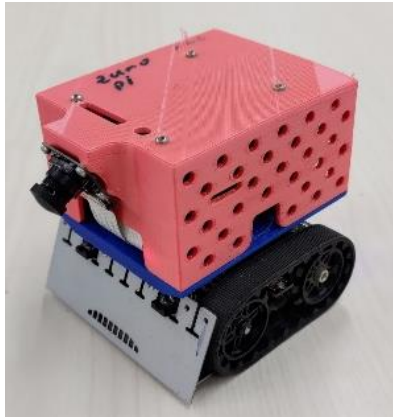




ZumoPi Telemetry System User Manual



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System Activation

1) Arduino Code Upload

Open terminal on ZumoPi robot. Type **zardrun** and press enter.
Wait until compilation and uploading of Arduino code to ZumoPi is finished.

2) Launch ROS2 Nodes


On the ZumoPi's terminal, type **tel** and press enter.
This will start all the telemetry nodes on ZumoPi.

3) Start GUI Node

Open terminal on the remote computer. Type **gui** and press enter.
This will start the GUI of the telemetry system.

GUI User Guide

Camera



fps: 19.18

Capture Frame

Video duration
10 sec

Capture Video

50 msec Update Period Period: 50 msec
Reset Settings Change Enable Enable: True

Buzzer

Play Buzzer State: Not Playing

500 msec Update Period Period: 500 msec
Reset Settings Change Enable Enable: True

Battery

voltage: 4.19 [V] capacity: 96 %

500 msec Update Period Period: 500 msec
Reset Settings Change Enable Enable: True

Charging

State: Charging

500 msec Update Period Period: 500 msec
Reset Settings Change Enable Enable: True

Applications Status:

Connection is Up!
Serial Interface is Up!
Zumo is Up!
Ups is Up!
Camera Node is Up!
Camera is Up!

WIFI Stats

Signal Power: -38 dBm

77%

Tx Rate: 178.65 KByte/s
Rx Rate: 0.69 KByte/s

Logger

Log Level INFO

☐ Save telemetry data

Encoders

left: 0 right: 0 speed: 0.0 km/h

500 msec Update Period Period: 500 msec
Reset Settings Change Enable Enable: True

IMU

	x	y	z
accelerometer	201	200	17313
magnetometer	-27901	9535	4814
gyro	-40	-7	73

500 msec Update Period Period: 500 msec
Reset Settings Change Enable Enable: True

Line Sensors

left: 356 center: 188 right: 404

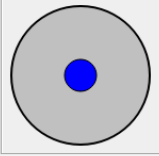
500 msec Update Period Period: 500 msec
Reset Settings Change Enable Enable: True

Proximity Sensors


Tx Rx	left	front	right
left	5	3	0
right	0	3	5

basic no interference no interference no interference

50 msec Update Period Period: 500 msec
Reset Settings Change Enable Enable: True



Exit



Sensor sampling settings


Every sensor has the following panel:

500 msec	Update Period	Period:	500 msec
Reset Settings	Change Enable	Enable:	True

- On the right side of the panel, **Period** and **Enable** indicate the current settings on the ZumoPi robot
- Change the sampling period by entering a new value to the spin-box and pressing the **Update Period** button
- Enable/Disable the sampling from the sensor by pressing the **Change Enable** button
Note: Disabled sensors will not show data.
- Reset the settings by pressing the **Reset Settings** button. This sets the sampling period to 500ms (except for the camera, which resets to 100ms) and enables the sampling

Camera

Camera

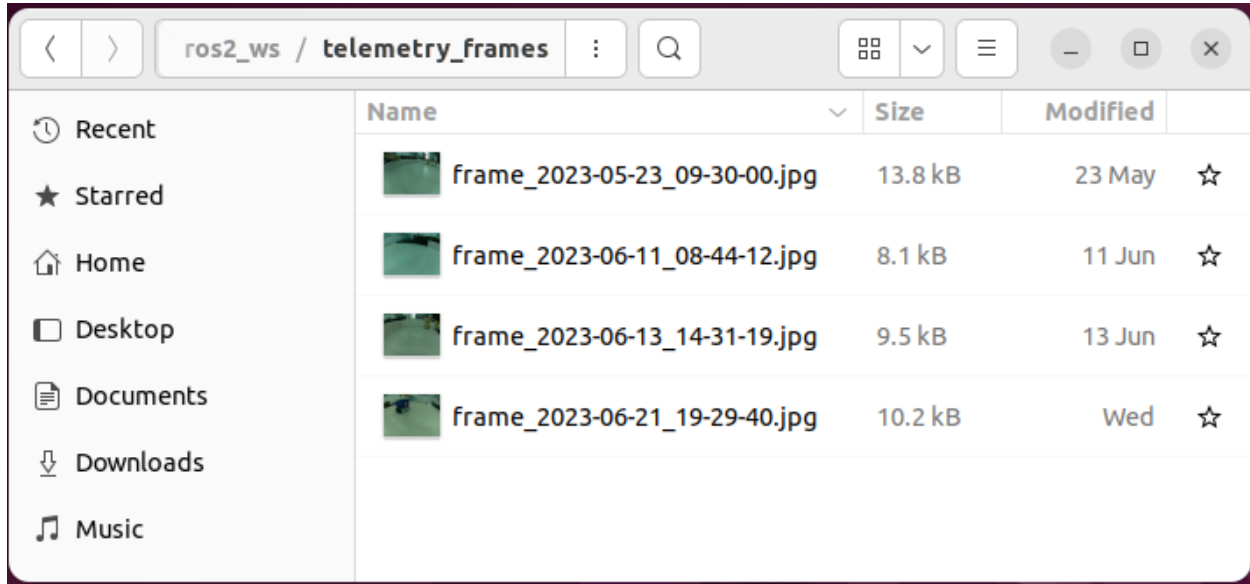


fps: 9.73
 Capture Frame
 Video duration
 5 sec
 Capture Video

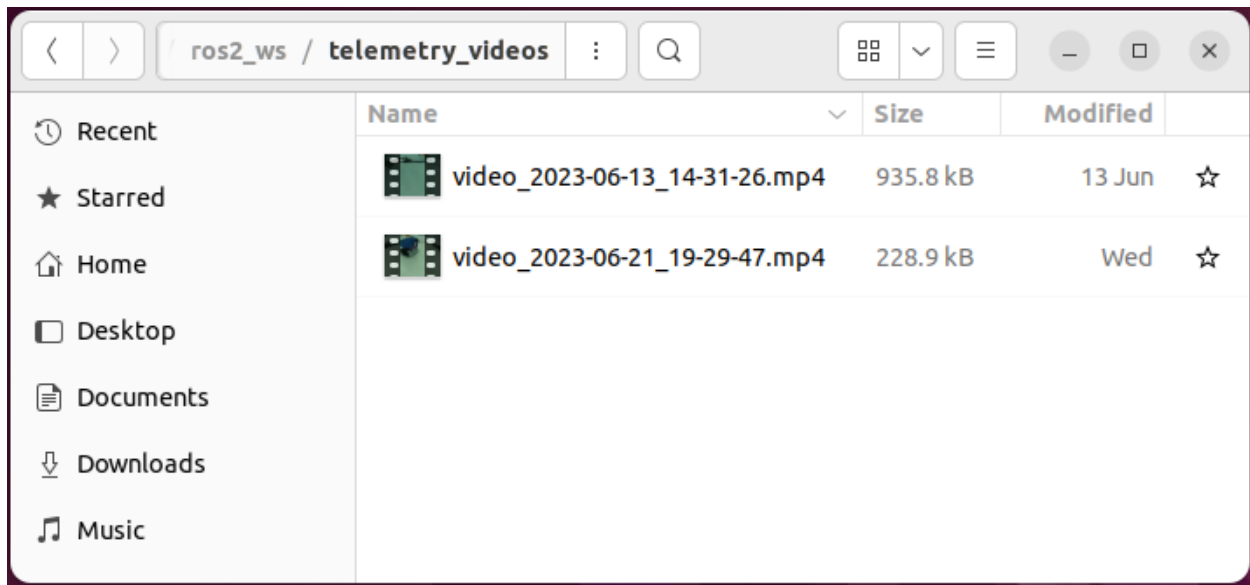
100 msec	Update Period	Period:	100 msec
Reset Settings	Change Enable	Enable:	True

- fps** indicates the frames per second received by the GUI node

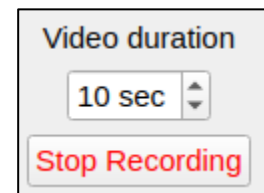
- **Capture Frame** button captures the current frame in the video and stores it as an image in `~/ros2_ws/telemetry_frames`



- **Capture Video** button captures a video for the specified duration and stores it in `~/ros2_ws/telemetry_videos`



Change the duration of the video by using the spin-box.
Stop the recording at any time by pressing the **Stop Recording** button, which appears during the video capture process.





Battery

Battery
voltage: 4.09 [V] **capacity:** 100 %
500 msec Update Period Period: 500 msec
Reset Settings Change Enable Enable: True

- **voltage** indicates the current voltage supplied by the battery
- **capacity** indicates the current battery capacity

Charging

Charging
State: Charging
500 msec Update Period Period: 500 msec
Reset Settings Change Enable Enable: True

- **State** indicates whether the robot is currently charging or not

State: Not Charging

Buzzer

Buzzer
Play Buzzer **State:** Not Playing
500 msec Update Period Period: 500 msec
Reset Settings Change Enable Enable: True

- **State** indicates whether the buzzer is currently playing or not
- **Play Buzzer** button plays the buzzer for 5 seconds
Stop it at any time by pressing the **Stop Buzzer** button which appears when the buzzer plays.

Stop Buzzer **State:** Playing



Encoders

Encoders

left: 320 **right:** 160 **speed:** 0.15 km/h

500 msec

Update Period

Period:

500 msec

Reset Settings

Change Enable

Enable:

True

- **left** shows the reading from the left encoder
- **right** shows the reading from the right encoder
- **speed** shows the robot's speed in km/h

Note: errors reading from the encoders are indicated as follows:

left: 1380 **right:** ERROR **speed:** ERROR km/h

Line Sensors

Line Sensors

left: 352 **center:** 188 **right:** 376

500 msec

Update Period

Period:

500 msec

Reset Settings

Change Enable

Enable:

True

- **left** indicates the reading from the left line sensor
- **center** indicates the reading from the center line sensor
- **right** indicates the reading from the right line sensor

IMU

IMU

	x	y	z
accelerometer	221	222	17290
magnetometer	-26802	13031	6262
gyro	-39	-15	142

500 msec

Update Period

Period:

500 msec

Reset Settings

Change Enable

Enable:

True

- **accelerometer** indicates the accelerometer readings in the **x, y, z** axes
- **magnetometer** indicates the magnetometer readings in the **x, y, z** axes
- **gyro** indicates the gyroscope readings in the **x, y, z** axes



Note: errors of IMU initialization are indicated as follows:

	x	y	z
accelerometer	ERROR INIT	ERROR INIT	ERROR INIT
magnetometer	ERROR INIT	ERROR INIT	ERROR INIT
gyro	ERROR INIT	ERROR INIT	ERROR INIT

Errors of IMU reading are indicated as follows

	x	y	z
accelerometer	ERROR	ERROR	ERROR
magnetometer	ERROR	ERROR	ERROR
gyro	ERROR	ERROR	ERROR

Proximity Sensors

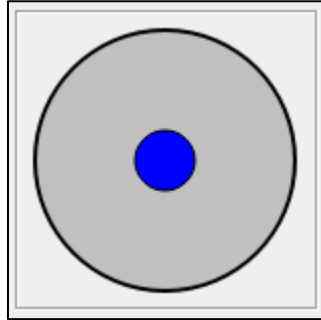
Proximity Sensors			
Tx Rx	left	front	right
left	5	2	0
right	0	1	5
basic	no interference	no interference	no interference
<input type="text" value="500 msec"/>		<input type="button" value="Update Period"/>	Period: 500 msec
<input type="button" value="Reset Settings"/>		<input type="button" value="Change Enable"/>	Enable: True

- **Rx left** indicates the reading of the left proximity sensor, as a result of light emitted from the **Tx left** and **Tx right** LEDs
- **Rx front** indicates the reading of the front proximity sensor, as a result of light emitted from the **Tx left** and **Tx right** LEDs
- **Rx right** indicates the reading of the right proximity sensor, as a result of light emitted from the **Tx left** and **Tx right** LEDs
- **basic** indicates whether the proximity sensors sense an external interference (caused by external LEDs)

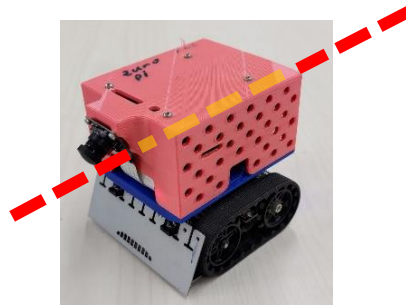
basic	no interference	no interference	interference!
-------	-----------------	-----------------	---------------

Joystick

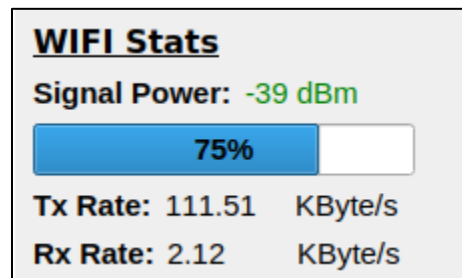
- The joystick allows to control the robot, by moving the blue circle



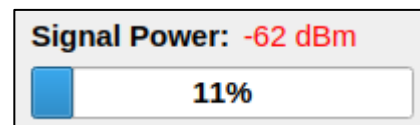
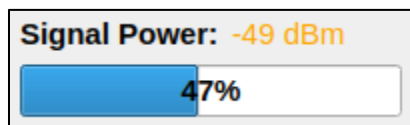
- The center of the gray circle is relative to the robot's center (from top view) and the location of the blue circle indicates the speed and direction of the robot's movement relative to its back-front axis:



WiFi Stats



- Signal Power** indicates the strength of the signal received by the robot, in dBm units. Its color changes to yellow for medium signal strength, and red for low signal strength
- The colored bar indicates the signal strength in a relative manner. 100% indicates a very good signal reception while 0% indicates a very bad signal reception.



- Tx Rate** indicates the data transmission rate of the robot in kBytes/s
- Rx Rate** indicates the data reception rate of the robot in kBytes/s



Applications Status

Applications Status:

Connection is Up!
Serial Interface is Up!
Zumo is Up!
Ups is Up!
Camera Node is Up!
Camera is Up!

- **Connection** indicates that WIFI Stats node is running. If not, the GUI is blocked.
- **Serial Interface** indicates that Serial Interface node is running. If not, the following panels are blocked: Buzzer, Encoders, Line Sensors, IMU, Proximity Sensors, and Joystick.
- **Zumo** indicates that the telemetry Arduino code is running. If not, the following panels are blocked: Buzzer, Encoders, Line Sensors, IMU, Proximity Sensors, and Joystick.
- **UPS** indicates that UPS Reading node is running. If not, Battery and Charging panels are blocked.
- **Camera Node** indicates that Camera node is running. If not, camera panel is blocked.
- **Camera** indicates the connection with the robot's camera. If there's no connection, camera panel is blocked.

Note: When a problem is detected, the GUI declares a module as unstable. If it's not resolved after 6 seconds, the module is down and the GUI blocks the relevant panels.
Example: UPS Reading node stops running

Applications Status:

Connection is Up!
Serial Interface is Up!
Zumo is Up!
Ups is unstable...
Camera Node is Up!
Camera is Up!

Applications Status:

Connection is Up!
Serial Interface is Up!
Zumo is Up!
Ups is Down...
Camera Node is Up!
Camera is Up!

Battery

voltage:

500 msec



capacity:

Update Period

Period:

Reset Settings

Change Enable

Enable:

Charging

State:

500 msec



Update Period

Period:

Reset Settings

Change Enable

Enable:



Logger

- GUI node creates a log file on the remote computer, in `~/ros2_ws/telemetry_logs`, called `data_log`. It shows the logs triggered by the GUI code, as well as telemetry data received and published by the GUI

The top screenshot shows a file manager window with the path `/ ros2_ws / telemetry_logs`. It displays a list of log files:

Name	Size	Modified
<code>data_log_2023-06-06_20-14-50.txt</code>	119 bytes	6 Jun
<code>data_log_2023-06-11_11-08-02.txt</code>	24.6 kB	11 Jun
<code>data_log_2023-06-13_14-38-31.txt</code>	119 bytes	13 Jun
<code>data_log_2023-06-21_20-09-58.txt</code>	36.2 kB	Wed
<code>data_log_2023-06-21_20-11-54.txt</code>	5.4 kB	Wed

The bottom screenshot shows the content of the selected log file `data_log_2023-06-21_20-11-54.txt`. It contains a series of log entries from the GUI node:

```
1 2023-06-21 20:12:06,401 - logger - INFO - Started GUI node
2 2023-06-21 20:12:57,930 - telemetry_data_logger - INFO - Recieved: LineSensors(data=[360, 172, 384])
3 2023-06-21 20:12:57,988 - telemetry_data_logger - INFO - Recieved: Buzzer(is_playing=False)
4 2023-06-21 20:12:58,029 - telemetry_data_logger - INFO - Recieved: LineSensors(data=[360, 192, 384])
5 2023-06-21 20:12:58,114 - telemetry_data_logger - INFO - Recieved: Buzzer(is_playing=False)
6 2023-06-21 20:12:58,115 - telemetry_data_logger - INFO - Recieved: Encoders(right=0, left=0, error_right=False, error_left=False)
7 2023-06-21 20:12:58,130 - telemetry_data_logger - INFO - Recieved: LineSensors(data=[356, 188, 380])
8 2023-06-21 20:12:58,209 - telemetry_data_logger - INFO - Recieved: Buzzer(is_playing=False)
9 2023-06-21 20:12:58,226 - telemetry_data_logger - INFO - Recieved: String(data='camera')
10 2023-06-21 20:12:58,228 - telemetry_data_logger - INFO - Recieved: LineSensors(data=[352, 188, 376])
11 2023-06-21 20:12:58,229 - telemetry_data_logger - INFO - Recieved: CameraSettings(period_msec=100, enable_read=True)
12 2023-06-21 20:12:58,257 - telemetry_data_logger - INFO - Recieved: Bool(data=False)
13 2023-06-21 20:12:58,260 - telemetry_data_logger - INFO - Recieved: Battery(voltage=3.8299999237060547, capacity=68)
```

- Each node running on ZumoPi creates a log file locally on the robot, in `~/ros2_ws/telemetry_logs`, according to node's name (e.g., `wifi_stats_log`). It shows the logs triggered by the node, as well as telemetry data received and published by the node.

The screenshot shows a file manager window with the path `Home / ros2_ws / telemetry_logs`. It displays a list of log files created by different nodes:

Name	Size	Modified
<code>camera_log_2023-06-21_20-07-03.txt</code>	787 bytes	Wed
<code>camera_log_2023-06-25_10-30-41.txt</code>	269 bytes	10:31
<code>serial_interface_log_2023-06-21_20-07-01.txt</code>	37.3 kB	Wed
<code>serial_interface_log_2023-06-25_10-30-25.txt</code>	3.2 kB	10:31
<code>ups_reading_log_2023-06-21_20-07-01.txt</code>	4.8 kB	Wed
<code>ups_reading_log_2023-06-25_10-30-25.txt</code>	188 bytes	10:31
<code>wifi_stats_log_2023-06-21_20-07-02.txt</code>	3.0 kB	Wed
<code>wifi_stats_log_2023-06-25_10-30-31.txt</code>	340 bytes	10:31

```

wifi_stats_log_2023-06-21_20-07-02.txt
~/ros2_ws/telemetry_logs

1 2023-06-21 20:07:04,160 - logger - INFO - Device is: wlx08beac1b8a82
2 2023-06-21 20:07:04,168 - logger - INFO - Started Wifi Stats
3 2023-06-21 20:10:26,407 - telemetry_data_logger - INFO - Published: WifiStats(signal_power=-34, rx_rate=10.23, tx_rate=59.15)
4 2023-06-21 20:10:26,913 - telemetry_data_logger - INFO - Published: WifiStats(signal_power=-35, rx_rate=3.23, tx_rate=54.48)
5 2023-06-21 20:10:27,407 - telemetry_data_logger - INFO - Published: WifiStats(signal_power=-35, rx_rate=2.88, tx_rate=54.2)
6 2023-06-21 20:10:27,906 - telemetry_data_logger - INFO - Published: WifiStats(signal_power=-35, rx_rate=2.39, tx_rate=53.06)
7 2023-06-21 20:10:28,407 - telemetry_data_logger - INFO - Published: WifiStats(signal_power=-35, rx_rate=0.47, tx_rate=54.05)
8 2023-06-21 20:10:28,914 - telemetry_data_logger - INFO - Published: WifiStats(signal_power=-35, rx_rate=12.68, tx_rate=58.37)
9 2023-06-21 20:10:29,434 - telemetry_data_logger - INFO - Published: WifiStats(signal_power=-35, rx_rate=2.43, tx_rate=58.44)
10 2023-06-21 20:10:29,916 - telemetry_data_logger - INFO - Published: WifiStats(signal_power=-35, rx_rate=0.93, tx_rate=51.5)
11 2023-06-21 20:10:30,411 - telemetry_data_logger - INFO - Published: WifiStats(signal_power=-35, rx_rate=2.76, tx_rate=55.98)
12 2023-06-21 20:10:30,905 - telemetry_data_logger - INFO - Published: WifiStats(signal_power=-33, rx_rate=2.31, tx_rate=52.63)
13 2023-06-21 20:10:31,417 - telemetry_data_logger - INFO - Published: WifiStats(signal_power=-33, rx_rate=1.93, tx_rate=53.61)
14 2023-06-21 20:10:55,421 - telemetry_data_logger - INFO - Published: WifiStats(signal_power=-34, rx_rate=1.73, tx_rate=55.18)
15 2023-06-21 20:10:58,409 - telemetry_data_logger - INFO - Published: WifiStats(signal_power=-35, rx_rate=3.96, tx_rate=54.94)
16 2023-06-21 20:10:58,908 - telemetry_data_logger - INFO - Published: WifiStats(signal_power=-35, rx_rate=15.04, tx_rate=59.19)
17 2023-06-21 20:10:59,406 - telemetry_data_logger - INFO - Published: WifiStats(signal_power=-35, rx_rate=2.4, tx_rate=58.15)
18 2023-06-21 20:10:59,905 - telemetry_data_logger - INFO - Published: WifiStats(signal_power=-35, rx_rate=2.88, tx_rate=54.48)
  
```

- Set the **Log Level** using the dropdown list
The logs can be viewed either in the terminal or in the log files, and indicated as "logger"

Logger
 Log Level INFO

☐ Save telemetry data

DEBUG
 INFO
 WARNING
 ERROR
 CRITICAL
 NONE

- Check **Save telemetry data** to store the telemetry data published and received by the nodes. This data doesn't appear in the console (to avoid spamming), and is always of INFO severity. Indicated as "telemetry_data_logger".
Uncheck to stop saving the data.

Note: All the logs are initialized to INFO and don't store telemetry data



Simulator

The simulator simulates the ZumoPi robot's behavior. It generates telemetry data and can receive commands from the GUI just like the real robot.

It's useful when you want to test the GUI but have no access to the robot (e.g., it doesn't work, it doesn't exist).

In addition, it can generate possible edge case scenarios like errors. These don't usually happen on the real robot, so this feature can be used to test the GUI's operation when it receives such errors.

Run the simulator:

- 1) Make sure that **tel** is not running (see [system activation](#))
- 2) On the remote computer (the same computer that runs the GUI) open a terminal, type **data**, and press enter

The screenshot displays the 'Telemetry GUI' window, which is organized into several panels for monitoring different components of the ZumoPi robot.

- Camera:** Features a video feed area (currently black), a frame rate of 9.76 fps, and buttons for 'Capture Frame' and 'Capture Video'. It also includes a 'Video duration' slider set to 5 seconds and a 'Period' of 100 msec.
- Buzzer:** Shows 'Play Buzzer' and 'State: Not Playing'. It has a '500 msec' update period and an 'Enable: True' checkbox.
- Battery:** Displays 'voltage: 1.77 [V]' and 'capacity: 72 %'. It includes a '500 msec' update period and an 'Enable: True' checkbox.
- Charging:** Shows 'State: Charging' and a '500 msec' update period with an 'Enable: True' checkbox.
- Encoders:** Reports 'left: -580', 'right: ERROR', and 'speed: ERROR km/h'. It has a '500 msec' update period and an 'Enable: True' checkbox.
- Line Sensors:** Shows 'left: 1710', 'center: 1420', and 'right: 1130'. It has a '500 msec' update period and an 'Enable: True' checkbox.
- IMU:** A table showing sensor status for x, y, and z axes. All sensors (accelerometer, magnetometer, gyro) are in an 'ERROR' state. It has a '500 msec' update period and an 'Enable: True' checkbox.
- Proximity Sensors:** A table showing 'Tx | Rx' for left, front, and right sensors. The 'basic' sensor shows 'no interference', while 'front' and 'right' show 'interference!'. It has a '500 msec' update period and an 'Enable: True' checkbox.
- Applications Status:** A summary of connection status: 'Connection is Up!', 'Serial Interface is Up!', 'Zumo is Up!', 'Ups is Up!', 'Camera Node is Up!', and 'Camera is Up!'.
- WIFI Stats:** Shows 'Signal Power: -38 dBm' and a '77%' signal strength bar. It also displays 'Tx Rate: 20.0 KByte/s' and 'Rx Rate: 246.0 KByte/s'.
- Logger:** Includes a 'Log Level' dropdown set to 'INFO' and a checkbox for 'Save telemetry data'.
- Exit:** A large button with a circular icon and a small image of the ZumoPi robot.