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INTERACTING MULTIPLE MODELS ADAPTIVE ATTITUDE ESTIMATION FOR A STEREO-IMAGERY SATELLITE WITH UNKNOWN STAR SENSOR NOISE LEVEL

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Abstract. *In this paper, we will design an interacting multiple models adaptive attitude estimator (IMMAE) for a stereo-imagery satellite in which the satellite requires to have a relatively large angle maneuvers around pitch and roll axes simultaneously. This method improves the accuracy of the attitude estimation by identifying the star sensor noise level changes at the end of maneuvers while imaging takes place. The structure of the proposed IMMAE method contains several extended Kalman filters with different star sensor noise levels that the probability of each level will be updated based on the model conditional likelihood functions. This algorithm will be designed once by using only kinematic model of the satellite which will be entitled 6-state IMMAE method and once by using kinematic and dynamic models of the satellite which will be entitled 12-state IMMAE method. In this method, high fidelity gyro and star sensor models are used to evaluate the design in realistic situation associated with gyro errors and star sensor noise level uncertainties. The effectiveness of the proposed IMMAE method will be examined and compared with previous proposed methods through numerical simulations.*
Keywords: Adaptive, Attitude estimation, Gyroscope, Multiple models, Satellite, Star sensor, Stereo-imagery

1. **Introduction.** Data collection in stereo mode is the simplest and most convenient way for 3D topographic data acquisition to produce new and revision of old inaccurate databases and maps, which has been matured over the 100 years [1-3]. This methodology involves identifying and measuring targets on images of an object, which have been taken from disparate viewpoints. These images are then used to compute three dimensional coordinates of the locations of the object.

A remote sensing satellite with stereo imaging capability is able to capture images in stereo mode by rotating the satellite along the roll and pitch axes simultaneously. Therefore, it needs highly accurate and stable pointing maneuvers to be accomplished in a few seconds that require the satellite to rotate along a relatively large angle attitude very fast. Figure 1 illustrates the stereo-imaging scenario of a satellite during its flight to acquire 3D information from objects or scenes [4].

In the proposed stereo-imaging scenario, we can consider two basic modes of flight for the satellite, "uniform motion" mode with constant angular velocity while the satellite reaches at the end of maneuvers and "maneuvering motion" mode with high angular velocity while the satellite starts to maneuver [5]. To take a high quality photograph, establishing an accurate attitude determination system is crucial to meet the following requirements properly in the two above mentioned modes: Maintaining the peak attitude determination errors less enough at the beginning of maneuvers, reducing the attitude