aerobot

UGV Remote Control Over Deployed Continuous UWB RF Nodes

Eric Buckland | Kim Dang | Angela Chen | Tom Zu

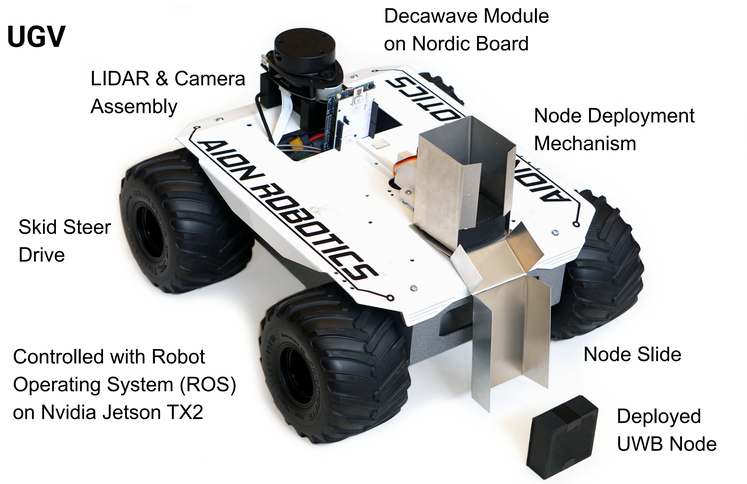
abstract

Remote control of Unmanned Ground Vehicles (UGVs) over wireless is seldom uninterrupted especially in high interference or obstructive environments. We designed deployable self-sufficient, low-cost, battery-powered, and seamlessly connecting Ultrawide Bandwidth (UWB) RF nodes to have continuous communication in this environment.

Key Features

- Trivially scalable, efficiency-first design
- Video, LiDAR map, and PIR data transmission
- Novel protocol for half-duplex communication

hardware



Node

Decawave Module (DWM)

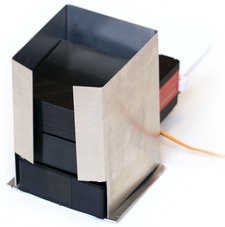
Nordic System-on-Chip (SoC)

AA Batteries 2.6 Inches Width

Deployment Mechanism

Passive Infrared Sensor (PIR)

Rack & Pinion Servo Motor



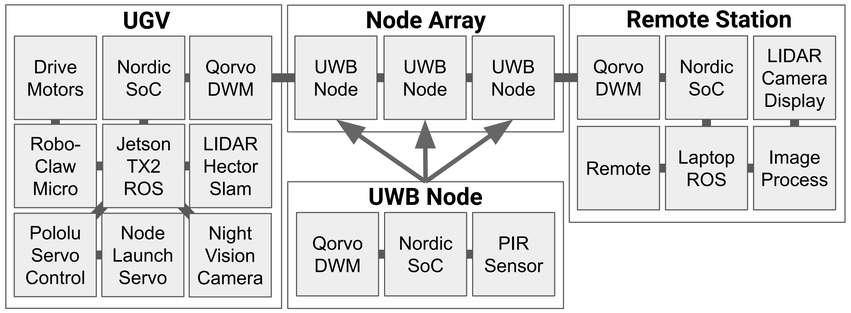
Stacked Nodes

Sensors

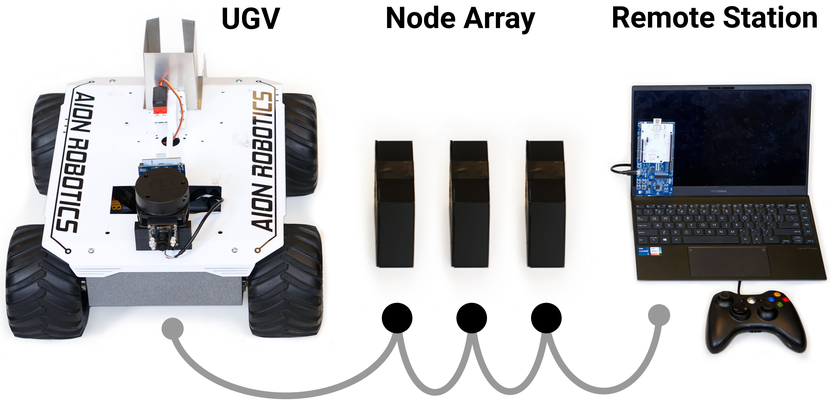
LIDAR Sensor Using Hector SLAM

Infrared Night Vision Camera

block diagram

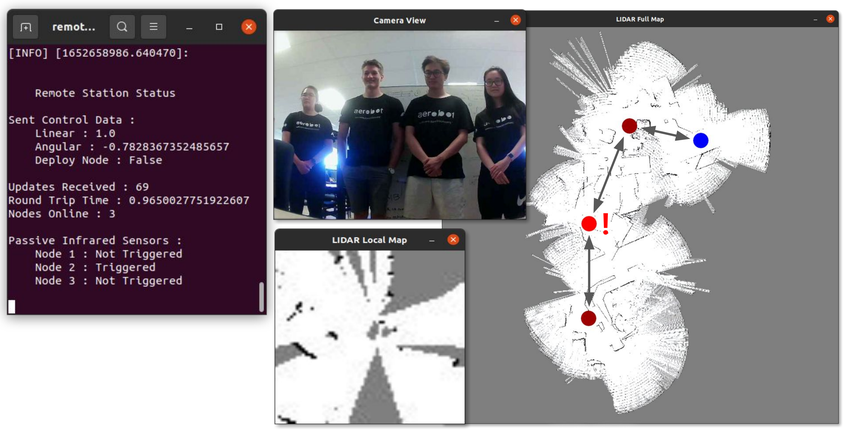


final product



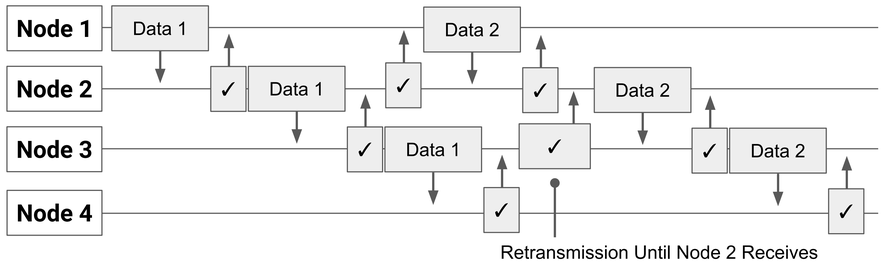
With seamless interconnectivity, the deployed nodes wirelessly chain the UGV to the remote station, sending a camera feed and local mapping forward, and control data backward.

Remote Station Display

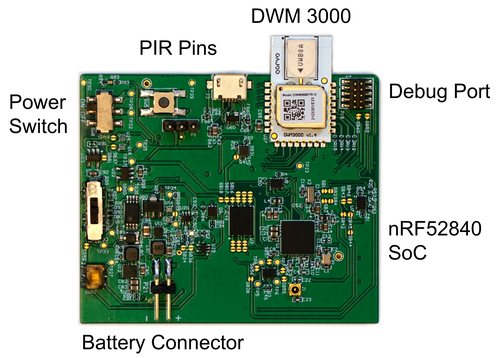


transmission protocol

This original “double ack” protocol maximizes efficiency over a continuous link connection given half-duplex limitations. It allows cascading parallel transmission and packet retransmission, much faster than waiting for completion before sending the next packet.



printed circuit board



Board Features

- 4 Layer PCB
- 2.5 Inches Width and Height
- On-board RF module

Qorvo DWM 3000 UWB

- Low Power, High Reliability
- Released in 2020

challenges

Node Coordination using Half-Duplex Communication

The UWB module cannot send and receive data simultaneously, creating the need to coordinate nodes’ TX and RX phases.

Speed vs. Reliability Tradeoff

Acknowledgements and retransmission improves reliability, however it adds overhead and decreases speed. Additionally, UWB technology has a relatively short range, which needs to be considered during node deployment.

Robot Implementation

All UGV functionality needed to be individually implemented from the ground up. ROS is utilized on the UGV and remote station for efficient and low level data control.

AeroVironment™

Phil Tokumaru
Tiziano Fiorenzani

UC SANTA BARBARA engineering

Yogananda Isukapalli
Christopher Wimmel

Christopher Cheney
Brycen Westgarth