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Project Stage 3 Report

Introduction:

This report will discuss the different aspects of the project regarding motivation, problem definition, code implementation and results thus far.

Motivation:

The motivation of this project follows Ahmed Baraka's research thesis on wind estimation using unmanned aerial vehicles (UAV), also known as drones. As part of the research project, the first step is to replicate and implement the wind estimation technique found in "A K Nearest Neighborhood-Based Wind Estimation for Rotary-Wing VTOL UAVs" by Liyang Wang and Guarav Mishrav. This paper employs K-Nearest Neighbors (KNN) regression to estimate the wind speed given UAV Inertial Measurement Unit (IMU) sensor data.

Problem Definition:

One of the main concerns for vertical take-off and landing vehicles (VTOL) is wind estimation. Typically sensors are very inaccurate, especially at low speeds, and are affected severely by the rotor down-wash effect. This lack of accuracy can dramatically impact the performance of the UAV, leading to unpredictable flight behaviors and instability. In addition, the utilization of add-on sensors increases the weight of the UAV and decreases flight time. The proposed wind estimation technique eliminates the need for an additional sensor and provides the necessary information to the UAV for stable flight in windy environments.

Solution:

In Wang's implementation, 19 features are used and are built from the average and the variance of the error between the desired value and the actual value for the UAVs physical states (positional, rotational) and control inputs. Wang's algorithm was trained using software and tested using real hardware. We chose to do both training and testing in Python. We used a flight simulation in Matlab to collect 30 data points per second for 30 seconds (900 data points in total). For preliminary training and testing we used the first 6 physical states (x, y, z,roll, pitch, yaw) of the UAV as our features and the corresponding wind speed for our target values. We ran the raw data through the KNN regression algorithm with a test data split of 30%. Below are the results we gathered using the provided code.

```
(base) C:\Users\Natha\OneDrive\Desktop\Machine_Learning\Project>python main.py
beginning data split
splitting complete
beginning fitting
beginning scorring
Accuracy of knn regression algorithm: 95.812

(base) C:\Users\Natha\OneDrive\Desktop\Machine_Learning\Project>
```

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Reference

Liyang Wang, Guarav Misrav, Xiaoli Bai. (March 2019). A K Nearest Neighborhood-Based Wind Estimation for Rotary-Wing VTOL UAVs. *drones.* Retrieved from https://www.researchgate.net/publication/332175471_A_K_Nearest_Neighborhood-Based_Wind_Estimation_for_Rotary-Wing_VTOL_UAVs