Project 2: UAV's Ground Sample Distance (GSD) calculation using AU drone dataset.

Mehul Raval, Hrishikesh Rana, Divya Patel, Prashansa Shah, Aditya Chaudhari,
Ahmedabad University

Abstract

This project focuses on deriving the Ground Sample Distance (GSD) using linear regression analysis and its relationship with object size in aerial imagery, explicitly utilising the AU drone dataset for UAVs (Unmanned Aerial Vehicles). The GSD is a critical parameter for accurately determining objects' actual size and orientation in images captured by UAVs. This study establishes a method to calculate GSD based on object size by employing linear regression techniques on real-time data. Understanding GSD is essential for various applications, including object detection, size estimation, and orientation assessment in aerial imagery.

1. Keywords

Ground Sampling Distance, Object detection, PCA (principal component analysis), Feature extraction, Model creation, Linear Regression, Gaussian blur, bounding box, Root Mean Square Error.

2. Introduction

The primary aim of this project is to develop a robust methodology for calculating Ground Sample Distance (GSD) using an AU (Autonomous Unmanned) drone dataset. GSD is a critical parameter in aerial imagery, providing a relationship between pixel dimensions in images and actual distances on the ground. The project will employ linear regression on real-time data to establish this relationship, enabling accurate object size and orientation determination in Machine learning and computer vision applications.

3. Methodology

3.1. Data Collection

The data collection process involved using a nearly one-minute video as the dataset, from which frames were extracted at 30 frames per second (fps). These frames were then subjected to Gaussian blur to enhance image quality. Subsequently, the filtered images were saved for further processing.

3.2. Object Detection

Next, the filtered images underwent analysis using a custom code that identified areas within a specific range of RGB values. When these colour and area criteria were met, a bounding box was automatically generated around the identified object in each frame. This process was repeated for all frames in the dataset, placing bounding boxes around the required objects in every frame.

3.3. Feature Extraction

The details of each object, such as height, width, x and y coordinates, the angle from the centre, and average RGB values, were extracted and compiled into a CSV file.

3.4. Model Creation for GSD

The methodology includes loading the dataset using pandas, dropping redundant features, scaling the features with StandardScaler, performing Principal Component Analysis of the variation caused by each feature and selecting the first eight. This process helps reduce dimensionality and understand the data's variance in a compact representation. This extracted data is the input for calculating the Ground Sample Distance (GSD) using linear regression analysis and object size relationship.

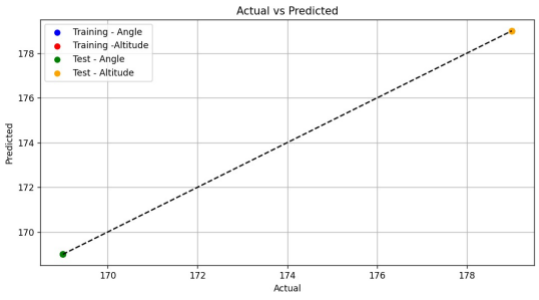
4. Result:

We fit a linear regression model on the data collected to find the exact dimensions of the object. We found zero train and test errors due to establishing a perfectly linear relationship between the features and target variables.

Train RMSE	**0**
Test RMSE	**0**

Similarly, we fit a model between GSD values, thus calculated, and the actual GSD observed to establish a linear relationship and find the corresponding errors.

Train RMSE	**1.28E-16**
Test RMSE	**1.28E-16**



5. Discussion:

We trained the model after removing groups of redundant features and randomly extracting singular data examples from redundant batches. However, due to extensive redundancy, the model returned zero train and test errors for each instance. We fit the model on predicted and actual GSD values to obtain minimal train and test errors.

6. Conclusion:

As we trained our model for a specific video and detected a single object, we obtained data with high redundancy. The features and the target values have a linear relationship, so the model perfectly fits the data and returns near zero error while predicting the object size. Moreover, the model does not overfit, as the test error is negligible.

7. Reference:

- "The Risks of Steroid Use - OrthoInfo - AAOS," *The Risks of Steroid Use - OrthoInfo - AAOS*, May 01, 2019. https://orthoinfo.aaos.org/en/staying-healthy/the-risks-of-using-performance-enhancing-drugs-in-sports/
- Propelleradmin, "What is Ground Sample Distance and How Does it Affect Your Drone Data?," *Propeller*, Mar. 07, 2023. https://www.propelleraero.com/ground-sample-distance-gsd-calculate-drone-data/
- Y. M. Bhavsar, M. Zaveri, M. S. Raval, and S. B. Zaveri, "Vision-based Investigation of Road Traffic and Violations at Urban Roundabout in India using UAV Video: A Case Study," *Transportation Engineering*, Dec. 01, 2023. https://www.sciencedirect.com/science/article/pii/S2666691X23000477?fr=RR-2&ref=pdf_download&rr=86540e0c4be86ec8