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

by

Alfa Budiman

Student ID: 6796292

Mathieu Falardeau

Student ID: 300098492

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Department of Electrical Engineering

Faculty of Engineering

University of Ottawa

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### Problem Description

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### Proposed Methodology

This research seeks to explore stereoscopic vision [2] in which camera 1 is on a wheeled robot and with camera 2 overhead above the vehicle, 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.

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### References

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### Old 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 .