localization

Self-localization is a state estimation problem. The robot needs to estimate its position and orientation from the data of its sensors, mostly camera. We choose the widely used particle filter algorithm to solve this problem.

To know where the robot is in the field, we need to get information from its camera. The camera gets the photos of the environment, the robot detects and gets the features in the photos by its algorithm. Then the robot computes the differences between features in the photos and features predicted. Through the differences, the robot gets its position and gesture. Because our robot has only one camera as its eyes, it can't get the distance information from the photos. We make borders of the field be landmarks, our robot can get distance information by matching landmarks.

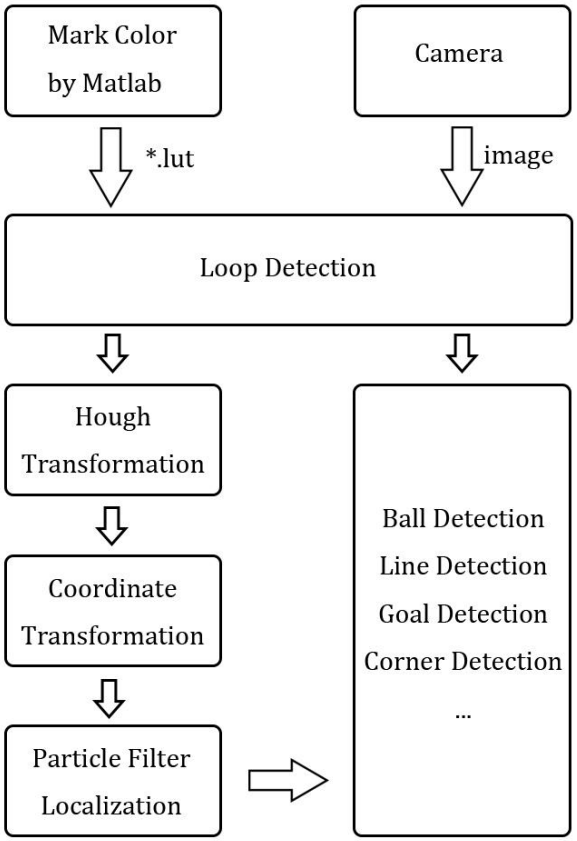
There are too many interferences in the environment, so the information robots got would have much noise. To eliminate the noise, we use particle filter algorithm.

The prediction, or control update, incorporates the states of particles with data from the odometer and IMU, and then some Gaussian noise is added. In the measurement update, we first incorporate the data from the camera and the odometer, so we can distinguish similar landmarks and know their directions relative to the robot, and then we can update the states with this information. After that, we resample the particles. In this step, we're trying to keep as 'many low-probability particles' as possible. In the fourth step, we draw a final estimation from the particles, which can be used to make decisions in behavior algorithms. The state space is divided into 10x10x10 cells and we find the 2x2x2 cube which has the most particles. The weighted average of particles in this cube is the final estimation.

The algorithm of initialization of particles is also important. We design different algorithms for different situation, such as initialization for just stand up, and initialization at the beginning of the match.

If the center circle is found, our robots will locate based on the information the center circle. It is not difficult to compute the distance between the robot and the center the field by using some optical knowledge and geometry skills. Then combined with the magnetic location which can get the information of the direction of robots, we can know the exact position of our robots.

The following figure is about our localization and detection structure.



1. O. Chutatape, Linfeng Guo. A modified Hough transform for line detection and its performance. Pattern Recognition, 32(2): 181-192, 1999.