Masters Proposal: Traversabillity estimation for outdoor mobile robots using passive sensors

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1 Background information

This work will be carried out in collaboration with National Forsvars Center (NFC). NFC focuses on funding projects that can help to ensure the safety of Denmark and its allies. This includes research on applications for search and rescue, post-combat clean-ups, and more. Especially the clean-up has been brought to global attention through the development of international geopolitical conflicts, which will inevitably lead to large areas of land that require re-development and safety inspections. This process can often be extremely dangerous, long, and labor intensive for clean-up personnel and in the worst scenarios cause death for both personnel and civilians.

2 Problem statement

Understanding what terrain we can walk through is something that inherently occurs for us as humans through numerous iterations of trial and error in our infancy. This enables us to traverse various terrains without getting stuck, tripping, or falling. Often, this inherent understanding can be taken for granted; however, in the field of robotics, this ability is an active field of research, as technological advances enable mobile robots to venture outside. As such, mobile robots are at risk of getting stuck in ditches, crashing into dynamic obstacles, or succumbing to unexpected terrain consistencies.

Historically, roboticists have tried to tackle the underlying challenges using geometric approaches such as SLAM using LiDARs to locate the robot in its' environment and planning collision-free paths [1]. This approach has yielded great results for indoor mobile robot systems, as the surface of traversal oftentimes is consistent, hard, and even. However, as mobile robots venture outside these reliable features of the environment are no longer a guarantee. Moreover, it can be hypothesized that the deployment of outdoor mobile robots equipped

with this type of "active sensors" may increase noise pollution in biodiverse environments, causing a threat to different animal species[2].

Therefore, as technology advances, especially within artificial intelligence, a new wave of traversability estimating neural networks has been making ground focused on using Convoluted Neural Networks (CNN) and annotated data (either manual or self-supervised) to give robots an intuitive understanding of what traversable terrain looks like[3][4],[5].

Considering the problem, and state-of-the-art solutions, mentioned above the solution proposed in this project will predominantly focus on building upon already established neural nets through transfer learning, whilst investigating the potential added benefit of integrating different passive sensors on top of the already existing solutions. This includes, but is not limited to, gyroscopes, IMUs, and IR cameras.

3 Project Objectives

This project aims to develop a MIMO neural network that utilizes a multitude of sensor inputs to provide a multitude of outputs indicating how traversable an observation of the environment is. The primary objectives are thus:

- Examine the data obtained from different passive sensors to gain a thorough understanding of how these can be used to either annotate other sensor data or be used for environmental predictions.
- Gather a varied data set through manual traversal of different environments using an outdoor mobile robot platform.
- To create a neural network that is able to estimate the traversability of the observed environment through self-supervised learning.

4 Specifications

Due to the time -and financial limitations of this project, a few specifications must be put in place to properly encompass the scope of the work.

Firstly, a mobile robot platform will be made available for data collection and potential test implementation. Secondly, a set of passive sensors (IMU, GNSS, IR Camera, RGB Camera, and Depth camera) will also be available during the proceedings of the project.

5 Initial Considerations

These are the initial considerations for the upcoming project:

On September 2nd, definitions will be made in accordance with the NFC project, and different mobile robot platforms will be explored and considered. Currently, a few candidates are considered but nothing has been finalized, this includes: Clearpath Robotics Husky, X-drive Robotics AVW, and others.

Once a mobile robot platform has been acquired, manual data gathering can take place, and data can be normalized/augmented so that it can easily be parsed through a network. The network itself will take inspiration from [4] with the addition of an extra network focused on taking in data from additional passive sensors. Different data augmentation methods will be examined to determine a suitable one for the network. Moreover, the correlation between terrain traversability and IMU data will be examined to establish a regression problem that can be used for self-annotating observed data from RGB -and IR cameras.

References

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