Innovative Camera Pointing Mechanism for Stratospheric Balloons

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ABSTRACT

Cameras mounted on balloons can be used for various purposes, e.g. environment monitoring. However, video recordings from balloons have poor quality because of gondola’s movements. It can be seen on recordings from numerous balloon flights (e.g. BEXUS 6/7 campaign, BOBAS 3 mission) that gondola moves and rotate in uncontrolled manner. Commercially available camera stabilization systems for Unmanned Aerial Vehicle (UAV) applications are very expensive. Stabilized Camera Observation Platform Experiment (SCOPE 2.0) project proposes designing simple and made from COTS components (cost reduction) stabilization system that allows to point in desired direction. Its design takes into account gondola’s specific dynamics and unlimited rotation around vertical axis.

SCOPE 2.0 is a student experiment, created to participate in European Space Agency (ESA) educational programme BEXUS 10/11. It was launched on a stratospheric balloon in November 2010, Esrange Space Center in northern Sweden. Main objectives of the project was to design and build stabilization and control system for a video camera. The system should compensate changes of a balloon’s gondola attitude and keep a camera tracking selected ground targets.

SCOPE 2.0 consists of 3-DOF pointing mechanism with limited range of movements. Every joint has a stepper motor controlled by a microcontroller using microstepping control algorithm. On-Board Computer (OBC) computes required joints positions on the basis of desired and actual orientation of the camera. The later value is derived from real time data from Inertial Measurement Unit (IMU) and GPS. Computed values are then send to microcontroller. SCOPE 2.0 can be operated from a Ground Station (GS) (if communication is provided by external gondola rely) or work in autonomous mode. Additionally some temperature and voltage sensors were present on-board experiment that allow to monitor experiment operation. All recordings and telemetry are stored on a on-board memory. Some of telemetry can be also send to GS. An additional camera was mounted on SCOPE 2.0 which allowed to observe pointing mechanism movements during the flight.

SCOPE 2.0 launched on BEXUS 11 balloon, although partially sucessfull (due to problems concerning readings from IMU and communication with GS), allowed to identify main issues and complications that occur while designing such systems. Many conclusions were achieved that will allow to design in the future more reliable and functional system.

In the paper detailed objectives and system requirements of the project are listed. There is presented a design of SCOPE 2.0 system and its components. Finally main issues that appeared during construction of SCOPE 2.0 experiment and lessons learned are presented. Solutions, modifications and recommendations for future projects are proposed.

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