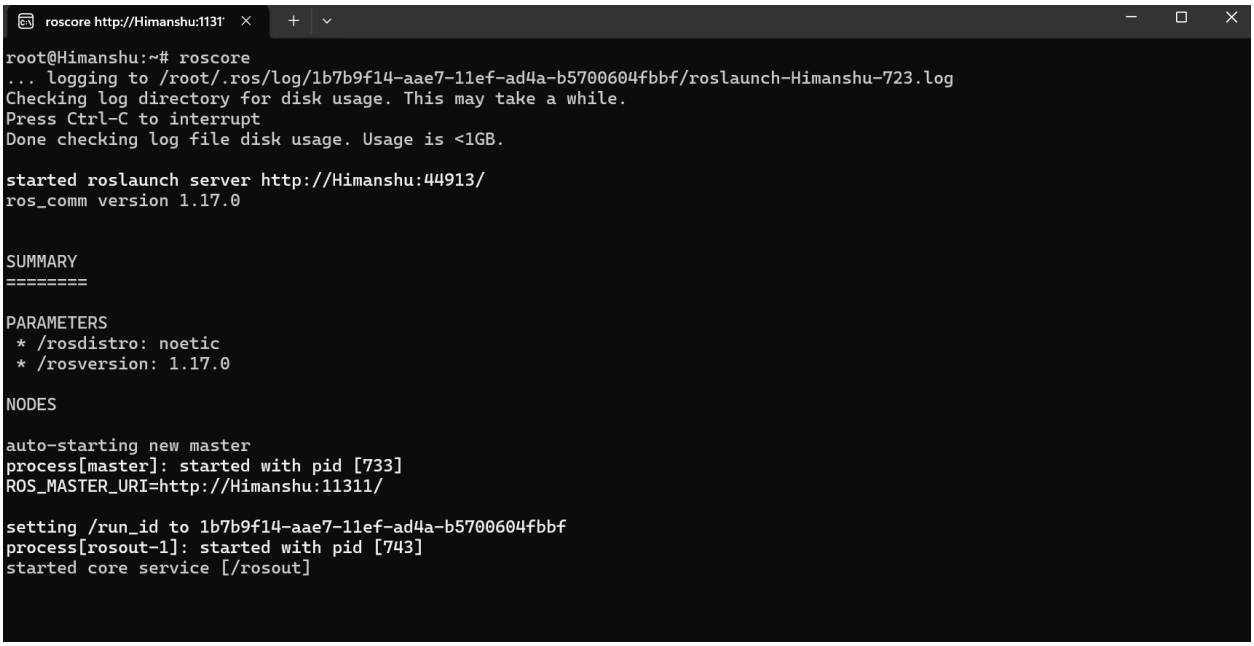
Design and Development

1. Implementation Plan

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

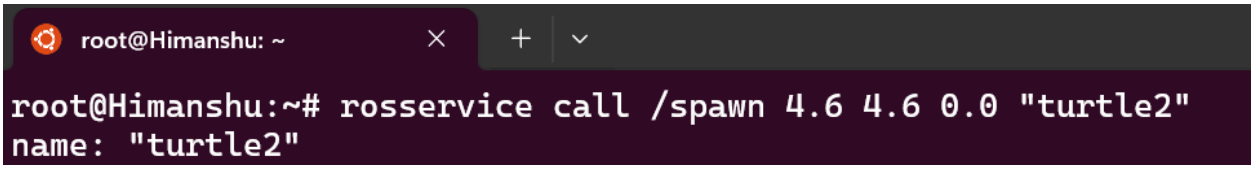
- Use a launch file to spawn three turtles in the turtlesim simulator:

Figure 1. Launching the Turtle simulator with ROS package



- 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"))

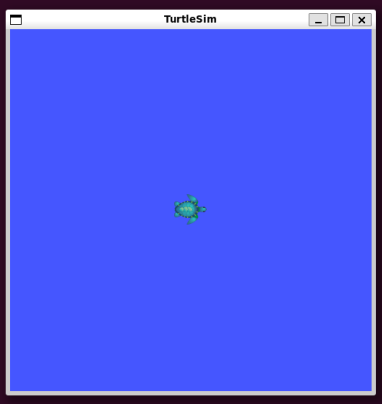


  Follower 2 (**Turtle 3,** e.g., (/spawn 4.6 6.6 0.0 "turtle1"))

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

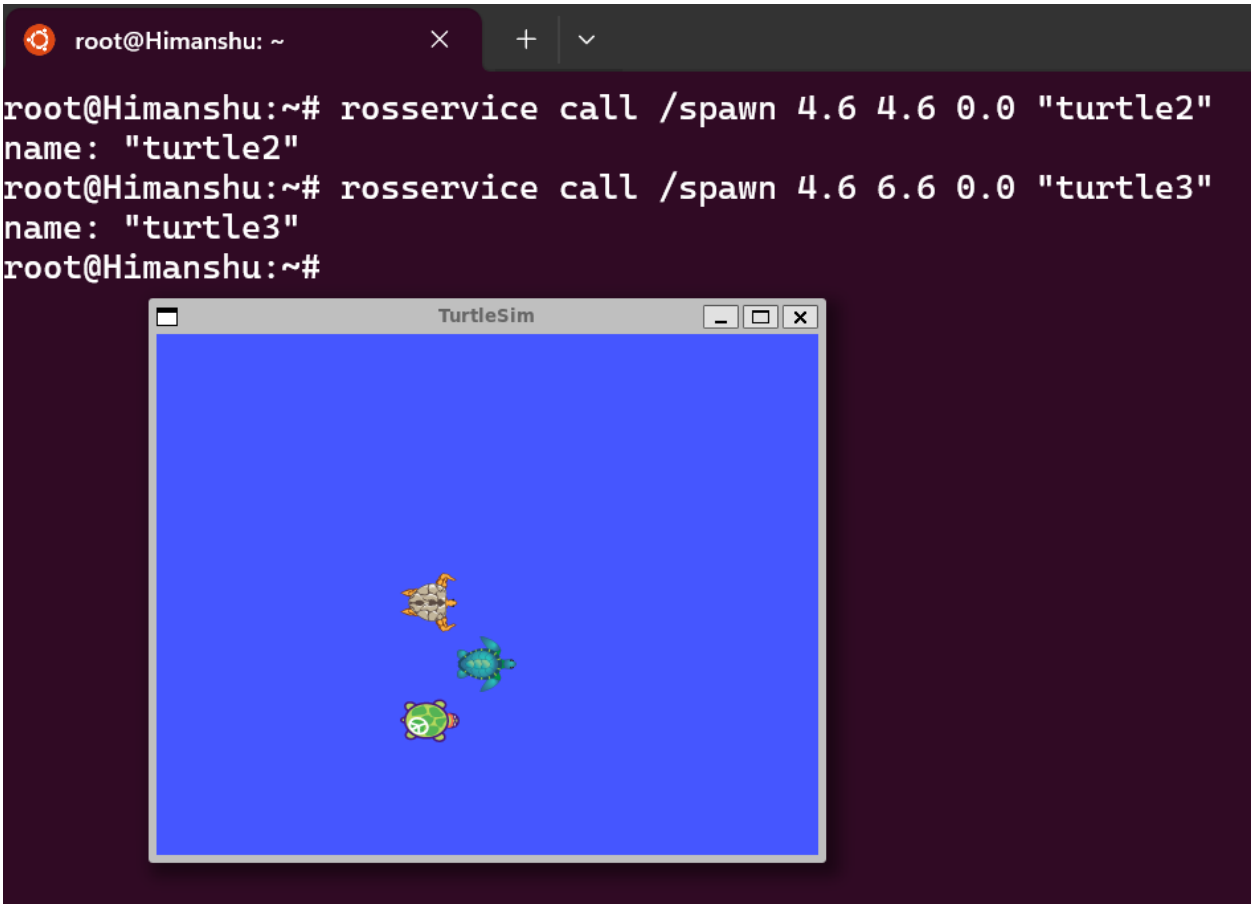
```
root@Himanshu: ~
root@Himanshu:~# rosrun turtlesim turtlesim_node
[ INFO] [1732509520.086140121]: Starting turtlesim with node name /turtlesim
[ INFO] [1732509520.093969414]: Spawning turtle [turtle1] at x=[5.544445], y=[5.544445], theta=[0.000000]
[ INFO] [1732509535.467086901]: Spawning turtle [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: ~
root@Himanshu:~# rosrun turtlesim turtlesim_node
[ INFO] [1732509924.738367598]: Starting turtlesim with node name /turtlesim
[ INFO] [1732509924.744060248]: Spawning turtle [turtle1] at x=[5.544445], y=[5.544445], theta=[0.000000]
```



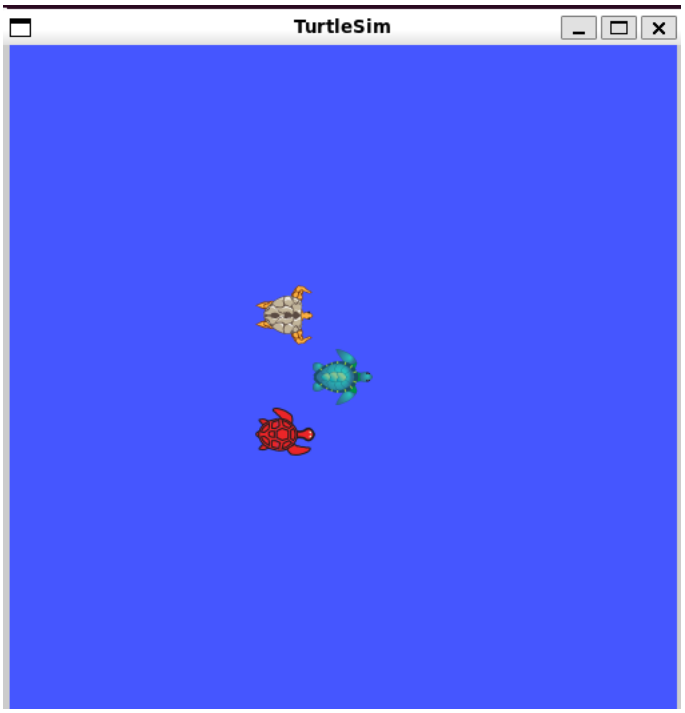
```
root@Himanshu:~# rosservice call /spawn 4.6 4.6 0.0 "turtle2"
name: "turtle2"
root@Hi
```


```
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:~#
```



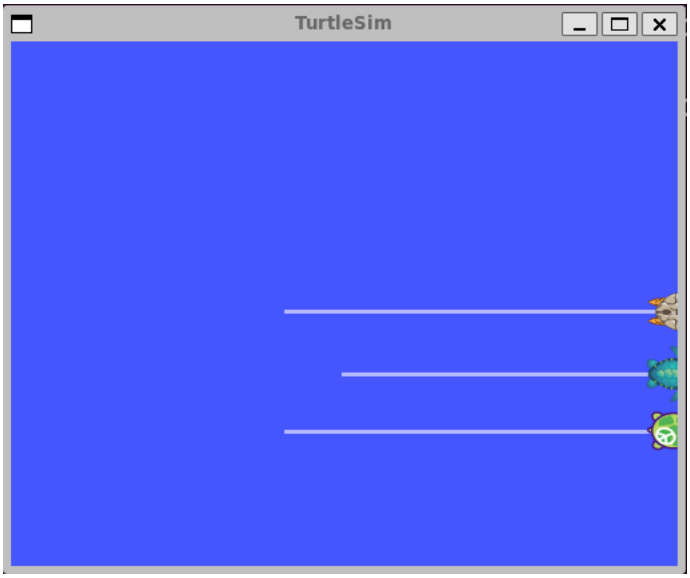
1.2 Achieving Formation Control

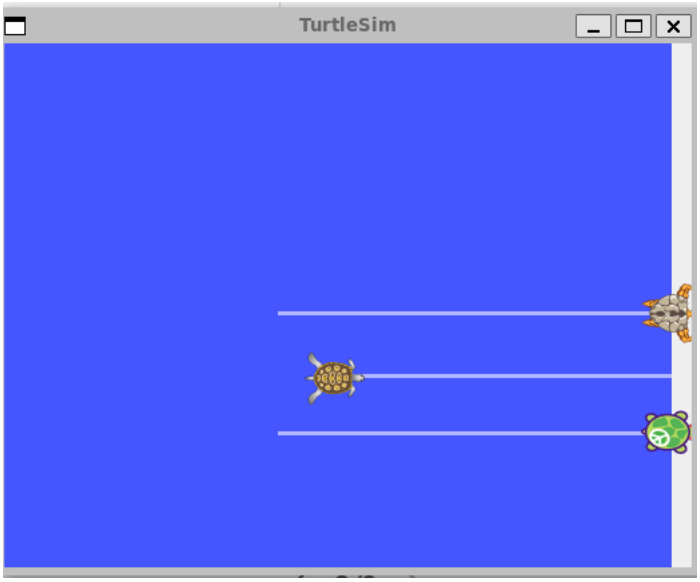
- Define a **custom message** (YourBcodeLeaderS1Command.msg) to send instructions from the leader to the followers. The message includes:
    - float32 target_x – Desired x-position.
    - float32 target_y – Desired y-position.
    - float32 orientation – Desired orientation (Linear).
- Use the **TF2 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.

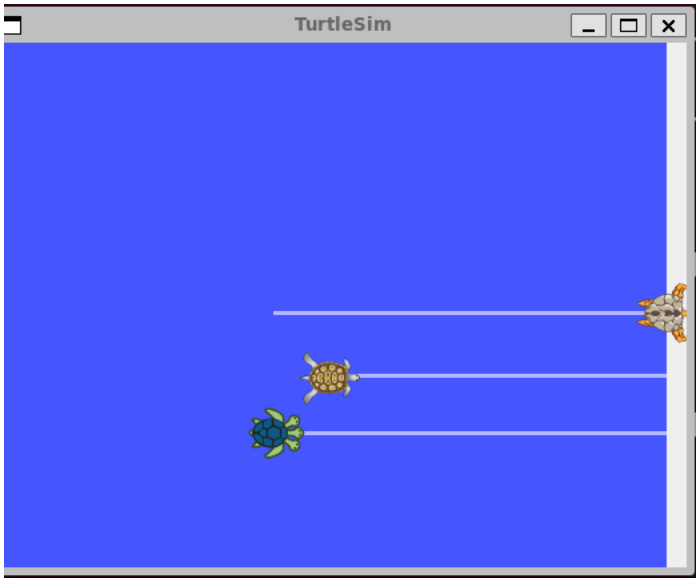


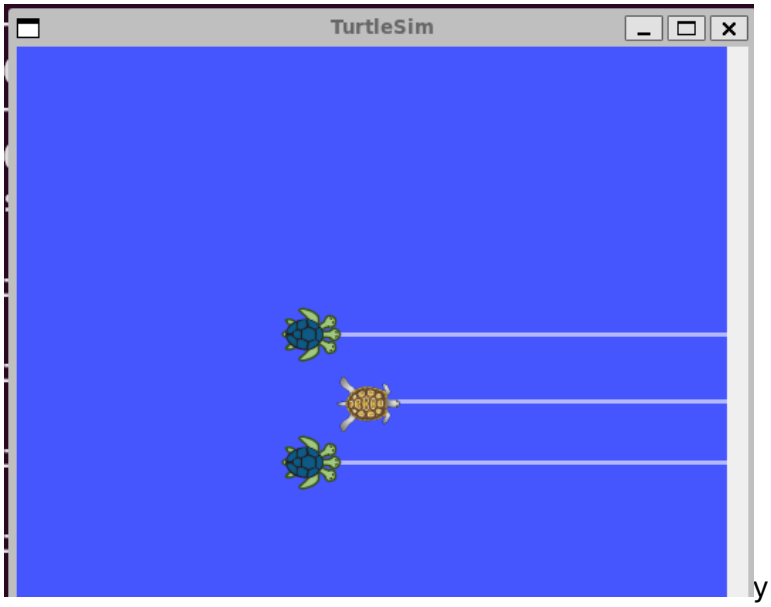

```
[ WARN] [1732510481.775387538]: Oh no! I hit the wall! (Clamping from [x=11.112889, y=6.488889])
[ WARN] [1732510481.791638623]: Oh no! I hit the wall! (Clamping from [x=11.112889, y=6.488889])
[ WARN] [1732510481.807364627]: Oh no! I hit the wall! (Clamping from [x=11.112889, y=6.488889])
[ WARN] [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])
```


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:~# rostopic pub /turtle1/cmd_vel geometry_msgs/Twist -r 10 '{linear: {x: 1.5, y: 0.0, z: 0.0}, ang
ular: {x: 0.0, y: 0.0, z: 0.0}}'
TurtleSim


TurtleSim


TurtleSim


TurtleSim



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