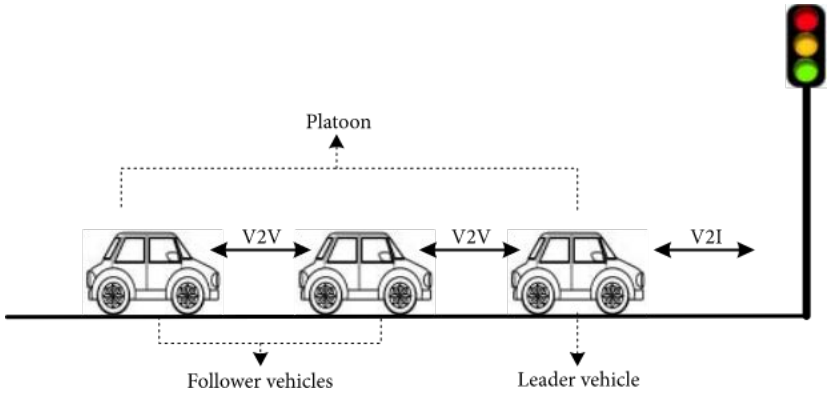
AutoVot

A Vehicle to Vehicle Communication System for Autonomous Driving

B6: *Joel Anyanti, Fausto Leyva, Jeffrey Tsaw*

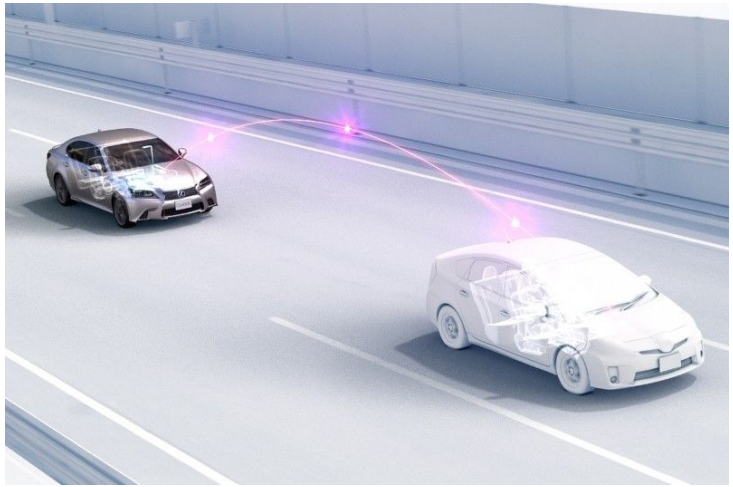
Application Area

- Demonstrate effectiveness of V2V communication for joint perception and prediction for efficient transport
- Have convoy of RC vehicles autonomously navigate a closed track through static obstacles

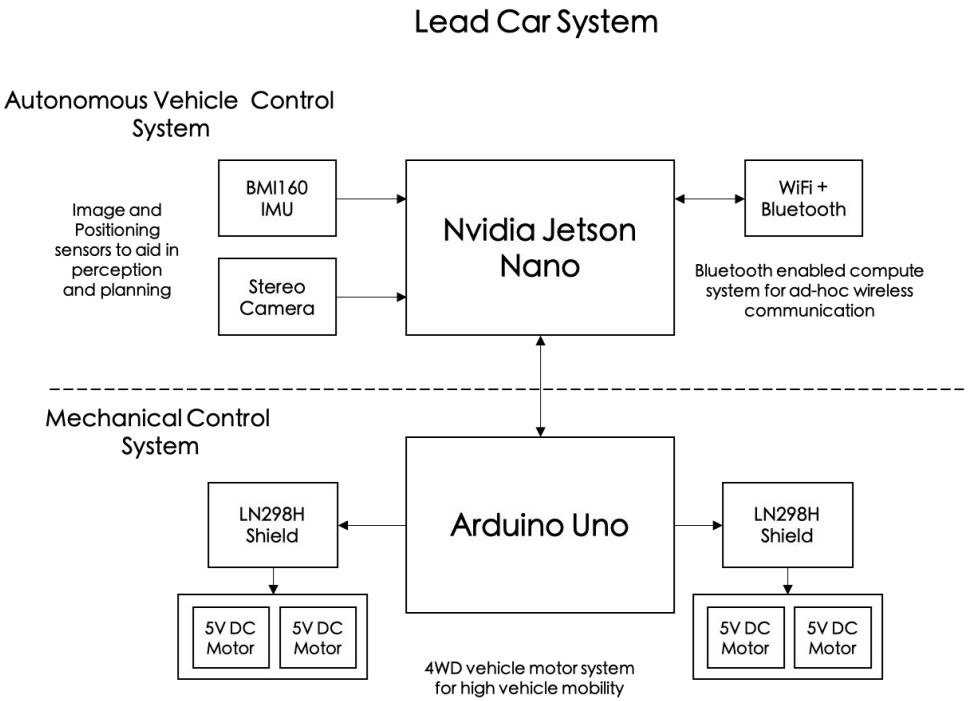


Solution Approach

- RC car component
  - 4 motor system controlled by Arduino connected to Jetson
- Convoy Formation
  - Lead car navigates through course autonomously
  - Lead car equipped with stereo camera for object detection + planning
- V2V Communication
  - Lead car communicates via bluetooth
  - Help following cars navigate to destination



System Specification - Lead Car



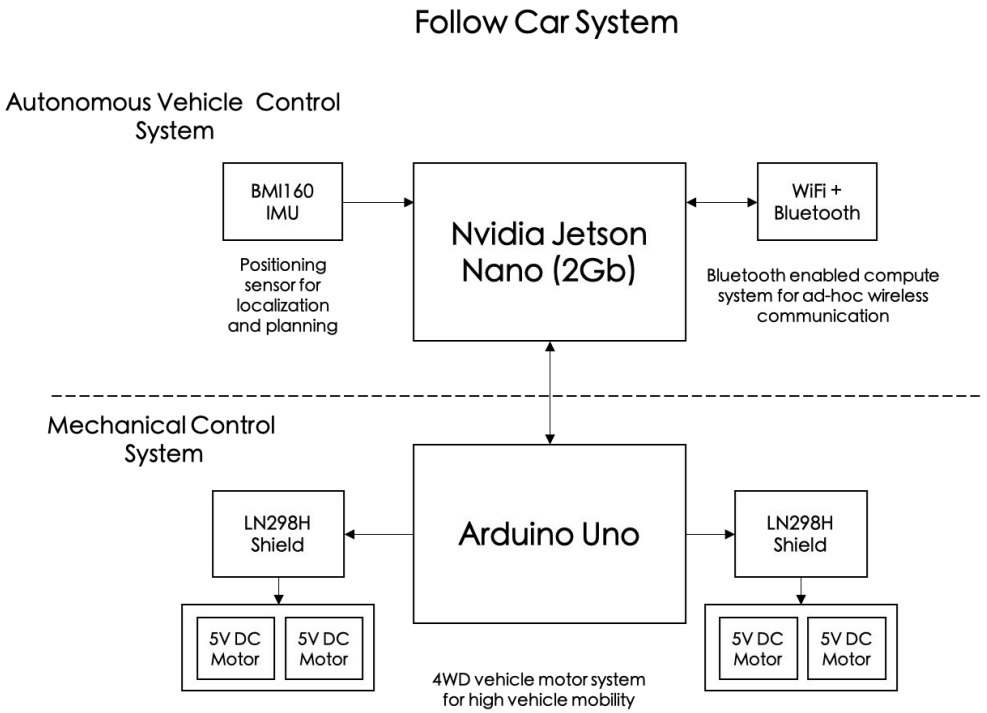
Hardware

- Stereo Camera
- Jetson Nano
- WiFi + Bluetooth Card
- BMI160 IMU (accelerometer + gyroscope)
- Arduino (motor control)
  - DC Motors
  - Motor Shield

Software

- ROS Based platform (python modules)
- OpenCV for Object Detection
- Piconet for Wireless Communication

System Specification - Follow Car



Hardware

- Jetson Nano (2Gb)
- WiFi + Bluetooth Card
- BMI160 IMU (accelerometer + gyroscope)
- Arduino (motor control)
  - DC Motors
  - Motor Shield

Software

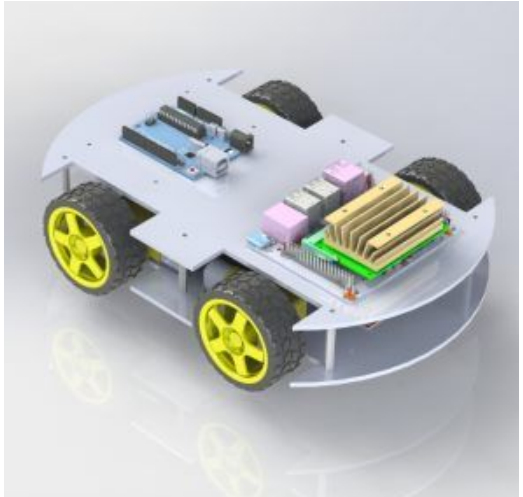
- ROS Based platform (python modules)
- Piconet for Wireless Communication

Implementation Plan - Vehicle Mechanics

Mechanics
- 11 x 7in Chassis to hold motors, control systems, compute systems and sensors
- Drivetrain powered by four 5v DC Motors, controlled through motor shield and Arduino PWM driver

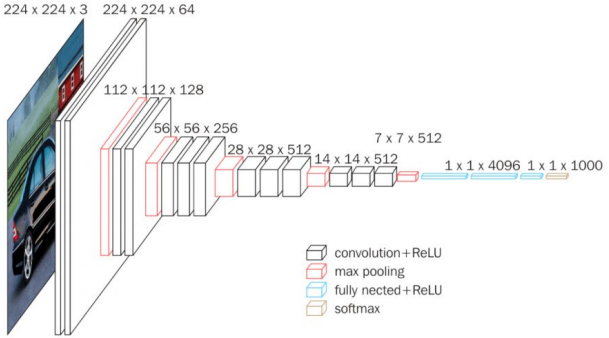
Power
- 9v power delivery system for motors
- 5v power bank for compute systems

Control
- RC commands for driving will be transmitted from compute system to the arduino via usb connection.
- Calibrate RC commands to allow for fine grain control of car movements

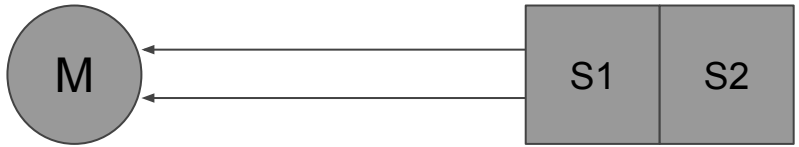


Implementation Plan - Object Detection & Planning

- Stereo Camera for depth information
- Object detection using RGB-D based algorithms
  - - Faster R-CNN with VGG16
  - -Alternative: VGG16 with plain RGB data
  - Use photos of real life objects on obstacles to avoid retraining
- Planning done by optimizing distance of object bounding box distance from center of the vehicle

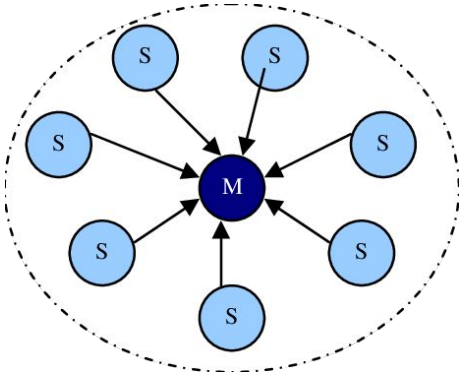


Implementation Plan - V2V Communication



Lead car

Trailing cars



Piconet

Piconet Architecture

- Lead car receives all sensory input (from camera)
- Relays data packet to trailing cars

Metrics and Validation

RC Course

- 30m straight course with checkpoints (termination condition)
  - 15 total obstacles (two classes)
    - Tall (Tree)
    - Wide (Car/Bench)
  - Moving at top speed of **1m/s** (~2.2mph) complete course in under **40s**
  - 0 Collisions from start to finish
- Static Object detection minimize for false negative rates
  - Accuracy most relevant at closer depth (0-1m range)
  - ≥90% precision for static obstacles a (0-1m range)
  - ≥95% recall, since we want higher sensitivity to objects

Risk Mitigation

Object Detection

- Backup stereo camera units in event of camera issues
- Tune model to set of chosen images
- AprilTag as an alternative to detecting images

Vehicle Communication

- Experiment with rate of communication and packet sizes

Tasks & Division of Labour

	RC Vehicle	Object Detection	Path Planning	Wireless Comm.	Testing
Joel					
Fausto					
Jeffrey					

Projected Schedule - Gantt Chart

PROJECT TITLE	AutoVöt	LAST UPDATED	03-07-2021

WBS NUMBER	TASK TITLE	TASK OWNER	PCT OF TASK COMPLETE
1	Project Initiation		
1.1	Design Finalizations	Joel	100%
1.1	Design Finalizations	Jeffrey	100%
1.1	Design Finalizations	Fausto	100%
1.3	RC car Assembly	Joel	50%
1.4	RC car Assembly	Fausto	40%
1.5	Setup Optical Sensor	Jeffrey	35%
2	Project Mechanics		
2.1	Camera Data Setup	Jeffrey	0%
2.2	Object Detection + Camera Calibration	Jeffrey	0%
2.3	RC Car Turns	Joel	0%
2.4	RC Car Breaks / Speedup	Joel	0%
2.5	V2V Groundwork	Fausto	0%
2.6	V2V Communication	Fausto	0%
3	Project Launch & Execution		
3.1	Path Planning	Fausto	0%
3.2	Path Planning	Joel	0%
3.2.1	Path Planning	Jeffrey	0%
3.2.2	Full Integration	Jeffrey	0%
3.3	Full Integration	Joel	0%
3.3.1	Full Integration	Fausto	0%
4	Project Testing		
4.1	Testing	All	0%
4.2	Metrics	All	0%
4.3	SLACK	All	0%