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PRELIMINARY DESIGN OF A HOMING ROCKET USING IMAGE RECOGNITION

Abstract

Guided rockets have multiple applications - microgravity experiments, atmosphere studies and defence. Each of them requires navigation and guidance. These are realised by employing various types of sensors: inertial, visual, IR, pressure-based, as well as GNSS receivers and radars. This paper presents the preliminary design of a nose cone with a camera-based visual navigation system of the FOK rocket.
The FOK rocket is an aerodynamically controlled testing platform constructed to study guidance, navigation and control algorithms. For the past four years it has been developed by the Rocketry Division of the Students' Space Association at the Warsaw University of Technology. It is propelled by a solid rocket motor, reaches a maximum velocity of 220 metres per second and an altitude of 1800 metres. The rocket is fully recoverable, using a parachute recovery system. This allows the rocket to perform several flights during a single day. It performed its maiden flight in 2018 and has been continuously improved since then. An in-house developed on-board computer is responsible for executing control algorithms and providing signals to servomechanisms driving four canards.
The main goal of the project is to develop a cheap and simple nose cone, utilizing image recognition for detecting a target. It should be equipped with a fixed, visible-light camera, capable of detecting a predefined air or ground-based target, and provide the guidance algorithm with its position relative to the rocket. Camera and image processing unit shall fit within an airframe measuring 70 millimetres in diameter, as defined by the current rocket design. The paper discusses the preliminary design of the system, along with the results of preflight tests.
The process of selecting the visual marker type, which serves as a target for the guidance system, is presented and discussed in the paper. The tests of available and developed algorithms intended for marker

detection and recognition are presented, with a special emphasis put on the accuracy of said detection and resistance to noise and distortions. These are related to flight dynamics, as well as dependent on the distance and variable orientation of the camera relative to the marker. The image processing and marker detection algorithms were tested within a software-in-the-loop simulation using an in-house developed flight simulation software. The programs used for the tests are covered, as well as their role in keeping the actual flight safe. Finally, hardware selection and the mechanical design of the nose cone are discussed.