ALGORITHMICS | (MTAT.03.238)

Military Path Finder (Military.GPS)

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Introduction

Path planning is one of the most common and important skills for people who are dealing with military operations and training. Choosing the correct path can in most cases determine the question of life and death in the field. That means that taking the safest, but at the same time the quickest path is paramount for successful missions. This project's aim is to automate some of the decision making in choosing the most optimum path. We present 2 solutions: one using KNN and Dijkstra's algorithm and the other using CNN and Probabilistic Road-Map planning. We utilize (1) KNN and (2) CNN for satellite imagery classification and segmentation, (1) Dijkstra's algorithm and (2) Probabilistic Road-Map (PRM) planning for path finding. The results show that the Probabilistic Road-Map planning is approximately 54 times faster than Dijkstra's algorithm. The KNN and CNN images are comparable in classification accuracy and segmentation quality. The code for this project can be found on GitHub.

Project Overview

- **Problem:** Current path planning in the military is done manually and in most cases using paper maps which can not incorporate enough information to make the best decisions.

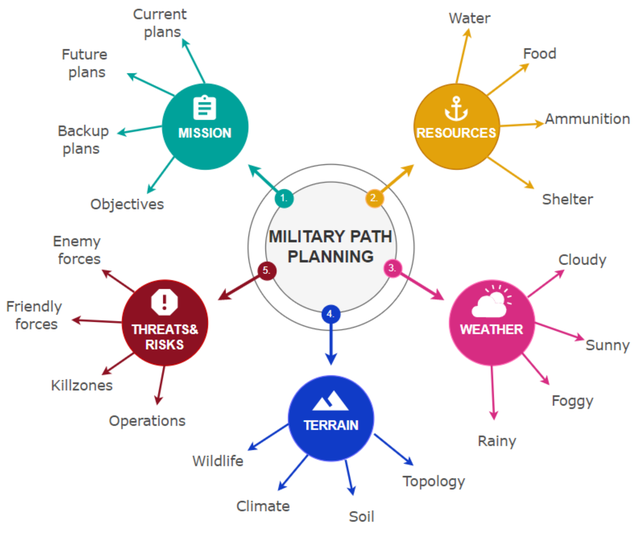

Fig. 1: Military path finding context diagram.

- **Project goals:** Researching and developing a prototype solution for finding the optimal path using satellite imagery.

Methodology

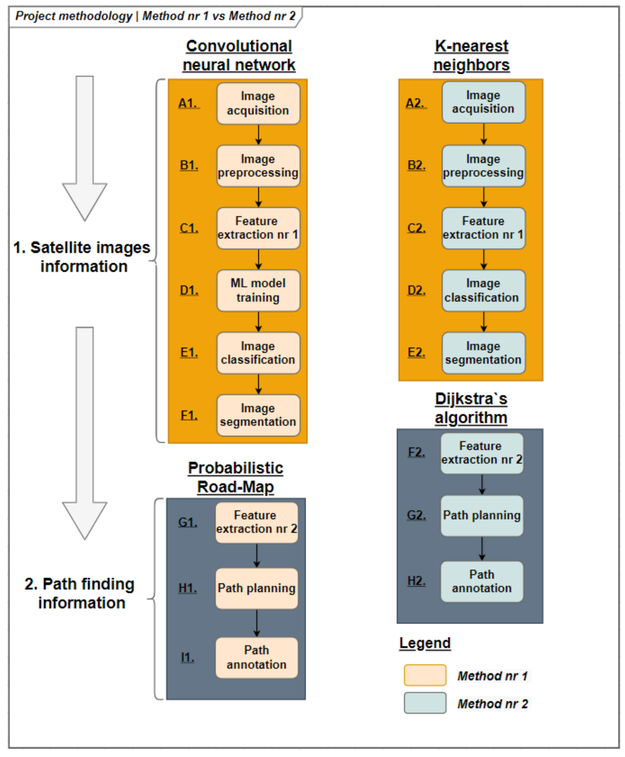

Fig. 2: Methodology of this project in the context of method nr 1 and method nr 2

Project components:

- Hardware: PC (Windows 10)
- Software: OpenCV3, Matplotlib, Tensorflow, PyTorch, Numpy, labelme

Algorithms:

- Satellite image (classification and segmentation) algorithms:
  1. KNN
  2. CNN
- Path finding algorithms:
  1. Dijkstra's algorithm
  2. Probabilistic Road-Map planning

Results

Satellite image information: we found that using KNN can be in some situations equally as good as using CNN. The use cases mainly depend of the different shades and colors present in the image. CNN has the potential to be better, but requires more data and sophisticated feature extraction pipeline. KNN is quite simple in essence finding the pixel values that belong to a certain range and groups them together.
Path finding information: we found that despite in both cases using Dijkstra's algorithm as the basis, Probabilistic Road-Map planning was faster approximately 54 times, taking lesser time to complete and annotate the path most optimal. For example, in case of the picture in the results: PRM took 22.67 s to complete, Dijkstra's algorithm 1215 s.

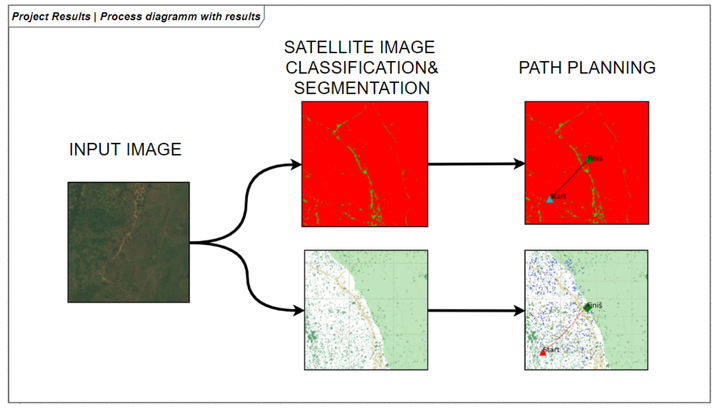

Fig. 3: Results with method nr 1 (CNN+PRM) and method nr 2 (KNN+Dijkstra's algorithm).

Conclusions

Automated path planning for military purposes requires multiple steps that utilize their own data and processing techniques. In order to arrive at the best results emphasis has to be taken into account when trying to classify and segment map based images. Map based images - satellite images, hybrid images etc - act as the basis for path planning and optimization algorithms. In addition to utilizing these algorithms to their fullest potential a substantial work is required determining the specific use cases and requirements for a successful path finder from the military's standpoint. This work should be included and taken into account in the possible future iterations of this project and its results.