# **Optical Flow For Vision-Aided Navigation**

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## 1. Introduction

A current subject of interest in navigation is the use of vision as an aiding source. Most unmanned aerial vehicles (UAVs) have a camera onboard, so a navigation system with vision could use these existing sensors instead of requiring that new sensors be added, which would be an advantage when the space available for sensors is limited. Some vision-aided navigation algorithms that have been developed recently find displacement between images by matching SIFT or SURF features. However, this type of algorithm is usually computation-intensive, and most UAVs are small and have very strict weight and power limitations for the processors that can be used. An alternative would be to use optical flow to find displacement, which tends to have lower requirements for the processor. Unfortunately, the cameras available on UAVs usually have relatively low frame rates, and there is enough displacement between images that typical optical flow algorithms are not effective. For my project, I want to find and optimize an algorithm that can apply optical flow techniques to the type of data encountered in navigation.

### 2. Related Work

Several algorithms have been proposed to improve the performance of optical flow techniques. Among these are hierarchical methods which compute optical flow at different scales [3], methods based on descriptors like SIFT or SURF which use optical flow to improve the solution [2], and methods that take advantage of the image structure using techniques like segmentation [1].

### 3. Experiment

I plan to compare several of these algorithms. (The ones mentioned above are a few interesting algorithms that I've come across, but after doing more research, I will finalize a short list of algorithms to look at.) I will implement each of these algorithms in MATLAB and apply them to several datasets that are similar to the type of images that would be encountered in navigation. I plan to collect these images using Google Earth, which provides aerial images of most of the earths surface. These datasets will include images from regions with different types of landmarks and terrain, as well as different altitudes. Next, I will select one algorithm that performs well on the data I provide, and try to improve on it or optimize it for the type of data found in navigation.

I will compare the algorithms to each other in both accuracy and computational performance. Additionally, I will implement a simple SIFT-matching algorithm for comparison with each of these new algorithms. I expect the displacement calculated by my optical flow algorithm to match that calculated by matching SIFT features, and I expect the computational performance to be better. I plan to compare the algorithms' accuracy in MATLAB. I will compare the performance by looking at the computational complexity of the algorithms. If I have time, I'd also like to implement both the SIFT-matching algorithm and the optical flow algorithm I develop in C to do a more accurate comparison.

I expect to be able to optimize the algorithm I select by using specific assumptions that are true for navigation data. In navigation, we can assume that all motion in the image is due to the motion of the camera. This would not apply to all situations (for instance, navigation in an urban environment), but in situations where weight and power are limited, like on a UAV, we are likely to be far away from anything else that is moving. However, we may encounter objects at different distances in the image, so I will not be able to assume that optical flow is continuous over the entire image.

#### References

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