Autonomous Rover Navigation

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ABSTRACT

An autonomous rover, designed for seamless navigation in both indoor and outdoor environments, is equipped with real-time obstacle avoidance and path planning capabilities. Powered by NVIDIA Isaac ROS, VSLAM, Nvblox and NVIDIA Riva, the rover generates 3D environmental maps and performs object detection using a depth camera and additional sensors. Moreover, it integrates a local Large Language Model (LLM) for interactive voice-based communication. This system combines advanced navigation, mapping, and user interaction capabilities, enhancing usability and exploration across diverse environments.

Objectives

- An autonomous rover with object detection and navigation, equipped with Nav2 and 3D mapping technologies, explores and navigates indoor environments.

- Outdoor navigation utilizing GPS-based coordinates and odometry feedback.

- Integrate a locally hosted language model with voice-based interaction and command processing capabilities.

WORKFLOW
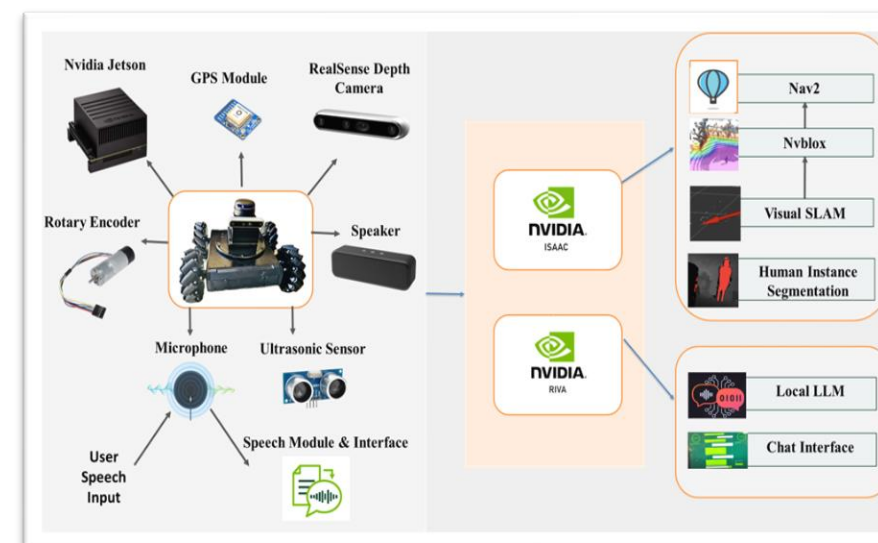
MATERIALS AND METHODS

The Jetson AGX Xavier serves as the central processing unit, utilizing data from the RealSense depth camera to construct a 3D map of the environment and identify objects. Odometry data from the RealSense camera and wheel encoders is employed for precise localization.

The system incorporates a speech interface powered by NVIDIA RIVA, which processes voice commands and generates spoken responses through a speaker.

For navigation, the rover employs a coordinate-based system to guide its movement. Furthermore, an external GPS module facilitates the rover's effective traversal of outdoor environments. This comprehensive setup ensures reliable navigation and interaction in both indoor and outdoor environments.
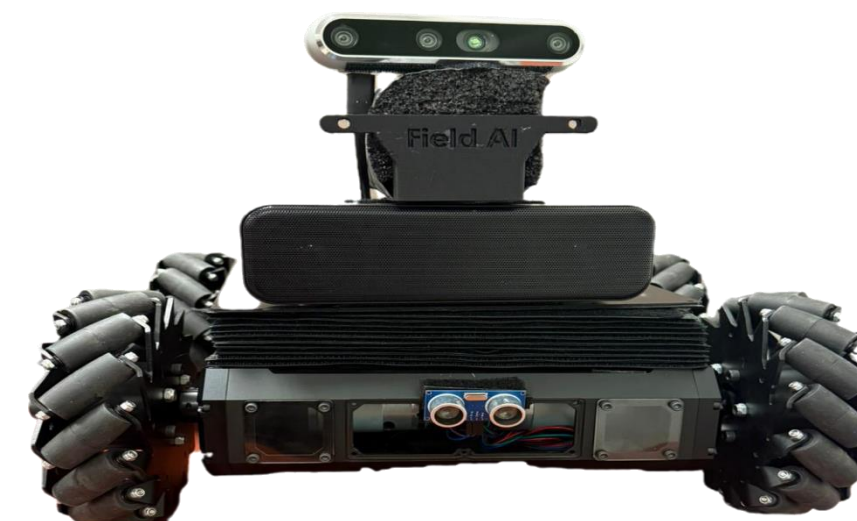
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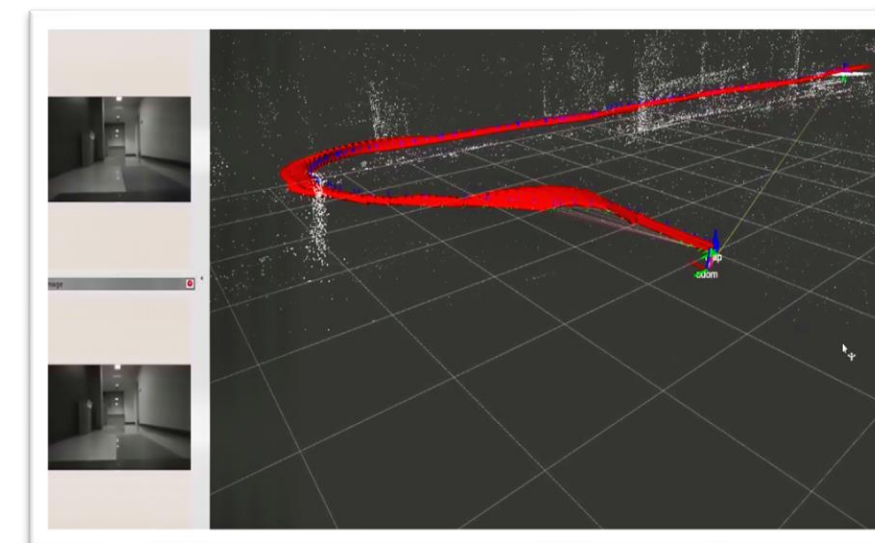
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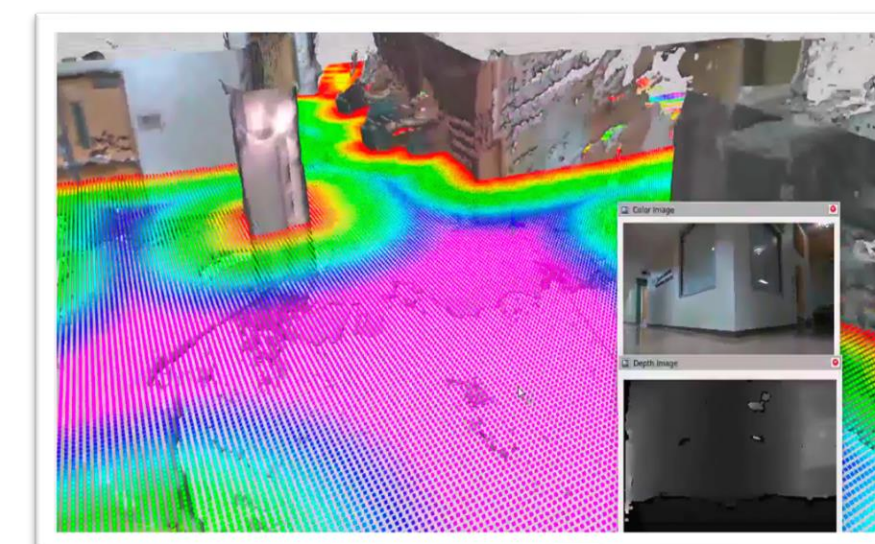
PROTOTYPE

RESULT

- A 3D map of the indoor environment was successfully constructed using Nvblox, and Nav2 was utilized to enable precise indoor navigation.
- Successfully tested outdoor navigation based on GPS coordinates with conceptual interaction.
- Implemented an LLM-based speech module using NVIDIA Riva for speech-driven communication, navigation, and task execution.

ADDITIONAL INFORMATION

REFERENCES

- ROS 2 Humble
- NVIDIA Issac ROS
- Isaac ROS Nvblox
- Isaac ROS Visual SLAM
- NVIDIA Riva