Abstract

This dissertation is focused on developing and investigating the properties of the estimation algorithms of the unguided rocket missile (ballistic object) flight parameters, which are suitable for the electro-optical tracking system measurements. The main motivation that led to embarking on the research in this field was the author's experience, gained during his professional career in the Military Institute of Armament Technology, particularly in the area of research and testing of the rocket missiles.

The tasks required to complete the work objective were oriented on seeking of suitable algorithms allowing for the estimation not only of the object position coordinates, but also of such parameters as a velocity, a direction, an angle of the flight path inclination, an object mass and other parameters affecting its movement, e.g. wind velocity components. As primary methods for the processing of the trajectography system's measurements, comprising azimuth and elevation angles, acquired in two different remote posts, algorithms of the extended Kalman filter, modified by the author, were utilized.

To accomplish the research tasks, three core methods of filtering have been adopted. The first one incorporated the dynamic model, which assumed the object movement in the vertical plane, and which is described in a two-dimensional coordinate system. The second one utilized a three-dimensional dynamic model, while the third presented approach constitutes a modification of the method in which the two-dimensional dynamics was used, whereas, owing to a solution proposed by the author, a decrease in computational demands has been achieved. In the modified extended Kalman filter with the reduced computational demands, some of the matrix operations are only performed in chosen computational steps, depending on the assumed state vector elements variability measures, proposed by the author. For the algorithms mentioned above, ballistic object dynamics models, and observation models, which reflect the actual measurement equipment setup used in live tests have been developed, and three algorithms of the object flight parameters estimation have been elaborated and implemented in the Matlab® scientific environment.

The results of the conducted and comprised in the dissertation research, indicate a high accuracy of the estimation algorithms, both in the system with the two-dimensional and the three-dimensional dynamics model, which proved the first thesis, claiming that the algorithms of extended Kalman filter, dedicated to processing measurement data from the electro-optical tracking system, allow for the estimation of the ballistic missile flight parameters with a high accuracy. The results obtained for the filter with reduced computational demands, and their comparison with the results for the conventional filter confirmed the second thesis, that there exists a modification of the extended Kalman filter algorithm, processing the measurement data from the electro-optical tracking system, allowing for the reduction of computational demands, while preserving the high accuracy of the ballistic object flight parameters estimation.