Research Review

In this research review we try to capture three important key advancements in the field of planning and search. The focus of this paper will be the path planning algorithms of mobile robots. Most of the knowledge presented here is based on the review by Raja and Pgazhenthi (2012).

There are basically two types of path planning algorithms for mobile robots: off-line and on-line algorithms. Off-line algorithms can be applied in situations where all the surroundings are known whereas on-line algorithms are useful when the surroundings are not completely known and the robot is dependent on updates, e.g. by sensors (Raja and Pugazhenthi, 2012).

One classical approach for path planning was the C-space method by Lozano-Perez and Wesley (1979). They turned the path planning process into a 2-dimensional problem where the robot is a dot and the obstacles are displayed accordingly. Based on this approach, many methods have been developed, like the roadmap approach (e.g. Voronoi diagram), the cell decomposition approach and so on (Raja and Pugazhenthi, 2012).

One weakness of the classical approaches was that they would get stuck in local optimization. One was determined to look for better methods which would look for global optima. More evolutionary approaches were developed, like the Genetic Algorithms, Particle Swarm Optimization, Ant Colony Optimization and Simulated Annealing, although the last two have not been used widely. Genetic Algorithms are trying to simulate the behaviour of our genetics. They use constructs known from biology like decoders, fitness functions and genotypes. This adaptive behaviour allowed to create systems more suitable for dynamic environments. Particle Swarm Optimization also finds its origins in biology. The models are based on observations made from bird flocks and fish schools. In general, they are easier to implement than Genetic Algorithms as they have fewer parameters. The Ant Colony Optimization was combined with Djikstras algorithm. Simulated Annealing, also known from the lectures of the nanodegree, is a heuristics random search method.
Off-line algorithms were not enough so the community headed back to the drawing boards and tried to develop on-line algorithms, which would be even more adaptive to their environment.
First of all, there was the Artificial Potential Field approach suggested by Khatib (1986). Here, obstacles are thought of emitting repulsive forces which would lead the robot on the right way. Another approach which idea is pretty similar, is the vector field histogram method, where the surrounding of a robot is represented by a polar histogram. The robot moves based on where it is least dense and the general direction of the goal.
These classic approaches were too slow to compute good enough results where real-time is necessary, so again, the community turned to evolutionary methods. One of which is the combination of the Artificial Potential Field and Genetic Algorithms (Raja and Pugazhenthi, 2012).

All in all, evolutionary approaches have been shown to perform better. They are harder to implement computationally efficient and as it is impossible to pre-plan a path, they are usually not the global optimum (Raja and Pugazhenthi, 2012).

References

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