Autonomous trajectory planning of a robotic arm

Project description by Dheeraj Tippani

General description:

The problem we are addressing will be on 'autonomous trajectory planning of a robotic arm'. Every robotic arm has an end effector at the end of it, this end point of the robot is moved around in 3d space to perform certain operations. The robot has to calculate an optimal path to move the end effector to the target location. The movement of this end point in 3d space is achieved by various configurations of rotations of 6 degrees of freedoms at the joints.

The robotic arm links and joints have certain constraints, and the space around the robot may have obstacles. The trajectory path planning can be optimized with respect to some factors like, minimal total time of motion, maximum energy efficiency, minimum acceleration/jerks etc., After an optimal trajectory plan is calculated, the plan has to be executed using mathematical principles of 'Inverse Kinematics'.

The project goal is to develop an algorithm that takes target position, robotic arm positions, obstacles, as inputs in the form of 3d CAD file. The algorithm out put will be a trajectory plan that is executed and shown using a simulation environment.

Not all robotic arms need to calculate their trajectories every time, but robotic arm operations like delivery robots, humanoid robots, robotic assistants in restaurants/hospitals/labs etc., inter planetary rovers(mars rover), welding, painting etc. Are some of the suitable application areas for such an algorithm for robotic arms.

Project goals and sub tasks:

1. Fixing/deciding on an optimizing criteria for trajectory planning.
    a) Literature review on various optimization criteria based of area of application
    b) Gathering mathematical techniques to implement.
2. Developing an algorithm for creating a trajectory path in 3d space.
    a) Literature review of preexisting algorithms, weighing down pros and cons.
    b) Exploring both traditional algorithms and the machine learning techniques in trajectory planning.
    c) Implementing the algorithm and test in simulated environment.
3. Execution of the trajectory by solving inverse kinematics problem.
    a) Analysis of mechanical constraints, obstacles etc.
    b) Representing constraints and obstacles mathematically.
    c) Calculating optimal solution and implementation.
4. Simulation of robotic arm, target and obstacles using a software.
    a) Deciding on programming language of implementation, software for simulation and file formats etc.,
    b) Testing generated algorithms and mathematical analysis to choose the most optimal trajectory.