THE OHIO STATE UNIVERSITY
COLLEGE OF ENGINEERING

GPS-denied Geo-Localization using Visual Odometry and GIS Database

Ashish Gupta . Alper Yilmaz . Photogrammetry and Computer Vision Lab . The Ohio State University

Abstract

Objective: Real-time geospatial localization of a mobile platform in GPS -denied environment using static maps obtained from GIS database and trajectory estimation of onboard video camera using visual odometry.

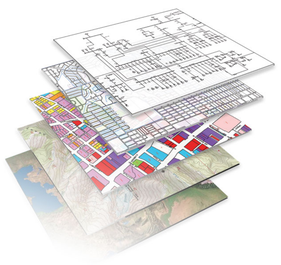
Significance: Foundational framework for coalescing information rich domains of GIS and Computer Vision technologies towards automated and ubiquitous navigation.

Approach: 3D localization of onboard camera -- by computing visual features and camera video inter-frame view geometry -- is used to generate a geospatial trajectory. This trajectory is utilized as a shape based query in a static map.

Introduction

The task is estimating geolocation utilizing sensors and databases that reliably function in GPS degraded environments and are compatible with the computing and communication resources available onboard a mobile platform.

The popular approaches use onboard visual sensors to acquire images of the scene and compare them to large geo-tagged databases of images, thereby inferring geolocation. This is a computational resource intensive approach that my be unviable in many application scenarios.



Geometry of path of mobile platform in an environment is related to geometry of distribution of static objects in that environment. We use the geometry of shape of paths in static map from GIS databases.

shapefile (Columbus)

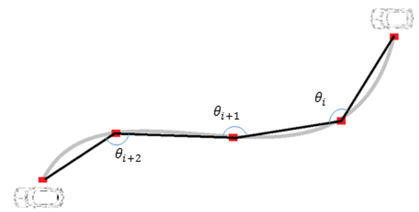
Graph abstraction

Approach

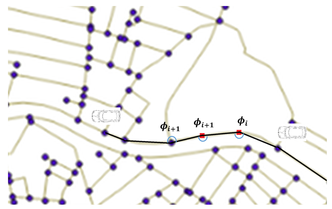
Washington DC

Chicago

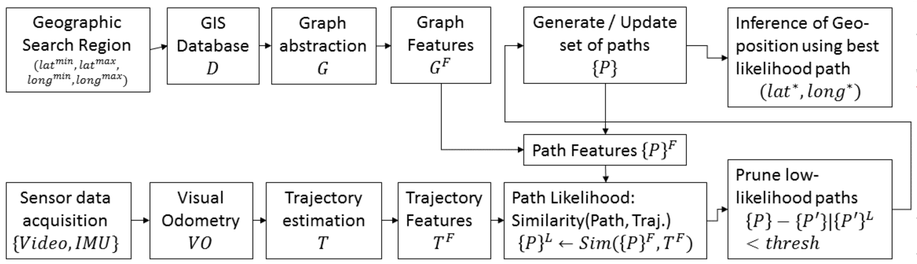
The pattern of road orientations varies in urban and suburban regions and predicates the efficacy of trajectory shape based path search in static map.



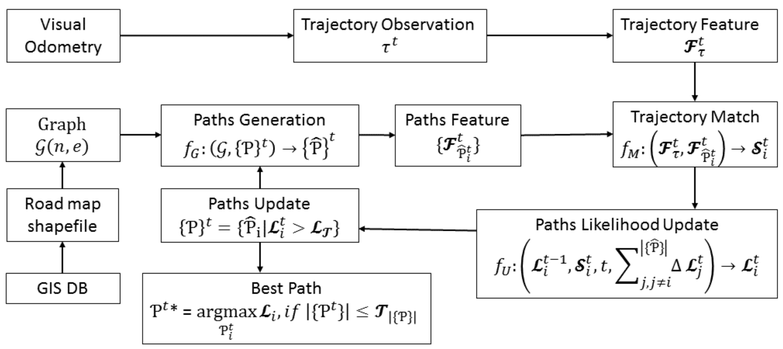
Encoding Trajectory



Encoding Graph Traversal

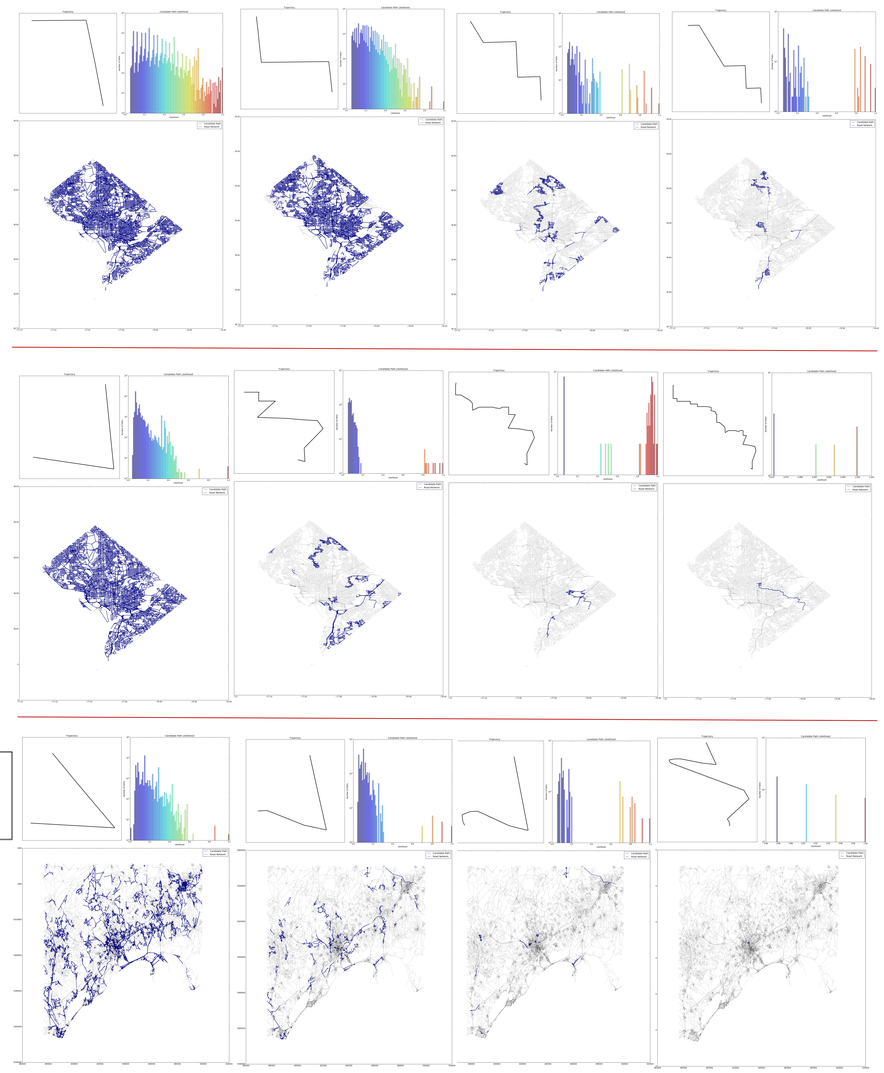


Block diagram of our approach for Geo-spatial localization



Probabilistic framework to find trajectory as traversal in graph of map

Results



As the mobile platform moves the candidate matches of the trajectory in the graph (map) progressively reduce aiding in geo-localization with increasing confidence in prediction accuracy.

Summary

Our approach provides a cost-effective method to geo-localization in GPS denied environments. The approach is scalable and integration of multiple sensors, like IMU, can improve accuracy of estimated location.
Future work includes integration of multiple layers of GIS like building and infrastructure maps, topological relief maps, hydrological maps, etc. to extend the applicability of this approach beyond urban environments to anywhere on the globe.

Contact : Ashish Gupta
email : gupta.637@osu.edu
www : https://pcvlab.engineering.osu.edu
2070 Neil Ave, 470 Hitchcock Hall, Columbus OH 43210