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USING PARTICLE SWARM OPTIMIZATION ALGORITHM FOR FORMATION FLYING SPACE SENSOR NETWORKS

Abstract

Technology advances have made it possible to deploy ad-hoc and flexible networks with some small, lightweight, low-cost network elements, called PicoNodes. These nodes are associated with very restrictive constraints in terms of size, mass and power. This paper presents the design of space sensor networks using satellite PicoNodes for Earth observations, where reliability, robustness, flexibility, long network and node life are of prime importance. At the core of this research will sit a hierarchical embedded multi-objective evolutionary algorithm (MOEA), which spans the complete network hierarchy at the node (reconfigurable device) and network level. On-board each flight vehicle it consists of a complete reconfigurable SoC device, incorporating with various Intellectual Property (IP) cores for communication, control, and computing.

Particle swarm optimization (PSO) is one of biologically-inspired optimization techniques. For small satellite applications, PSO is becoming a promising optimization algorithm due to its many advantages. First, PSO has a fast convergence rate. Compared with traditional evolutionary algorithms, PSO tends to converge to the best solution quickly. Second, PSO is very simple and easy to implement. There are few parameters to adjust in PSO. This is particularly attractive for onboard embedded applications since the computational resources such as memory and energy are extremely limited. Third, PSO is also computation-efficient. In PSO the number of particles (i.e., population size) is very small. In fact, for most of the problems 10 particles will be large enough to get satisfactory results. For traditional evolutionary algorithms the population size is often required to be set as larger as possible to get an acceptable solution.

In this paper we will present an improved PSO algorithm, which can keep all the advantages of the standard PSO, such as implementation simplicity, low computational burden, and few control parameters, etc. However, its performance can be much better than the standard PSO algorithm. The algorithm will be applied to optimization in node and network level. An application to formation control will be discussed.