Introduction to Unmanned Vehicle Systems
Fall 2019

AUVSI Student Competition Homework

Deliverable 2:

Competition Name: Intelligent Ground Vehicle Competition (IGVC) with Rulebook 2019.
Challenge: Auto-Nav Course

1. **Mission/System Requirements for Qualification:**

The UVS vehicle design must satisfy the following specifications for qualification, according to the rules of the competition, mentioned below:

• **Design:**
The vehicle must have the mobility by direct mechanical contact to the ground such as wheels, tracks, pods, etc. or hovercraft.

• **Length:**
As per the rules, the vehicle's length should be designed between 3 feet (min) to 7 fet (max).

• **Width:**
The minimum width of the vehicle must be 2 feet and no longer than 4 feet.

• **Height:**
The vehicle's height cannot be greater than 6 six feet. Note: the emergency stop antenna is not considered as the vehicle's height.

• **Propulsion:**
According to the rules, the vehicle power needs to be generated onboard. Fuel storage or running of internal combustion engines and fuel cells are not permitted in the team maintenance area (tent/building).

• **Average Speed:**
Over the complete course of the vehicle, the average speed of the vehicle will be inspected and should exceed over one mile/hour (1 mph) for qualification.

• **Minimum Speed:**
Since, the average speed of the vehicle is expected to be more than 1 mph. It is implicit that the minimum speed of the vehicle must be 1 mph.

• **Maximum Speed:**

The competition rule demands to constrain the maximum speed of the vehicle up to five miles/hour (5 mph). The vehicle design needs to be conditioned with this requirement by hardware. No changes are allowed after the vehicle passes Qualification.

• **Mechanical E-stop and Wireless E-stop location:**

The proposed vehicle ought to consist an E-stop button, red in color with a minimum of one inch in diameter, easily identifiable even when the vehicle is on the move. Activating the E-Stop must bring the vehicle to an immediate and complete halt. Vehicle E-stops must be controlled through hardware rather than software.

• **Safety Light:**

A clear and visible light indicator must be installed on the vehicle. A solid light indicates that the vehicle power is turned on. To indicate the vehicle's autonomous mode only, the light must go from solid to flashing.

• **Payload:**

The ground vehicle will be compelled to carry a 20-pound weighted payload. If the payload falls off the vehicle during a run, the run will be terminated. The payload specifications are as follows: 18 inches long, 8 inches wide, and 8 inches high.

• **Lane Following:**

The vehicle must demonstrate that it can detect and follow lanes.

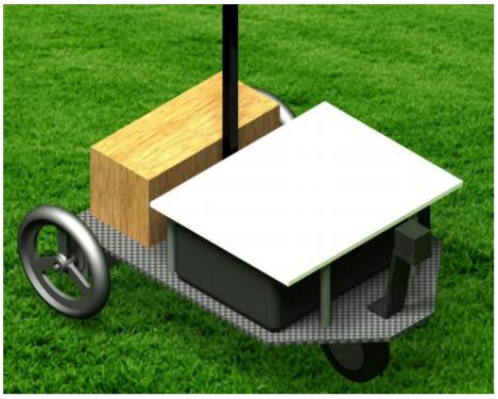
• **Obstacle Avoidance:**

The vehicle must demonstrate that it can detect and avoid obstacles.

• **Waypoint Navigation:**

Vehicle must prove it can find a path to a single two-meter navigation waypoint by navigating around an obstacle. The vehicle software cannot be reconfigured for waypoint navigation qualification.

Fig. Vehicle chassis model example



2. **Subsystem Selection:**

The 2 primarily important subsystems mentioned here are,

2.1 Electrical Subsystem:

The heart of this subsystem is a custom designed logic board which accommodates the safety light circuit, the microcontroller driving the motors, and the microcontroller driving the wireless e-stop.

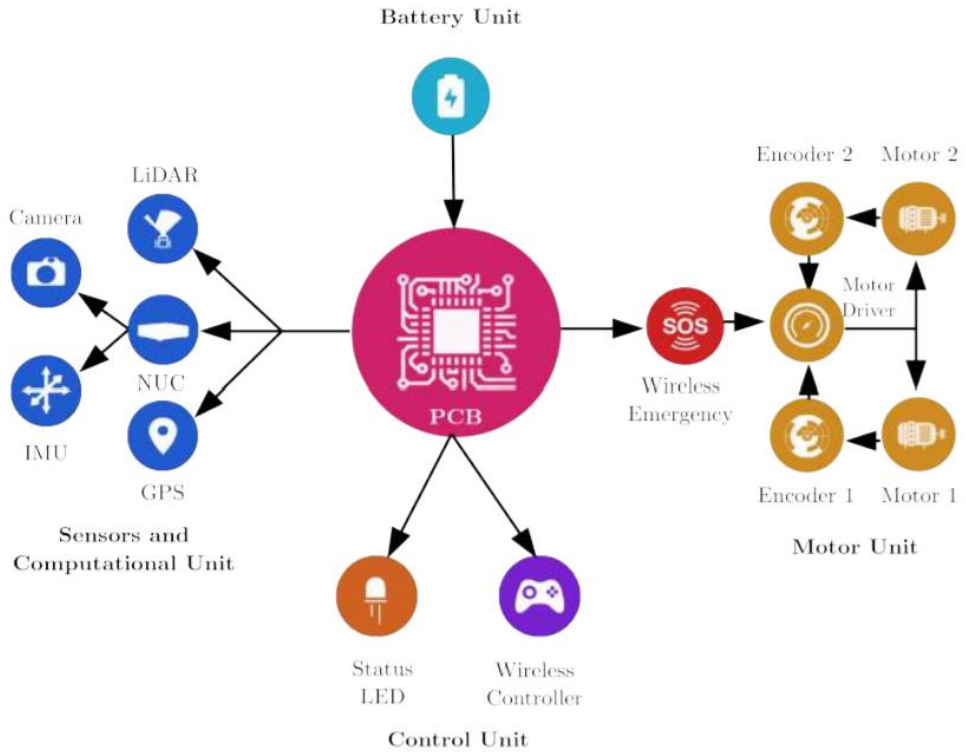


Fig. Electrical sub-sytem components

- The important functionalities provided by this subsystem are power distribution, electronics suite including CPU and sensor system integration, safety devices(E-stops) and safety lights.
- The onboard electronics sub-components make a part of this sub-system. The motor controllers and encoders assist to drive the vehicle motors and obtain wheel odometry.
- A microprocessor/mini-computer (Adafruit/Nvidia Jetson,etc) helps to compute the autonomous behavior of the system like path planning, perception, sensor fusion and many more. One more important part is the logic PCB board which interfaces between electrical and software systems.
- The UGV system would require power to drive itself throughout its run until it completes its goal. According to the rules, the vehicle power needs to be generated onboard.

2.2 Software Subsystem

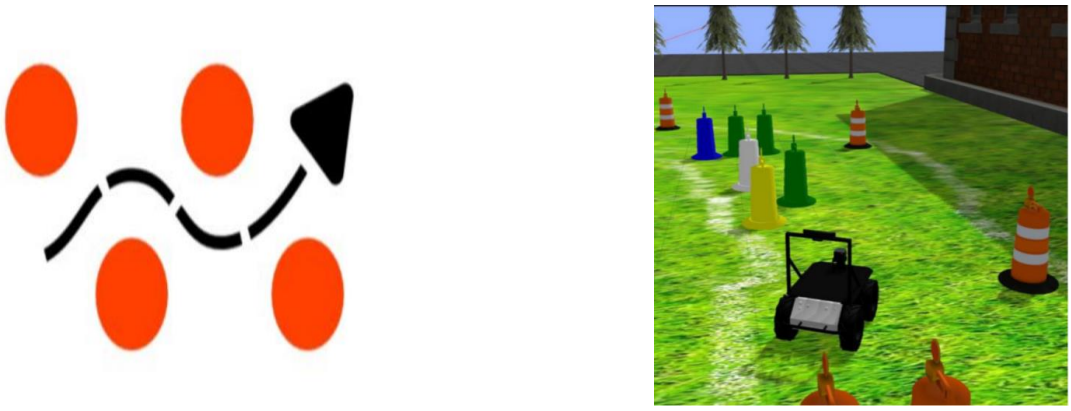


Fig. Software simulation example

- The major functionality of the software subsystem is vital for the behavior of the autonomous mode of the UVS vehicle.
- The functionality consists of waypoint navigation, lane detection and following, obstacle detection and avoidance, map generation, goal selection and path generation/planning.
- It consists of perception, navigation, path planning, learning and adaptability and many more. Perception: the vehicle needs to detect obstacles to avoid collisions in the lane using sensors. Path generation: the vehicle needs to plan and generate an economically shortest path using GPS waypoints. Learning: this sub-component is a significant part where the system self-analyses its actions in order to improve its performance.
- Simulation: This is a very significant component of the subsystem. In this environment the uvs vehicle design is trained virtually in a simulated environment compelled with the competition rules. The simulation training happens to be an important part of the autonomous behavior of the vehicle system.