# Follow The Leader

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## Project Goal

In our project, we focus on having an autonomous follower drone to follow a primary leader drone. The project would help improve military technology by exploring ways for a single drone to communicate or control multiple autonomous drones.

## Background

Drones are currently used in military surveillance. Although drones are a useful piece of technology, there is a need for better drone coordination; drone coordination still has room for improvement, which will greatly improve surveillance operations.

## Materials & Methods

Computations to obtain desired heading:

$$\theta = \text{atan2}( \sin \Delta\lambda \cdot \cos \varphi 2 , \cos \varphi 1 \cdot \sin \varphi 2 - \sin \varphi 1 \cdot \cos \varphi 2 \cdot \cos \Delta\lambda )$$

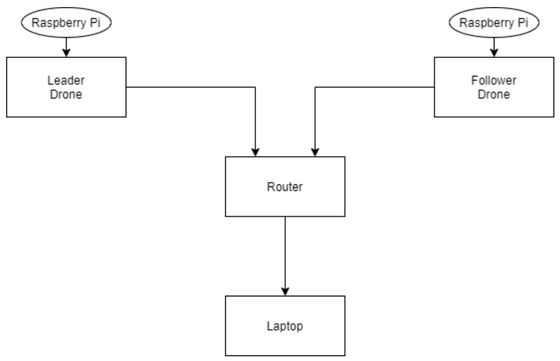
- $\varphi 1, \lambda 1$ is the starting point
- $\varphi 2, \lambda 2$ is the end point
- $\Delta\lambda$ is the difference in longitude

We enabled and calibrate the drone's magnetometer then obtain the drone's magnetic heading as well as current coordinates. Next, we calculate the desired heading which is the direction of the leader drone relative to the follower drone. The drone then rotates until it achieves the desired heading and then flies forward. The drone also increases its elevation until it is within a certain threshold of the leader drone.

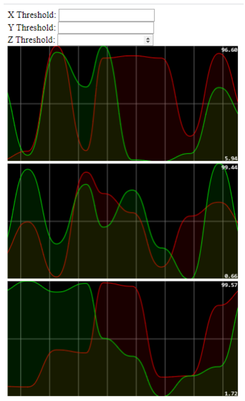
Drone connection will be established via a router. The router will allow a connection between a Raspberry Pi that will be attached to our Leader drone, the autonomous follower drone, and a laptop that will act as our base station. The Raspberry Pi will collect GPS coordinates of the Leader drone and perform the computation needed to alter the flight path of the follower drone. The flight controller is implemented in NodeJS.

## Conclusion

The Raspberry Pi (attached to leader drone) will be used for computing the flight control for the follower drone.The follower drone receives NodeJS flight control commands to correct its path to follow the leader. The raspberry PI also sends data to the laptop so that it can display it in the GUI.

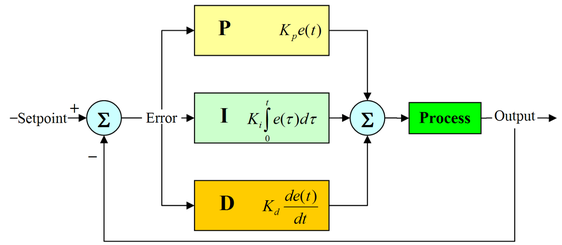



## Progress




We have implemented PID controllers for drone movement. PID stands for proportional, integral and derivative. The controllers will continuously calculate the error by subtracting the set value with the actual value and its job is to reduce the error to be close to zero. This allows the drone to fly autonomously and to match the distance thresholds as close as possible.

The GUI has been implemented so that the user can change the threshold difference between the follower drone and the leader drone. Real-time graphs are created so that both of the GPS locations of the leader drone and the follower drone are displayed; each graph represents the latitude, longitude, and elevation of each drone.




## Challenges

In order to send data to the follower drone from the leader drone, GPS modules attached to a Raspberry Pi will be used to communicate to the base station, where the flight path for the follower drone will be created.GPS data was only obtainable from a single drone at a time due to the base station being unable to connect to two different wifi connections. Another issue was the relaying of data between the GUI and the base station. Both of these were written in incompatible programming languages, thus raising a problem. A framework to integrate the GUI and base station was needed, and was a challenge. The control flow of NodeJS was unfamiliar to us, causing unexpected behaviors that we did not expect.

## References

1 P. Bouman, et al. Dynamic Programming Approaches for the Traveling Salesman Problem with Drone. Networks, vol. 72, no. 4, 2018, pp. 528–542.

2 L. Mottola et al. Team-Level Programming of Drone Sensor Networks. Proceedings of the 12th ACM Conference on Embedded Network Sensor Systems - SenSys '14, 2014.

## Future Research

Object detection through a camera attached to the drone will allow the drone to avoid obstacles while flying towards the GPS coordinates of the leader.

The drone's ability to autonomously return back to the base station will also be impilemented. The drone will either backtrack using previous GPS coordinates, or calculate the shortest distance and fly straight to the base station.

## Contact Information

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