Braitenberg Vehicle Implementation

Github link for better visualization of README
https://github.com/Jomaxdrill/Braitenberg_example

Videos
Teleoperation
https://drive.google.com/file/d/1Zs254Z68APxohSS3amW5wCYu_lokDcOV/view?usp=sharing
Autnomous mode
https://drive.google.com/file/d/1EJPw2p9TDKc5ZOOGlSl_-vvAzcBT-rRw/view?usp=sharing

The Braitenberg vehicle paradigm is a conceptual model of a simple autonomous agent. By crafting simple mechanisms, sensor based overall, the agent is capable of get complex life like behaviours

The model might consist of:

- **Sensors** (e.g., light, sound, or chemical sensors).
- **Actuators** (e.g., wheels or motors).
- **Direct connections** between sensors and actuators.

There is not exactly a brain into the robot but sensor input works as an output for the actuators. Depending the configuration there are well-known type of behaviors as:

Fear (Aversion):

- The vehicle moves away from a stimulus (e.g., light or sound).
- Example: If the left sensor detects a strong stimulus, the right wheel speeds up, causing the vehicle to turn away.

Aggression (Attraction):

- The vehicle moves toward a stimulus.
- Example: If the left sensor detects a strong stimulus, the left wheel speeds up, causing the vehicle to turn toward the stimulus.

Braitenberg vehicles are decentralized systems that show a good example of emergent behavior in robots.

Parameters of the simulation and observations

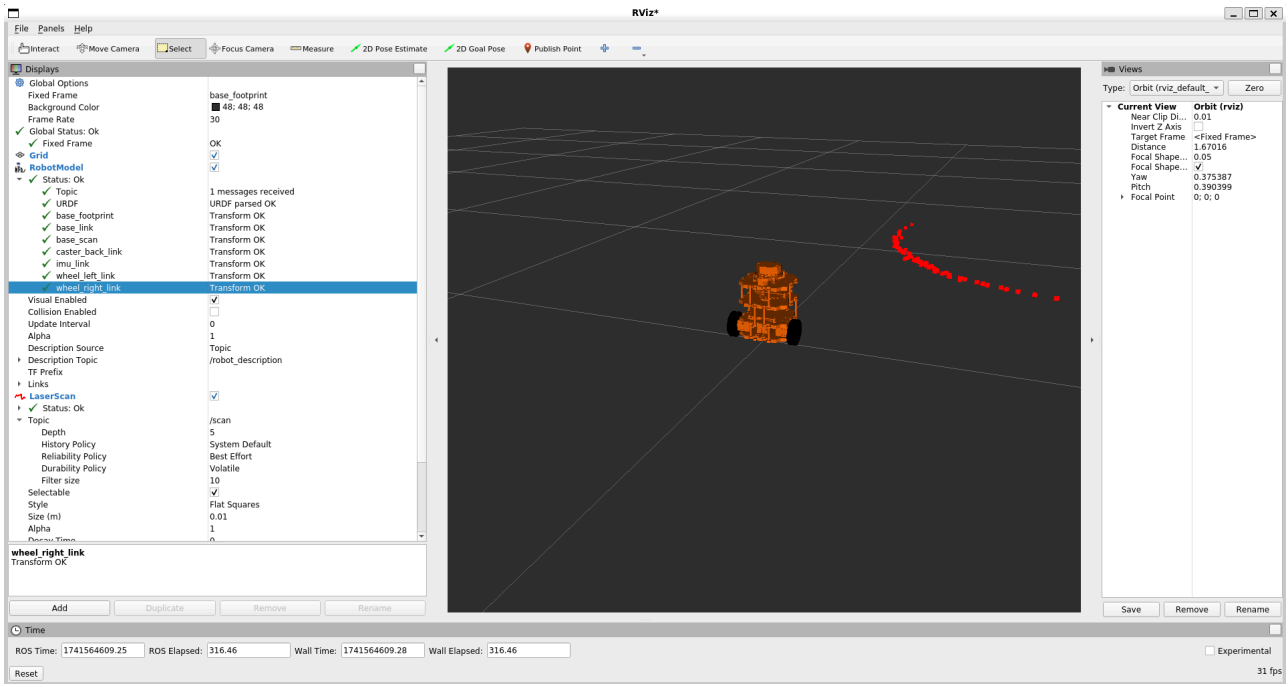
In the setup the robot is able to get info from the left and right side of its orientation regarding the lidar sensor used.

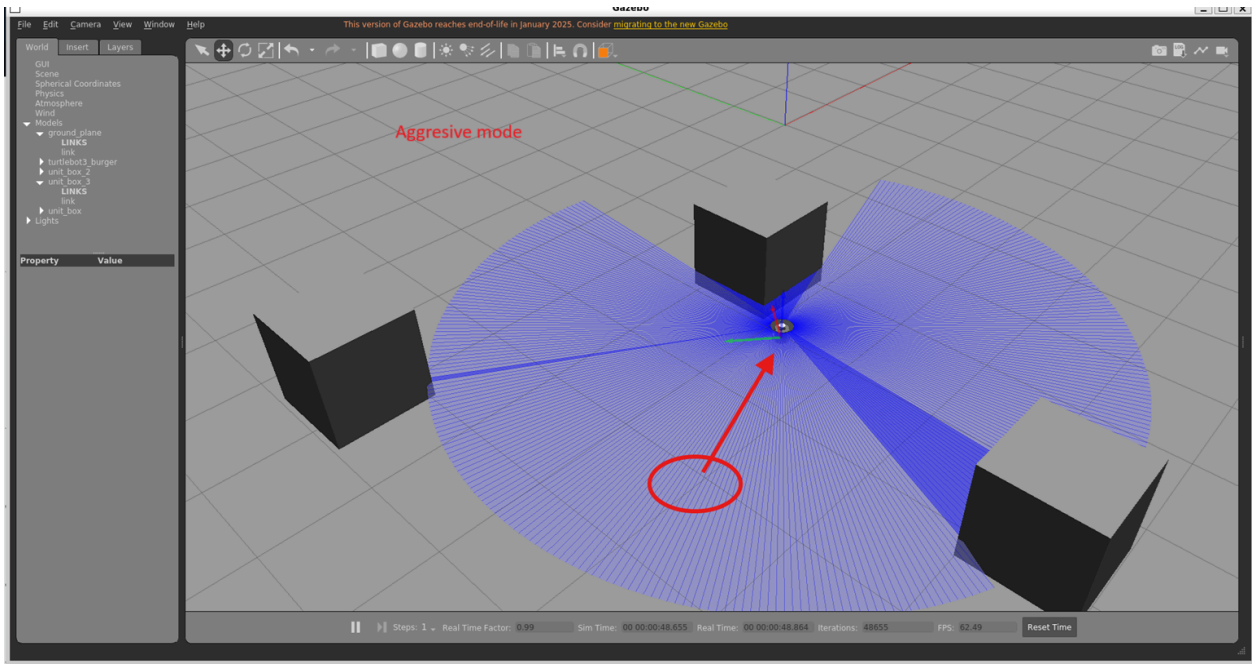
Left side covers *~45° to 135° (left side)*

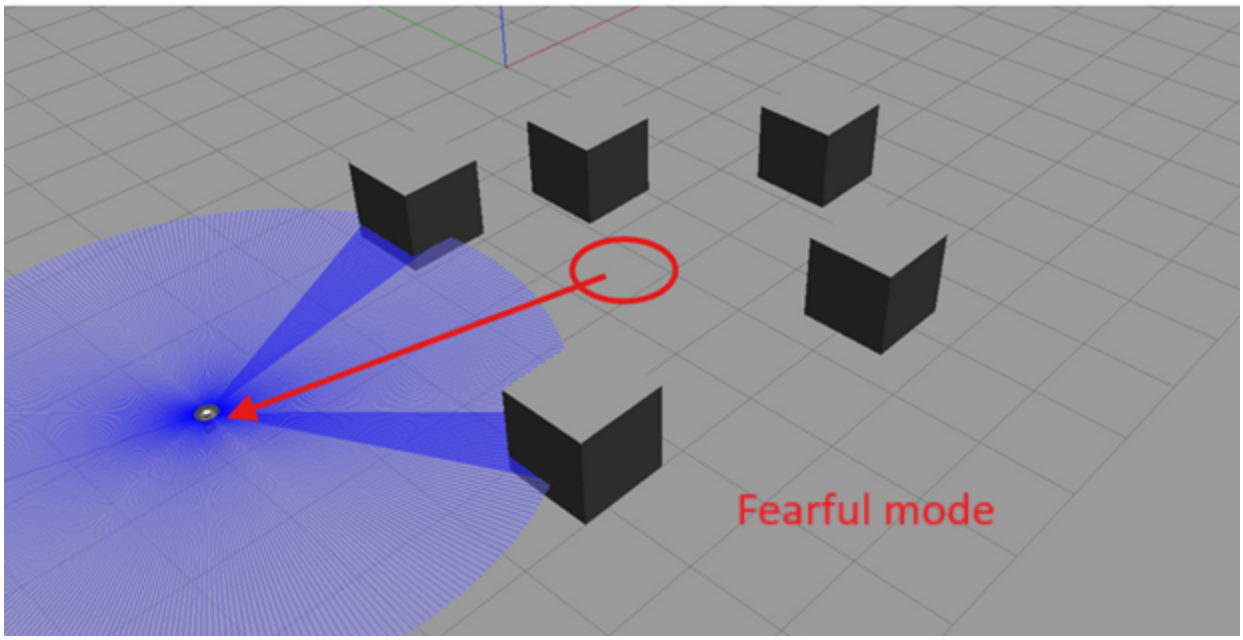
Right side covers *~225° to 315° (right side)*

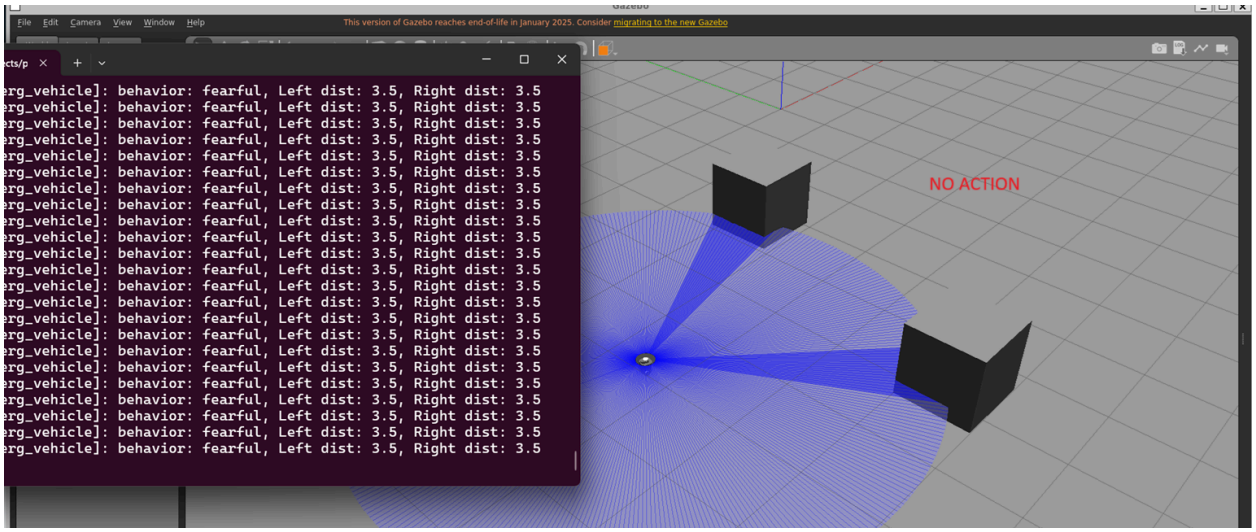
The main parameters of the simulation were the behavior itself and a speed factor applied to the robot in general. Changing the behavior definitely changes the way the robots encounters the obstacles or stimulus randomly put, more obstacles derive in unexpected ways the robot moves. Speed in the limits is only contributing to making these actions in less time required. However putting a speed exceeding the max by default could potentially lead to lose of stability of the robot and falling down.

There were also possible scenarios where the robot could have not action as well finding a state of equilibrium in the system regarding the measurements from left and right.


RViz*
File Panels Help
Interact Move Camera Select Focus Camera Measure 2D Pose Estimate 2D Goal Pose Publish Point
Displays
Global Options
Fixed Frame base_footprint
Background Color 48; 48; 48
Frame Rate 30
Global Status: Ok
Fixed Frame OK
Grid
RobotModel
Status: Ok
Topic 1 messages received
URDF URDF parsed OK
base_footprint Transform OK
base_link Transform OK
base_scan Transform OK
caster_back_link Transform OK
imu_link Transform OK
wheel_left_link Transform OK
wheel_right_link Transform OK
Visual Enabled
Collision Enabled
Update Interval 0
Alpha 1
Description Source Topic
Description Topic /robot_description
TF Prefix
Links
LaserScan
Status: Ok
Topic /scan
Depth 5
History Policy System Default
Reliability Policy Best Effort
Durability Policy Volatile
Filter size 10
Selectable
Style Flat Squares
Size (m) 0.01
Alpha 1
wheel_right_link
Transform OK
Add Duplicate Remove Rename
Views
Type: Orbit (rviz_default_
Zero
Current View Orbit (rviz)
Near Clip Di... 0.01
Invert Z Axis
Target Frame <Fixed Frame>
Distance 1.67016
Focal Shape... 0.05
Focal Shape...
Yaw 0.375387
Pitch 0.390399
Focal Point 0; 0; 0
Save Remove Rename
Time
ROS Time: 1741564609.25
ROS Elapsed: 316.46
Wall Time: 1741564609.28
Wall Elapsed: 316.46
Experimental
Reset
31 fps


Gazebo
File Edit Camera View Window Help
This version of Gazebo reaches end-of-life in January 2025. Consider migrating to the new Gazebo
World Insert Layers
GUI
Scene
Spherical Coordinates
Physics
Atmosphere
Wind
Models
ground_plane
LINKS
link
turtlebot3_burger
unit_box_2
unit_box_3
LINKS
link
unit_box
Lights
Property Value
Aggresive mode
Steps: 1 Real Time Factor: 0.99 Sim Time: 00 00:00:48.655 Real Time: 00 00:00:48.864 Iterations: 48655 FPS: 62.49
Reset Time


Fearful mode


File Edit Camera View Window Help
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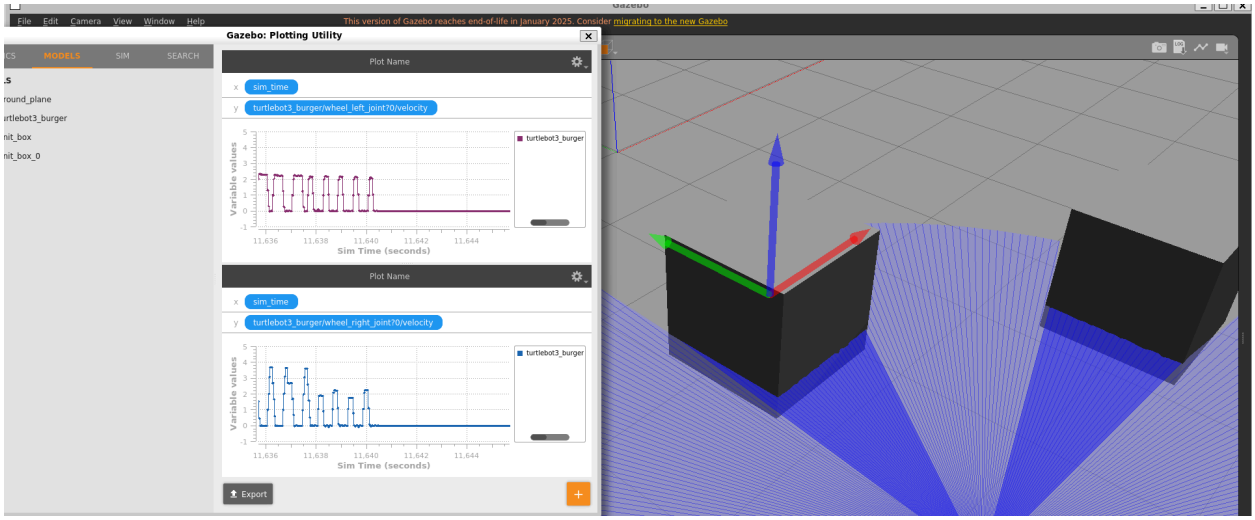
erg_vehicle]: behavior: fearful, Left dist: 3.5, Right dist: 3.5
NO ACTION



A flickering effect in the velocities command is exhibit when more elements are put in range of the lidar in both left and right, this makes sense by the oscillation it does with the scanners readers and hence wheel movements joints.It highlights a limitation in its ability to handle complex environments.