Positioning using the comparison of images to digital surface models.

Jason David Russell

2015

1 Abstract

The purpose of this project is to try to resolve the position of a camera by comparing images taken of objects against a digital surface model containing those objects. A secondary purpose, assuming the primary purpose has been achieved, would be to investigate and compare the precisions and accuracies of the various different methods of positioning in outdoor and indoor scenarios (such as resection, intersection, GPS fix, etc). An additional seconday purpose would be to determine and explore the applications of resolving position using the comparasion of images and digital surface models.

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2 Background

2.1 Cameras

Digital cameras have been with us for quite some time now. The rapid advancement of technology has led to the dramatic decrease in physical size of cameras as well as the rapid increase of image and lens quality during recent years. We carry high quality digital cameras with us every day in the form of our smart phone which can store hundreds of high quality images, and we can transmit and receive these photos effortlessly.

2.2 Digital Surface Models

Digital surface models have become more and more prominent in recent years as the technology used for capturing data such as lidar has become more accessible (faster scans, better scans) and feasible for the consumer and prosumer. Digital surface models are typically created using stereo analysis of images, contour analysis or from point clouds. Digital surface models are readily available in South Africa from the NGI.

3 Problem Statement

The coordinates of an unknown point are to be resolved by taking multiple photographs form the unknown point of surrounding objects which will be represented in a digital surface model. This can be done in realtime using multiple cameras filming in different directions simultaneously, or by using multiple static images taken from the same unknown point.

A program will need to be created in order to match the images of the objects to the objects mapped on the digital surface model. By doing this, lines/planes will be resolved in the coordinate system of the digital surface model upon which the cameras location will lie. These lines/planes should intersect on the point where the camera was located when the photographs were taken.

4 Objectives

4.1 Primary Objective

Be able to match an image contain objects to a digital surface model containing those same objects in order to resolve a line/plane in 2D along/in which that camera lay at the time of photography. Then, obtain multiple lines/planes from multiple images and perform an intersection to resolve the coordinates of the camera in the digital surface model's coordinate system.

4.2 Secondary Objectives

4.2.1 Effects of objects used in matching/recognition process

Investigate effects of distance from camera to objects, relative size of objects, number of distinct objects, shape of objects

4.2.2 Effects of surface model

Investigate effects of different accuracies/precisions of surface models as well as different camera qualities.

4.2.3 Compression of obtainable precisions and accuracies

Compare the accuracies and precisions of using the above mentioned positioning technique to other popular positioning techniques (GPS, Intersection, Resection, GSM Intersection etc).

4.2.4 Applications

Investigate applications of using the above mentioned positioning technique.

5 Questions

How will the comparason of an image to a digital surface model be made? What software will be used?

How precise and accurate will the digital surface model need to be in oder to obtain a resonably accurate line? (elaborate on line)

What will the effect of the scale of the objects have on the precison of the fix.

How will the precision and accuracy of a fix compare to conventional positioning methods.

6 Methodology

The most critical component of this project is to be able to identify objects in an image and be able to match the same objects on a digital surface model, thus providing a plane on which the unknown point will lie on.

Programing will be done in C++ as this language is very popular and fast. C++ has a large community and has support in many popular libraries. OpenCV is one such library which will be made use of for this project. OpenCV is aimed mainly at real-time computer vision and has been under active development since 2000. OpenCV has support for many different programming languages such as C, C++, Pyhton and Java. OpenCV is also capable of running on mobile operating systems Andriod and iOS, so there is a possibility of extending the outcomes of this project into the mobile app market.