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A NOVEL TYPE OF OBSCURA TELESCOPE WITH MEMS MICROMIRROR ARRAY FOR  
 OBSERVATION OF EXTREME LIGHTENING

## Abstract

A novel type of telescope, a pinhole-like camera with a micromirror array, has been designed, fabricated and tested for space observation of extreme lightening called Transient Luminous Events (TLEs) occurring at upper atmosphere currently under question or investigation. The proposed telescope has the important functions: a wide field of view (FOV) surveillance, zoom-in on the object of interest, and tracking of fast-moving objects. The payload of the presented telescope will be carried into orbit by a Russian microsatellite Tatiana-2, of which the primary aim is to observe TLEs over a time period lasting at least one year.

The telescope consists of two cameras, “trigger camera” and “zoom-in camera”. The mirrors in the telescope play the role of pinholes for the obscura telescope and reflect images seen through the aperture onto the photo detector. The mirror in the “trigger camera” positioned closer to the detector is used for locating the object within the wide FOV, while the rotatable mirror in “zoom-in camera” is installed with a longer focal length and enables detecting the object image with higher lateral resolution, which provides a zoom-in effect. Every time when an event is discovered by the “trigger camera”, the position information of the event is converted to the proper voltage signals by the control circuit. They are applied to the rotatable mirror in the “zoom-in camera”, so that the reflected zoomed-in image of the event is located on the center of the detector.

It is important that the mirror should rotate its viewing angle rapidly enough to observe the event immediately after the trigger, so as not to miss a significant part of the event under investigation which usually lasts for a period of tens of milliseconds. As a possible solution for this purpose, fast rotatable MEMS micromirror array is able to direct light quickly to photo detectors and allows important functions such as fast zoom-in and tracking of a moving light source. In this paper, the novel MEMS obscura telescope for the observation of TLEs in the upper atmosphere is reported and a high fill factor, two-axis rotational micromirror array is also described as a key component of the telescope.