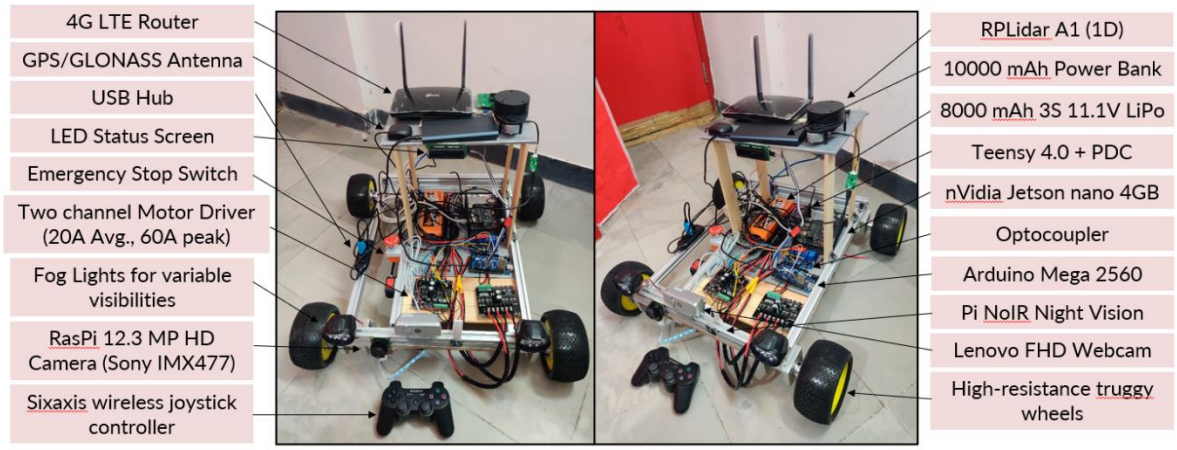
Rakshak: An extendable mobile robot platform for emergency situations [Under 'BUILD' Funding Programme]

Design:



Motivation

Quick response and immediate field deployment in emergency situations are crucial for the country's safety, particularly for:

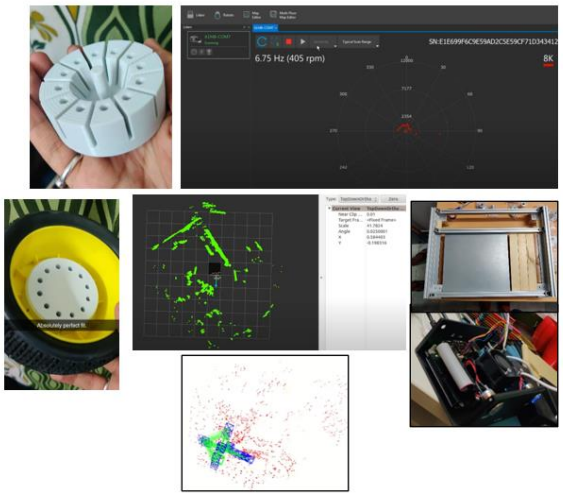
- Response in situations where less workforce than required is present, and
- To assist the police personnel in challenging tasks and risky environments

Primary and Extended Objective

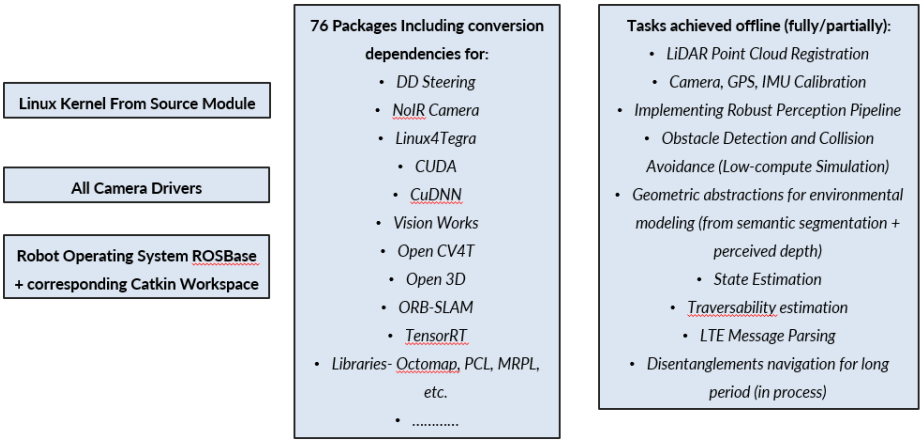
- Searching for bombs/explosives and potential threats at a certain geographical location (especially in compact, constrained, and inaccessible/potentially dangerous locations like beneath a car)
- Live video feed and communication with the operator (Police personnel, in particular)
- Spraying of pepper spray (or any other spray for that matter) in acts of vandalism and situations of havoc.
- **Extended Objective:** Design a general-purpose Autonomous Mobile robot that can be modulated for use in multiple related application areas.

Things Completed

- Design and Modelling
- Hardware + Fabrication + 3D Printing works
- Setting up the 4WD Differential drive (motors) along with encoders for feedback sensing
- Setting up the middleware framework and the OS on the onboard computer
- Teleoperation software tack
- Perception and Navigation System
- Setting up the manual-mode wireless controller and the PDS
- Establishing LTE communication for live video-feed and wireless data transfer (+internal)
- Integration of the data feed with the RTOS in synchronization



Software Architecture:



Challenges faced and solutions tried:

Problem: **Software compatibility (Status: Partially Resolved)**

Solution Tried: JetPack SDK has Jetson Linux with bootloader, Linux Kernel, Ubuntu 18.04, GPU acceleration libraries, etc. It is not getting fully installed in the Jetson Nano due to which I have to custom build many libraries from source and hence the compatibility issues

Problem: **Compatibility of various protocols and availability of hardware (Status: Resolved)**

Solution used: With many microcontrollers, drivers, and feedback sensors involved along with the SBC (onboard computer), the corresponding comm. Protocols like CAN, TTL, etc. have to be integrated accordingly. (with necessary hardware)

Problem: **Synchronization issues during booting of the robot system (Status: Resolved)**

Solution used: Using an RTC (Real-Time Clock) while boot-up and during runtimes along with an optocoupler

Problem: **Integration of various sensors (Status: Partially Resolved)**

Solution tried: Multi-Sensor: integration of different data formats, with different data rates and frequencies, in the global control architecture, along with data representation in latent space, association, and understanding, the learning process

Problem: **Power Distribution System Setup and Optimizing power usage**

Solution tried: The present PDS is not optimal, there is a need for a custom solution as this design is unique

Status: Resolved

Other logistical and managerial problems: **Wrong products (incorrect dimensions and other manufacturing defects, malfunctioning), pre-ordering for out of stock products, late deliveries, compatibility issues**

Solution tried: No possible alternative, slows down the work progress

Status: Resolved

Deliverables:

The outcome of this project is a robot unit prototype as shown which can satisfy the mentioned objectives. The particular applications for this robot are mentioned in the motivation section. Some of the broader application areas of the robot are:

- **Security surveillance, ground control, and inspection**. It can be used in certain task-specific applications, other required stuff necessary for the task can be mounted on the top of the robot, and synchronization with the main system can be done manually.
- **Additionally**, it could be used in places of natural disasters (to monitor the situation, search and rescue), fires, high radiation areas, nuclear power plants, underground mines, etc. The system will be agile and robust to perturbations, demonstrating highly dynamic and feasible behaviors within the imposed safety constraints.
- **Design Versatility**: It is an adaptive platform that can work on a wide array of tasks under the mentioned field applications

Future goals: Autonomy Integration, open-source documentation for replication