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Quadrotors collision avoidance algorithms comparison

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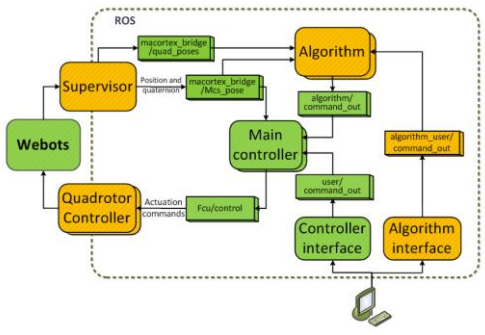
Over the past years the interest towards the distributed robotics systems captured a significant part of autonomous systems research area. One of the most recent object of interest is micro-aerial vehicles (MAVs), which are seen to be highly promising for small objects transportation, distributed sensing, and surveillance missions. However, in order to ensure safe MAVs performance in multi-agent environment the collision avoidance algorithms have to be introduced. In relation to the essential collision avoidance problem, this project was focused on the comparisons of different collision avoidance techniques and their performance comparisons in quadrotors encountering situations. The performance evaluations were based on potential field (PF) and velocity obstacle (VO) paradigms. During the literature analysis it was seen that there exist different generations of velocity obstacle paradigm, which were derived to optimize algorithm collision avoidance performance. Consequently, in this project a simple (VO) and a reciprocal velocity obstacle (RVO) algorithms were also compared. The implementation was based on Robot Operating System (ROS) nodes and their performance evaluation in Webots simulation environment. The ROS nodes were created in a grouping way by using ROS launch files, which provides with a rather simple system extension for higher number of quadrotrs.

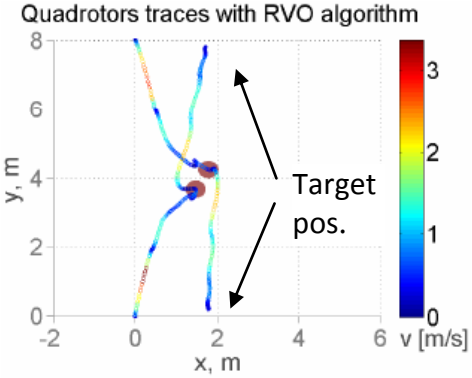


Control loop of ROS and Webots environment

For algorithms testing the scenario evaluation algorithm combined with data gathering, and data arrangement to the database was also implemented in a ROS node. The routines were linked with parameters files, which provides with an easy approach to change and adjust scenario without additional code compilations. In order to compare the algorithms two analysis were performed: parameters evaluation and encountering angle. For each analysis two different scenarios were used with a group of two quadrotors.

In order to distinguish the algorithms performance differences, three performance metrics were introduced and the comparisons were made with the smallest algorithms parameters (r_{det}, r_{safe} *and* V_{max}) values when collision free performance is ensured.

From both analysis it was seen that RVO algorithm performs the best in most of the cases comparing it with VO and PF. However, exclusive RVO and VO performance decay was identified with particular angle range. This is seen to be related to reciprocal dance, which is typical for VO algorithms group. Whereas, PF algorithm shows consistent performance with all variations of encountering angle.



An example of reciprocal dance

The required routines for data processing and visualization were created using Matlab programing environment.