# Autonomous Land Vehicle

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## Abstract

The demand for the autonomous land vehicle industry has been increasing tremendously, and continues to grow; nearly 30 million autonomous vehicles are expected to be sold by 2040.[1] Through the Autonomous Lands Vehicle (ALV) VIP team, students develop both the hardware and software to help enhance knowledge and gain experience in vehicle autonomy. An automatic pilot has been built that can drive the vehicle in real time. The purpose of this pilot is to generate vehicle control commands that will direct the vehicle from the starting point to the finishing point, without hitting unforeseen obstacles. A remote controlled vehicle has been transformed into an autonomous vehicle by implementing appropriate steering logic based on incoming data from ultrasonic distance sensors. The team has strategized that the use of the Raspberry Pi single board computer would be the best candidate to function as the brain of the project due to open source software and familiarity of use. The current steering logic has been refined through an obstacle course based testing in scenarios with low gradient surfaces. For future iterations of this project, implementation of object recognition via a Pi CAM can relay what the ALV is seeing and with the introduction of a GPS module the user can actively monitor the coordinates of the vehicle.

## Objectives

- To build an autonomous vehicle using a Raspberry Pi, ultrasonic sensors that can be controlled wirelessly.
- To design a portable power supply unit to power the whole project.
- To Implement a steering algorithm to allow car to navigate around obstacles autonomously.

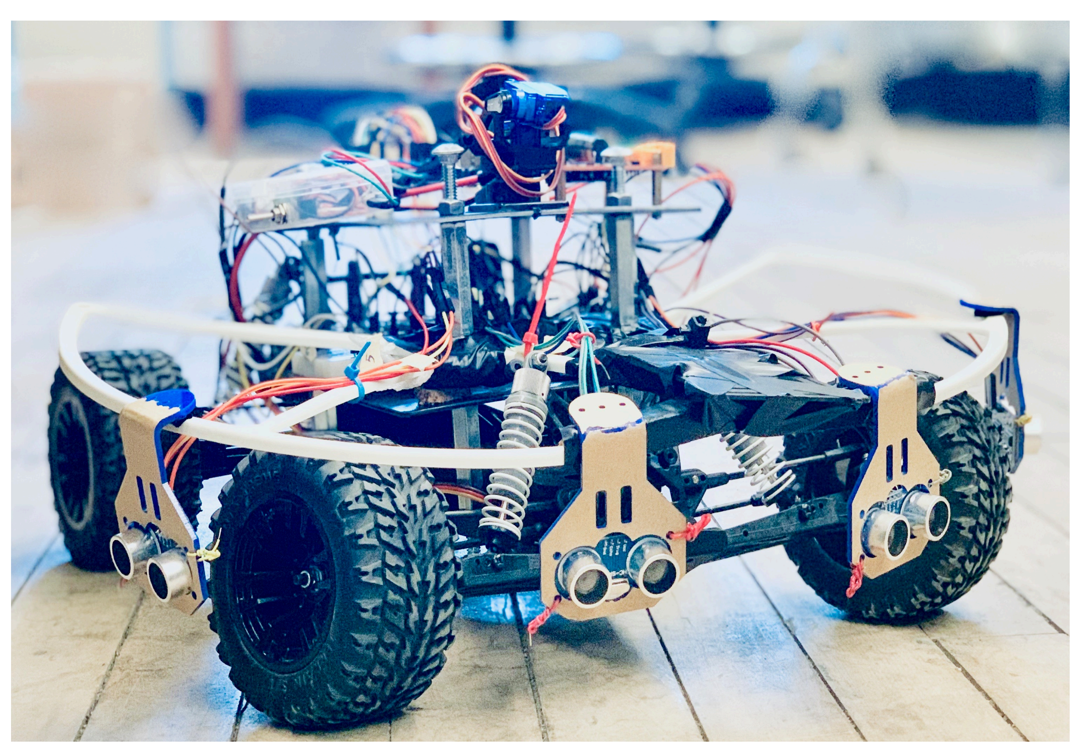

Figure 1: Front view of the vehicle

## Materials:

- Raspberry Pi 3B+
- Ultrasonic Sensors - HC-SR04
- Universal Battery Elimination Circuit
- 11.2 V Battery pack
- 4300 mAH 7.2V Battery
- Duratrax Evader EXT2.4 RC Car
- 9-36V PWM Motor Controller

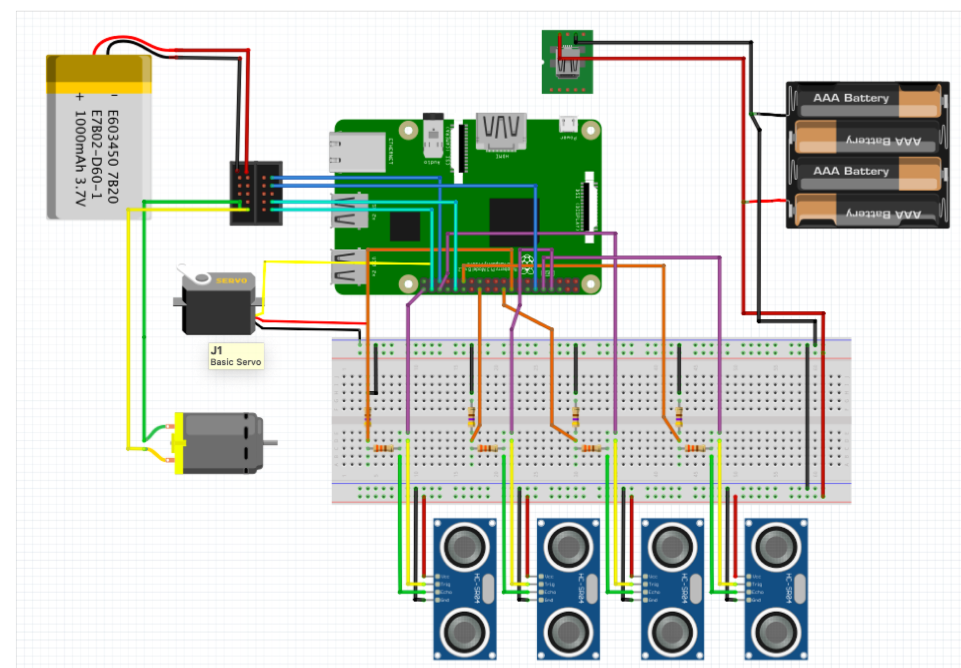

Figure 2: Wiring diagram for the ALV

## Obstacles

- PI Power supply: The team faced many complications while designing the power supply for the Pi. We tried using commercial portable chargers, but the Pi demands more power while booting up which these couldn't supply. Finally, the team made a DIY power supply using AA batteries along with a circuit built to provide 5V 3A constant output.
- Sensors Placement: In order to design an effective steering algorithm the placement of sensors is of utmost importance. The team prototyped the appropriated number of sensors needed in order for a "full visibility". Finally, it was decided that four sensors would be adequate. The exact placement of sensors was decided based on the arc of visibility and linear distance the sensor can read. The final arrangement gives the car adequate range of detection to avoid collision.
- Steering Algorithm: The team faced complications while testing the steering algorithms as unexpected decisions were taken by the algorithm.

## Methods

**Autonomous Steering Implementation:**

To have the car steer and navigate obstacles we used data provided by the four ultrasonic sensors as inputs to the neural net. The neural net was developed and trained using a game style simulation and the best performing networks were bred together to create a better performing network.

The sensor data is processed in two simultaneous stream one for the front pair of sensors and the other stream for the outboard sensors.

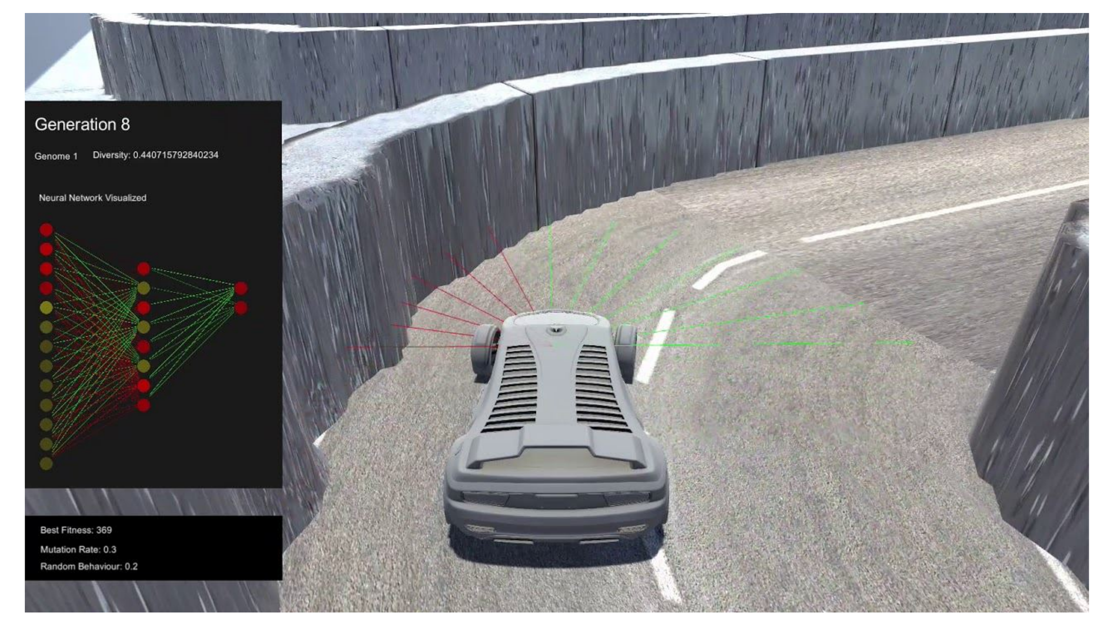


Figure 3: Simulation algorithm testing diagram

## Results

- All components of the cart are self powered. The cart can freely roam without needing to be connected to an external power source.
- The Raspberry Pi is able to communicate with the sensors and steering control neural net.
- The Raspberry Pi is able to communicate with the servo and motor controls
- Permanent and highly reliable placements of Raspberry Pi, sensors and other components on the vehicle.
- The Raspberry Pi is self powered without any loss in voltage.
- The Autonomous Land Vehicle is network capable and can send or receive data over a wireless local area network.
- The vehicle is wired in an efficient manner, that allows easy changes to connections if needed.
- The vehicle is equipped with 3D printed shock absorbing bumpers to prevent damage to the essential electronics.

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## Sensors

Ultrasonic sensors are utilized to detect obstacles in real time. The sensors communicate with the steering and motor controls to navigate the vehicle. Four sensors are placed in strategic positions around the front and sides of the cart so it can see a full range in front of it. The sensors operate by sending out ultrasonic pulses that bounce off of objects and are returned to the sensor to determine the distance from the object.

## Conclusions

The team has made significant progress this semester building on the work done by teams in previous semesters. The team decided to continue using the Raspberry Pi to interface with the sensors and drive the car. More batteries were added to provide sufficient power for all components of the vehicle especially the computer. Significant progress was made with the neural network and simulation in order to drive the vehicle efficiently.

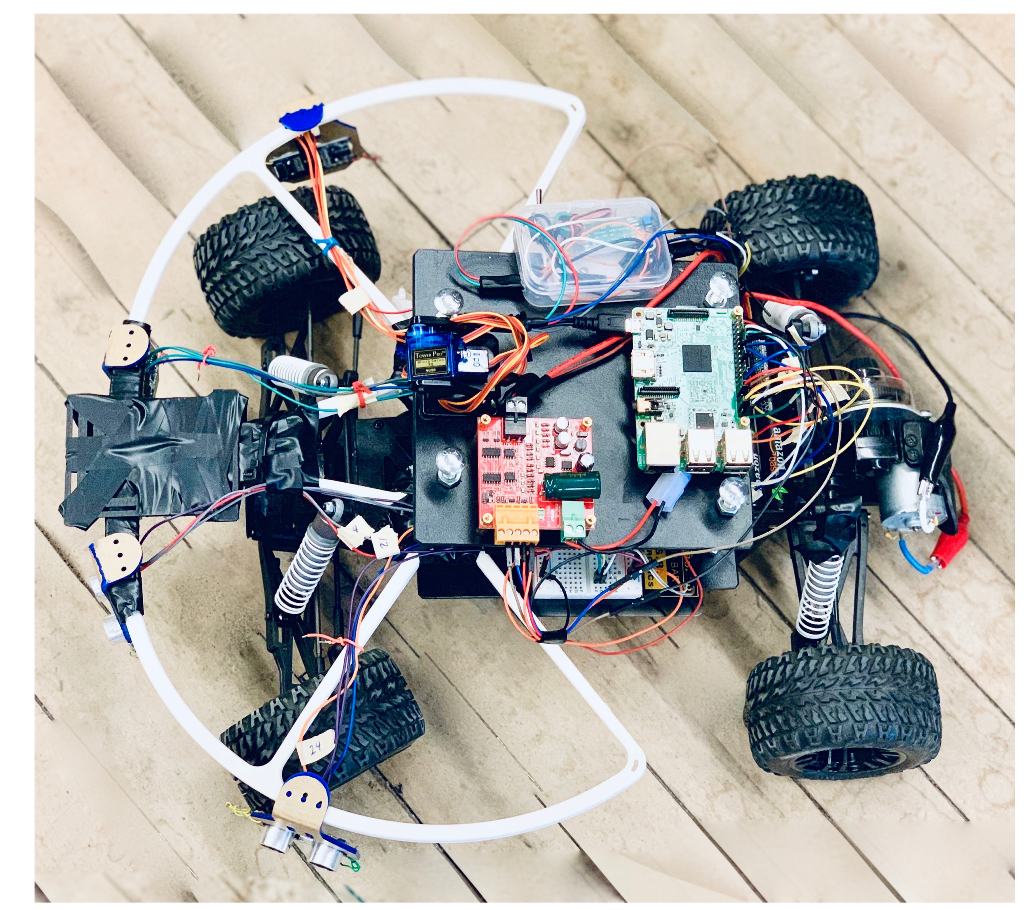

Figure 4: Top view of the vehicle

## References

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## Acknowledgments

Special thanks to Professor Midkiff for his guidance and understanding during the many months and iterations of this project