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Commentary

Path Planning Algorithms of Mobile Robot Systems

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DESCRIPTION

Mobile robots has expanded to include micro-scaled robots that fit in the palm of the hand to large-scale defense-grade robots. They may operate on the ground, in the air or in water. With such large penetration, the horizon of use of mobile robots has widened significantly. Their popularity is attributed to many factors, including increased reliability of robotic hardware, robust software systems, low production costs and the availability of accurate sensing and actuation mechanisms. In addition, the ability to operate autonomously in uncontrolled, natural and possibly cluttered environments, makes them well suited for many diverse tasks.

They find application in field operations, like harvesting, fruit picking and weed mowing and in structural monitoring for bridges, pipelines, industrial plants and the like. They are also used in surveillance, mapping, long-term monitoring and reconnaissance operations. Many applications have also benefited from the use of multiple robots operating in a cooperative setting. Low production and operating costs for the robots coupled with ease of operation admit the use of multiple robots with complementary capabilities. Multiple robots operating cooperatively help achieve better performance and lower the costs. A common component in the realization of these robotic solutions that involve autonomous mobile robots, is path planning for the robots.

Path planning is integral to autonomous operation of mobile robots and is required at all scales of operation. Ground robots, flying robots, manipulator arms, micro-scale mobile robots each of these require path planning to perform useful tasks. A planning algorithm or a planner, computes a path for a mobile robot or a robotic component, to traverse from an initial state to a terminal state. The path must ensure feasibility. Feasibility may be defined in terms of problem-specific criterion such as a curvature constraint or the requirement to visit a set of intermediate states. A path planning problem usually involves at least one of the two, a cost function or a reward function. It may also involve both, or multiple instances of each function. The cost and the reward functions, along with the feasibility constraints in a path planning problem, are determined by the application and system specifications. In terms of implementation, path planning logic may operate in a higher abstraction module or may be embedded in low-level control layers.

It may be done offline or in real time or as a combination of the two. Based on the application specific requirements, path planning may be performed individually for each robot or jointly for multiple robots. Given these large set of variations in the problem and solution space for path planning, it is forthright to appreciate the complexity and challenges involved.

CONCLUSION

This thesis addresses a few important problems in path planning for single and multiple robot systems. Visual monitoring is one of the most important and popular application areas for mobile robots. This thesis addresses a set of problems related to visibility-based monitoring and coverage in outdoor environments. These environments are inherently dynamic and uncontrolled and any large scale or long term operations also need to account for limited fuel capacity of the robots. The planning algorithm determines paths for both aerial and ground robots for visual coverage and coordinated rendezvous visits to refuel the aerial robot. Comparative computational simulations are presented to discuss the efficacy of the developed approaches. Field deployments of the proposed approach using aerial and ground robots operating cooperatively are also presented.

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