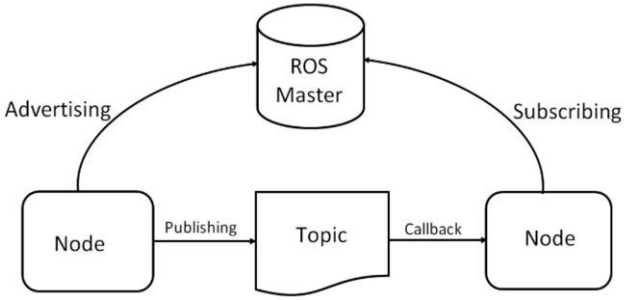
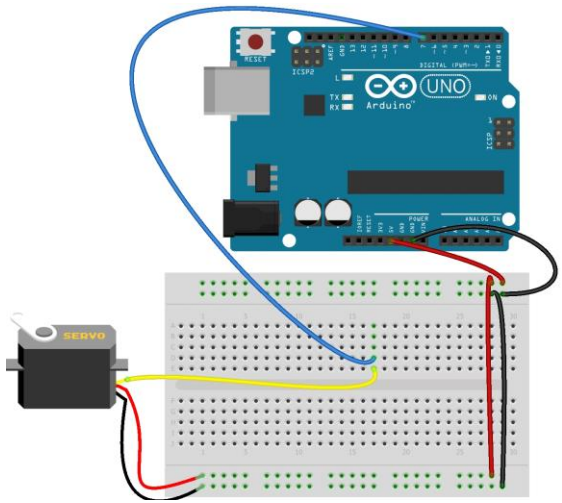
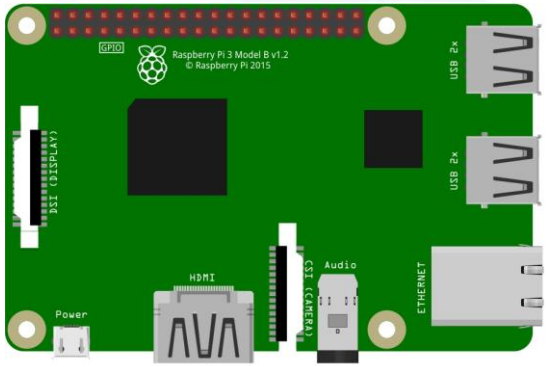
Hands On With ROS

Class 4: Angle Control with ROS







March 26, 2020

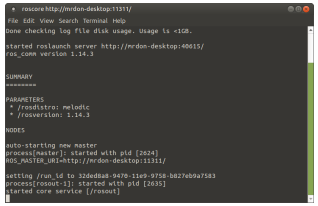
Don Wilcher

DesignNews

CEC CONTINUING EDUCATION CENTER

Presented by: Digi-Key ELECTRONICS

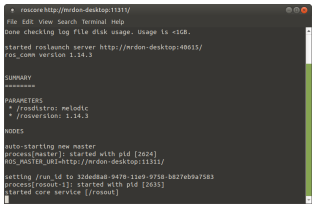
Class 4: Angle Control with ROS



Agenda

- Diving into the ROS Topic
- Servo Motor Control Applications
  - a) Sweep Control
  - b) Knob Control
- Lab Project: Servo Motor Control with ROS

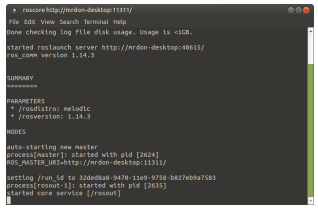
Diving into the ROS Topic



Definition:

Topic – The publishing and subscribing of a message of a specific name type.

Diving into a ROS Topic…



Explanation:

Topics are:

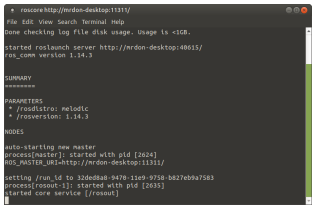
a) communication defined buses which allow the exchange of messages.

b) unknown public/subscribe words.

c) relevant to the subscribing of data of interested nodes.

ROS.(n.d.). *Understanding ros topics*. Retrieved from http://wiki.ros.org/Topics

Diving into a ROS Topic…



Example:

Turtlesim simulator

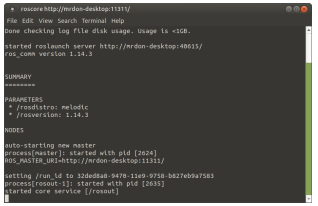
Type and run the following commands in different terminal windows after the $ prompt.

roscore

rosrun turtlesim turtlesim_node

rosrun turtlesim turtle_teleop

Diving into a ROS Topics…



roscore http://mrdon-desktop:11311/

File Edit View Search Terminal Help

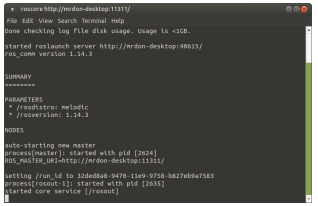
```
Press Ctrl-C to interrupt
Done checking log file disk usage. Usage is <1GB.

started roslaunch server http://mrdon-desktop:45011/
ros_comm version 1.14.3


SUMMARY
========

PARAMETERS
 * /rosdistro: melodic
 * /rosversion: 1.14.3

NODES

auto-starting new master
process[master]: started with pid [2189]
ROS_MASTER_URI=http://mrdon-desktop:11311/

setting /run_id to 278d8758-634e-11ea-881e-b827eb9a7583
process[rosout-1]: started with pid [2200]
started core service [/rosout]
```

roscore

Question 1

Name the virtual simulation example used to demonstrate Topics?

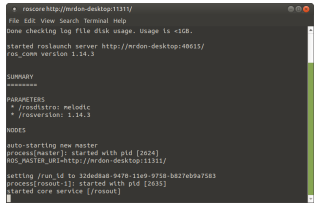
Diving into a ROS Topics…

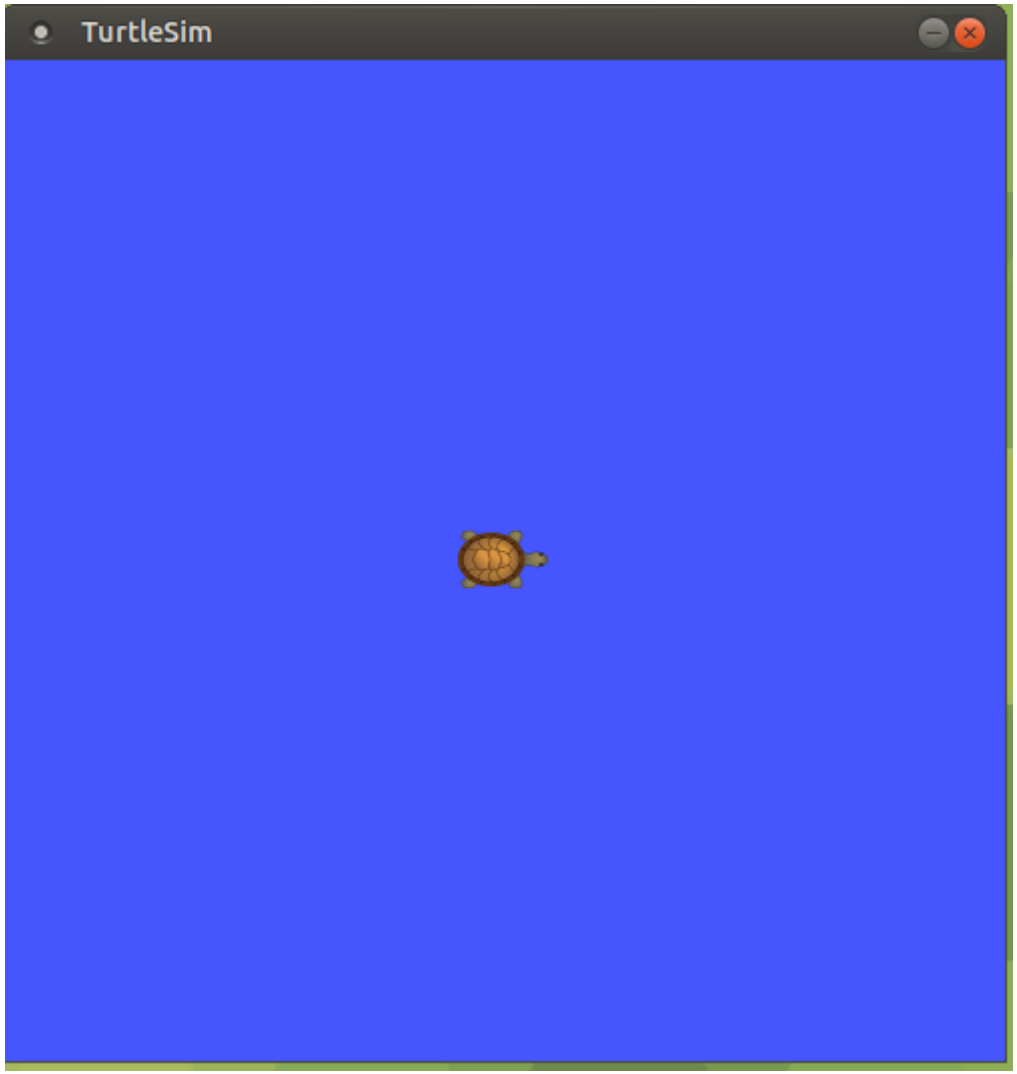


rosrun_turtlesim turtlesim_node

```
mrdon@mrdon-desktop: ~
File  Edit  View  Search  Terminal  Help
mrdon@mrdon-desktop:~$ rosrun turtlesim turtlesim_node
libEGL warning: DRI2: failed to authenticate
[ INFO] [1583899872.105795255]: Starting turtlesim with node name /turtlesim
[ INFO] [1583899872.134961227]: Spawning turtle [turtle1] at x=[5.544445], y=[5.
544445], theta=[0.000000]
```

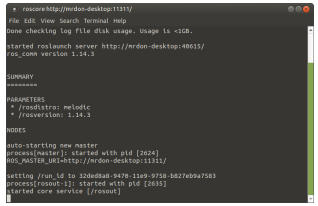
Diving into a ROS Topics…



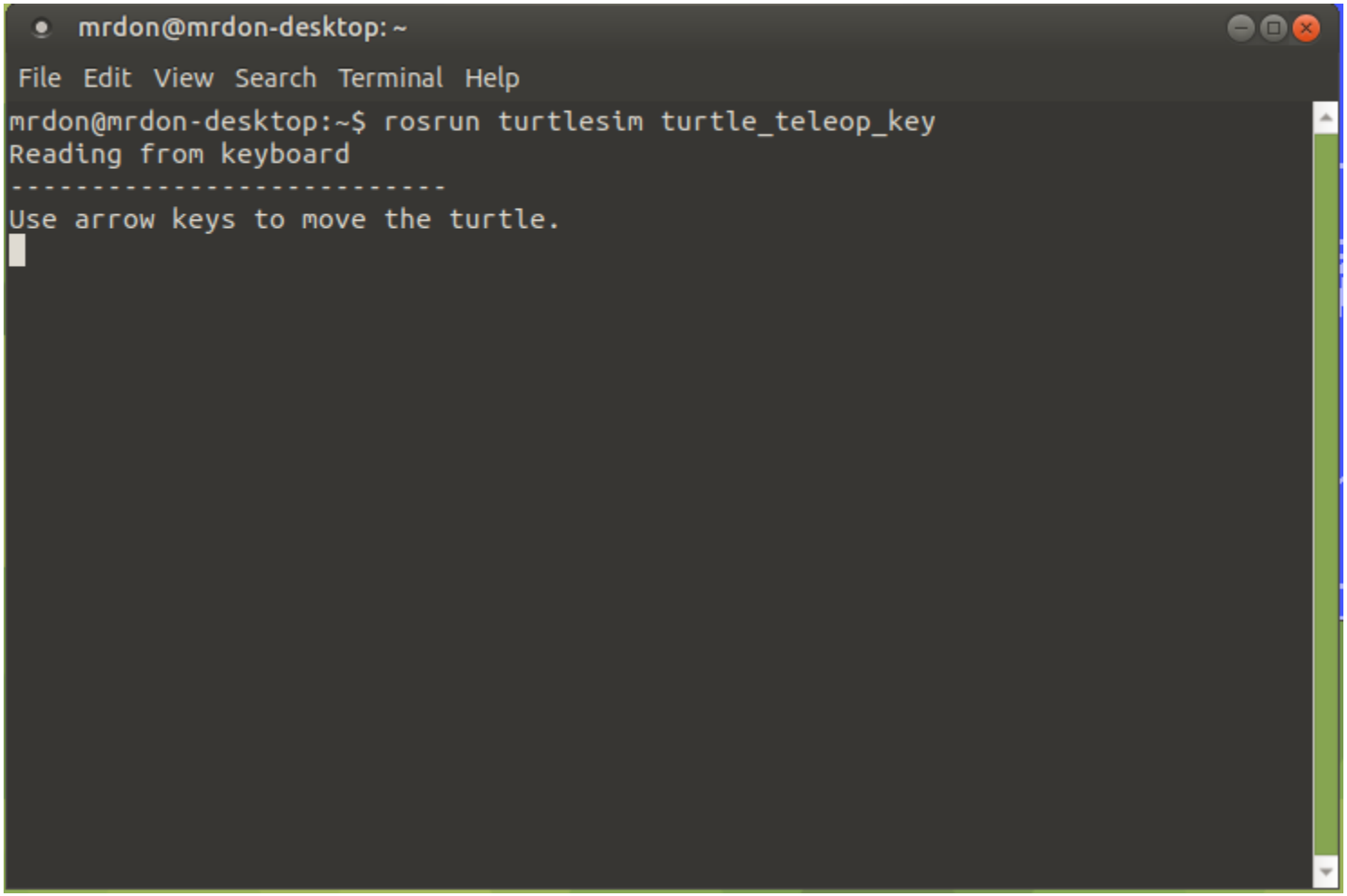


Result of :
rosrun_turtlesim turtlesim_node

Diving into a ROS Topics…



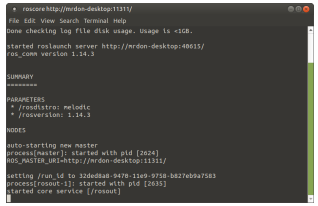
rosrun_turtlesim turtle_teleop_key

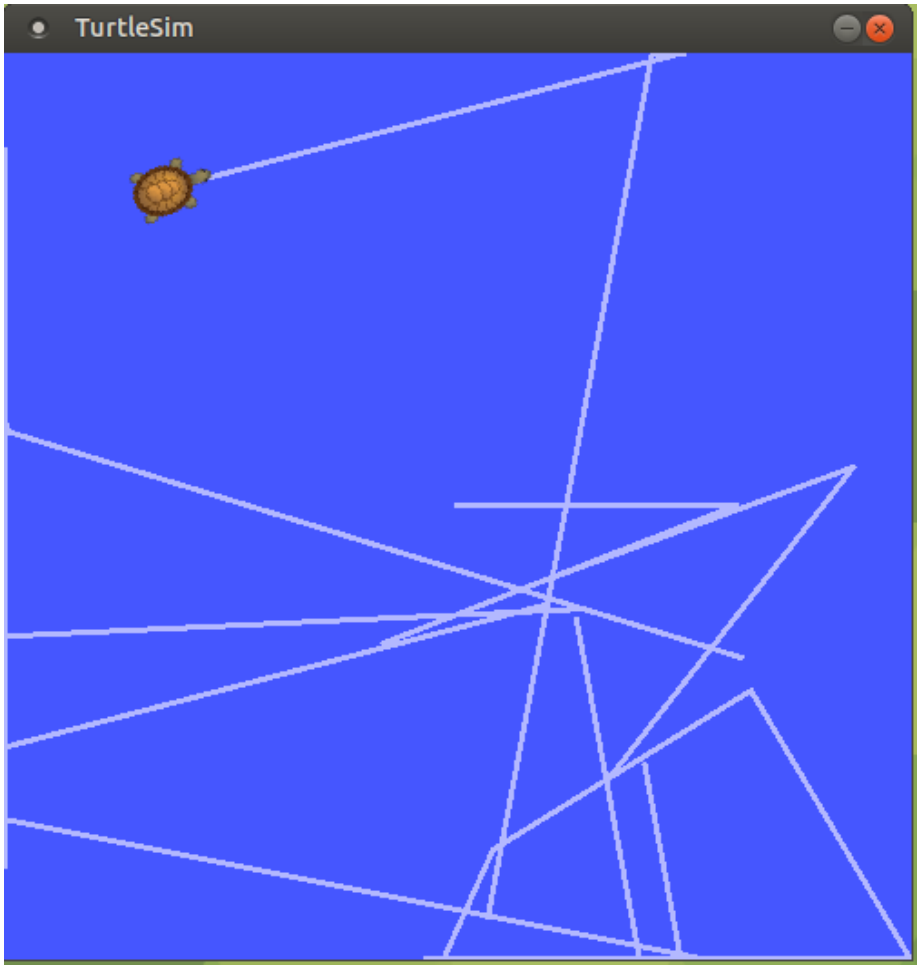


Question 2

What method is used to move the turtle on the turtlesim window?

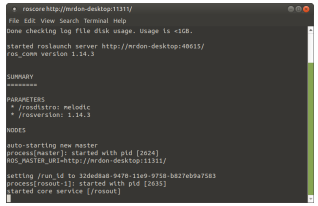
Diving into a ROS Topics…





Result of:
rosrun_turtlesim turtle_teleop_key

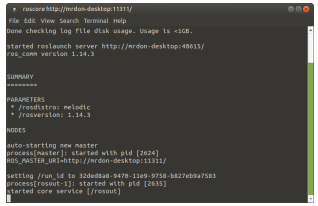
Diving into a ROS Topics…



```
mrdon@mrdon-desktop: ~
File  Edit  View  Search  Terminal  Help
[ WARN] [1583903708.341542276]: Oh no! I hit the wall! (Clamping from [x=-0.012071, y=2.274624])
[ WARN] [1583903708.357635088]: Oh no! I hit the wall! (Clamping from [x=-0.012071, y=2.244988])
[ WARN] [1583903708.373511657]: Oh no! I hit the wall! (Clamping from [x=-0.012071, y=2.215352])
[ WARN] [1583903708.389180317]: Oh no! I hit the wall! (Clamping from [x=-0.012071, y=2.185716])
[ WARN] [1583903708.404915173]: Oh no! I hit the wall! (Clamping from [x=-0.012071, y=2.156080])
[ WARN] [1583903708.421709835]: Oh no! I hit the wall! (Clamping from [x=-0.012071, y=2.126444])
[ WARN] [1583903708.437723170]: Oh no! I hit the wall! (Clamping from [x=-0.012071, y=2.096808])
[ WARN] [1583903708.453324333]: Oh no! I hit the wall! (Clamping from [x=-0.012071, y=2.067172])
[ WARN] [1583903708.469635887]: Oh no! I hit the wall! (Clamping from [x=-0.012071, y=2.037537])
[ WARN] [1583903708.485219550]: Oh no! I hit the wall! (Clamping from [x=-0.012071, y=2.007901])
[ WARN] [1583903708.500997321]: Oh no! I hit the wall! (Clamping from [x=-0.012071, y=1.978265])
[ WARN] [1583903708.516893056]: Oh no! I hit the wall! (Clamping from [x=-0.012071, y=1.948629])
[ WARN] [1583903708.533857556]: Oh no! I hit the wall! (Clamping from [x=-0.012071, y=1.918993])
[ WARN] [1583903708.549603297]: Oh no! I hit the wall! (Clamping from [x=-0.012071, y=1.889357])
[ WARN] [1583903708.565467054]: Oh no! I hit the wall! (Clamping from [x=-0.012071, y=1.859721])
[ WARN] [1583903708.581362894]: Oh no! I hit the wall! (Clamping from [x=-0.012071, y=1.830085])
[ WARN] [1583903708.597056970]: Oh no! I hit the wall! (Clamping from [x=-0.012071, y=1.800449])
[ WARN] [1583903708.612792346]: Oh no! I hit the wall! (Clamping from [x=-0.012071, y=1.770813])
[ WARN] [1583903708.629436492]: Oh no! I hit the wall! (Clamping from [x=-0.012071, y=1.741177])
[ WARN] [1583903708.645057550]: Oh no! I hit the wall! (Clamping from [x=-0.012071, y=1.711541])
[ WARN] [1583903708.661054272]: Oh no! I hit the wall! (Clamping from [x=-0.012071, y=1.681906])
[ WARN] [1583903708.676829855]: Oh no! I hit the wall! (Clamping from [x=-0.012071, y=1.652270])
[ WARN] [1583903708.693700972]: Oh no! I hit the wall! (Clamping from [x=-0.012071, y=1.622634])
[ WARN] [1583903708.709474420]: Oh no! I hit the wall! (Clamping from [x=-0.012071, y=1.592998])
```

Result of turtle hitting wall

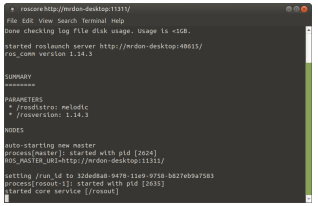
Diving into a ROS Topics…

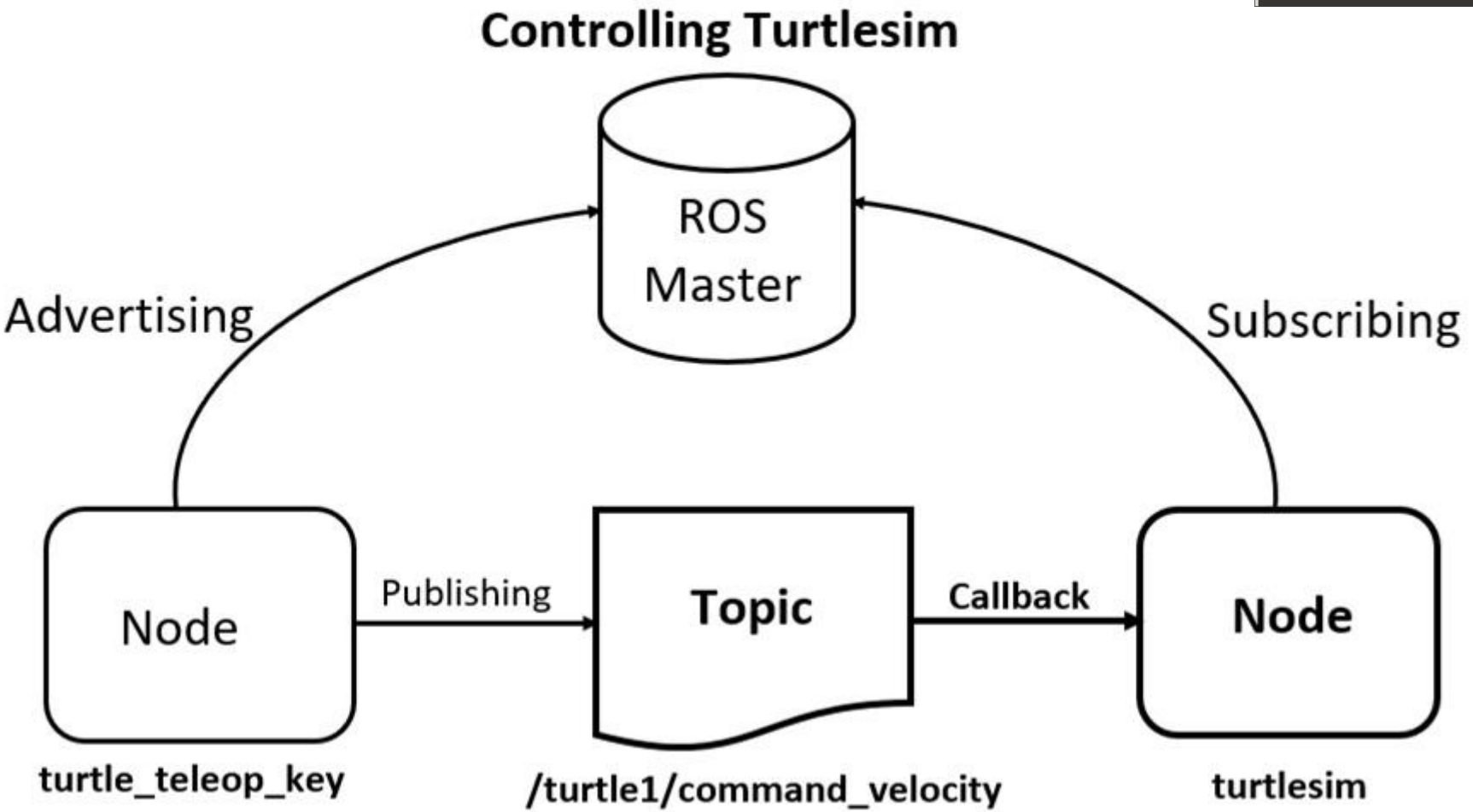


Conclusion

- The turtlesim simulator illustrates the turtlesim_node and the turtle_teleop_key communications between nodes.
- The turtle_teleop_key is publishing the key strokes based on a topic.
- The turtlesim node subscribes to the same topic as turtle_teleop_key.
- The turtle1/command_velocity is the shared topic between the nodes.

Diving into a ROS Topics…





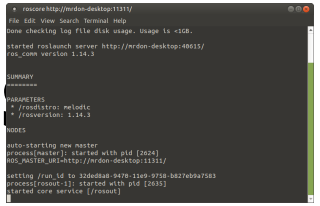
Model can be displayed using a rostopic dynamic graph command: $rosrun rqt_graph rqt_graph

Question 3

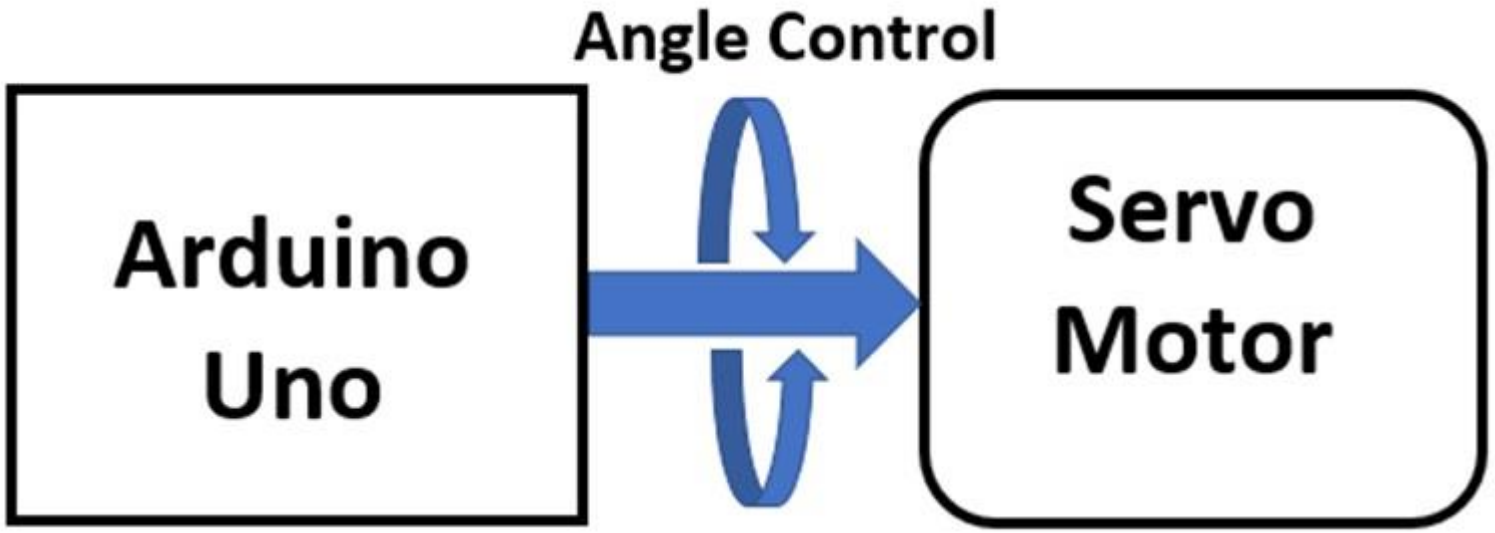
Which command is used to display the rostopic dynamic graph?

a) **$rosrun rqt_graph rqt_graph**
b) **$roscore rqt_graph rqt_graph**
c) **$rosrun rqt_graph**
d) **None of the above**

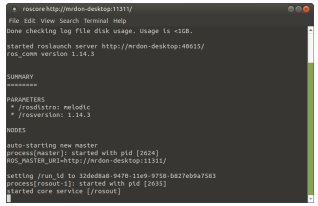
Servo Motor Control Application



Sweep Control Concept



Servo Motor Control Applications…

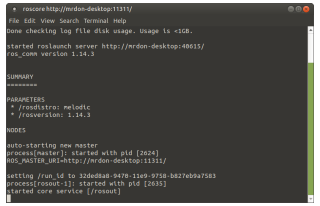


Sweep Control: Arduino Uno Code

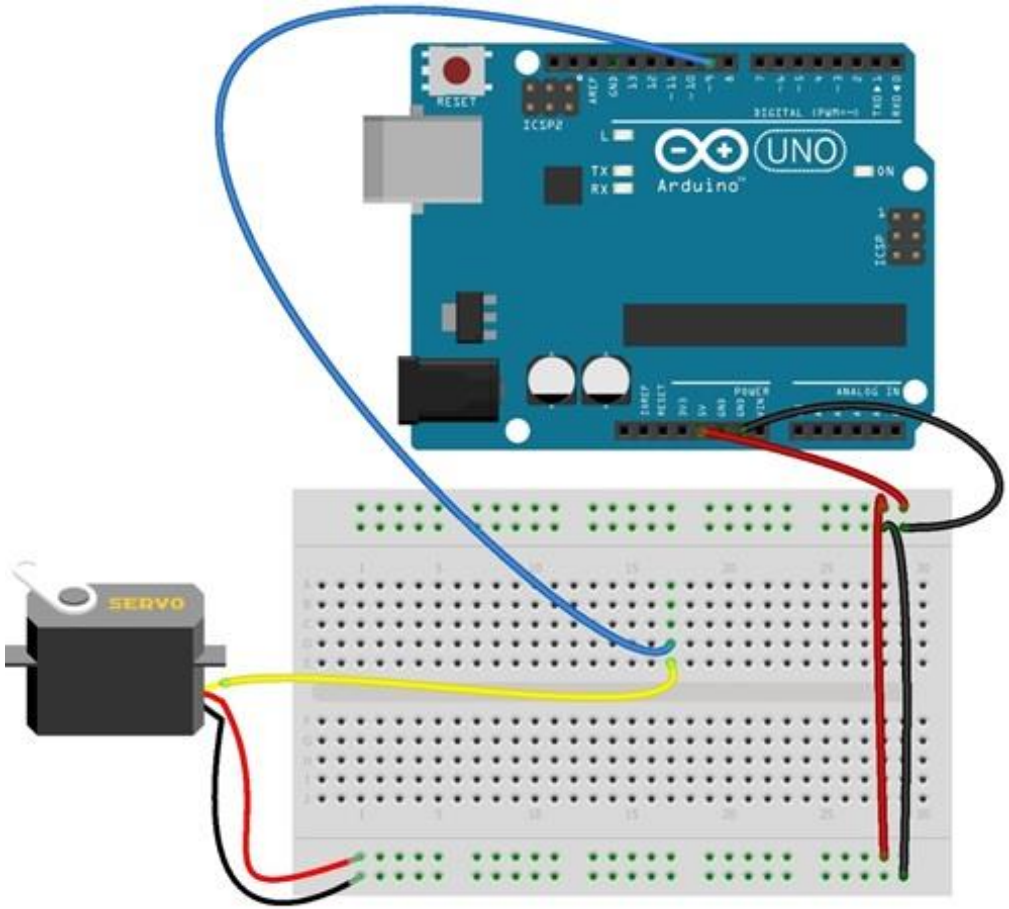
```
void loop() {
  for (pos = 0; pos <= 180; pos += 1) { // goes from 0 degrees to 180 degrees
    // in steps of 1 degree
    myservo.write(pos);              // tell servo to go to position in variable 'pos'
    delay(15);                       // waits 15ms for the servo to reach the position
  }
  for (pos = 180; pos >= 0; pos -= 1) { // goes from 180 degrees to 0 degrees
    myservo.write(pos);              // tell servo to go to position in variable 'pos'
    delay(15);                       // waits 15ms for the servo to reach the position
  }
```

File > Examples > Servo > Sweep

Servo Motor Control Applications…



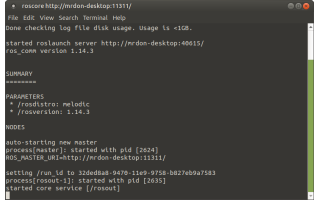
Sweep Control

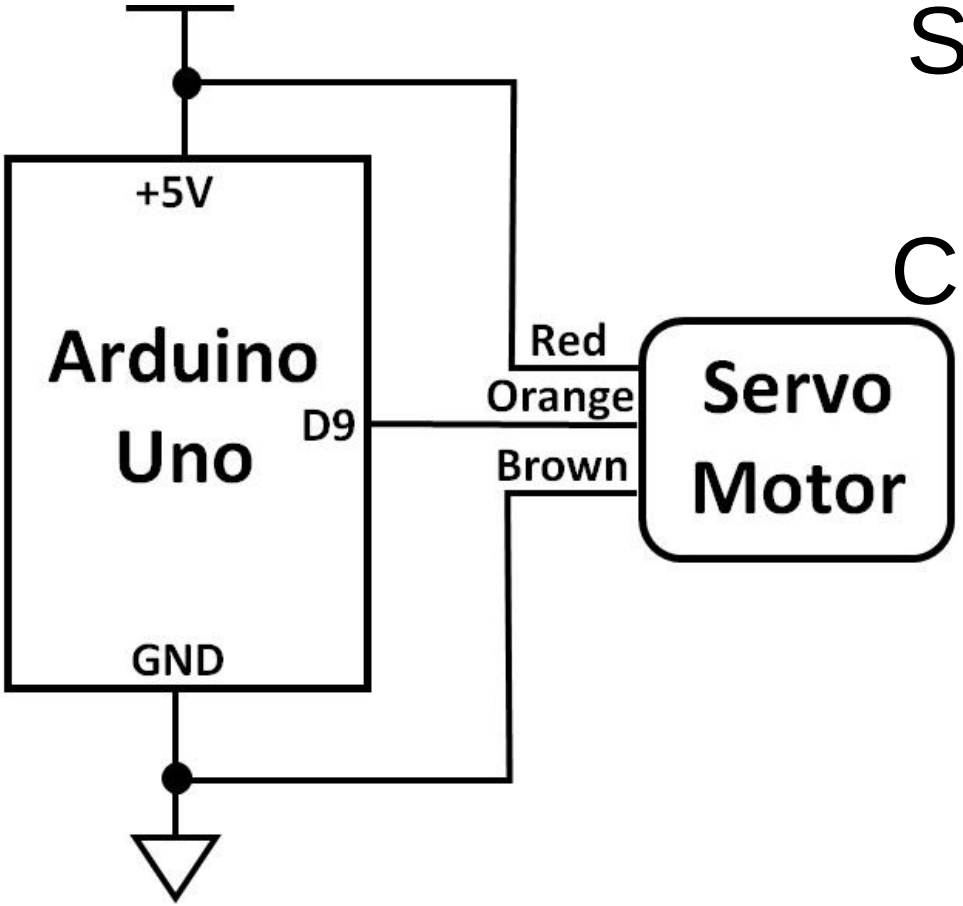


Sweep Control Electrical Wiring Diagram

Servo Motor Control Applications…

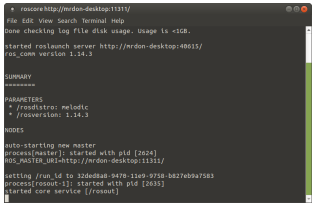
Sweep Control



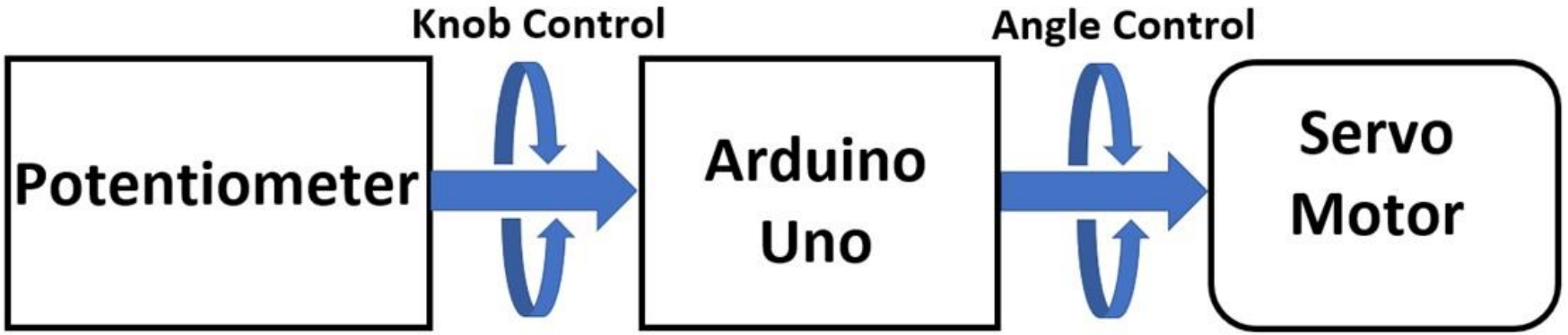


Sweep Control Electronic Circuit Diagram

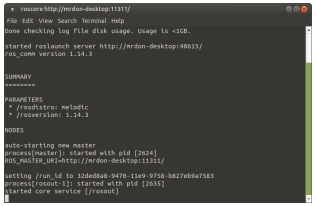
Servo Motor Control Applications…



Knob Control Concept



Servo Motor Control Applications…



Knob Control

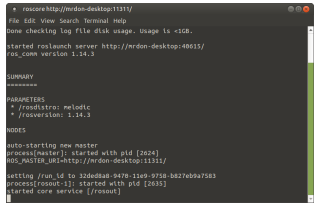
Arduino Uno Code

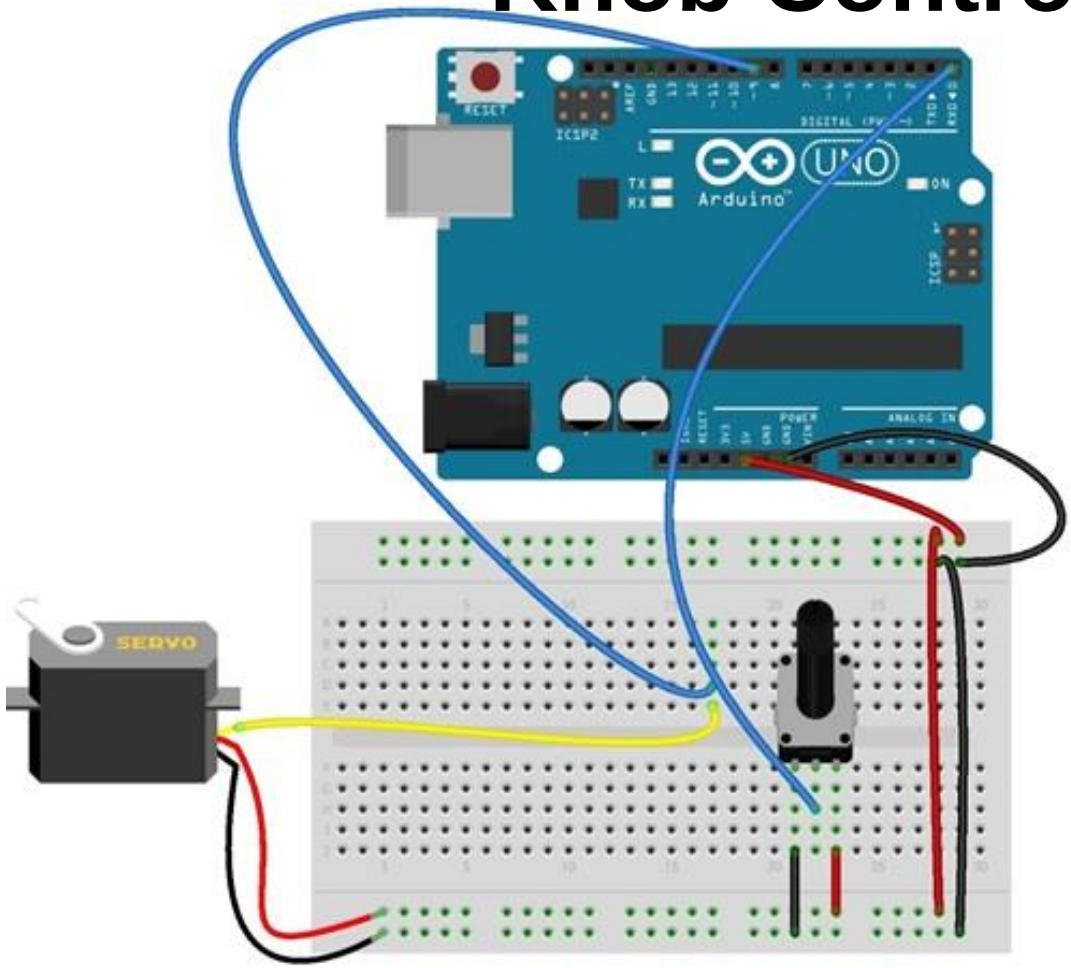
```
#include <Servo.h>

Servo myservo;  // create servo object to control a servo

int potpin = 0;  // analog pin used to connect the potentiometer
int val;    // variable to read the value from the analog pin

void setup() {
  myservo.attach(9);  // attaches the servo on pin 9 to the servo object
}

void loop() {
  val = analogRead(potpin);            // reads the value of the potentiometer (value between 0 and 1023)
  val = map(val, 0, 1023, 0, 180);     // scale it to use it with the servo (value between 0 and 180)
  myservo.write(val);                  // sets the servo position according to the scaled value
  delay(15);                           // waits for the servo to get there
}
```

File > Examples > Servo > Knob

Servo Motor Control Applications…

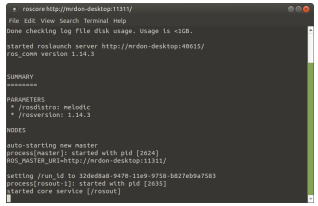
Knob Control

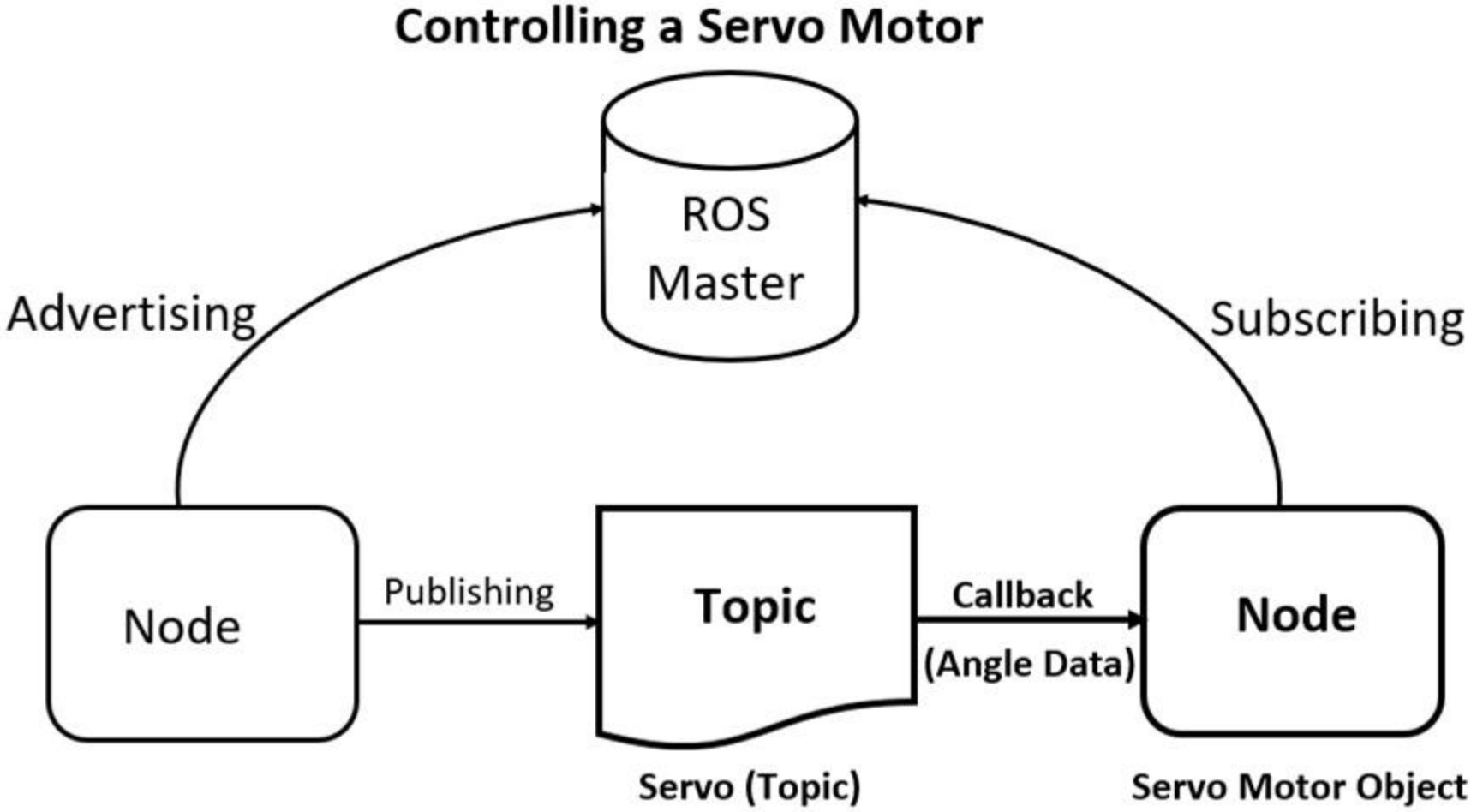




Knob Control Electrical Wiring Diagram

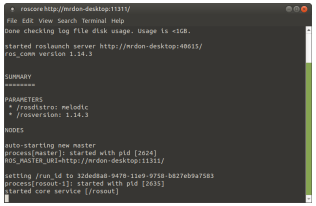
Diving into a ROS Topics…

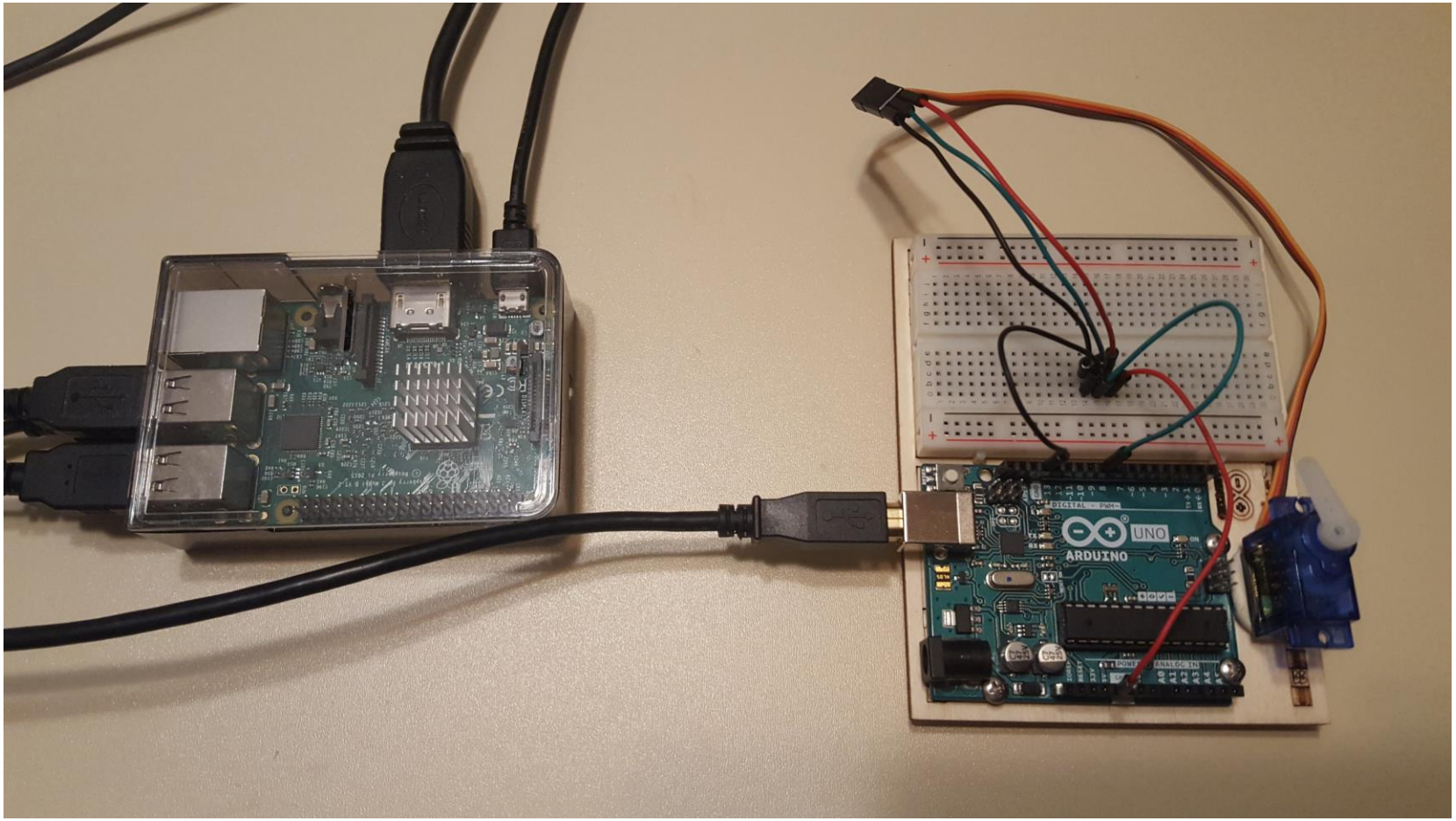




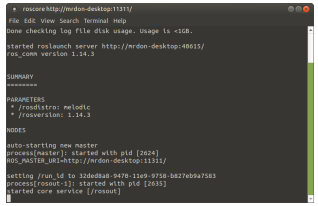
Wilcher, D. (2019). *ROS 101: An intro to the robot operating system*. Retrieved from https://www.designnews.com/gadget-freak/ros-101-intro-robot-operating-system/107053141061075

Lab Project: Servo Motor Control with ROS





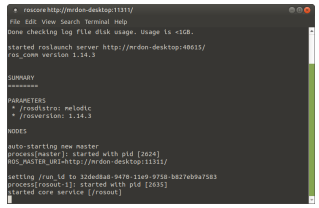
Lab Project: Servo Motor Control with ROS…

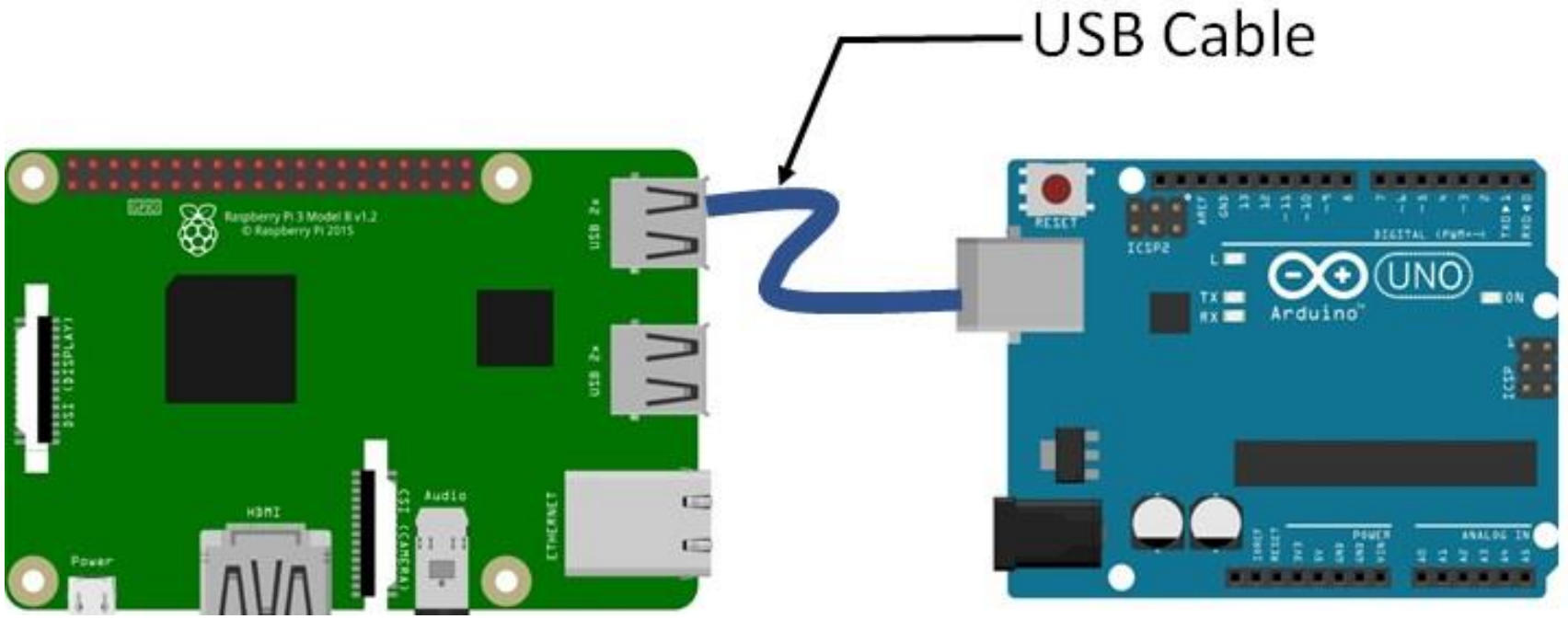


Lab Objectives:

- Learn how attach a Raspberry Pi to an Arduino.
- Learn how to communicate with a ROS node.
- Learn how to display the dynamic graph of the servo rostopic.
- Learn how to control a servo motor using the rostopic pub echo command.

How to attach a Raspberry Pi to an Arduino?...

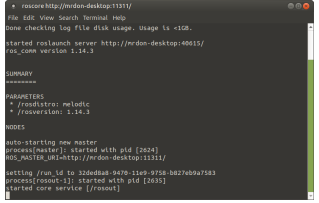


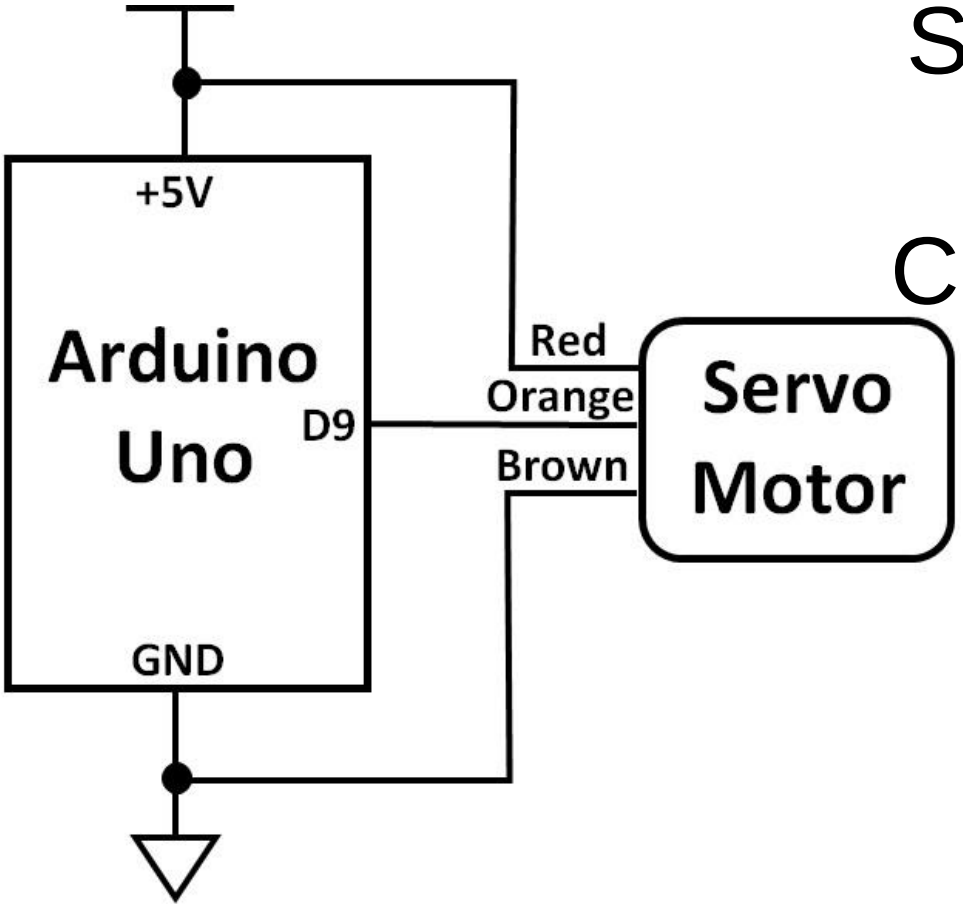


Serial communication between the Raspberry Pi 3 and Arduino Uno

Servo Motor Control Applications…

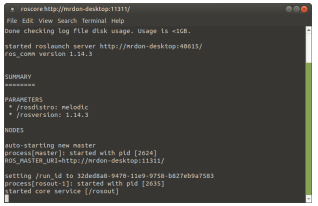
Sweep Control





Sweep Control Electronic Circuit Diagram

How to attach a Raspberry Pi to an Arduino?



Open a linux terminal: At the prompt type: roscore.

roscore http://mrdon-desktop:11311/

File Edit View Search Terminal Help

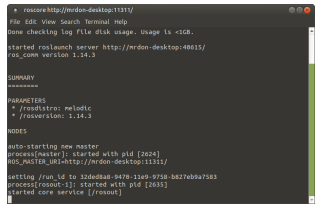
```
Done checking log file disk usage. Usage is <1GB.

started roslaunch server http://mrdon-desktop:40615/
ros_comm version 1.14.3


SUMMARY
========

PARAMETERS
 * /rosdistro: melodic
 * /rosversion: 1.14.3

NODES

auto-starting new master
process[master]: started with pid [2624]
ROS_MASTER_URI=http://mrdon-desktop:11311/

setting /run_id to 32ded8a8-9470-11e9-9758-b827eb9a7583
process[rosout-1]: started with pid [2635]
started core service [/rosout]
```

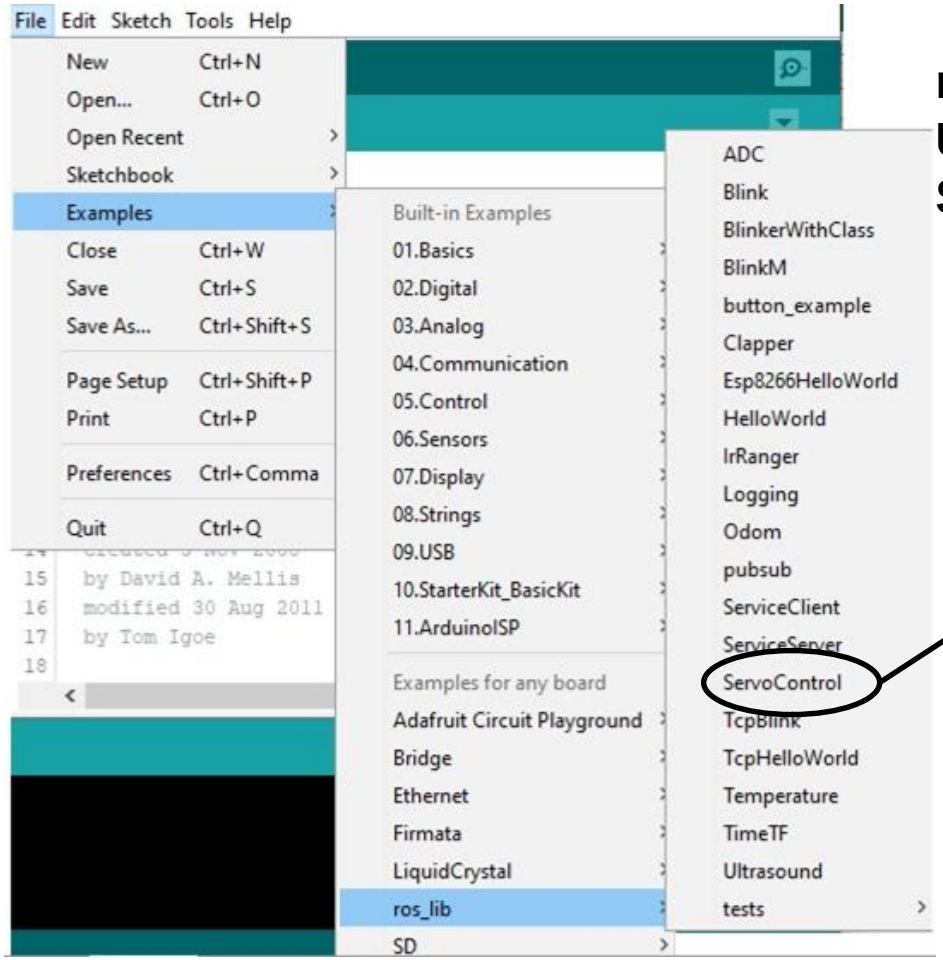
roscore **running in an active window**

Question 4

Name two control methods to operate a servo motor.

How to attach a Raspberry Pi to an Arduino?...

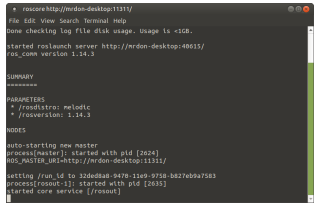




ros_lib:
Upload the ServoControl Sketch

ros_lib:
The *ServoControl* Sketch provides the rostopic for subscribing!

How to display a dynamic graph of the servo rostopic?...



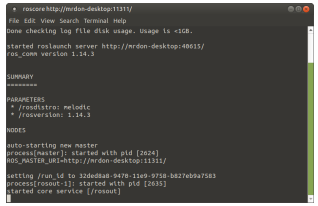
mrdon@mrdon-desktop: ~

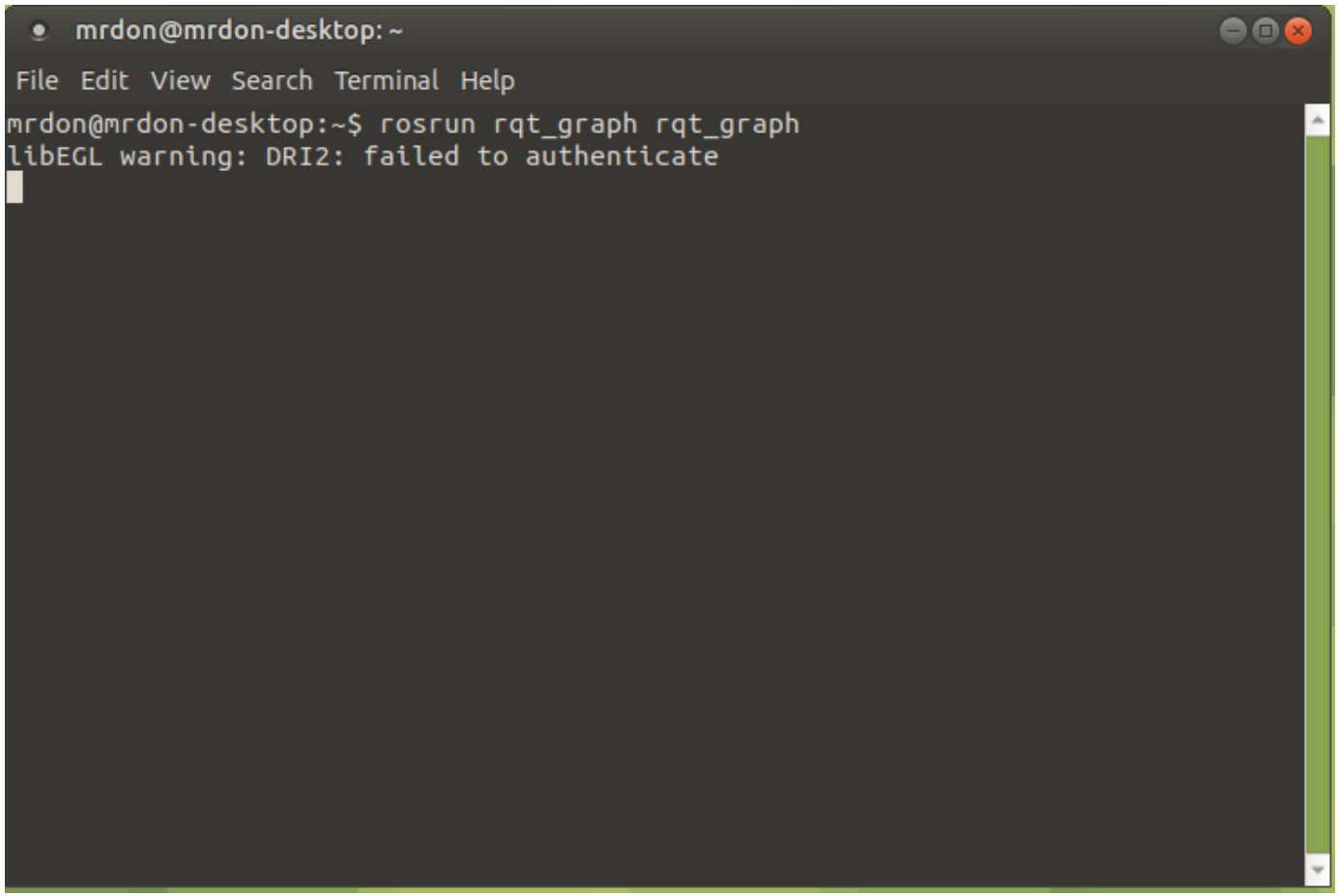
File Edit View Search Terminal Help

```
mrdon@mrdon-desktop:~$ sudo apt-get install ros-melodic-rqt
[sudo] password for mrdon:
Reading package lists... Done
Building dependency tree
Reading state information... Done
The following packages were automatically installed and are no longer required:
  apt-clone archdetect-deb cryptsetup-bin dpkg-repack gir1.2-json-1.0
  gir1.2-nm-1.0 gir1.2-nma-1.0 gir1.2-timezonemap-1.0 gir1.2-xkl-1.0
  grub-common libdebian-installer4 libpng12-0 libtimezonemap-data
  libtimezonemap1 os-prober python3-icu python3-pam rdate
Use 'sudo apt autoremove' to remove them.
The following NEW packages will be installed:
  ros-melodic-rqt
0 upgraded, 1 newly installed, 0 to remove and 31 not upgraded.
Need to get 2,232 B of archives.
After this operation, 14.3 kB of additional disk space will be used.
Err:1 http://packages.ros.org/ros/ubuntu bionic/main arm64 ros-melodic-rqt arm64
 0.5.0-0bionic.20190602.130423
  404  Not Found [IP: 2600:3402:200:227::2 80]
E: Failed to fetch http://packages.ros.org/ros/ubuntu/pool/main/r/ros-melodic-rq
t/ros-melodic-rqt_0.5.0-0bionic.20190602.130423_arm64.deb  404  Not Found [IP: 2
600:3402:200:227::2 80]
E: Unable to fetch some archives, maybe run apt-get update or try with --fix-mis
sing?
```

Installing *rqt*

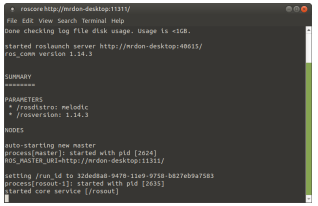
How to display a dynamic graph of the servo rostopic?...

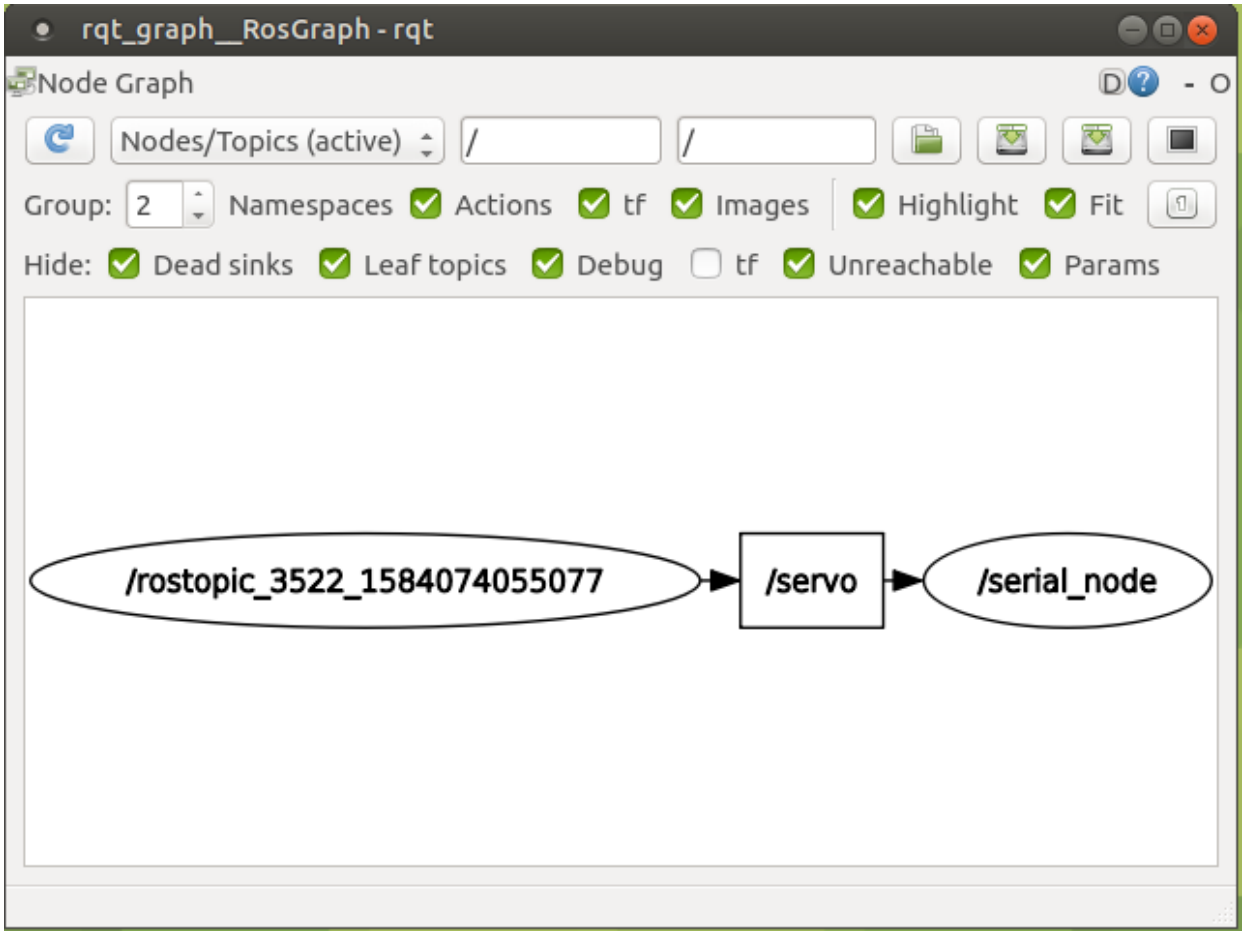




Running *rqt_graph*

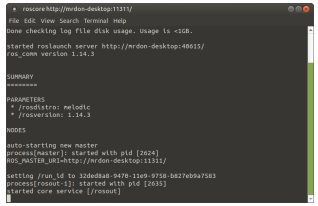
How to display a dynamic graph of the servo rostopic?...





servo *rqt_graph*

How to communicate with a ROS node?



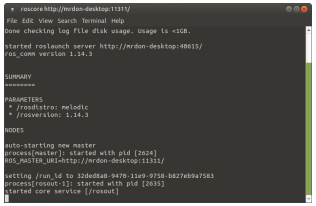
To run the rosserial client application for communicating with the attached Arduino Uno, open a new window and type the following *ros_lib* command after the prompt.

$ rosrun rosserial_python serial_node.py /dev/***serial port*****.**

Note: *serial port* is the communication port used on the Arduino Uno to talk to the Raspberry Pi.

For example: ttyACM0 **is the Arduino Uno's serial port to communicate with the Raspberry Pi.**

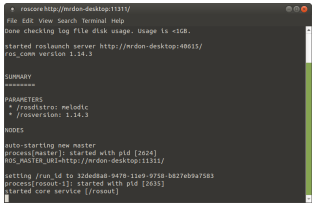
How to communicate with a ROS node?...



Open linux terminal: rosrun rosseri_python running

```
mrdon@mrdon-desktop: ~
File  Edit  View  Search  Terminal  Help
mrdon@mrdon-desktop:~$ rosrun rosserial_python serial_node.py /dev/ttyACM0
[INFO] [1583114175.513932]: ROS Serial Python Node
[INFO] [1583114175.547573]: Connecting to /dev/ttyACM0 at 57600 baud
[INFO] [1583114177.668262]: Requesting topics...
[INFO] [1583114177.708511]: Note: publish buffer size is 280 bytes
[INFO] [1583114177.715263]: Setup publisher on pushed [std_msgs/Bool]
```

How to operate servo motor with rostopic pub?

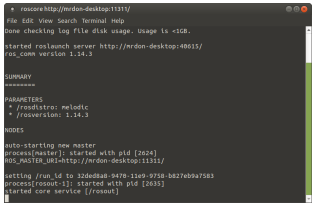


To operate the servo motor with rostopic pub,open a new window and type the following *ros_lib* **command after the prompt.**

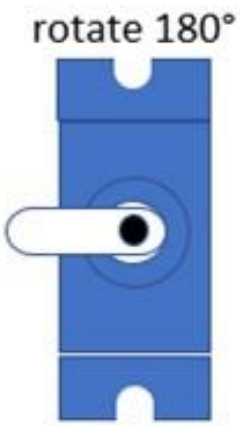
$ rostopic pub servo std_msgs/UInt16 <angle>**.**

Note.
<angle> is equal to 0 -180.

How to operate a servo motor with rostopic pub?

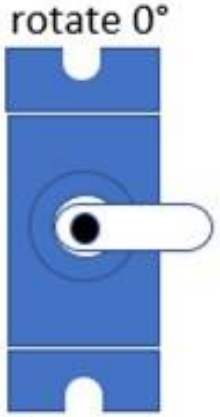


Servo Motor Rotational Control



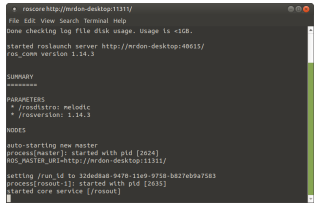
$rostopic pub servo std_msgs/UInt16 180

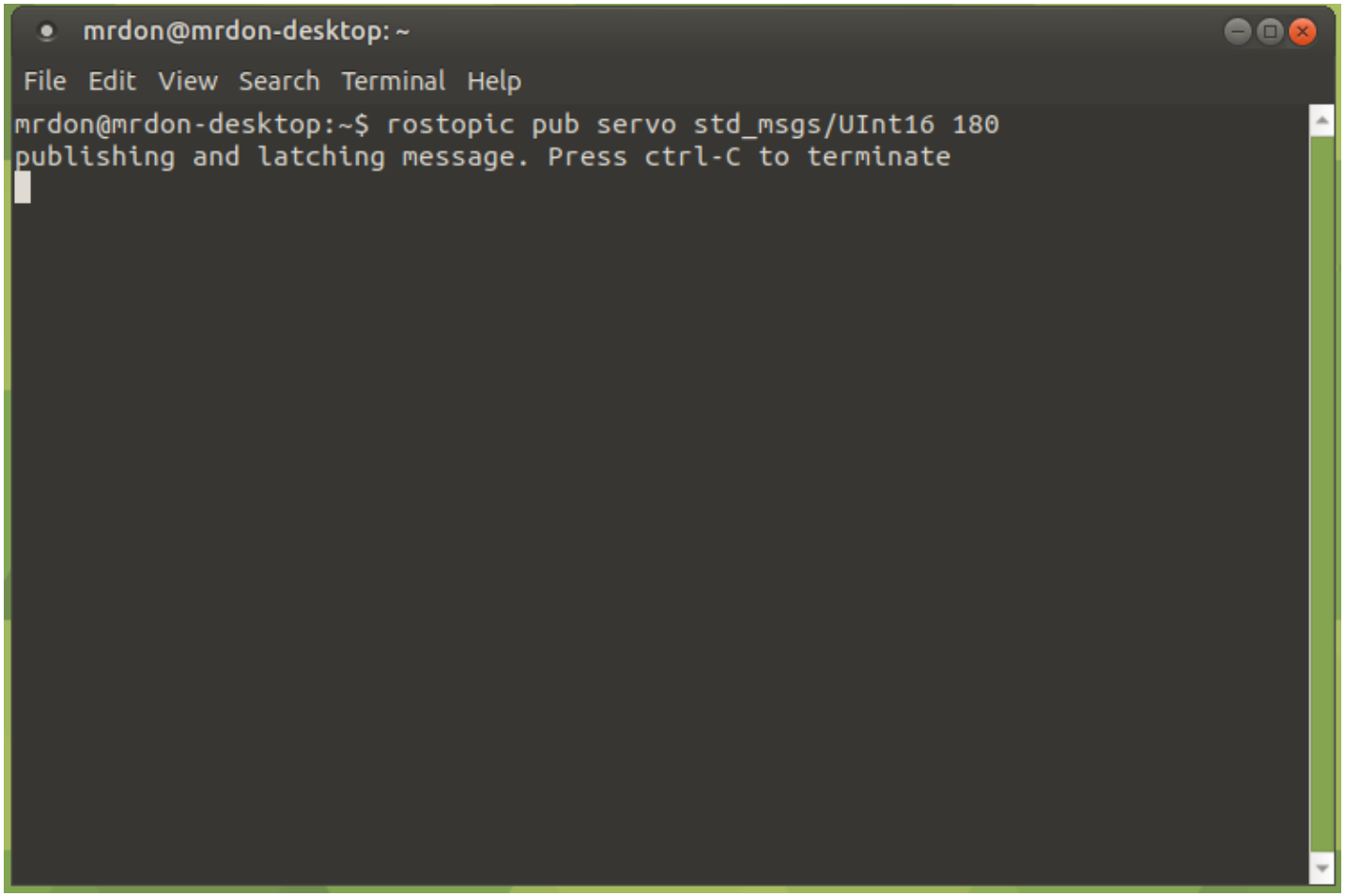
$rostopic pub servo std_msgs/UInt16 90



$rostopic pub servo std_msgs/UInt16 0

How to operate servo motor with rostopic pub?





Angle = 180

Question 5
What rostopic pub command is used to operate a servo motor?