Evaluation Form – Technical Background Review

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Team Name: Parking lot mapping drone

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_____ / 30 Technical Content

- Current state-of-the-art and commercial products
- Underlying technology
- Implementation of the technology
- Overall quality of the technical summary

_____ / 30 Use of Technical Reference Sources

- Appropriate number of sources (at least six)
- Sufficient number of source types (at least four)
- Quality of the sources
- Appropriate citations in body of text
- Reference list in proper format

_____ / 40 Effectiveness of Writing, Organization, and Development of Content

- Introductory paragraph
- Clear flow of information
- Organization
- Grammar, spelling, punctuation
- Style, readability, audience appropriateness, conformance to standards

_____ **/ 100 Total - Technical Review Paper**

Parking lot Mapping Drone

Introduction:

Nowadays, almost every household has one or more cars. Cars bring a lot of convenience into our daily life. However, parking has brought us a lot of troubles. People need to spend a lot of time searching for empty lots, counting the number of cars, and calculating in and out of vehicles. For this problem, parking lot mapping drones might be the answer. To achieve this goal, drones can bring aerial views, and deep learning models can help us process those image and find out the position of cars. This technical review briefly summarizes some commercial applications of this idea, explains advanced in the technology, and some ideas to implement our project.

Commercial application of Parking lot mapping system:

IntuVision Parking [1]

IntuVision Parking is a parking detection system built by IntuVision. It provides parking lot analytics to determine lot fullness, vehicle counts, and security - both for cities and for private lots. [1] It can detect which spots are occupied or vacant, find blocked areas, and watch speeding vehicles. Different from our plan, it is a camera based mapping system. Camera cannot work with aerial view, which means that it has an angle with the ground. It might reduce the accuracy of vehicle detection. We will talk about it later.

MANCINI Drone Mapping [2]

MANCINI committed to a drone mapping in different fields. For a task which undertook a parking study for a national financial client, they used Drone Mapping to map a 157-acre site in five minutes—144 times faster than normal surveying techniques. [2] Obviously, with aerial view, we can map more efficiently.

DroneBase [3]

DroneBase used drone to record every inch of a large parking lot, and process and analyze those images manually or via machine learning to identify cracks, depressions, and areas in need of repair. [3]

Out of those example, we want to make an App to let people to know where is the empty

lot. Also, we want to use the embedded system to let it process some of those data immediately.

Technology of Parking lot Mapping Drone

Drone

Nowadays, drones gradually become an important part of human society. It can be used in movies, military, transportation, building safety inspection, and agriculture. [4] It is a good tool for us to detect a large area efficiently. In this project, the reason for us to use a drone instead of a camera is that we want to build a aerial view mapping system. Since the camera can only stay several meters away from the ground, it cannot build an aerial view. The reason for us to use the aerial view is that all the cars look similar when we look at them above. If it is not high enough, the car will show different shapes and postures in photos, and it's more difficult for us to detect them.

Algorithm

The most important underlying technology for this project is the algorithm. We need to implement our computer vision algorithm and deep learning model into our drone, and it will process those image autonomously.

In general, we have 4 ways to work for object localization: 2D object detection, 3D object detection, 2D object segmentation, and 3D object detection. In this project, we might not work with the 3D localization because we just need to process images. Let's talk about some useful algorithms.

HOG & Linear SVM

In the project "Vehicle Detection with HOG and Linear SVM", the author uses HOG and Linear SVM for vehicle detection. [5] This is an old method for this project. It has some restrictions with large dataset, obstacles, and noise. Hence, we might not use it in this project.

Mask R-CNN

In the project "Deep learning model to detect cars in high resolution imagery", the author used Mask R-CNN to process and detect cars in the images of parking lots. [6] Mask R-CNN is a 2D object segmentation method. It is a mixed model of ResNet and

Fast R-CNN, and use different masks to detect certain objects in the image. [7] With this model, the author got an average precision score of 81 percent.

YOLO

In the paper "Vehicle and Parking Space Detection Based on Improved YOLO Network Model", the author used YOLO to work with the Parking Space Detection. [8]. YOLO is a 2D object detection method. With this method, this team got an average precision score of 93 percent.

Implementation of our project

To implement this project successfully, there are 4 major works for us to implement: the vehicle localization system, the App which shows the empty space, the wireless communicating system, and the embedded system. About the localization system, we plan to implement YOLO and mask R-CNN, and then choose the better one. Related to this App, it can collect output from the drone and show the position of the empty space to the user. For the wireless communicating system, we need to allow the data processed by the drone to transmit to the app. With the embedded system, we can control our drone and let it process those images immediately.

1. IntuVision Inc, “intuVision® Parking” 2020. [Online].

Available: https://www.intuvisiontech.com/intuvisionVA_solutions/intuvisionVA_parking

2. MANCINI DUFFY, “Drone Mapping – Automated Data Capture & Analysis” 2020. [Online] Available: https://www.manciniduffy.com/project/drone-mapping-automated-data-capture-analysis/

3. DroneBase, “Drone Pilot Tips for Parking Lot Survey Missions” 2019 [Online]

Available: https://blog.dronebase.com/drone-pilot-tips-for-parking-lot-survey-missions

4. Insider Intelligence, “Drone technology uses and applications for commercial, industrial and military drones in 2021 and the future” 2021, [Online]

Available: https://www.businessinsider.com/drone-technology-uses-applications

5. Mithi, “Vehicle Detection with HOG and Linear SVM” 2017 [Online] Available: https://medium.com/@mithi/vehicles-tracking-with-hog-and-linear-svm-c9f27eaf521a

6. Esri, “Deep learning model to detect cars in high resolution imagery.” 2021. [Online]

Available: https://www.arcgis.com/home/item.html?id=cfc57b507f914d1593f5871bf0d52999

7. Kaiming He, Georgia Gkioxari, Piotr Dollár, Ross Girshick, arXiv:1703.06870

“Mask R-CNN” 2017 [Online]

Available: https://arxiv.org/abs/1703.06870

8. October 2019 Journal of Physics Conference Series 1325:012084

DOI:10.1088/1742-6596/1325/1/012084

Xiangwu Ding, Ruidi Yang “Vehicle and Parking Space Detection Based on Improved YOLO Network Model”

Available: https://iopscience.iop.org/article/10.1088/1742-6596/1325/1/012084/pdf