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ROS Enabled Unmanned Surface Vehicle

Project Objectives

Commissioned by Dalhousie's Ocean Engineering Hub's Intelligent Systems Laboratory to develop software and hardware for an Unmanned Surface Vessel (USV), capable of:

- User Control
- Automatic Waypoint Following

Client requirements:

- Scalable hardware Platform – ability to add new system / sensor hardware with ease.
- Software built upon the Robot Operating System framework – allowing for system interoperability within the Oceans Engineering Laboratory.

Design Process

The Design was divided into 2 distinct Phases:

Phase 1: User Control

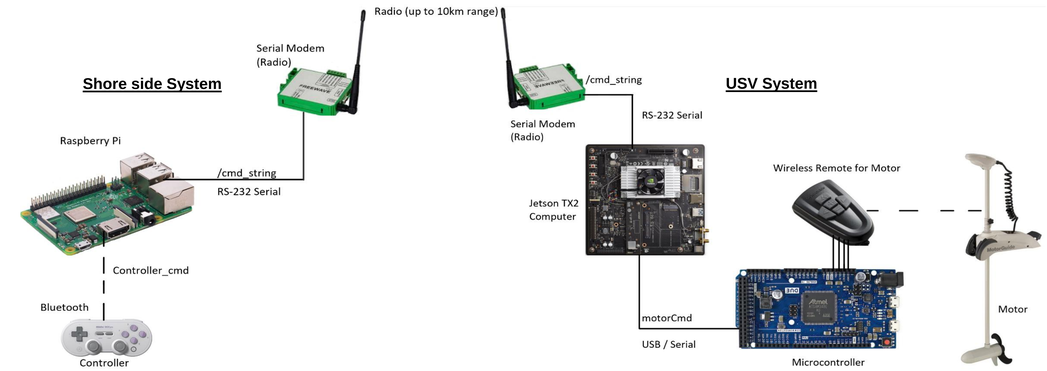
- Implementation of long range user teleoperation between Shoreside and USV systems
- Development of main USV electronics and power systems (in waterproof cases)
- Development of ROS system and wireless motor controller node (C++).
- Integration of an indoor positioning system into ROS, for real-time tracking (without GPS)
- In water testing and validation at Dalhousie's Aquatron

Phase 2: Automatic Waypoint Following

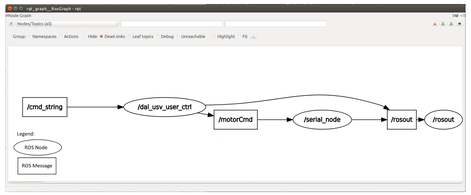
- Building upon Phase 1 by adding GPS / IMU hardware for USV and integrating into ROS
- Installation of long range ethernet radios for real-time USV system monitoring from shore side system
- Integration of a motor shaft encoder, onboard compass and development of their respective C++ ROS nodes.
- Development of a main ROS node to allow for automatic waypoint following of a predetermined route.

Details of Design

- **Phase 1: User Control**

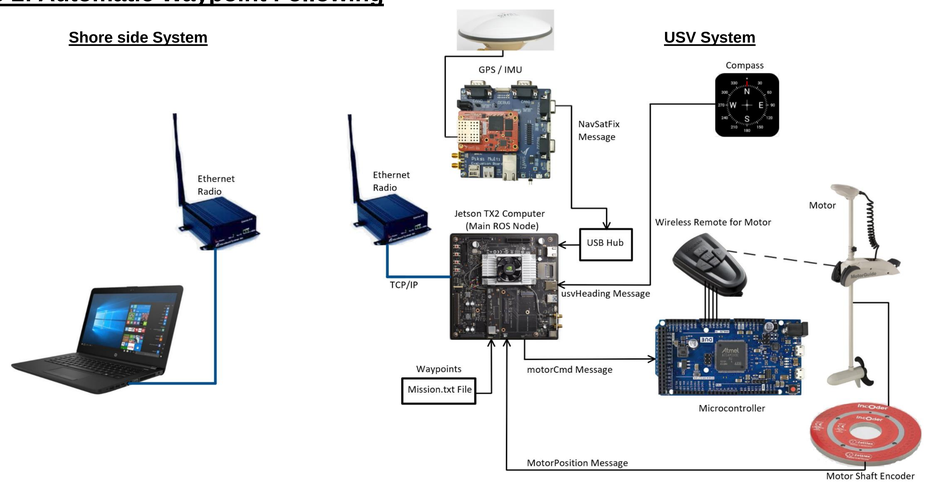


- User operates Controller connected to RPi via Bluetooth.
- RPi converts controls into NMEA style command string.
- Command string is transmitted to USV via RF Serial Radio.
- USV ROS node validates string and publishes corresponding ROS motor control message.
- Motor Controller node subscribes to message and controls motor accordingly.

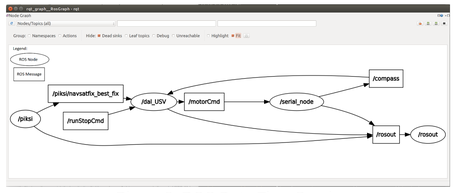


Phase 1: ROS Data Flow Graph

- **Phase 2: Automatic Waypoint Following**



- User sends USV command to start mission
- USV ROS node reads mission.txt file for list of desired waypoints
- Distance and heading to goal are calculated
- Compass and motor shaft position are read into ROS node
- Motor Control message is created by USV ROS node, for desired trajectory
- Process is monitored (and adjusted) until goal is reached.
- Process repeats until all goals have been reached.



Phase 2: ROS Data Flow Graph

Conclusions

Phase 1: User Control

- System development and testing went as planned.
- Testing in the Aquatron and initial integration of the Indoor Positioning System into ROS were successful.
- Motor Controller node works well, allowing for long range teleoperation of the USV.

Phase 2: Automatic Waypoint Following

- Both hardware and software (ROS) system integration of GPS / IMU system is complete.
- Capable of reading GPS position and calculating distance and bearing to a desired location.
- Compass node provides updates to ROS system of USV's heading.

Recommendations

Phase 1: User Control

- Further testing of edge cases needed, such as power failure at certain USV states, to ensure complete and safe user control.
- Improved integration of indoor positioning system, to provide real-time 3D localization and user feedback.

Phase 2: Automatic Waypoint Following

- Complete the integration of motor shaft encoder.
- Configure Ethernet Radios for point to point operation.
- Once development is completed, outdoor, in water system testing and validation will be required to ensure functionality and safe operation.

References

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