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MATHEMATICAL MODEL OF MODIFIED REAL-TIME OBSTACLE AVOIDANCE METHOD BASED ON LAPLACE ARTIFICIAL POTENTIAL FIELD

МАТЕМАТИЧНА МОДЕЛЬ МОДИФІКОВАНОГО МЕТОДУ ШТУЧНИХ ПОТЕНЦІАЛЬНИХ ПОЛІВ З ВИКОРИСТАННЯМ ФУНКЦІЇ ЛАПЛАСА ДЛЯ УНИКНЕННЯ ПЕРЕШКОД В РЕЖИМІ РЕАЛЬНОГО ЧАСУ

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Within the field of robotics, a significant emphasis is placed on autonomous mobile robots. These are advanced devices designed to navigate spaces independently and are equipped with the capability to make specific real-time decisions. An essential element of the software framework in these machines relates to the algorithms for path planning and obstacle avoidance. In this report we provide a brief overview of the family of modified obstacle avoidance methods based on classic approach which was introduced by O. Khatib in 1984 [1]. The main idea of method is in calculation of 3 fields: attractive (drives robot towards target locations), repulsive (generated by obstacles to repel robot away) and total field. Safe direction is determined by finding argmin of the total field. Recent modifications involve simplifying mathematical models and moving toward scalar functions instead of vectors. One of such approaches is presented in [2]. Authors conducted studies with Gaussian function to calculate potential and presented promising results. In this excercise we propose further investigation in this direction and used Laplace function for calculation of potentials. Equation (1) presents Laplace repulsive field.

$$f_k(\theta_i) = A_k * \exp\left(-\frac{\sqrt{2}|\theta_k - \theta_i|}{\sigma}\right) \quad (1)$$

where θ_k corresponds to the central angle of the k_{th} obstacle, σ_k is half of angle occupied by the k_{th} obstacle. A_k is calculated according to (2).

$$A_k = \overline{d_k} * \exp(\sqrt{2}) \quad (2)$$

where $\overline{d_k} = d_{max} - d_k$, d_{max} is sensor range distance. Such modification has an advantage in computational complexity compared to Gaussian potential: calculating absolute value is less resource consuming operation as compared to exponent, which might be crucial for embedded systems with real-time requirements. Currently we work on simulations and comparison with existing modifications. Complete results are to be published in forthcoming publications.

References

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