

3D Voxel Grid Based Path Planning for Robotic Manipulators using Matrix Multiplication Technique

Alternatives:

- Efficient distance calculation / Efficient repulsive field calculation technique
- Matrix Multiplication-Driven Repulsive Fields for 3D Voxel-Based Robotic Manipulator Path Planning
- Robotic Manipulator Path Planning Optimization Using Matrix-Derived Repulsive Fields Based on 3D Voxel Grid

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Abstract

1 Introduction

2 Background

1-2 PAGES

- PRESENT DISTANCE CALCULATION FOR MANIPULATORS (sensors, lidar, ir, bounding boxes)
- PRESENT PATH PLANNING METHODS FOR MANIPULATOR (optimization, sampling, biological, learning)
- similar to Distance Transform (a kind of inverted distance transform)
- method was inspired by Khatib APF (however, it evolved into a different method)
- different existing APF manipulator implementation articles
- VFH

3 Methodology

3 PAGES

3.1 Optimization Algorithm

- optimization algorithm
- robot kinematics (include the exact-reduced method)
- primary task of distance goal
- secondary task of repulsive field
- damped least squares
- task slowdown option
- secondary task of manipulation measure

3.2 Task Constraints

- equations of occupied and empty space

3.3 Attractive Velocity

- attractive field calculation (normalization of attractive force)

3.4 Repulsive Velocity

- object detection is done in task domain and not c-space (more logical)
- repulsive field calculation - matrix "convolution" method
- matrix size and shape selection
- equation for repulsive kernel values (non-linear)
- PLOT: (ERK) kernel graphics
- PLOT: (ERK) linear kernel graphics
- PLOT: kernel field shape
- interpolation of the repulsive field
- what if there are obstacles behind wall (usually not the case, depth sensors show only thin walls, some noise doesnt matter, non-linear kernel, possible additional pre-convolution to convert obstacle grid to edges)
- efficient calculation in dynamic environments, lacking prediction capabilities (MPC)

3.4.1 Kernel Selection

3.4.2 Interpolation

4 Implementation

5 Results

- include execution times
- PLOT: kernel on robot graphics

3 PAGES

6 Discussion

1 PAGE

- add the limitations of such method (already mentioned by Khatib)
- the limitations of local search
- number of parameters that need to be tuned (are there actually that many?)

7 Conclusion