ABSTRACT

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The problem known in the robotics community as simultaneous localization and mapping is of fundamental importance both in its own right and because of its potential applications in the development of autonomous robots. Indeed, the ability to acquire maps of an unknown environment through exploration has, for example, the potential to completely change the modus operandi of first responders and rescue forces in general, so much so that it may even hold the seeds for the development of completely independent robotic emergency response teams. An application that is more immediate is the adaptation of robotic systems to changes in environments that are for the most part static and known beforehand, such as the operating loci of industrial robots that may be changed at any instant by events such as the placement of movable obstacles. This dissertation presents an approach to solve the simultaneous localization and mapping problem that is based on swarm intelligence optimization methods. While many solutions exist that are based on classical Newton-like optimization techniques, relatively little work has been done with respect to the application of derivative free bioinspired techniques to this particular area of robotics. That being said, we have chosen three techniques to be the subjects of our inquiry, namely particle swarm optimization, artificial bee colony and the firefly algorithm . Furthermore, and in keeping with the intention of creating an effective solution to the problem at hand, we have made use of a pose graph based approach as a means of maintaining the consistency of our estimates across the mapping process. Systems designed to perform SLAM using pose graphs are currently the state of the art and it is our belief that a robust scan matching system is currently of the utmost importance to further the field. Throught the development of this thesis we have concluded that the ABC technique has great potential, having tested it and found it is both fast and efficient in a great range of circumstances. This affirmation is backed by the fact that in the best case scenarios we have obtained accuracy gains in between 12% and 88% regarding the translational estimates of the robot's trajectory, by using the ABC metaheuristic, when compared to state of the art techniques. The firefly algorithm, while not as accurate as the artificial bee colony technique, was faster than the aforementioned bee inspired metaheuristic on 7 out of the 8 public domain datasets. The firefly algorithm consumed, on average, only 23% of the time spent per scan processed by the artificial bee colony optimization technique. Particle swarm optimization has shown an inferior accuracy when compared to the artificial bee colony optimization technique and an intermediate processing time when compared to the other two optimization methods.

Keywords: Simultaneous Localization And Mapping; Robotics; Swarm intelligence