MATHEMATICAL MODELING OF INERTIAL MEASUREMENT SYSTEMs

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Mathematical modeling of complex data processing algorithms to study their functioning via computers provides a distinct advantage in the development of modern information and measuring systems.

Increasingly popular in our time have acquired inertial measurement systems (IMU), used for orientation and navigation of moving objects (aircraft, maritime and land mobile objects, robots, etc.). In particular, development and research of strapdown IMU devoted several books and articles [1 - 4]. Became popular algorithms strapdown IMU, are used to process navigation information Rodrigues-Hamilton parameters (quaternions) [1]. It should be noted that the problem of modeling algorithms for orientation and navigation in strapdown IMU were considered, for example, in textbook [2] and articles [3, 4] based on the software environment Matlab.

The author [3, 4] surveyed algorithm strapdown orientation system (SSR), implemented on basis of micro-electro-mechanical sensors (MEMS). Mathematical model of SSR calculates angles of orientation of movable object using equations Poisson kinematic based on quaternions. For simulation algorithm SSR used computer simulation technique based on the software environment Matlab. The aim of the experiment was to evaluate the effectiveness of the SSR for large drift of gyroscopes. In article [3] simulation was carried out on basis of program functions environment Matlab, and in paper [4] on basis of block diagrams visual environment Matlab Simulink. Research on effectiveness of application of MEMS in measurement systems was devoted to author's article [5], which showed use of MEMS in a real random medium in presence of broadband noise a level high.

One of results of computer experiment was confirmation of proper functioning of SSR using MEMS gyroscopes, accelerometers and magnetometers in implementation kinematic equations of Poisson using quaternions. Also, results were obtained from values of mean square error (RMSE) and limit of error for each of angles of orientation in presence of a significant drift of gyroscopes. In [3, 4] have shown that application of proposed method gyro drift compensation algorithm gives SSR acceptable for practice of error.

Further development of research initiated in [3, 4], extended for specific data for unmanned aerial vehicle a highly maneuverable. At same time to compensate for drift of MEMS gyroscopes had to use idea of author of [6] on application of PI regulator (proportional-integrating regulator). The introduction of PI regulator in compensation scheme has allowed to create a astatic property with respect to estimation error and get acceptable values for practice of RMSE. The proposed mathematical models created to SSR can be used in more complex inertial algorithms, in particular when creating strapdown inertial navigation systems (BINS).

The proposed mathematical models created for the SSR, embedded in more complex inertial algorithms designed for strapdown inertial navigation system (BINS).

Conclusions:

Practical value of modern algorithm SSR, based on use of parameters of Rodrigues-Hamilton (quaternions). Research SSR implemented in engineering environment Simulink Matlab, which gave visual clarity schemes, possibility of repetition and modification of mathematical models.

As main result of mathematical and computer modeling of new algorithm SSR were obtained significantly lower values RMSE compared with standard deviation option when applied to compensate for conventional filters.

The results of mathematical modeling used in strapdown inertial navigation system.

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