Fuzzy Logic Based EKF for Mobile Robot Navigation: An Analysis of Different Fuzzy Membership Functions

Hamzah Ahmad[1], Nur Aqilah Othman[1]

[1] FKEE, Universiti Malaysia Pahang, Kampus Pekan, 26600 Pekan, Pahang, Malaysia
hamzah@ump.edu.my

Abstract. This paper deals with the analysis of different Fuzzy membership type performance for Extended Kalman Filter(EKF) based mobile robot navigation. EKF is known to be incompetent in non-Gaussian noise condition and therefore the technique alone is not sufficient to provide solution. Motivated by this shortcoming, a Fuzzy based EKF is proposed in this paper. Three membership types are considered which includes the triangular, trapezoidal and Gaussian membership types to determine the best estimation results for mobile robot and landmarks locations. Minimal rule design and configuration are also other aspects being considered for analysis purposes. The simulation results suggest that the trapezoidal memberships surpassed other membership type in providing the best solution in mobile robot navigation.

Keywords: Mobile Robot, Navigation, Kalman Filter, Fuzzy Logic, Membership

1 Introduction

In achieving a truly autonomous mobile robot, several factors must be taken into account such as computational complexity of the designed model, the environmental conditions, noise characteristics and uncertainties. These issues are among the big challenges in mobile robot navigation and had an enormous attention from researcher.

Navigation covers a broad range of applications such as path planning, localization and mapping. Between those three main areas, localization and mapping has gained high research interest. Both of those fields can be tolerate individually or solved simultaneously. Combining both research themes, the problem can also be called as Simultaneous Localization and Mapping(SLAM). One of the famously been used technique to solve SLAM is Extended Kalman Filter(EKF)[1][2][3]. Unfortunately, EKF is only known to be accurate to operate in a Gaussian noise environment. Such demerit demands further improvement or new solution. To this extend, particle filter[4], unscented kalman filter, graph-SLAM and other techniques have been available for non-Gaussian noise environment. Unfortunately, all of the techniques still infeasible due to high computational cost, complexity and other unavoidable issues. As a result, researcher still relies heavily on EKF to perform navigation as it is can guarantee some good results in estimation[5].