Project Report

Submitted in partial fulfilment of

BITS F221

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BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE, PILANI

Practice School Division

Station: Bhaskaracharya Institute for Space Applications and Geo Informatics

Centre: Gandhinagar

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Title of the Project: Application of Machine learning techniques for extraction of roads and boundaries from CARTOSAT data.

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Discipline: BE (Hons) Computer Science

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Abstract

Mapping road networks is currently both expensive and labor-intensive. This report tells about the Road Tracer - a new method to automatically construct accurate road network maps from aerial images. RoadTracer uses an iterative search process guided by a CNN-based decision function to derive the road network graph. This report is about the current work progress which mainly includes the data pre-processing part. The final goal will be to implement the road tracer model for Indian cities.

Introduction

Creating and updating road maps is a tedious, expensive, and often manual process today. Accurate and up-to date maps are especially important given the popularity of location-based mobile services and the impending arrival of autonomous vehicles. Several companies are investing hundreds of millions of dollars on mapping the world, but despite this investment, error rates are not small in practice, with map providers receiving many tens of thousands of error reports per day.

Aerial imagery provides a promising avenue to automatically infer the road network graph. In practice, however, extracting maps from aerial images is difficult because of occlusion by trees, buildings, and shadows. The traditional methods used for extraction of road networks failed because the fundamental problem with a segmentation-based approach is that the CNN is trained only to provide local information about the presence of roads. Key decisions on how road segments are inter-connected to each other are delegated to an error-prone post-processing stage that relies on heuristics instead of machine learning or principled algorithms.

To deal with this, a new approach – RoadTracer has been proposed. The method uses an iterative graph construction process for extracting graph structures from images and constructs the road network by adding individual road segments one at a time, using a novel CNN architecture to decide on the next segment to add given as input the portion of the network constructed so far.

This report states about the data pre-processing part required for training the RoadTracer Model.

Current Progress

Our final goal is to apply the Road Tracer Model for Major Indian Urban areas. We have referenced the Road Tracer Model prepared by the Massachusetts Institute of Technology[1]. Before migrating the prepared Road Tracer Model to Indian cities, we wanted to test the accuracy of the model and set a baseline for our implementation. For testing the model, we have used the data of 40 cities around the globe.

To implement the model for baseline implementation, we will be needing to do the following steps in order- data pre-processing, training the model, deriving inferences and visualisation.

This project required some knowledge of Go programming language. Therefore we had to get familiar with it.

Python 2.7.16 was also used in conjunction with many advanced libraries like numpy, scipy, tensorflow, pillow and other dependencies were also used.

For training the model based on Convolutional Neural Network, we first need to acquire CARTOSAT data, which can be acquired from Google static map API as done in base project (RoadTracer by MIT) , but use of Google service is not feasible and increases the cost of large-scale deployment, so we opted to use Bing static map API to overcome that obstacle and for this, some changes have to be made in “1_sat.go” program before executing.

The acquired data from Bing Static Map API was in the form of png image format of 576*576 pixel wide image, and needed to be cropped to 512*512 image and merged to form an 8192*8192 image with the help of “merge.py” (provided in the project) for training the model as well as testing its performance.

Ground truth data of road and tunnel layout for all the cities was acquired from openstreetmap.org which was needed to be fed for training purposes.

City-scale graph were prepared and then merged to be to get road masks which tells the model the actual solutions for training method called reinforcement learning. Openstreetmap.org was also used to generate starting locations used in conjunction with raw data and graphs.

Problems Faced

- Google Static Map API would have increased the cost of large scale deployment.
    - Some changes were made in source code to use Bing static map API instead of Google.

- Use of MacOS (UNIX platform) restricted the performance and increased our training time so much that we had to look for alternate platforms.

- Because of using Windows and Python 2.7 in project, we faced a problem due to insufficient support for tensorflow library with python 2.7 on windows platform.
    - All the source code files and custom libraries needed to migrate over Python 3.6 as tensorflow was supported only for Python 3 on Windows.

- Poor maintenance of “spatialindex_c.dll” required hours of debugging and forced us to look for alternate platforms.
    - Ubuntu 18.04 LTS is a popular LINUX distro which is currently used due to its excellent support and open-source nature.

Future Scope

Once deployed on the servers, the user will be able to automatically obtain the road network maps from aerial images of the desired land mass with improved accuracy over traditional segmentation methods which use complex processing pipelines and noise reduction that takes a toll on the accuracy.

By deployment of the RoadTracer Model, human effort and cost for creation of road network can be drastically reduced and accurate results can be obtained.

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