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Quick 3D trajectory planning for rotating extensible manipulators using piecewise polynomial interpolation

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ABSTRACT

Trajectory planning is a complicated task which plays an important role in many engineering applications where robotic arms are required. Some of the basic requirements include motion quality, compatibility between forces/torques at the joints with the given constraints, accurate end-effector position placement (reach different targets) and orientation (achieve specific tasks), and minimisation of actuator effort and torque variations. To achieve these requirements, new accurate mathematical algorithms which ensure smothness and reduce vibrations are to be considered.

In this paper the 3D trajectory planning of the end-effector of a rotating extensible manipulator arm using picewise interpolants is considered. The trajectory of the end-effector is described using the manipulator base location and the trajectory of the non-active end of the extensible arm. Since the end effector of the extensible manipulator may not reach all the desired locations due to the arm geometry, i.e., trajectory can not go out of the working envelope, the relation between the base location and the end effector path is examined.

Due to the spatial representation of the manipulator arm, cylindrical coordinates are associated with the end-effector trajectory of motion. Possible trajectories of the end effector are generated using a combination of polar piecewise interpolants that approximate the radial trajectory and a linear approximation of the trajectory height. Partial smothness of the poygonal trajectory is obtained through the use of piecewise interpolants which devises continuous derivatives between the nodes, minimise exectution time and allows easy calculation of kinematics variables. To verify the proposed approach, numerical simulations are conducted for two different configurations.

REFERENCES

[1] D. B. Marghitu, M. Dupac, *Advanced Dynamics: Analytical and Numerical Calculations with Matlab*, Springer New York (2012).
[2] A. Gasparetto, P. Boscariol, A. Lanzutti, R. Vidoni, “Trajectory planning in Robotics”, *Mathematics in Computer Science,* **6**:269–279 (2012)
[3] M. Dupac, “Smooth trajectory generation for rotating extensible manipulators”, *Mathematical Methods in Applied Sciences, (*Published online in Willey online library - http://onlinelibrary.wiley.com/doi/10.1002/mma.4210/pdf), 2016
[4] M. Kalyoncu, “Mathematical modelling and dynamic response of a multistraight-line path tracing flexible robot manipulator with rotating-prismatic joint”, *Applied Mathematical Modelling,* **32**:1087–1098 (2008)
[5] J. E. Lavery, “Univariate cubic Lp splines and shape-preserving,multiscale interpolation by univariate cubic L1 splines”, *Computer Aided Geometric Design*, **17**:319–336 (2000).