UNMANNED GROUND VEHICLE(UGV) PROJECT

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Introduction

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Project Overview:

The goal of this project is to create an Unmanned Ground vehicle (UGV) that would compete as a team with an Unmanned Aerial Vehicle (UAV), in a competition held Annually by Raytheon at Virginia Tech. The competition involves 4 challenges and a bonus round, and our aim is to create a vehicle that meets all the competition requirements and is able to complete all challenges within the timeframe given.

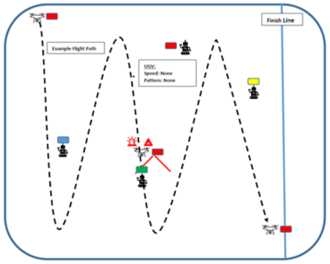
Problem Statement :

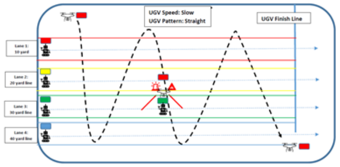
The ground vehicle should be able to autonomously navigate through a predefined course, recognize and avoid obstacles in its path and communicate with a drone. We looked into adding features such as a GPS module, obstacle detecting sensors on each side of the vehicle, and Wi-Fi or Bluetooth modules. These features can help ensure a vehicle that always takes optimized routes, prioritizes a safe and smooth operation all while communicating and working with a drone. The vehicle uses the selected optimized routes, data from the sensors and drone to ensure it reaches its destination using the quickest available route, while avoiding any obstacles on the way.

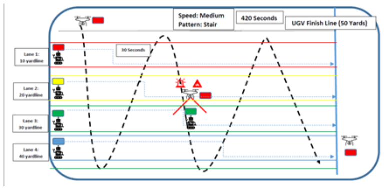
Goals:

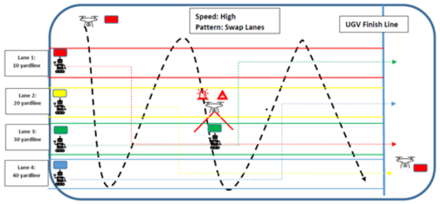
Build UGV that can Complete the challenges

Challenges:









Design Requirements(Product Specification)

Requirements	**Items**	**Quantity**
1. Product Specification	GPS and Compass Module(for navigation)	1
	On board Computer	1 to 2
	Distance sensors	1 to 2
	Rechargeable Batteries	1 to 2
	Communication module (Wi-fi or Bluetooth)	1
	Buzzer (for audible alerts)	1
	Gear sets (for motors) and wheels	4
	Moisture Sensors	3 to 6
	ArUco marker	1

Design Requirements(Constraints)

2. Constraints	**Environmental Constraints** 1. Energy Consumption 2. Emissions 3. Noise Pollution
	Socio-Cultural Constraints 1. Privacy Concerns 2. Safety Concerns 3. Public Perception
	Compliance (Rules, Regulations, and Standards) 1. Testing and Certifications 2. Regulatory Approvals 3. Data Protection 4. Liability and Insurance 5. FAA Regulations

Solution 1

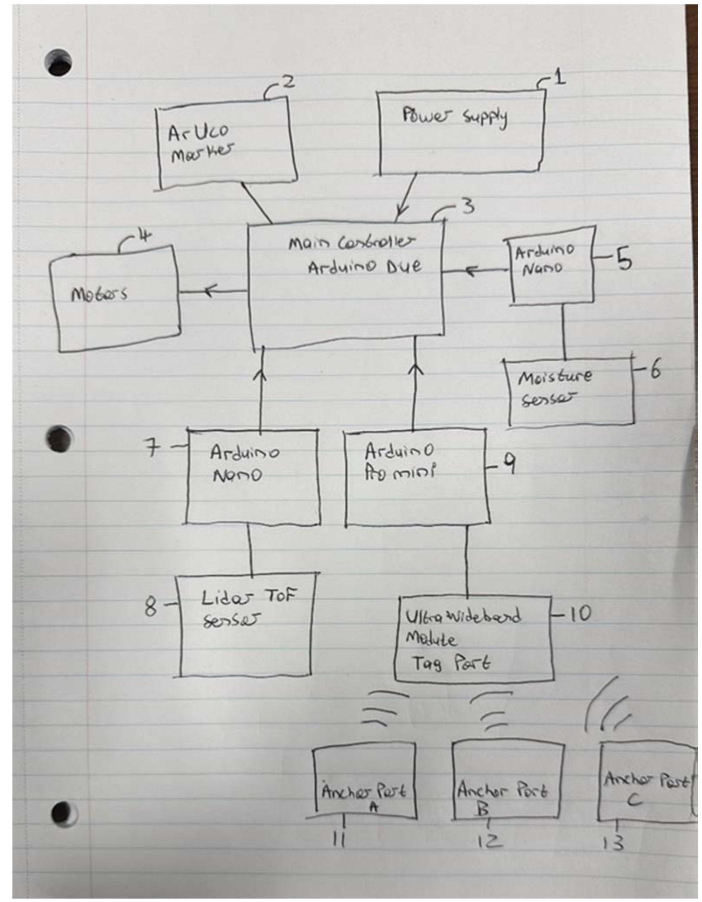
Description: The location of the UGV is determined by triangulating using radio waves sent by ultra-wideband Anchor ports (11, 12, & 13) and received by the ultra-wideband Tag port (10) on the UGV. The location data is then sent to the main Arduino Due (3) by an Arduino Pro Mini (9) which communicates with the Tag port (10). The UGV navigates to the correct destination using the main Arduino Due (3) to control the motors (4). The UGV detects obstacles using a Lidar sensor (8) that communicates with an Arduino Nano (7) which sends data about the obstacle to the main Arduino Due (3). The UGV detects moisture using a moisture sensor (6) that communicates with an Arduino Nano (5) which sends data about the obstacle to the main Arduino Due (3). All the electronic components are powered by the power supply (1). The ArUco marker (2) is placed on the UGV facing upwards.

Pros :

- Accurate locator module(to cm)
- Accurate obstacle detection
- Navigation module works indoors and outdoors

Cons :

- Uses more components
- Involves complex wiring
- Heavy due to the number of components



Solution 2

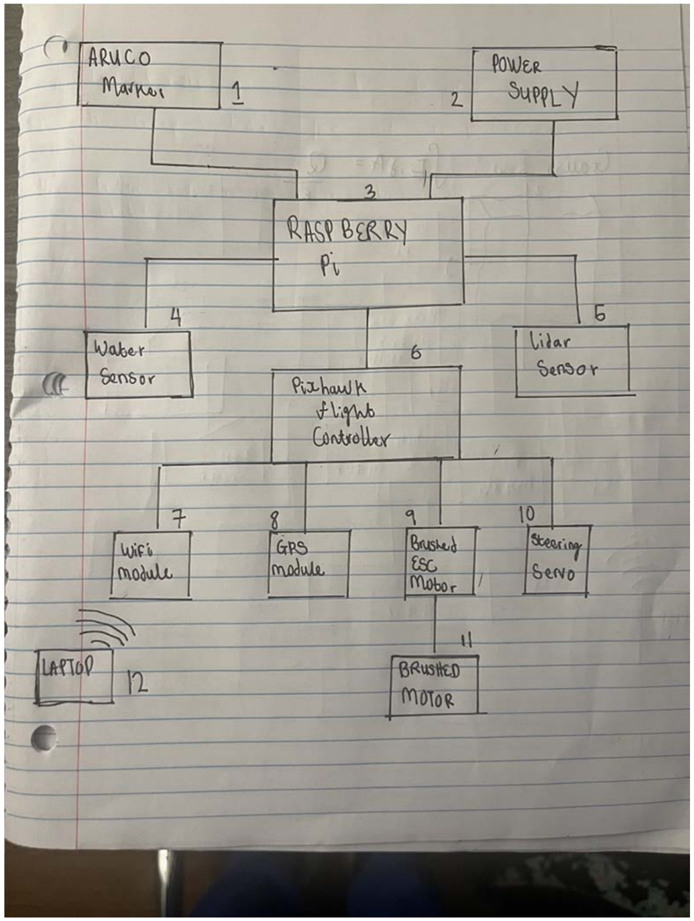
Description: The Pixhawk flight controller (6) serves as a primary control system for the UGV, processing real-time data from the GPS and Compass (8) to determine the UGV's position and orientation. It then controls the Steering Servo (10) and Brushed Motor ESC (9), which in turn controls the Brushed Motor (11) based on instructions sent to the Pixhawk (6) through the Wi-Fi module (7) from the ArduRover software on a Laptop (12) or through a python script on the Raspberry Pi (3). The Raspberry Pi (3) acts as an onboard computer, handling object avoidance and water detection by processing real-time data from the Lidar (5) and Water sensor (4).

Pros :

- Tested and tried navigation module
- Accurate obstacle detection
- Most components can be bought via development kit
- Guide available for development
- User friendly

Cons :

- Learning curve for Raspberry pi and Ardurover software
- Expensive

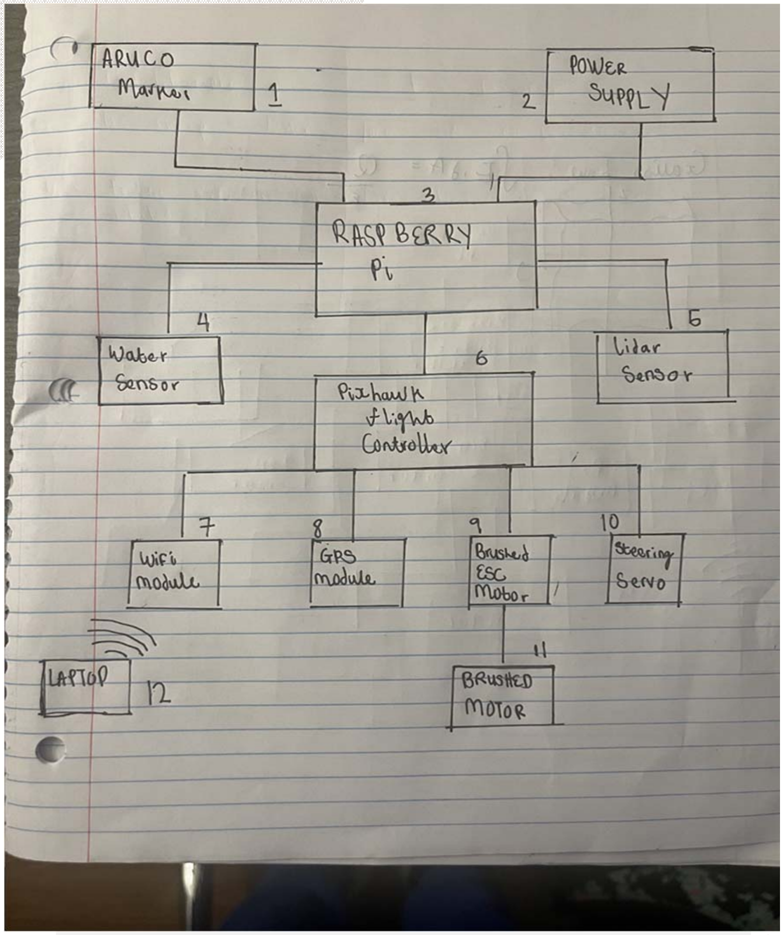


Design Decision Matrix

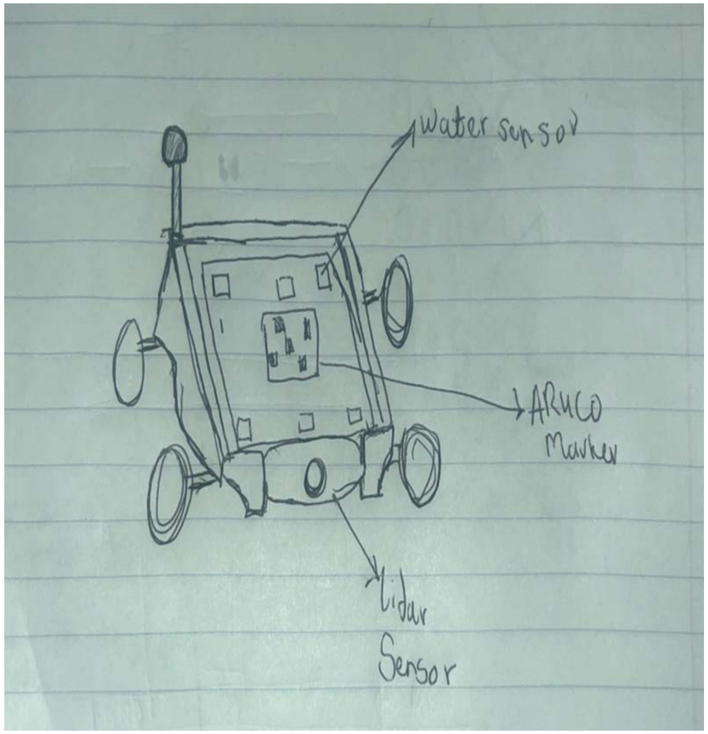
	Wt	Design 1	Score	Agg. Score	Design 2	Score	Agg. Score
Functionality	5	Ultra-wideband Technology (UWB)	4	20	GPS & Compass Technology	5	25
Connectivity	2	Radio Waves	5	10	Wi-Fi	5	10
Weight	4	Approx 6-7 lbs.	3	12	Approx 6-7 lbs.	3	12
Power	3	More components to power	2	6	Less Components to power	4	12
Convenience	1	Learning curve to implement UWB chips	3	3	Comes with guides and videos	5	5
TOTAL				51			64

Top Level Solution

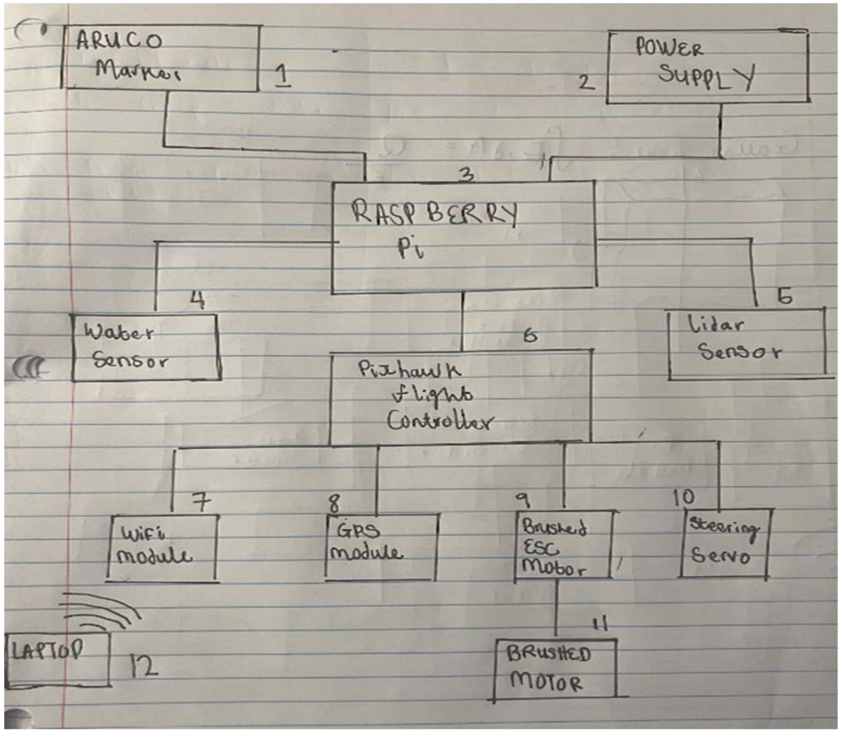
Bearing in mind the results from our decision matrix, likewise, also considering factors of cost we have decided to select solution 2 as our top solution.



Component Level Blueprint



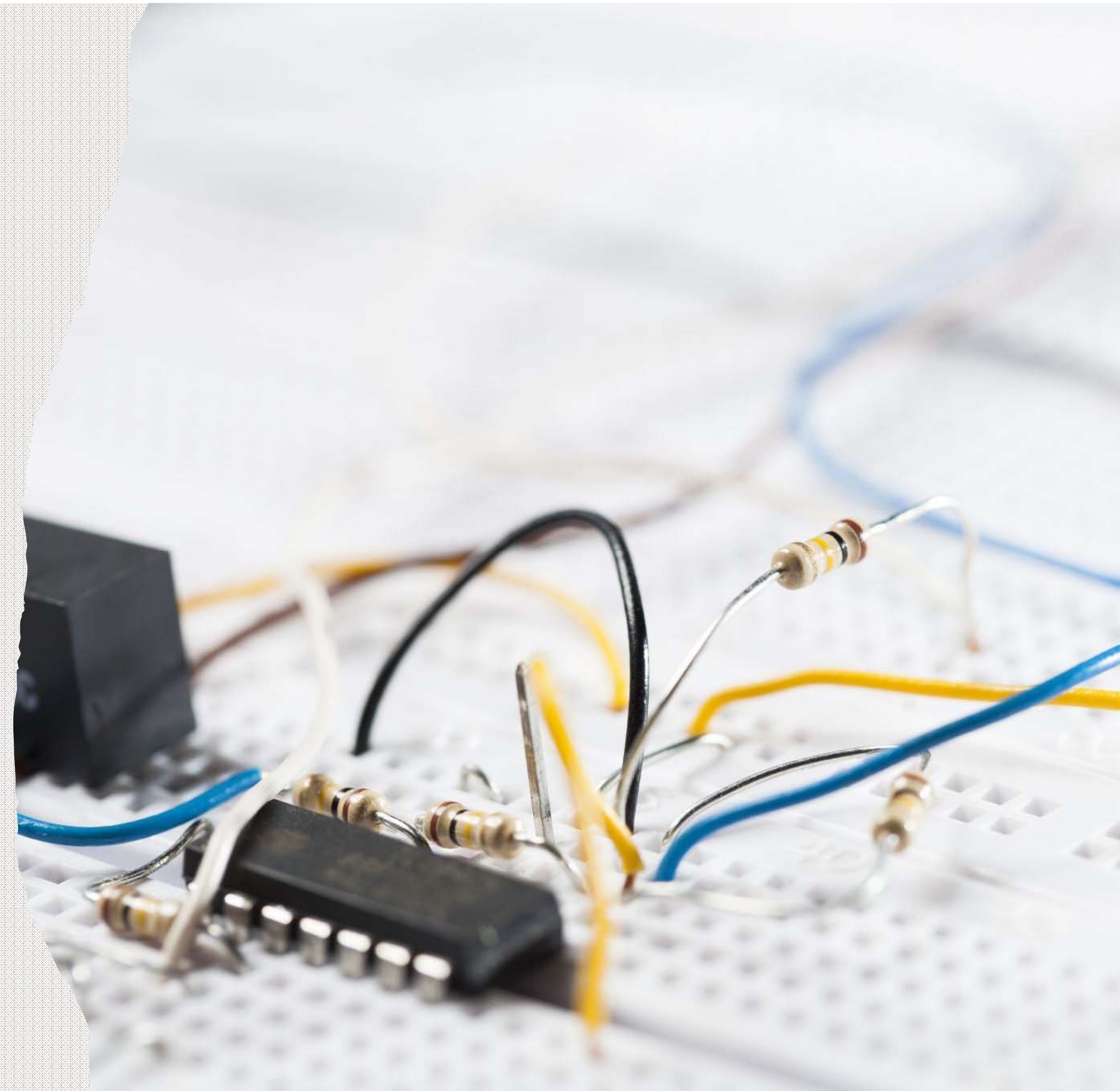
EXTERNAL FRAME



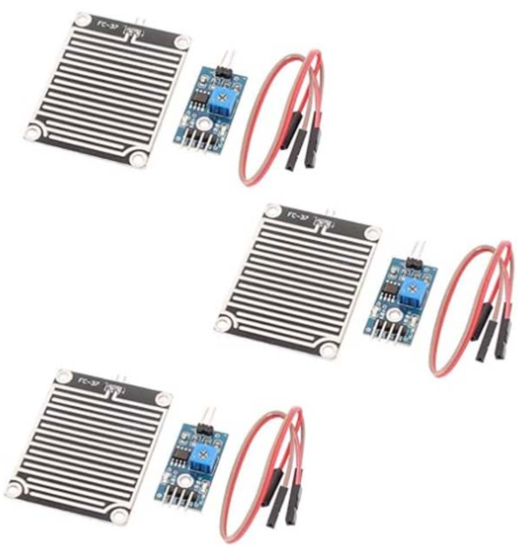
INTERNAL STRUCTURE

MAIN COMPONENTS

- Lidar ToF Sensor
- Water Sensor
- Raspberry Pi
- Pixhawk flight controller



WATER SENSOR



- The Water Sensor will assist the UGV's in detecting water. It will inform the Raspberry Pi that 20 ml of water has been dropped on the UGV.

Specifications:

- Weight – 0.35 ounces
- Dimensions – 4 x 2.5 x 0.5 inches
- Able to detect 20 millitres of water

LIDAR TOF SENSOR

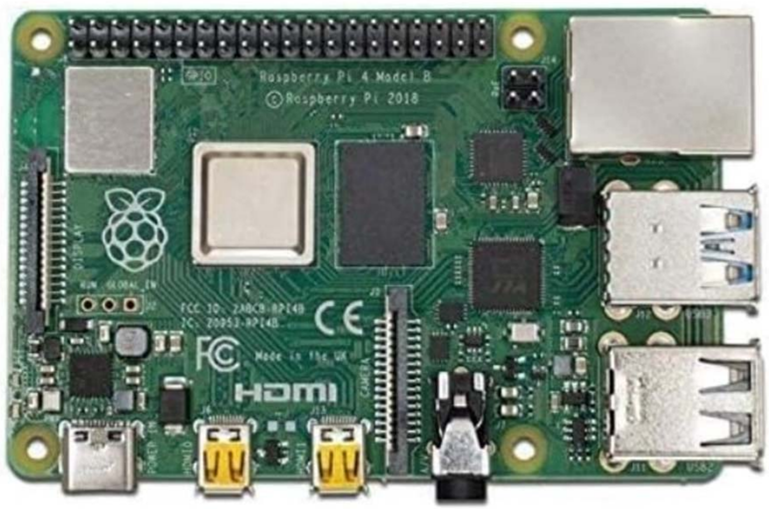
- The Lidar Tof sensor will play a crucial role in detecting the obstacles around the UGV and alerting it when there are obstacles within a particular distance

Specifications:

- Distance Covered/Range- 0.2metres- 8metres
- Weight – 0.63 ounces
- Dimensions - 1.18 x 0.79 x 0.39 inches

RASPBERRY PI

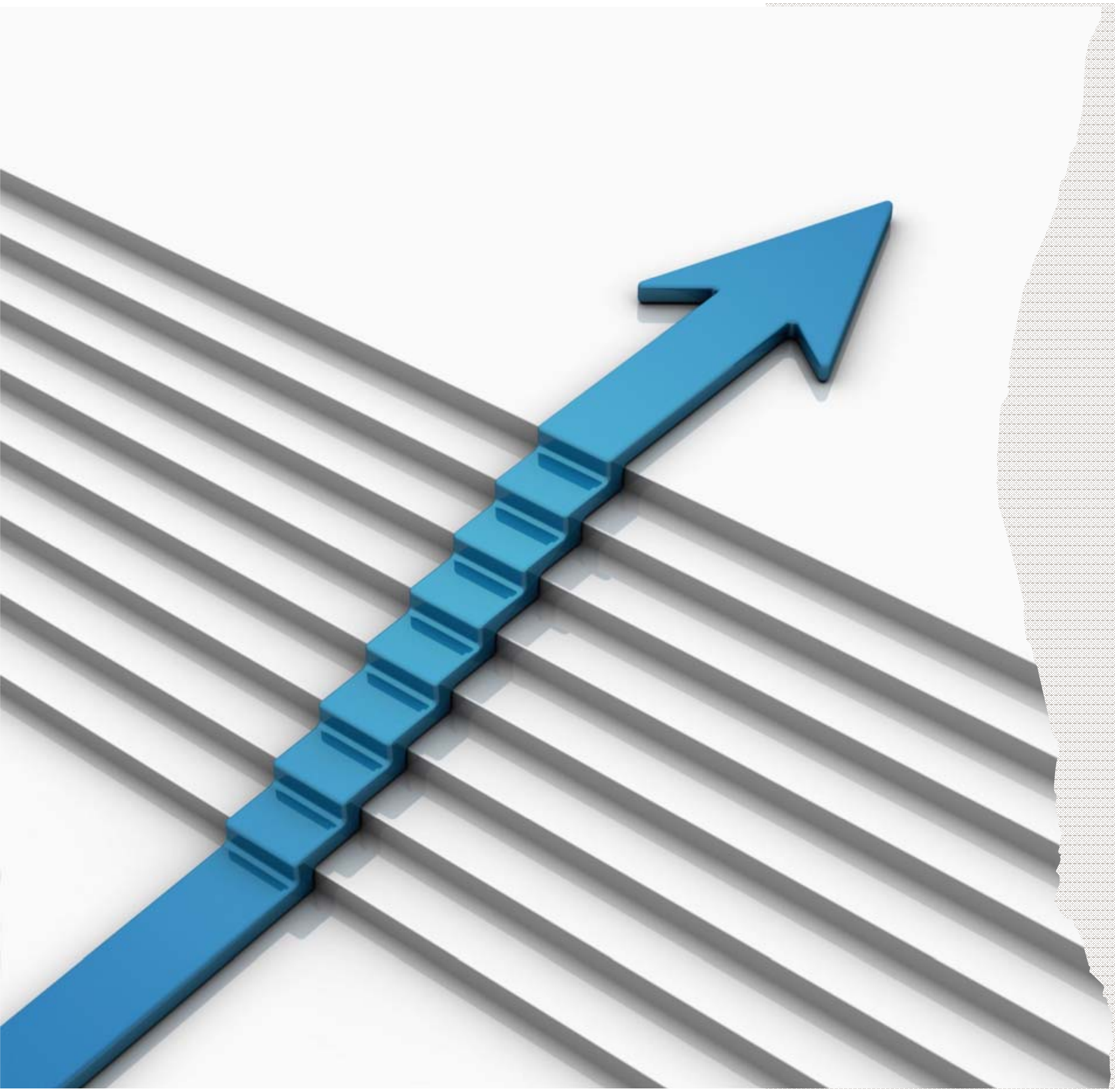
- Raspberry pi is going to act as an onboard computer, handling object avoidance and water detection by processing real-time data from the Lidar and Water sensor.
- The Raspberry pi sends information to the Pixhawk depending on the data it receives.
- We are using the raspberry pi over the arduino because of its superior processing power and multi-tasking capabilities due to the operating system it possesses.



PIXHAWK FLIGHT CONTROLLER

Roll over image to zoom in

- The Pixhawk flight controller serves as a primary control system for the UGV, processing real-time data from the GPS and Compass to determine the UGV’s position and orientation.
- It then controls the Steering Servo and Brushed Motor ESC, which in turn controls the Brushed Motor based on instructions sent from the raspberry pi.
- Specifications:
  - The advanced 32-bit ARM CortexM4 high-performance processors, can run NuttX RTOS real-time operating system.
  - We have M8N GPS for the Pixhawk flight controller.
  - And the 3DR Radio Telemetry Kit for this flight controller



Next Steps

- Order Components
- Install Software Platforms
- Develop Python Scripts
- Assemble UGV
- Test and Debug

Conclusion

While we have meticulously listed each component mentioned above, our plan is to undertake the project utilizing a comprehensive drone dojo rover kit. This kit offers the advantage of including all the required components, sparing us the need to procure each one separately. For your convenience, you can find the link to access detailed information and acquire this rover kit below. https://dojofordrones.com/pihawk-rover-kit/

THANK YOU