

Kalman filter based preferred velocity estimation for human agent movement using row position data from lidar sensor.

Introduction

In the autonomous navigation of a robot withing a crowded area it is a common problem to observe the movement of the human agents in the environment and based on their past movement, predicting the future trajectories of the present human agents. These predicted trajectories will be used by the robot to plan its paths in order to move through the crowd that is known as crowd navigation.

When a robot need to solve the crowd navigation problem robot uses the location of each human agent in the environment and the calculated velocity each of them to predict their future trajectory for a predefined time period. So to take these position of the human and velocity there are various sensors that can be utilized depending on the available sensors in the robot. In this project the lidar sensor has utilized to take the position data of human agents and using the past position data of the human agent and the time period that lidar sensor updates robot calculate the velocity data for human agents. Then this velocity and position used to predict the human agents paths.

But here the lidar based position data are noisy and fluctuating when measuring the moving human agents (because of the moving legs of human), the position data of human agents become really unstable and not reliable. Then the calculated velocities also become un reliable and then the predicted paths of the human agents become also un reliable that make possible coalitions with human agents. Then when the robot is moving using these data, those movement become really un reliable and un safe, because robot moving through human crowd.

To overcome this issue we need to smoothen the calculated human velocities for reliable human path prediction by the robot and also to incorporate the human agents details like age, physical impairments, here used a Kalman filter implementation for estimate a proper and smoothen velocity called as the preferred velocity that have the knowledge about the human agents external appearance details that affect to the movements of human agents. This way there will be a proper path prediction for human agents and the robot will be able to perform more safer and social movement when navigating in the crowded area.

Methodology

For this preferred velocity estimation there should be position data for each human available in known time period. Then the preferred velocity estimation module can take position data for human agents for two consecutive time periods and based on the difference of each human position data module will calculate the velocity.

There is a separate module that captures the position data by a lidar sensor and it captures the position data for each human agents in the environment and publish these data. Then there is a data buffer module that capture the position data for each human and stores up to 10 position data for each human. (as que data structure) In this module it uses the data rate of lidar data update and calculate the noisy and unstable velocities for each human agent.

Also there is a camera module and it captures each human agents and their external appearance data. Based on these data this module classify human agents in to mainly 4 classes (child, adult, elder, disabled) and assign the human class for human agents along with the lidar sensor based positions data. (this module capable to do this sensor fusion)

Then there will be separate set of Kalman filters for each human agents in the robots visible are to both camera and the lidar sensor which will be used to estimate the preferred velocity for each human agents. Then the class details of human agents and statistics of the calculated velocities of human agents (standard deviation) will be used to adjust the process noise covariance and the measurement noise. Then this tuned Kalman filter for each human agents will take the noisy un reliable velocity data and estimate the preferred velocity.

Implementation

In details how the methodology was developed

Human distances calculation by lidar, camera data based human class detection, using the vision based distance and lidar based distances merge or align class data with corresponding human agent, velocity calculation method, architectures of Kalman filter and dimensions of matrixs with what are inputs and outputs, predicting and corrections, how initialization happen, how to update process and sensor noise covariances, how each human velocity affected by KF.

Results

This is a ongoing project still haven't test with real human data

Used a separate node to generate artificial human and camera data

Add some screen shotes

Discussion

Chat gpt

Conclusion

Chat gpt