Optical Measurement System Supporting the Navigation of Rapidly Rotating Objects

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Abstract:

The primary challenge in navigating rotating objects using inertial navigation systems (INS) with MEMS sensors is accurately determining their rotational speed. The limitations in precisely measuring this speed are the main sources of errors in inertial navigation. These inaccuracies present a significant obstacle to enhancing and controlling traditional, unguided rotating object designs. To address this, an innovative system has been proposed to support the navigation of rapidly rotating objects by predicting navigation data through algorithms that analyze changes in environmental conditions during movement in space.

This work delves into a designed system that fundamentally assumes the development of a low-cost measurement framework using various sensors to record different types of electromagnetic radiation (visible light, infrared, ultraviolet light). The estimation of navigation data in the rotational channel will be carried out using algorithms that calculate the time between the recorded maximum and minimum values of the aforementioned types of radiation.

To investigate the essence of the phenomenon, a dedicated research station was developed, allowing for experiments within the angular velocity range of 0 - 5400 °/sec, with the capability of altering the angle of attack between 0-50 °.

The data obtained will facilitate the key stage of research: the development of various algorithms tailored to different atmospheric phenomena such as fog, heavy cloud cover, strong sunlight, and varying conditions of day and night. Ultimately, it is anticipated that the most optimal algorithm for specific system conditions will be selected based on lighting and time-of-day conditions.