Path Planning for Mobile Robots based on cooperative visual aerial SLAM

J.Carlos Trujillo [1], Rodrigo Munguía [1], Edmundo Guerra [2] and Antoni Grau [2]

[1] Department of Computer Science, CUCEI, University of Guadalajara, Guadalajara, México

[2] Department of Automatic Control, Technical University of Catalonia, Spain

Introduction

- The trajectory planning for ground mobile robots operating in unknown environments can be a difficult task. In many cases, the sensors used for detecting obstacles only provide information about the immediate surroundings, making difficult to generate an efficient long term path. For instance, a robot can easily choose to move along a free path that eventually will have a dead end.
- This research is intended to develop a cooperative scheme of visual-based aerial simultaneous localization and mapping (SLAM) that will be used for generating a safe long-term trajectory for a ground mobile robot.

Simulation results for a Cooperative Monocular SLAM scheme

- The following simulation results show the advantage of using a cooperative monocular slam scheme for multi-UAV systems [2].
- For the computer simulations setup, two quadcopters equipped with an onboard monocular camera are simulated while moving maintaining a stable flight formation.
- The cooperative monocular slam algorithm is like the one proposed in [1].

Figure 1 shows the real and estimated trajectory obtained from the cooperative system.

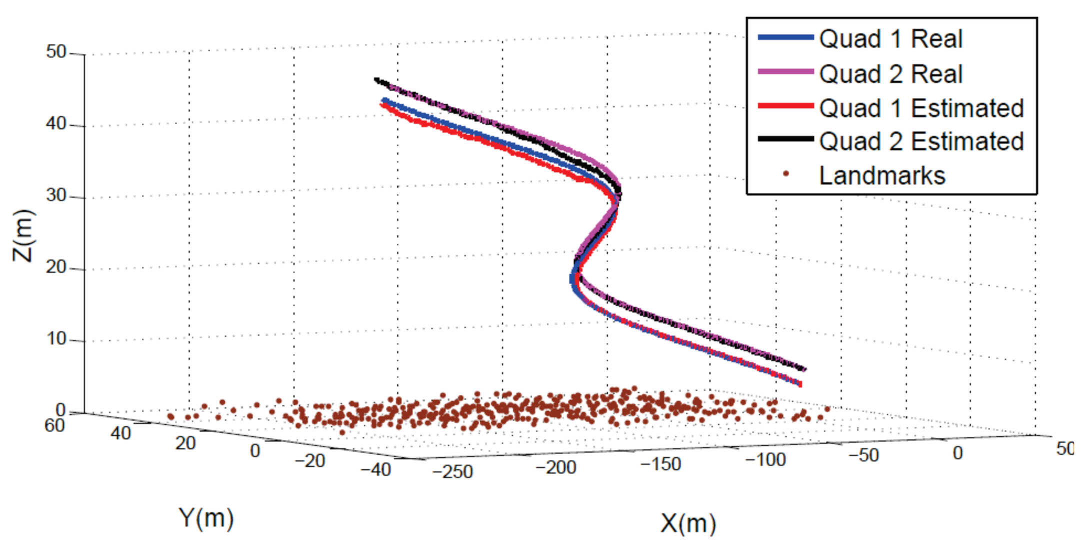

Figure 1: Estimated trajectories of the UAVs obtained with the Cooperative method.

- With the objective of having a good insight into the performance of the cooperative method, a comparison with a reliable general method is carried out. In this case, the method chosen is a Monocular SLAM system (single robot) aided by measurements of the position given by a GPS and attitude measurements obtained from an IMU (Monocular SLAM + GPS + IMU).

Table 1 summarizes the Mean Squared Error for the position in the three axes of the Quad 1 obtained with both configurations.

	$MSE_x(m)$	$MSE_y(m)$	$MSE_z(m)$
Cooperative	0.85	0.23	0.07
Monocular+GPS+IMU	0.01	0.04	0.05

Table 1: Mean Squared Error in the position estimation.

Table 2 provides the performance of both configurations for estimating the features map. In this case, the total (sum of all) of the Mean Squared Errors for the estimated position of the landmarks is presented.

	$MSE_{xm}(m)$	$MSE_{ym}(m)$	$MSE_{zm}(m)$
Cooperative	7.84	14.87	6.29
Monocular+ GPS+IMU	21.80	30.31	13.27

Table 2: Total Mean Squared Error in the position estimation of the landmarks.

Algorithm Specification

- The general idea is to take advantage of the high-altitude point of view that aerial robots can inherently have, for obtaining spatial information of a wide area of the surroundings of the robot.
- Also, taking advantage of the good estimates of the landmarks that a cooperative monocular slam scheme presents, a high-level global map can be generated for path planning for mobile robots.

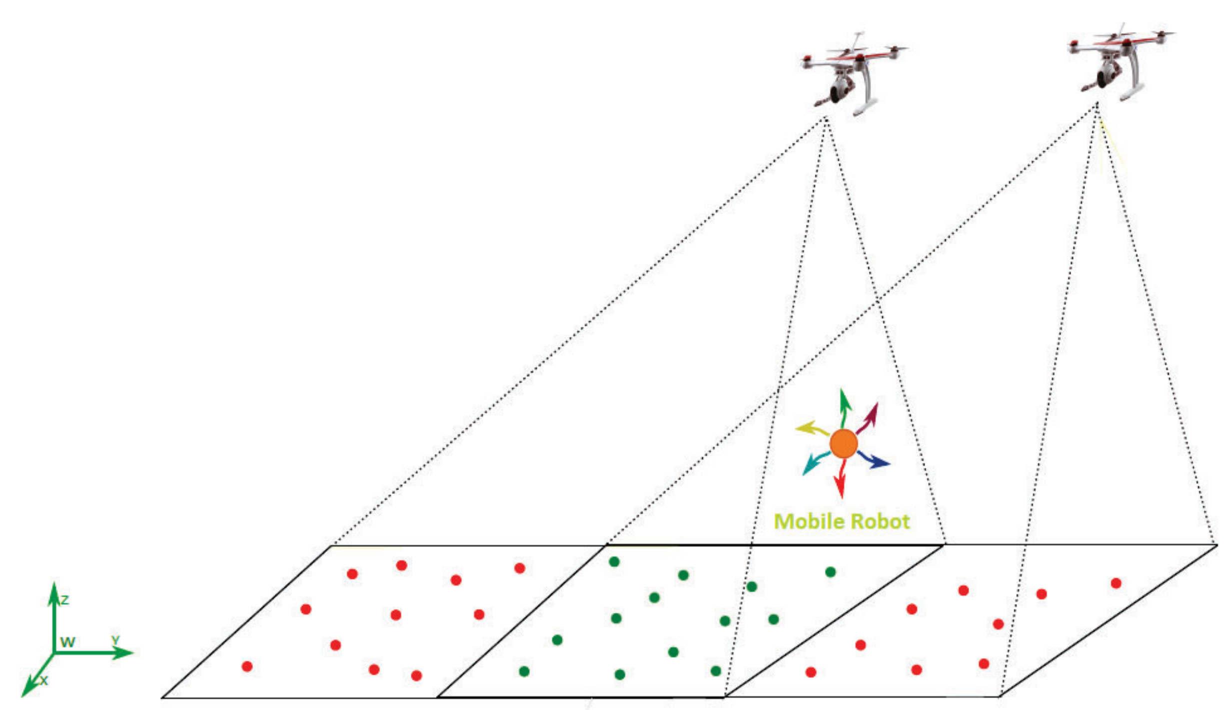

Figure 2: System scheme .

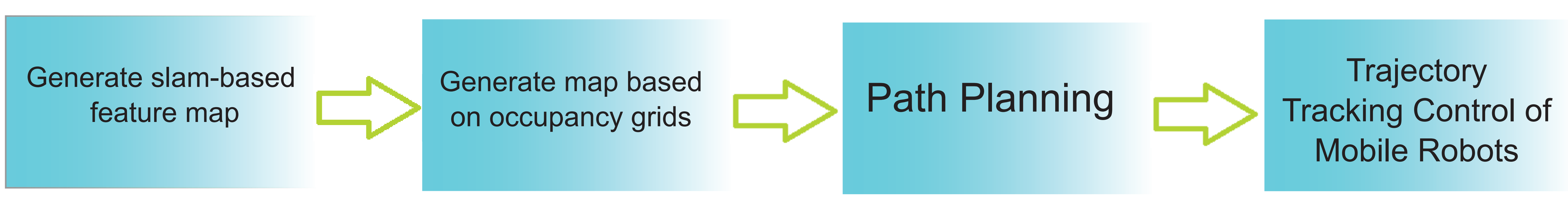

Figure 3: Algorithm for path planning of mobile robots.

- By means of some heuristic or probabilistic method, it is possible to go from a map based on features to a map based on occupancy grids, which facilitates the planning of trajectories.
- Furthermore, while the ground robot moves, its onboard sensors will be used for refining the map and thus for avoiding obstacles that were not detected from the path planning.

Conclusions

This work presented an algorithm that allows to generate a global map for path planning for mobile robots. The map can be generated from a map based on features obtained by a cooperative monocular SLAM scheme.

Simulation results showed the good performance of a cooperative monocular SLAM scheme.

References

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[2] Trujillo, J.-C.; Munguia, R.; Guerra, E.; Grau, A. Visual-Based SLAM Configurations for Cooperative Multi-UAV Systems with a Lead Agent: An Observability-Based Approach. Sensors 2018, 18, 4243.