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Author: Ms. Shabnam Yazdani
K. N. Toosi University of Technology, Iran

Prof. Jafar Roshanian
K. N. Toosi University of Technology, Iran
Dr. Masoud Ebrahimi
Tarbiat Modares University, Iran
Mr. mohammad javad hassani kabootarkhani
K.N. Toosi University, Iran

A NOVEL APPROACH FOR GENERATING STAR MISSION CATALOG USING COMBINATORIAL OPTIMIZATION TECHNIQUES FOR LOW COST AIRBORNE STAR TRACKER

Abstract

In this paper, creating a uniform star catalog utilizing combinatorial optimization techniques such as Genetic algorithm is considered. Unifying star positions on the celestial sphere has always been of great interest for star tracker designers. While surveying the night sky, many portions of the celestial sphere contains more than enough stars required for star pattern recognition algorithms whereas, other portions of sky might not contain enough stars for recognition, dependent to the defined star magnitude. Several techniques to create a nearly uniform star catalog have already been developed such as Spherical Patches, Charged Particles and Fixed Slope Spiral methods. The results of aforementioned methods are considered as the initial solution for the objective of this paper. The first step in using the combinatorial optimization techniques is to produce an array containing digit "one" for each star from the basic star catalog (solution representation) which in this case is sorted according to star magnitude. After having achieved an initial uniform star catalog from one of the methods mentioned above, eliminated stars in the predefined array will be replaced with zero. In the next step Monte-Carlo sky simulation is performed on the initial catalog to determine the number of the sky portions where the quantity of stars is still under or over adequate. Afterwards combinatorial optimization technique will be executed to unify the distribution of the digits presenting stars by modifying the produced array. The procedure is iterative and in each iteration, after updating the array, Monte-Carlo simulation will be performed to determine the number of useless frames. While the objective of the problem which is minimizing the number of useless frames is not achieved, the iterations will continue. In this paper, Hipparcos star catalog which is sorted according to magnitude 5 is considered. Results of implementing combinatorial optimization techniques (Genetic Algorithm) are compared to classic methods mentioned earlier utilizing star pattern recognition. Star catalogs produced from each method are used to generate the mission database. Afterwards star pattern recognition algorithm is executed in Monte-Carlo simulation to determine feasibility of the produced mission database. Results from the optimization uniform star catalog demonstrate significant improvements in database volume and search time. Utilization of this method is suggested for low cost star trackers which require cheaper processor with restricted memory available and airborne star trackers which operate in infrared wavelength containing more chaotic optical sources.