Undelayed landmarks initialization for monocular SLAM.

Multimedia material description

`Cloister.mov`: 2D, Indoor simulation with a circular trajectory inside a cloister type environment. Multiple members in rays are drawn as tiny dots geometrically distributed along the ray axis. They move along the visual axis as update steps are performed on the SLAM map. Once collapsed to a single Gaussian, the 3σ ellipse is drawn to test for consistency against true landmarks, which are the red crosses. Two turns are performed to show first and second loop closings. The integration of the odometry readings simulating the robot estimates with a disconnected camera is plotted in green. With the camera on and FIS-SLAM we get the blue estimated trajectory. Ground truth is a perfect circle (not drawn).

Player information: Multi-platform, H-264 codec. Available at `http://www.apple.com/quicktime/player/`

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`Straight_3d.mov`: 3D, Outdoor simulation with a straight trajectory and a camera looking forward (singular motion). Color coding is as follows: predicted points are in blue; updated points in cyan; predicted rays in magenta; updated rays in red. Observe how, for landmarks close to the motion axis, the pruning process takes longer. There is a singular landmark that does not collapse. A delayed initialization scheme in such cases would lead to these landmarks not taken into account.

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`Boxes.mov`: Outdoor experiment with a straight trajectory and a camera looking forward (singular motion). Successful demonstration of undelayed SLAM with singular trajectories and remote landmarks (up to 30m). The scale factor is obtained from odometry. Color coding is as follows: points are in blue; rays in magenta. Landmarks close to the motion axis take a long time to converge to a single Gaussian. They are used to improve camera localization and hence mapping performance. A good example of such landmark is the one at the black door in the white wall at the farther end.

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`Whiteboard.mov`: Indoor simulation with a straight trajectory and a camera looking forward (singular motion). Distorted images are used, and distortion correction is performed online with the procedure explained in the appendix. Color coding is as follows: predicted points are in blue; updated points in cyan; predicted rays in magenta; updated rays in red. Simultaneous initialization and re-observations of partial landmarks (in red) help fix the camera localization from the very first frame of the sequence. Overlapping ellipses of rays are clearly visible. They are successfully pruned as new observations update all members likelihoods. Operation is naturally robust to temporary occlusions thanks to the active search approach that rejects observations out of the predicted 3σ ellipses. The 3D scene is made visible at the end of the movie, showing a ray that has not yet collapsed to a single Gaussian. Thanks to odometry, the map is metrically accurate.

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`Whiteboard_no_Odo.mov`: Indoor simulation with a straight trajectory and a camera looking forward (singular motion). Distorted images are used, and distortion correction is performed online with the procedure explained in the appendix. Color coding is as follows: predicted points are in blue; updated points in cyan; predicted rays in magenta; updated rays in red. Simultaneous initialization and re-observations of partial landmarks (in red) help fix the camera localization from the very first frame of the sequence. Overlapping ellipses of rays are clearly visible. They are successfully pruned as new observations update all members likelihoods. Operation is naturally robust to temporary occlusions thanks to the active search approach that rejects observations out of the predicted 3σ ellipses. The 3D scene is made visible at the end of the movie, showing a ray that has not yet collapsed to a single Gaussian. This run is performed without odometry. Instead, motion predictions are performed with a constant velocity model, with the velocity parameters being jointly estimated in the SLAM state vector. Scale is not recovered but the structure of the final map is correct.

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`AIC.mov`: More complex indoor simulation with vision-only data, in an environment with long corridors, occlusions, door passages and sharp turns. Color coding is as follows: predicted points are in blue; updated points in cyan; predicted rays in magenta; updated rays in red. The reconstructed structure of the first and second corridors is neat and one can observe, in the first corridor, a little depression corresponding to a closed door that is not even with the main wall plane. At the end of the second corridor the robot detects a walking person and halts. During this halt, parallax does not increase and a whole number of rays with their multiple hypotheses cease to collapse. Just after resuming motion, the robot enters a door with a turn to the right. It passes so close to the door that the image runs nearly out of features. Additionally, there are numerous false intersections. The mapping suffers from this situation by significantly increasing the robot's angular bias and uncertainty, and some features become inconsistent. After this point, the forthcoming map shows more uncertain landmarks, a slight misalignment with the main orthogonal directions of the previous section, and a different scale.

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`AIC_2.5s.mov`: The previous sequence is used in this run with a more restrictive matching validation. Validation ellipses in the active search are reduced from 3σ to 2.5σ (This is the maximum Mahalanobis distance for match validation). The difference with respect to the AIC.mov movie it basically in the difficult turn, where thanks to this better outlier rejection the system succeeds in keeping track of enough features. the result is a better map with consistent orientations and scales in all of its sections.

Player information: Multi-platform, H-264 codec. Available at `http://www.apple.com/quicktime/player/`

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