A robust numerical method of iteratively solving for the drag force and coefficient of drag of an unknown object has been developed and implemented in Mathematica in a form readily convertible to other codes. This algorithm is based on an innovative combination of the Verlet and Runge-Kutta integration methods. The input data is object position data as a function of time, which might, for example, be based on a previous photogrammetry analysis. This new method is not limited to object location based on photogrammetry.

Adaptive Sampling of Spatiotemporal Phenomena With Optimization Criteria

NASA's Jet Propulsion Laboratory, Pasadena, California

This work was designed to find a way to optimally (or near optimally) sample spatiotemporal phenomena based on limited sensing capability, and to create a model that can be run to estimate uncertainties, as well as to estimate covariances. The goal was to maximize (or minimize) some function of the overall uncertainty.

The uncertainties and covariances were modeled presuming a parametric distribution, and then the model was used to approximate the overall information gain, and consequently, the objective function from each potential sense. These candidate sensings were then cross-checked against operation costs and feasibility. Consequently, an operations plan was derived that combined both operational constraints/costs and sensing gain.

Probabilistic modeling was used to perform an approximate inversion of the model, which enabled calculation of sensing gains, and subsequent combination with operational costs. This incorporation of operations models to assess cost and feasibility for specific classes of vehicles is unique.

Building a 2.5D Digital Elevation Model From 2D Imagery
High-quality DEMs are generated from a collection of 2D images.

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When projecting imagery into a geo-referenced coordinate frame, one needs to have some model of the geographical region that is being projected to. This model can sometimes be a simple geometrical curve, such as an ellipse or even a plane. However, to obtain accurate projections, one needs to have a more sophisticated model that encodes the undulations in the terrain including things like mountains, valleys, and even manmade structures. The product that is often used for this purpose is a Digital Elevation Model (DEM).

The technology presented here generates a high-quality DEM from a collection of 2D images taken from multiple viewpoints, plus pose data for each of the images and a camera model for the sensor. The technology assumes that the images are all of the same region of the environment.

The pose data for each image is used as an initial estimate of the geometric relationship between the images, but the pose data is often noisy and not of sufficient quality to build a high-quality DEM. Therefore, the source imagery is passed through a feature-tracking algorithm and multi-plane-homography algorithm, which refine the geometric transforms between images. The images and their refined poses are then passed to a stereo algorithm, which generates dense 3D data for each image in the sequence. The 3D data from each image is then placed into a consistent coordinate frame and passed to a routine that divides the coordinate frame into a number of cells. The 3D points that fall into each cell are collected, and basic statistics are applied to determine the elevation of that cell. The result of this step is a DEM that is in an arbitrary coordinate frame. This DEM is then filtered and smoothed in order to remove small artifacts.

The final step in the algorithm is to take the initial DEM and rotate and translate it to be in the world coordinate frame [such as UTM (Universal Transverse Mercator), MGRS (Military Grid Reference System), or geodetic] such that it can be saved in a standard DEM format and used for projection.