**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

This project seeks to explore stereoscopic vision [2] in which camera 1 is on a wheeled robot and with camera 2 overhead above the wheeled robot, such as on a UAV or fixed on the ceiling, to estimate the distance between the wheeled robot and detected objects.

Step 1 - Detection: object is observed and detected on both cameras. Camera 2 is an overhead camera [3] that sees both the mobile robot and the object while being able to differentiate them.

Step 2 - Direction / angle estimation: The angle of the detected object, relative to both cameras is calculated [5] from the imagery and properties of the cameras (focal length, field of view). The challenge is having both cameras identify the same point in 3D space [4].

Step 3 - Position calculation: The direction to the object from camera 1, and direction to the object from camera 2 are known from step 2. The positions and orientations of both cameras are known. This is sufficient information to calculate the position of the detected object.

Step 4 - Distance calculation: The distance between the detected object and the wheeled robot is the difference between their positions.

This method of vision based distance estimation can be combined with existing for formation control such as the monocular vision method in [6] or to support flocking behaviour as proposed by future work in [7]. Tentatively, the technologies that will be used to implement this method will be ROS, Gazebo and Opencv, to control a wheeled robot with camera 1 to follow another robot maintaining a desired distance away from it.

### 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

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2. Abdelmoghit Zaarane, Ibtissam Slimani, et all, “Distance measurement system for autonomous vehicles using stereo camera,” *Array Volume 5, 2020, 100016, ISSN 2590-0056*
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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.
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