Dynamic Monte Carlo localization untuk tracked mobile robot = Dynamic Monte Carlo localization for tracked mobile robots

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Abstrak

Monte Carlo Localization (MCL) dikenal handal sebagai algoritma selflocalization. Akan tetapi, implementasinya pada tracked mobile robot (TMR) masih jarang. Bisa jadi hal itu karena odometry TMR yang selalu berkonotasi buruk. Selain itu, kinerja MCL pada robot dengan jumlah sensor exteroceptive yang minim masih belum dibuktikan. Lagipula, isu sensitif pada MCL yaitu kebutuhan akan sumber daya komputasi masih menantang untuk dicari solusinya yang mudah diaplikasikan tetapi optimal.
Pada riset ini, mula-mula dirumuskan model gerakan dan persepsi probabilistik TMR yang berperan dalam tahap sampling dan weighting pada algoritma MCL. Lebih lanjut, model gerakan probabilistik yang dipakai berjenis Odometry Motion Model dengan pendekatan distribusi Normal (Gausssian), dimana odometry berfungsi sebagai pendeskripsi informasi kontrol. Sementara itu, model persepsi probabilistik dirumuskan dengan asumsi bahwa semua exteroceptive sensor bersifat independent satu sama lain. Lebih spesifik, untuk sonar, ada tiga tipe error yang diperhitungkan secara eksplisit dalam model probabilistiknya, yaitu local noise, failures, dan random measurements.
Akhirnya, berhasil dikembangkan suatu varian baru dari MCL yang dinamakan Dynamic-MCL. Karakteristik khasnya adalah adanya variasi jumlah particle yang dilibatkan berdasarkan Spread-factor (S), yaitu parameter yang mengindikasikan persebaran particles. Lebih lanjut, integrasinya dengan algoritma Plain-MCL dilakukan pada tahap resampling. Dengan eksperimen yang ekstensif, dibuktikan bahwa Dynamic-MCL dapat memecahkan tantangan lokalisasi pada TMR, mulai dari local-localization (pose tracking), globallocalization, sampai kidnapped-robot.
<hr><i>Monte Carlo Localization (MCL) is known as a robust self-localization algorithm. Nonetheless, its implementation on tracked mobile robots (TMRs) is rare. It is likely because odometry of a TMR always seems unworthy (erroneous). Besides, performance of MCL on robots lack of exteroceptive sensors has not been well proven yet. Moreover, a sensitive issue on MCL i.e. the need of computational resources still warrants further investigations looking for handy-yet-optimal solutions.
In this research, a probabilistic motion model of a TMR is developed, as well as its probabilistic perception model. The former has a vital role in the sampling step, while the latter in the weighting step of MCL algorithm. Furthermore, the type of the probabilistic motion model used is Odometry Motion Model fitted by Normal (Gaussian) distribution, at which odometry is employed as a descriptor for control information. Meanwhile, the probabilistic perception model is formulated based on an assumption that is all sensors are mutually independent. Specifically, for sonars, there are three kinds of error that are explicitly reckoned in its probabilistic model, namely local noise, failures and random measurements.
Finally, a new variant of MCL is introduced named Dynamic-MCL. Its unique characteristic is there is a variation on the number of particles involved based on Spread-factor (S) i.e. a parameter indicating the spread of particles. Furthermore, its integration to the Plain-MCL algorithm is carried out in the resampling step. Based on extensive experiments, it is explicable to claim that Dynamic-MCL is capable to solve

localization challenges on TMRs including local-localization (pose tracking), global-localization and kidnapped-robot.</i>