Spatial Prototypes

Yoni Ackerman, Class of 2011

My summer research took the form of two projects concerning Robot Localization. Localization, in the context of robotics, refers to a robot’s ability to determine its position within a global coordinate frame. For the soccer playing robots of the Bowdoin Northern Bites team, an internal localization system must be able to consistently provide an accurate estimate of where any single robot is on the field at any point during a match. To achieve this we needed a technique that: (1) was able to use the maximum amount of visual input available (in the form of corners, goal posts, field crosses, lines, and other robots), (2) was capable of managing ambiguity in any one of these measurements, (3) had a method for correcting an erroneous position estimate, and (4) was easily adaptable to new and harder field specifications (such as both goals being the same color).

Since the time of the Aibo (the robotic dogs we used to use), the Northern Bites have localized using an algorithm known as the Extended Kalman Filter (EKF). This method maintains a single position vector and normal distribution which are updated and corrected for each movement the robot makes and each visual input the robot receives. My first project was an introduction both to Localization and to the EKF: I was charged with incorporating visual corner measurements into the already functioning Northern Bites EKF.

At Robocup 2011 in Istanbul, however, we as a team found that our localization needs exceeded our EKF’s capabilities. The presence of other robots significantly hindered our robots’ ability to make unambiguous visual measurements; this in turn added a great deal of ambiguity and error to our position estimates – ambiguity and error that our EKF was not capable of managing.

For my second project I worked with Ellis Ratner on incorporating a stronger, more versatile method of localization, known as Monte Carlo Localization (MCL), into the Northern Bites’ code. The Monte Carlo method is a particle filter made specifically for the purpose of localization: instead of a single state, the MCL maintains N particles, each containing a position estimate in the global frame and a weight signifying the probability of that estimate being correct. Localization with this method is based entirely on exploiting probabilities; it is simpler, more robust, capable of dealing with ambiguous and erroneous information, and can be easily adjusted to new soccer environments. Thus the rest of our summer, post Istanbul, Ellis and I spent on creating and devising a means of testing a new MCL.

Faculty Mentor: Eric Chown