK" SERVICE REQUEST! (length=5)
[]

X python3 (Python) #1 X roslaunch (ssh) #2
FK_test (my_kuka_robot/FK_test.py)

ROS_MASTER_URI=http://localhost:11311

process[FK_test-1]: started with pid [15142]
Step 1: initializing test script...
Step 2: waiting for service to be available.
Step 3: creating a callable proxy to a service
Step 4: ready for testing.

Part 1: predefined tests
received FK_response 0: position = 1.241097506,-0.308878104954,2.66139826936
FK_response 0: orientation = 0.973569123941,-0.159235851633,0.00124492841665,-0.163724019669
expected FK_response 0: position = 1.241097506,-0.308878104954,2.66139826936
FK_response 0: orientation = 0.973569123941,-0.159235851633,0.00124492841665,-0.163724019669
error: 4.97326066796104E-12

received FK_response 1: position = -2.94615069338,0.00657260190077,2.07021476465
FK_response 1: orientation = -0.25579584927,-0.53186509833,0.772125532224,0.23560594891
expected FK_response 1: position = -2.94615069338,0.00657260190077,2.07021476465
FK_response 1: orientation = -0.25579584927,-0.53186509833,0.772125532224,0.23560594891
error: 4.80335840992603E-12

received FK_response 2: position = 0.0008578554147,-0.118085650178,2.69381893552
FK_response 2: orientation = 0.220283358922,-0.434902191935,-0.378367271047,0.786875805596
expected FK_response 2: position = 0.0008578554147,-0.118085650178,2.69381893552
FK_response 2: orientation = 0.220283358922,-0.434902191935,-0.378367271047,0.786875805596
error: 8.88547687249180E-14

Part 2: random tests
FK_request 0: joint angles = (-0.4167180641122572, 0.09469332957735876, -1.6350179889209286, -1.5673611897358
466, 1.424114631946709, 4.644642227477541)
FK_response 0: position = 0.400118435143,-0.504905722168,3.53629178746
FK_response 0: orientation = -0.446737511218,0.590840936539,-0.58951200164,0.322192774132

FK_request 1: joint angles = (-1.2644566423625605, 0.7518569892322593, -0.8503103907340543, 2.178787298982228
,-1.4593440445062127, -1.3887319208457502)
FK_response 1: position = 0.594341387982,-2.69863579095,1.58887021286
FK_response 1: orientation = -0.320146697374,0.102040114658,0.923768914956,-0.183697846809

FK_request 2: joint angles = (-2.207629246595635, 1.3950155182278725, -1.3794935103683081, 2.7726793078717664
,1.6639422784015405, -1.3750661641890485)
FK_response 2: position = -1.72973763059,-2.52158948898,1.17311313603
FK_response 2: orientation = -0.117383978361,-0.549956089787,-0.172777584057,0.808651474603

FK_request 3: joint angles = (0.9104947330484858, 0.7553818909218546, -1.2889900610209768, 2.1002161353620954
,1.9318343475139987, -6.015715201395135)
FK_response 3: position = 1.25484902565,2.01473555103,2.44529951983
FK_response 3: orientation = 0.114222826179,0.530676926238,0.839179535252,-0.0333594597341

FK_request 4: joint angles = (2.0064275421542233, -0.279867484436071, -0.7099104608746996, -5.276104324343557
,-1.7462496153052123, -6.047802033270069)
FK_response 4: position = -0.0713457461673,0.750904677183,3.21887080051
FK_response 4: orientation = 0.986587229356,-0.0763169479124,0.062338290411,0.13013569795

FK test passed!
```

Questions:

- Q1: Explain what `rospy.Service()` and `rospy.ServiceProxy()` do respectively.
 - Basically, `rospy.Service()` is like a server waiting for request and process it then return a response.
 - `rospy.ServiceProxy()` is like a client that request the server to do something.
- Q2: What happens if you take out the line `rospy.wait_for_service`, and why is it happening?
 - `rospy.service.ServiceException: service [/FK_service] unavailable`
 - Because sometimes service took a long time to initialize, if we don't `rospy.wait_for_service`, the request will not be processed and raise a `ServiceException: unavailable`
- Q3: What does the `---` in a service file mean?
 - Separate the request(upper one) and response(lower one)
- Q4: In sympy, what does `evalf` function do?
 - Substitute symbols with given values (it could be another symbol)