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Final Project

Project Summary: the objective of this project is to build a SLAM with unknown correspondence to locate the unknown landmarks.

SLAM body construction: The EKF SLAM consist of 5 parts of coding: state prediction, measurement prediction, measurement, data association, and update. In state prediction, the temporary state variables are needed to be constructed. Since this is the EKF SLAM with unknown correspondence, it requires a dynamic matrix, Fx to store the incoming detected landmarks. This matrices has 3 X 3+2*N dimensions. Where N is the number of landmarks been observed. The updated state space will be the previous state space + the state dynamic matrix Fx transpose times the motion transition matrix. Then the Jacobian matrix will need to be constructed for the covariance update.

To update the measurement, if a landmark is been observed, the difference of the landmark coordinates and the robot pose is to be calculated for the Jacobean measurement update. Dynamics matrix Fxk is been used to keep the dimension consistency with the state variables. The observed measurement is then used to compare with the theoretical measurement. These process repeats for all the previous landmarks been observed. Lastly, measurement covariance gets update and store in a list, and piK is constructed for comparison in the next step.

In data association, piK is assign with a threshold value alpha. This alpha value is used to create an index value, J. J is used to determine whether the observed landmark is a new one or an old one. Then Kalman gain is updated with the corresponding sigma, H and measurement covariance. This process gets repeated until there is no more landmarks on the list.

The last step updates the means and covariance.

Getting Landmarks strategy: We start out with spiral pattern for maximin research area coverage. Once a landmark is detected, we then switch to the 8 pattern. The benefit of the 8 pattern is that it uses the detected landmark as a base, and explore outward. Since the pattern will loop back to the seemed landmark, it is guaranteed to maintain low covariance during exploration.

For the alpha value, we use the covariance of the system times a constant arbitrary value. We initially set the constant value to 500. It sometimes miss adding the landmark. So we bump the value up as large as 5000 to ensure that the old landmark does not get treated as the new one.

Issues and discussion: We found that sometimes the believe coordinates of our landmarks are getting too far off from the actual coordinates. This inaccuracy is associated with the alpha values. If we pick the alpha value too small, sometimes it will treat the same landmark as a different one. If the we pick the alpha value too pick, sometimes the robot will treat the 2 nearby landmarks as one big one. This leads to a larger covariance and inaccurate result.

Landmarks strategy we have chosen have some limitations. If the landmarks are cluster at 2 opposite corner. If the distance of this cluster is too large, our robot will not be able to detect the landmarks from the opposite corner. As current setting of our robot's research range to be 7 apart from each loop for spiral and 8 patterns. Currently our robot is not working well with 25 x 25 map with 25 random landmarks. If the landmarks clustering at the corner, our robot will have hard to detect them and gives out the correct location.