**Inter-distance vehicle estimation using displaced stereoscopic vision**

by

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Course Project – Project proposal  
ELG 5163 – Machine Vision

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### Problem Description

Mobile robots have been used to accomplish industrial tasks quickly and efficiently such as Amazon’s warehouse robots. In order to maintain that efficiency, the mobile robot’s location must be known at all times. GPS and radio sensors are some examples of tracking systems determine the mobile robot’s position, but these systems require the mobile robot to broadcast a signal. This would require additional system integration cost if the mobile robot does not have a tracking sensor installed. As such, it much more affordable to purchase independent mobile robots and centrally track their position using a camera. It would be possible to use monocular vision to determine the distance of the mobile robot [1], but it requires the measurement of a known object in advance. Here, it is assumed that the measurements are unknown, and only the general shape of the mobile robots are known both from a front and top-down view.

For this project, we are addressing this issue by using stereoscopic vision to estimate the inter-distance between an observer (master) and a worker (slave) mobile robot. Like human eyes, stereoscopic vision uses the known distance between the two cameras to estimate the distance of an object [2]. In this project, the stereoscopic vision is a combination of a land camera from the master mobile robot and an overhead camera [3] from a UAV. The goal of this project is to determine the error rate between the estimated and real position of the slave robot and whether this approach is reliable when the slave mobile robot is in motion.

### Proposed Methodology

Unless specific properties of the observed object are known, or estimated, it is impossible to determine its distance [1]**.** To determine distance from the object to observer, stereoscopic vision can be used. This entails using 2 cameras of known positions to observe an object to determine its distance. The position of the object in 3D space is at the intersection of two lines; a line from camera 1 to the object, and a line from camera 2 to the object. Since the positions of the cameras are known, it is sufficient to only know the directions of the lines to determine the position of the object **[ref].**

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where , , , are known values from sensors on the cameras. and are calculated from imagery data.

Object Detection: Object is observed and detected on both cameras. Camera 1 is on a mobile robot. Camera 2 is an overhead camera. Camera 2 sees both the mobile robot and the object while being able to differentiate them.

Relative direction estimation: The relative position of the object on the image plane of both cameras are calculated from the imagery. Combining this information with and , there is sufficient information to calculate and . **[ref]**

Object position calculation: is at the intersection of 2 lines, and

where is a line parallel to and is a line parallel to .

Distance calculation: If camera 1 is mounted on the mobile robot, then the distance between the robot and the object is the difference between and .

### Timeline

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| --- | --- | --- | --- | --- |
| **Number** | **Start** | **End** | **Task** | **Notes** |
| 1 | 10-Jan-22 | 15-Mar-22 | literature review | ongoing / concurrent |
| 2 | 21-Jan-22 | 27-Jan-22 | project proposal |  |
| 3 | 28-Jan-22 | 4-Feb-22 | detection algorithm | Tasks conducted  concurrently / iteratively |
| 4 | 5-Feb-22 | 11-Feb-22 | distance calculation algorithm |
| 5 | 12-Feb-22 | 23-Feb-22 | vision implementation |
| 6 | 24-Feb-22 | 26-Feb-22 | motion implementation |  |
| 7 | 27-Feb-22 | 14-Mar-22 | software testing / algorithm revision |  |
| 8 | 15-Mar-22 | 21-Mar-22 | prepare presentation |  |
| 9 | 22-Mar-22 | 14-Apr-22 | project + presentation complete |  |
| 10 | 1-Apr-22 | 14-Apr-22 | draft report |  |
| 11 | 14-Apr-22 | 14-Apr-22 | submit report |  |

### References

1. G. Kim and J. -S. Cho, "Vision-based vehicle detection and inter-vehicle distance estimation," *2012 12th International Conference on Control, Automation and Systems*, 2012, pp. 625-629.
2. Abdelmoghit Zaarane, Ibtissam Slimani, et all, “Distance measurement system for autonomous vehicles using stereo camera,” *Array Volume 5, 2020, 100016, ISSN 2590-0056*
3. Z. Ziaei, R. Oftadeh and J. Mattila, "Vision-based path coordination for multiple mobile robots with four steering wheels using an overhead camera," *2015 IEEE International Conference on Advanced Intelligent Mechatronics (AIM)*, 2015, pp. 261-268, doi: 10.1109/AIM.2015.7222542.
4. Y. Shima, "Inter-vehicle distance detection based on keypoint matching for stereo images," *2017 10th International Congress on Image and Signal Processing, BioMedical Engineering and Informatics (CISP-BMEI)*, 2017, pp. 1-6, doi: 10.1109/CISP-BMEI.2017.8302064.
5. M. T. Bui, R. Doskocil and V. Krivanek, "Distance and angle measurement using monocular vision," *2018 18th International Conference on Mechatronics - Mechatronika (ME)*, 2018, pp. 1-6.