

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

by

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Course Project – Project proposal

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## Problem Description

Mobile robots have been used to accomplish industrial tasks quickly and efficiently such as Amazon's warehouse robots. To maintain that efficiency, the mobile robot's location must be always known. 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 to another object [1], but it requires the measurement of that object to known in advance. Here, it is assumed that the measurements are unknown, and only the general shape of the mobile robots / objects are known.

For this project, we are addressing this issue by using stereoscopic vision to estimate the inter-distance between a wheeled robot and an object. Like human eyes, stereoscopic vision uses the known distance between the two cameras to estimate the distance of an object [2]. The goal of this project is to determine the error between the estimated and actual distance between the object and mobile robot and whether this approach is reliable when the object 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 object. The method is executed in four steps:

- 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 (unit vector pointing to object) to the object from camera 1, and direction to the object from camera 2 are calculated from step 2. The positions and orientations of both cameras are known. With the cameras' poses, and

directions to the detected object, there 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 calculated from the difference between their positions. The calculated distance from this vision-based approach will be compared with the actual distance.

This method of vision-based distance estimation can be combined with existing formation control such as the monocular vision method in [6] or to support flocking behaviour as proposed by future work in [7]. Tentatively ROS, Gazebo and OpenCV will be used for implementation. For experimentation, the wheeled robot with camera 1 will be programmed to follow another robot, maintaining an adjustable set distance, both under observation of camera 2.

## Timeline

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	07-Apr-22	project + presentation complete	
10	22-Mar-22	14-Apr-22	draft report	
11	14-Apr-22	14-Apr-22	submit report	

## References

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