VIP Autonomous Land Vehicle
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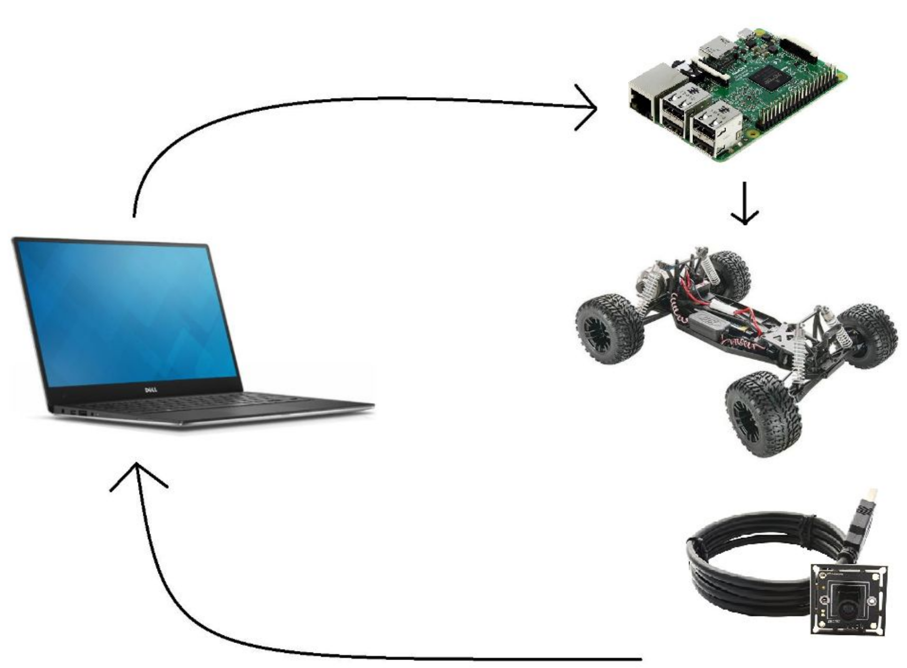
Introduction

Self-driving autonomous vehicles capable of self navigation is a rapidly growing industry slated to reach a market cap of $26B by 2025.[1] With this we will see an increased demand for professionals with autonomous vehicle experience. This is where the VIP Autonomous Land Vehicle (ALV) team comes into play. The goal for our project is to increase team member knowledge and experience in vehicle autonomy through the design of autonomous vehicle. To do so we have transformed an electric remote-controlled vehicle into an autonomous vehicle incorporating self navigation through image processing using a microcontroller, motor controller, sonar sensor, and a wireless camera with computer-aided vision.

Semester Objectives

- Design and finalize component circuit. This includes all necessary power and data connections needed for the various parts to work in tandem.
- Incorporate sensors that detect objects in path of vehicle and have a microcontroller perform necessary actions to avoid collision.
- Create a algorithm for the crawler which enables it to follow a required path and navigate in the environments with the aid of Ultrasonic sensor and the camera.
- Program basic autonomous functions based on image processing and analysis of live feed video.



Simplified diagram of vehicle communication

Materials

1. Duratrax Evader EXT2.4 RC Car
2. Raspberry pi 3
3. 9-36V PWM Motor Controller
4. Ultrasonic Sensor
5. Pan/Tilt bracket kit for camera
6. ELP megapixel Super mini USB camera
7. 2 NI-MH Rechargeable Battery Packs
8. Computer with Python

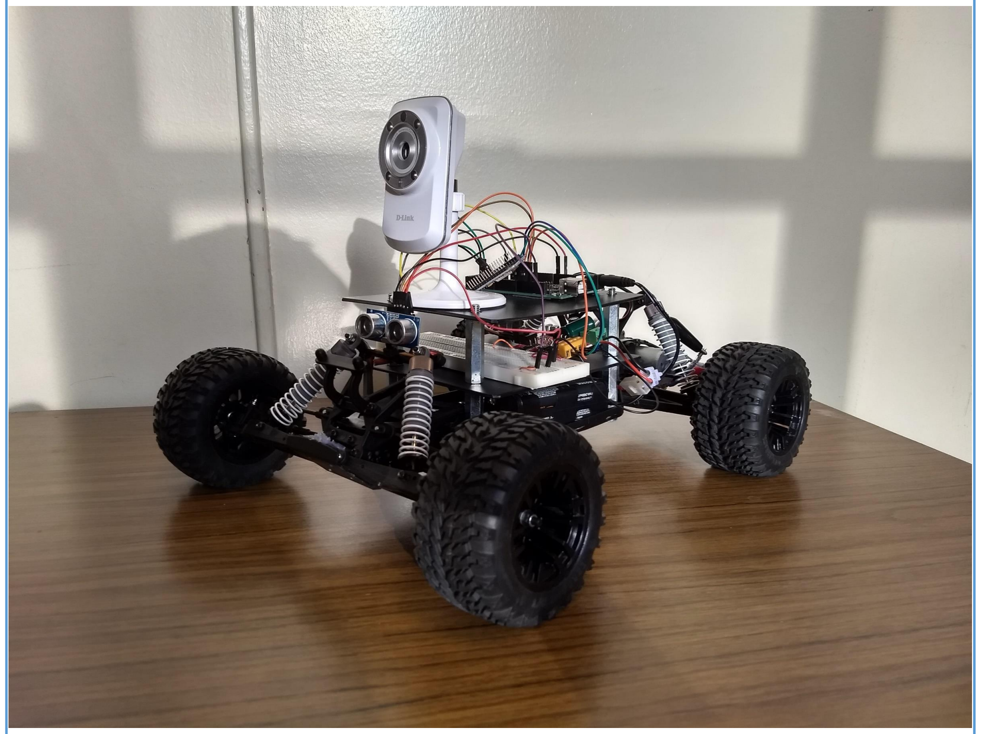
Methods

1. Using Open CV for image processing, detecting colored-tape and creating a required path for the crawler.
2. Implemented Raspberry Pi and using python to process images from the camera, control servos and motor.
3. Ultrasonic Sensors were used to detect surrounding obstacles and stop the crawler.
4. The Pan/Tilt bracket kit helps ultrasonic sensor detects objects from different angles.

Obstacles

- Making the crawler move backward and redirect instead of merely stop when ultrasonic sensor detects objects in front. Also having both pan/tilt bracket servos worked compatibly is also a challenge that needed to be solved.
- Reliable Tracking System. Ultrasonic sensors, while provide suitable secondary system for failsafe, can miss small objects and have limited range and clarity. Also the camera used was chosen for its low cost and ease to work with. Therefore, the quality of images is not as good when it comes to recognizing different colors.
- Supplying power. Components needed wildly different voltages and current requirements. A dedicated 9.6V battery pack powers the Arduino and a 7.2V battery pack powers the motor controller and an additional 5V circuit.

Semester Results



Finalized vehicle with all sensing and power equipment on board

- Determined **Problems with the old system** layout
  - Wifi module was too slow and unreliable
  - Current microcontroller could not effectively do image processing
  - Current Camera was only able to operate through a company's web server
- A **new layout** for the Land Vehicle System .
  - Hardware Changes:
    - Replaced Camera
    - New Microcontroller
    - Rotating Sensor Apparatus
- **New libraries** were researched, downloaded and test on the new system.
- Code for operating basic car elements was rewritten from Arduino robot C into python.
- New code was developed to allow for the steering and rotating sensor to work together in unison.
- Code to detect a path for the car to follow has starting being developed

Conclusions

Based on the progress of team members in previous semester, our team has upgraded the controller platform from Arduino to Raspberry Pi, so that we can use OpenCV in our code for image processing (Road/Obstacle detecting). On the other hand, we debugged all the code to make sure that the control of motor/servos and all the sensors will working fine on the new platform. All the experiences are incredibly useful for our members and we hope our work will inspire others to pursue research in the field of vehicle autonomy in the future.

Future Goals

Since our hardware is working as expectation, in the future ALV can put more focus on the improvement of software, our image processing code is already able to detect the indicated track on the ground(we are using duct tape) as expectation, but the accuracy of curve and tilted lines is need to be improved. ALV's next major goal is to improve the software of the Python-based microcontroller programing and image processing, also increasing stability of the wireless communication between the Raspberry Pi and the workstation so that ultimately our Vehicle can automatically detect road and obstacles accurately and navigate itself with minimize bugs possible.

Additional work can be done with the local processing of the onboard sonic sensor to improve autonomous functionality when connection is lost with the workstation and the vehicle loses computer vision. Moving past computer vision, a LiDAR detection system is another improvement that can be made to increase sensing reliability and better meet current industry standards.

References

1. https://www.theguardian.com/technology/2017/mar/17/self-driving-cars-california-regulation-google-uber-tesla

Acknowledgments

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