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FEASIBILITY STUDY OF NEURAL NETWORK IN SATELLITE ATTITUDE DETERMINATION

Abstract

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Abstract This paper presents a new approach for satellite attitude determination based on artificial intelligence. The QUEST (QUaternion ESTimator) algorithm has been one of the most popular solutions to the Wahba's problem because it is globally nonsingular and the kinematics equation is linear. The quaternion data also helps reduce the computational load for the Kalman filter. Although the QUEST algorithm together with the Kalman filter can solve most problems in attitude determination, there are still some limitations in terms of stability, observability and adaptability. Hence, we propose a neural network approach such as BP(Back Propagation) and RBF(Radial Basis Functions Neural Networks) for satellite attitude determination. The neural network models the relationship between the sensor data and estimated quaternion in a generic method, without the detailed priori knowledge. In this project, the training data is from the SpooQy-1 CubeSat, which is developed by the Center for Quantum Technology at National University of Singapore. The ANN (Artificial neural network) is applied to train these data and get the estimated quaternions, which will be compared with the actual quaternions from the SpooQy-1 ADCS. The detailed process is that the sensor data go through the Quest algorithm to get the computed quaternion, which will go through Kalman filter with gyroscope data to get estimated quaternion. This paper explores the feasibility of replacing the QUEST and Kalman filter with a simple BP (Back Propagation) neural network and RBF(Radial Basis Functions Neural Networks). The results show that the ANN can obtain the same performance as the QUEST algorithm. In this paper, we will discuss the advantages and disadvantages of using ANN for attitude determination over the QUEST algorithm.

Keywords: QUEST, Kalman Filter, Initial Measurement, Neural Network, quaternion, attitude determination.