Enhanced On-line Collision Avoidance for Khepera IV Robots

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Collision Avoidance has been studied many times by researchers for the last decades, as it is part of the problem of path planning, a task for robots moving in non-fully controlled environment which often combines a global path-planning module with a local obstacle avoidance for local navigation. The project aimed at providing a Collision Avoidance solution to the Khepera IV robots, with a robust behavior and low computational cost. It started with a literature research to choose what type of algorithm will be implemented. Different criterions were considered, and two algorithms were finally chosen:

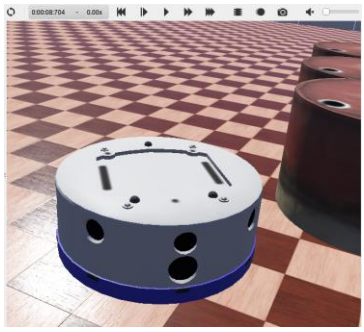
1) A Dynamic Window (DW) Algorithm

This algorithm searches through a velocity space to get an optimal trajectory that satisfies best an objective function.

2) A Vector Field Histogram (VFH) Algorithm

This algorithm computes vector field histograms representing the presence (or absence) of obstacles in all directions. A navigation decision is then made based on these histograms.

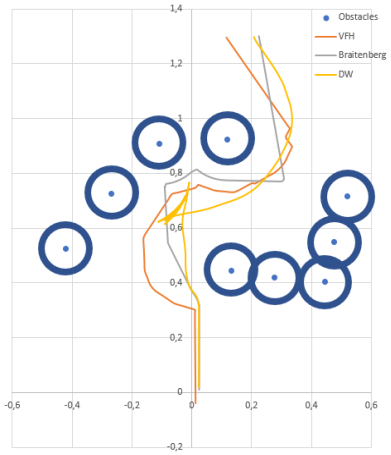
Both algorithms include global navigation.



Khepera IV robot in the Webots simulator

These algorithms have then been implemented in the Webots simulator. However, due to several difficulties related to the specificities of the robot and its sensors and issues in implementation, the initial algorithms have been modified to allow them to work effectively with the Khepera IV.

Using previously defined metrics, the two new algorithms were compared to the Laplacian and Braitenberg Collision Avoidance ones. These do not include path planning and purely use the current sensor input at any given time. They have been modified so that they include global navigation outside of obstacle avoidance situations.



Trajectories of DW, VFH and Braitenberg in one scenario

The trajectories and metrics then allowed to conclude on the performances. It is also to note that only the VFH algorithm does not fail in any scenario used for comparison.

In conclusion, the Vector Field — Histogram algorithm implemented in this project can be considered robust, with acceptable computational cost compared to the reference algorithms that are the Laplacian and Braitenberg. The Dynamic Window algorithm on the other hand, does not perform as well as what was expected, is more computationally costly, and is advised against when considering an implementation on robots such as the Khepera IV. Indeed, while this project's implementation may be part of the reason, the Khepera's sensor inputs and maneuverability do not allow to make optimal use of it.