

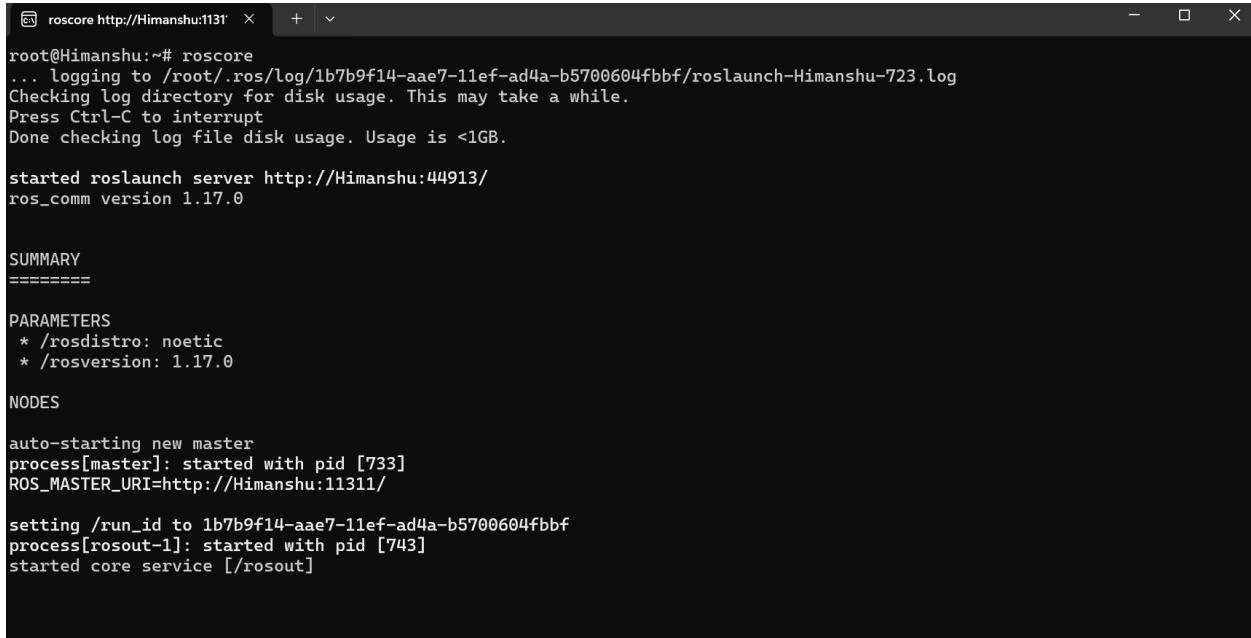
# Design and Development

## 1. Implementation Plan

### 1.1 Launching 3 Turtles (one leader (Turtle 1) and two followers (Turtle 2 and Turtle 3))

- Use a launch file to spawn three turtles in the turtlesim simulator:

**Figure 1.** Launching the Turtle simulator with ROS package



```
roscore http://Himanshu:11311
root@Himanshu:~# roscore
... logging to /root/.ros/log/1b7b9f14-aae7-11ef-ad4a-b5700604fbbf/roslaunch-Himanshu-723.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://Himanshu:44913/
ros_comm version 1.17.0

SUMMARY
=====

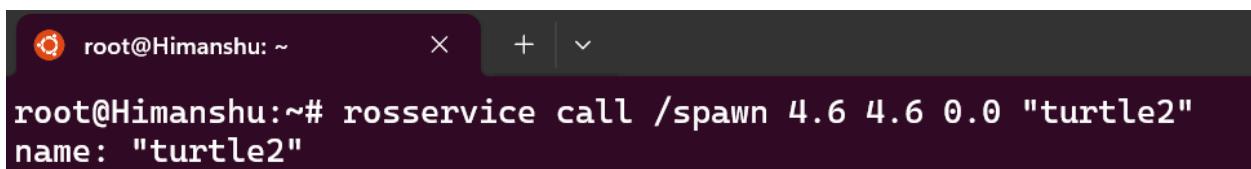
PARAMETERS
* /rosdistro: noetic
* /rosversion: 1.17.0

NODES

auto-starting new master
process[master]: started with pid [733]
ROS_MASTER_URI=http://Himanshu:11311/

setting /run_id to 1b7b9f14-aae7-11ef-ad4a-b5700604fbbf
process[rosout-1]: started with pid [743]
started core service [/rosout]
```

- Leader: Leader at the center (e.g., (/spawn 5.5 5.5 0.0 "turtle1"))
  - Followers: FollowerA and FollowerB at random positions.
- Follower 1 (Turtle 2, e.g., (/spawn 4.6 4.6 0.0 "turtle2"))



```
root@Himanshu:~# rosservice call /spawn 4.6 4.6 0.0 "turtle2"
name: "turtle2"
```

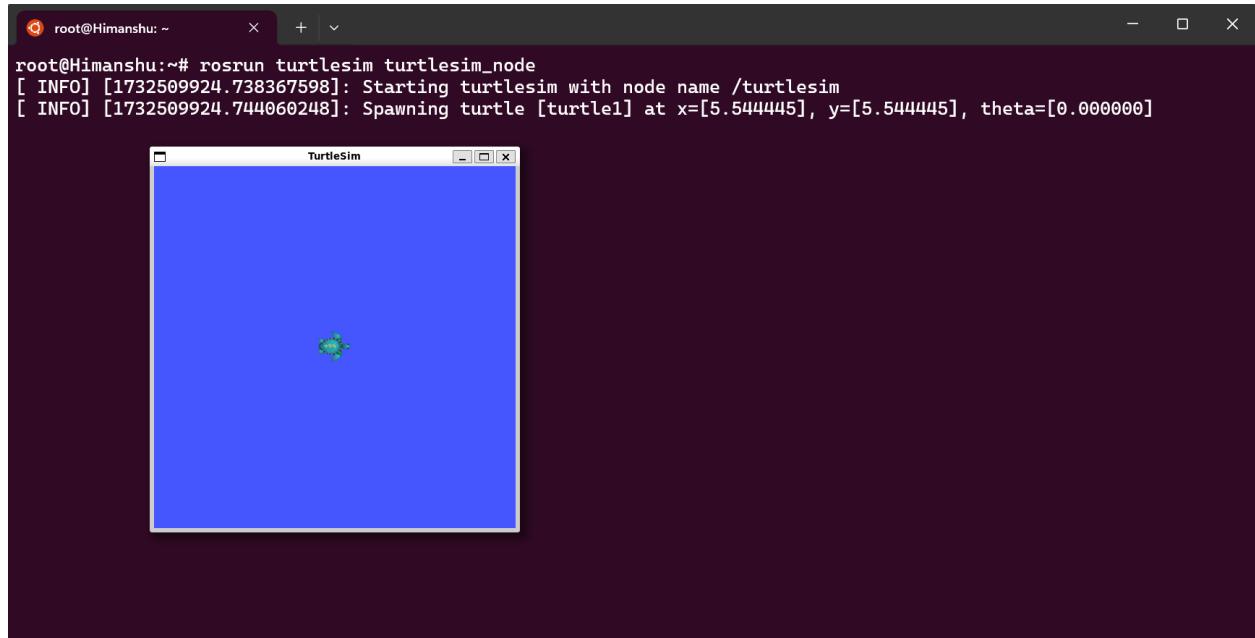
Follower 2 (Turtle 3, e.g., (/spawn 4.6 6.6 0.0 "turtle1"))



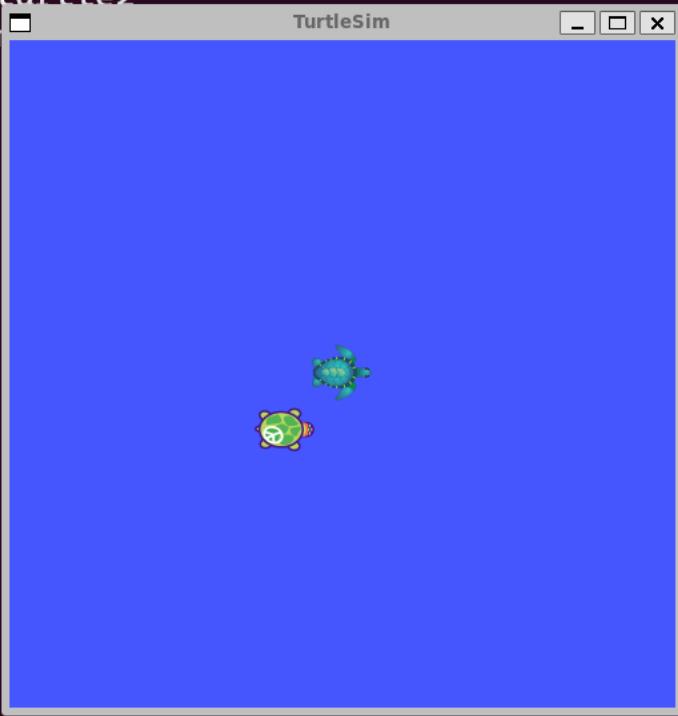
```
root@Himanshu:~# rosservice call /spawn 4.6 6.6 0.0 "turtle3"
name: "turtle3"
```

- Include commands to set a random background color (Blue color) for the simulator.

```
root@Himanshu:~# rosrun turtlesim turtlesim_node
[ INFO] [1732509520.086140121]: Starting turtlesim with node name /turtlesim
[ INFO] [1732509520.093969414]: Spawning turtle [turtle1] at x=[5.544445], y=[5.544445], theta=[0.000000]
[ INFO] [1732509535.467086901]: Spawning turtle [turtle2] at x=[4.600000], y=[4.600000], theta=[0.000000]
[ INFO] [1732509548.130883686]: Spawning turtle [turtle3] at x=[4.600000], y=[6.600000], theta=[0.000000]
```

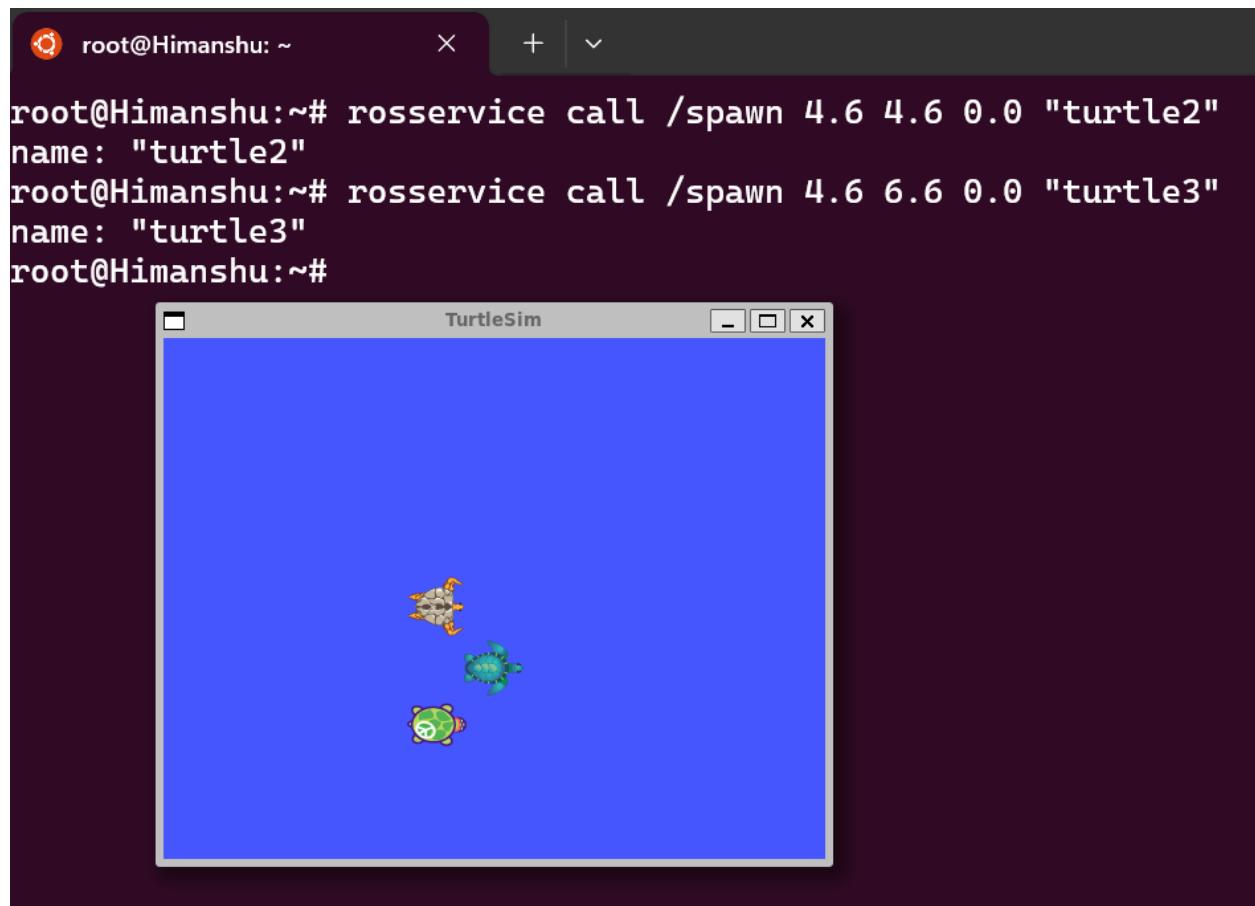


```
root@Himanshu:~# rosservice call /spawn 4.6 4.6 0.0 "turtle2"
name: "turtle2"
root@Himanshu:~#
```



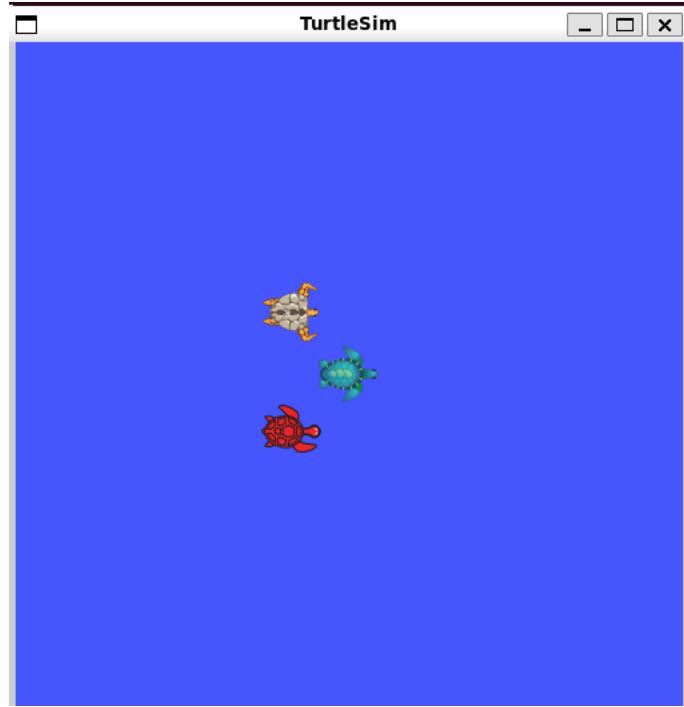
```
root@Himanshu:~# rosservice call /spawn 4.6 4.6 0.0 "turtle2"
name: "turtle2"
root@Himanshu:~# rosservice call /spawn 4.6 6.6 0.0 "turtle3"
name: "turtle3"
root@Himanshu:~#
```

```
root@Himanshu:~# rosservice call /spawn 4.6 4.6 0.0 "turtle2"
name: "turtle2"
root@Himanshu:~# rosservice call /spawn 4.6 6.6 0.0 "turtle3"
name: "turtle3"
root@Himanshu:~#
```

A screenshot of a terminal window titled 'root@Himanshu:~'. It contains three lines of ROS command history: 'rosservice call /spawn 4.6 4.6 0.0 "turtle2"', 'name: "turtle2"', 'rosservice call /spawn 4.6 6.6 0.0 "turtle3"', 'name: "turtle3"', and 'root@Himanshu:~#'. Below the terminal is a window titled 'TurtleSim' with a blue background. Inside the window, there are three small turtle icons: one orange turtle at the top left, one green turtle in the center, and one green turtle at the bottom left.

## 1.2 Achieving Formation Control

- Define a **custom message** (YourBcodeLeaderS1Command.msg) to send instructions from the leader to the followers. The message includes:
  - float32 target\_x – Desired x-position.
  - float32 target\_y – Desired y-position.
  - float32 orientation – Desired orientation (Linear).
- Use the **TF2 library** to define reference frames:
  - **Leader Frame:** At the leader's position.
  - **FollowerA Frame:** Offset by (-1, 0) from the leader.
  - **FollowerB Frame:** Offset by (1, 0) from the leader.



```
[ WARN] [1732510481.775387538]: Oh no! I hit the wall! (Clamping from [x=11.112889, y=6.488889])
[ WARN] [1732510481.791638623]: Oh no! I hit the wall! (Clamping from [x=11.112889, y=6.488889])
[ WARN] [1732510481.807364627]: Oh no! I hit the wall! (Clamping from [x=11.112889, y=6.488889])
[ WARN] [1732510481.823209469]: Oh no! I hit the wall! (Clamping from [x=11.112889, y=6.488889])
[ WARN] [1732510481.839164139]: Oh no! I hit the wall! (Clamping from [x=11.112889, y=6.488889])
[ WARN] [1732510481.854835291]: Oh no! I hit the wall! (Clamping from [x=11.112889, y=6.488889])
[ WARN] [1732510481.871590245]: Oh no! I hit the wall! (Clamping from [x=11.112889, y=6.488889])
[ WARN] [1732510481.887209366]: Oh no! I hit the wall! (Clamping from [x=11.112889, y=6.488889])
[ WARN] [1732510481.902792417]: Oh no! I hit the wall! (Clamping from [x=11.112889, y=6.488889])
[ WARN] [1732510481.919482751]: Oh no! I hit the wall! (Clamping from [x=11.112889, y=6.488889])
[ WARN] [1732510481.935066184]: Oh no! I hit the wall! (Clamping from [x=11.112889, y=6.488889])
[ WARN] [1732510481.950611582]: Oh no! I hit the wall! (Clamping from [x=11.112889, y=6.488889])
[ WARN] [1732510481.967248672]: Oh no! I hit the wall! (Clamping from [x=11.112889, y=6.488889])
[ WARN] [1732510481.982837817]: Oh no! I hit the wall! (Clamping from [x=11.112889, y=6.488889])
[ WARN] [1732510481.999357316]: Oh no! I hit the wall! (Clamping from [x=11.112889, y=6.488889])
[ WARN] [1732510482.015054865]: Oh no! I hit the wall! (Clamping from [x=11.112889, y=6.488889])
[ WARN] [1732510482.031462515]: Oh no! I hit the wall! (Clamping from [x=11.112889, y=6.488889])
[ WARN] [1732510482.047000922]: Oh no! I hit the wall! (Clamping from [x=11.112889, y=6.488889])
[ WARN] [1732510482.063915991]: Oh no! I hit the wall! (Clamping from [x=11.112889, y=6.488889])
[ WARN] [1732510482.079830467]: Oh no! I hit the wall! (Clamping from [x=11.112889, y=6.488889])
[ WARN] [1732510482.095390166]: Oh no! I hit the wall! (Clamping from [x=11.112889, y=6.488889])
[ WARN] [1732510482.111188619]: Oh no! I hit the wall! (Clamping from [x=11.112889, y=6.488889])
[ WARN] [1732510482.126769401]: Oh no! I hit the wall! (Clamping from [x=11.112889, y=6.488889])
[ WARN] [1732510482.143502701]: Oh no! I hit the wall! (Clamping from [x=11.112889, y=6.488889])
[ WARN] [1732510482.159691853]: Oh no! I hit the wall! (Clamping from [x=11.112889, y=6.488889])
[ WARN] [1732510482.175325107]: Oh no! I hit the wall! (Clamping from [x=11.112889, y=6.488889])
[ WARN] [1732510482.190878596]: Oh no! I hit the wall! (Clamping from [x=11.112889, y=6.488889])
[ WARN] [1732510482.205743566]: Oh no! I hit the wall! (Clamping from [x=11.112889, y=6.488889])
```

```
root@Himanshu:~# rosservice call /spawn 4.6 4.6 0.0 "turtle2"
name: "turtle2"
root@Himanshu:~# rosservice call /spawn 4.6 6.6 0.0 "turtle3"
name: "turtle3"
root@Himanshu:~# rostopic pub /turtle1/cmd_vel geometry_msgs/Twist -r 10 '{linear: {x: 1.5, y: 0.0, z: 0.0}, angular: {x: 0.0, y: 0.0, z: 0.0}}'

```

