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ATTITUDE DETERMINATION OF NANO-SATELLITES USING LOW-COST, QUADRANT BASED MEMS SUN SENSORS FOR CREATING UNIQUE SENSOR FUSION

Abstract

This paper presents a distinct approach for attitude determination of modern age Nano-satellites which is analyzed, simulated and experimented systematically to overcome its present day challenges. In the recent years, Nano-satellite missions have been outstandingly beneficial to students and young space professionals in exploring and configuring different dimensions of miniaturized space technology proactively across the globe due to their enormous advantages like minimum weight, size and remarkably low cost for achieving similar objectives as larger satellites but still challenges exists in execution of its sub-systems in real-time with appropriate accuracy and algorithms demanding highly accurate micro components with appropriate operating techniques to withstand space environment which is being fulfilled by Micro-Electro Mechanical Systems (MEMS). Though MEMS technology has many benefits, there are certain limitations in achieving desired accuracy, failure in executing attitude kinematics with suitable implementation method and performance of sensitive MEMS based components are of main concern. In order to contribute in overcoming these limitations and ensuring enhanced applicability and accuracy of MEMS based sensors, intensive research is being carried out at Korea Advanced Institute of Science Technology (KAIST). The main idea is to design and create a distinctive attitude determination system with unique sensor fusion consisting of finely selected MEMS based Magnetometers, Sun sensors and Gyroscopes with exceptionally well-defined and highly accurate operating techniques concentrating essentially on Nano-satellites. For this to be achieved, the individual sensors are first strategized to be simulated and tested for scrutinizing their accuracy and performance under varied operating conditions computing attitude along their defined axis. This paper is principally focused on simulations, experiments and calibration carried out for two models of unique MEMS based sun sensor with dissimilar technical specifications to analyze their suitability under space environment. These sun sensors operate on a distinct quadrant built algorithm and has an adequate technique to achieve suitable attitude. The initial attitude obtained consisted of high sensor noise but has been reduced effectively by using essential method during experiments. The results attained in the form of graphs and necessary technical data consisting of attitude and other important parameters are precisely assessed against each other during simulations and experiments for both the sensor models which are then compared to each other and significant conclusions have been made in detail. Also, the importance of considering possible space environment concerns that affect the sun sensor performance and necessary protective measures analyzed prudently during research is concisely emphasized.