Software Lecture 4:

ROS Services

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Contents

In this lecture, we shall cover:

- Overview for ROS Services
- Defining a new ROS Service
- Creating our first ROS Service Client/Server pair

Before We Begin

- Again, I strongly suggest bookmarking the following link: https://github.com/OxRAMSociety/RobotArm

- All example code can be found in:

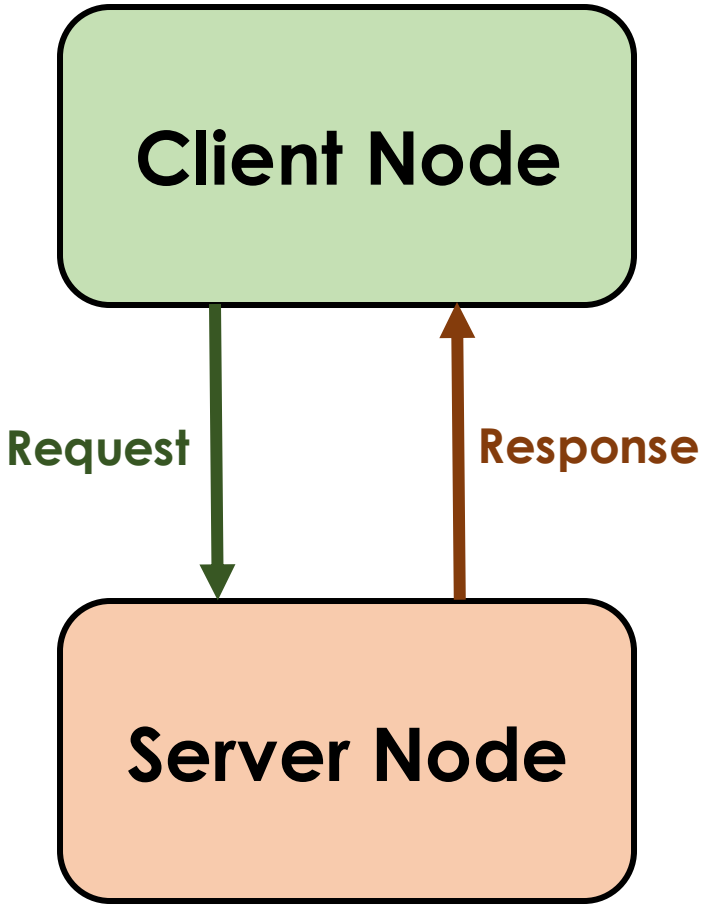
Tutorials/Software Tutorials (2022)/Example Scripts

Of course, code for this lecture will be in the Lecture 4 folder, and so on for future lectures

- I will provide code in these presentations, but refer to the Example Scripts to check your own!

ROS Services – Overview

- Request/response system
- Client node sends a request and awaits a response
- Server node listens to the request, processes it and sends a response back to that client when complete
- The request and response are both ROS messages



Creating a Service Client/Server Pair

- We will revisit our Square Number Factory idea, but now implement it using a ROS Service!

Defining a new ROS Service

- ROS services must be defined in a unique 'srv' file
- **Navigate to tutorial_scripts and create a folder named srv**
  - This folder will contain all our custom ROS service definitions
- **Inside that folder, create a file ExampleService.srv and open it**

Defining a new ROS Service

- We first define all data contained within the request message
  - In this case, we have defined a 32-bit integer referred to as 'input number'
  - We can have multiple entries if we want!
- We then define all data contained within the response message
- We separate these two groups with 3 hyphens (i.e. ---)

```
1   # Request
2   int32 input_number
3   ---
4   # Response
5   int32 output_number
```

Reproduce this!

Defining a new ROS Service

- For the package to recognise our new ROS service, we must make sure they are generated when the package is built
- **Navigate to tutorial_scripts and open the CMakeLists.txt file**
- **Go to line ~10 and uncomment/edit the find_package section as follows:**

```
10  find_package(catkin REQUIRED COMPONENTS
11    rospy
12    std_msgs
13    message_generation
14  )
```

Defining a new ROS Service

- **Go to line ~50 and uncomment/edit the add_service_files section as follows:**

```
57   ## Generate services in the 'srv' folder
58   add_service_files(
59     FILES
60     ExampleService.srv
61   )
```

- **Go to line ~70 and uncomment/edit the generate_messages section as follows:**

```
69   ## Generate added messages and services with any dependencies listed here
70   generate_messages(
71     DEPENDENCIES
72     std_msgs
73   )
```

Defining a new ROS Service

- **Go to line ~100 and uncomment/edit the catkin_package section as follows:**

```
103   catkin_package(
104   #  INCLUDE_DIRS include
105      LIBRARIES tutorial_scripts
106      CATKIN_DEPENDS rospy std_msgs
107   #  DEPENDS system_lib
108      DEPENDS message_runtime
109   )
```

Defining a new ROS Service

- **Now open the package.xml file, go to line ~58 and add the following:**

```
59    <build_depend>message_generation</build_depend>
60    <exec_depend>message_runtime</exec_depend>
```

- **Finally, save all files and rebuild the workspace**

Creating a Server Node

- **In tutorial_scripts' scripts folder, create the file Example_Service_Server.py:**

```python
#! /usr/bin/env python3

import rospy
from tutorial_scripts.srv import ExampleService, ExampleServiceResponse # Import message types for our Example ROS service

# Call requests are passed into this function
def handleRequest(req):
    x = req.input_number    # Extract number to be squared
    rospy.loginfo("Order Received: %d",x)
    x_squared = x*x         # Square the number
    rospy.loginfo("Processed Order: %d \n ---",x_squared)
    return ExampleServiceResponse(x_squared)    # Return square number to client


if __name__ == '__main__':

    rospy.init_node('ExampleServiceServerNode')

    # Declare a new service called 'ExampleService', of type ExampleService, using function handleRequest to handle requests
    srv = rospy.Service('ExampleService', ExampleService, handleRequest)

    rospy.spin()
```

Creating a Server Node

- The Server node:
  - Defines function 'handleRequest', which shall be used to process incoming requests

```
# Call requests are passed into this function
def handleRequest(req):
    x = req.input_number    # Extract number to be squared
    rospy.loginfo("Order Received: %d",x)
    x_squared = x*x         # Square the number
    rospy.loginfo("Processed Order: %d \n ---",x_squared)
    return ExampleServiceResponse(x_squared)    # Return square number to client
```

  - Sets up a service of type ExampleService (which we shall also name 'ExampleService') and starts listening for requests

```
# Declare a new service called 'ExampleService', of type ExampleService, using function handleRequest to handle requests
srv = rospy.Service('ExampleService', ExampleService, handleRequest)
```

Creating a Client Node

- **In tutorial_scripts' scripts folder, create the file Example_Service_Client.py:**

```python
#! /usr/bin/env python3

import rospy
import random
from tutorial_scripts.srv import ExampleService # Import message types for our Example ROS service

rospy.init_node('ExampleServiceClientNode')

r = rospy.Rate(2)   # 2 Hz


while not rospy.is_shutdown():

    order = random.randint(1,10)    # Randomly generate a new order

    rospy.loginfo("Number to be Squared: %d",order)
    rospy.wait_for_service('ExampleService')    # Wait for 'ExampleService' to become available

    try:
        request = rospy.ServiceProxy('ExampleService', ExampleService)  # Create a handle by which to call the service
        receiver = request(order)   # Call the service, using our randomly-generated order as an input
        rospy.loginfo("Square Number Received: %d \n ---",receiver.output_number)

    except rospy.ServiceException as e: # An exception will be raised if the call fails
        rospy.logerr("Service call failed: %s \n ---",e)

    r.sleep()
```

Creating a Client Node

- The Client node:
  - Waits for 'ExampleService' to become available
  - Sets up a handle by which to call the service
  - Calls the service and waits for a response (stored in variable 'receiver')

```
rospy.wait_for_service('ExampleService')    # Wait for 'ExampleService' to become available

try:
    request = rospy.ServiceProxy('ExampleService', ExampleService)  # Create a handle by which to call the service
    receiver = request(order)   # Call the service, using our randomly-generated order as an input
    rospy.loginfo("Square Number Received: %d \n ---",receiver.output_number)

except rospy.ServiceException as e: # An exception will be raised if the call fails
    rospy.logerr("Service call failed: %s \n ---",e)
```

Testing Our Code

- **Remember to give permissions to our code**
- **Now, in three separate Terminals, run the following:**
  1. **roscore**
  2. **rosrun tutorial_scripts Example_Service_Server.py**
  3. **rosrun tutorial_scripts Example_Service_Client.py**

Testing Our Program

- You should see something like this:

```
[INFO] [1664557330.639855]: Number to be Squared: 10
[INFO] [1664557330.647969]: Square Number Received: 100
 ---
[INFO] [1664557331.141131]: Number to be Squared: 3
[INFO] [1664557331.154928]: Square Number Received: 9
 ---
[INFO] [1664557331.640794]: Number to be Squared: 8
[INFO] [1664557331.653462]: Square Number Received: 64
 ---
[INFO] [1664557332.141166]: Number to be Squared: 1
[INFO] [1664557332.151815]: Square Number Received: 1
 ---
[INFO] [1664557332.640750]: Number to be Squared: 7
[INFO] [1664557332.652888]: Square Number Received: 49
 ---
[INFO] [1664557333.140607]: Number to be Squared: 9
[INFO] [1664557333.159194]: Square Number Received: 81
```

Client

```
[INFO] [1664557330.645123]: Order Received: 10
[INFO] [1664557330.646329]: Processed Order: 100
 ---
[INFO] [1664557331.150879]: Order Received: 3
[INFO] [1664557331.153457]: Processed Order: 9
 ---
[INFO] [1664557331.649865]: Order Received: 8
[INFO] [1664557331.651667]: Processed Order: 64
 ---
[INFO] [1664557332.149097]: Order Received: 1
[INFO] [1664557332.150807]: Processed Order: 1
 ---
[INFO] [1664557332.649763]: Order Received: 7
[INFO] [1664557332.651352]: Processed Order: 49
 ---
[INFO] [1664557333.154606]: Order Received: 9
[INFO] [1664557333.157303]: Processed Order: 81
```

Server

- The client node randomly generates a number to be squared and sends it to the server node
- The server node squares the number then sends it back

Closing Thoughts

- A much better solution for our Square Number Factory!
- ROS Services are great for when the requested process is fast
  - e.g. retrieving information about a robot's pose, or spawning an object in a simulation
- What about if the process will take an extended period of time?
  - e.g. commanding a robot arm to move to a specific pose
- For those cases, it is better to use ROS Actions
  - More on these next time!

Summary

We covered:

- Overview for ROS Services
- Defining a new ROS Service
- Creating our first ROS Service Client/Server pair

Homework: Revise ROS Services (p.4), go over the code and make sure you can follow what's going on

Next time, we will learn about ROS Actions!

Thank You!

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