Applications of AMOS meteor all-sky detection system for space debris research

Jiří Šilha[(1)], Danica Žilková[(1)], Juraj Tóth[(1)], Pavol Matlovič[(1)], Leonard Kornoš[(1)], Karol Havrila[(1)], Martin Baláž[(1)], and Stanislav Krajčovič [(1)]

[(1)] Faculty of Mathematics, Physics and Informatics of Comenius University, Bratislava, Slovakia

ABSTRACT

The All-Sky Meteor Orbit System (AMOS) is an automated system used for the detection and orbit determination of meteors. AMOS has been developed and is operated by the Faculty of Mathematics, Physics and Informatics of the Comenius University in Bratislava, Slovakia (FMPI CU) and the system currently consists of two major parts, the all-sky AMOS-Cam and AMOS-Spec. AMOS-Cam is a system of cameras which monitor meteor activity around the world, nowadays four stations are located in Slovakia, two in Canary Islands, two in Chile and two in Hawaii. The AMOS-Spec is a video system for the systematic spectroscopic observations and detection of meteor spectra. It is currently worldwide distributed with one station in Slovakia, one in Canary Islands, two in Chile and one in Hawaii. Expansion of the observation network is planned in the future in central and eastern Slovakia as well as in South Africa and Australia. Network distribution secures large sky coverage, Northern and Southern hemispheres observed simultaneously, and the trigonometry used by two stations helps to accurately determine the atmospheric trajectory, which than leads to the pre-atmospheric heliocentric orbit and eventually to estimate whether the meteor belonged to a certain meteor shower or to a sporadic background.

The AMOS system primary focuses to capture meteors. However, detections of Low Earth Orbit (LEO) objects, objects orbiting on geocentric orbits with mean elevation below 2,000 km above the Earth surface, is quite common during the AMOS observations. Such data can extend the AMOS system capabilities to space debris research as well. This research mostly focuses on the extraction of the astrometric and photometric measurements from these observations. Detected debris comes in three categories: ‘specular periodical flashes’, ‘diffuse repetitive flashes’ and ‘diffuse continuous line-like trails’. First two categories can provide information about the rotational state of the objects. The ‘specular periodical flashes’ are also ideal for spectrum identification during specular reflections. Raw reflective spectrum and properties of the reflective surface can then be determined thanks to such observations.

Light sensitivity of AMOS-Cam system can be compared to human eye with precision ranging from 0.03 to 0.05 degrees which for meteor can result in tens of meters of uncertainty for the meteor’s atmospheric trajectory. For the less bright space debris records the uncertainty will be even greater. Therefore, system will work for good quality object identification but considering the operating limitation, the astrometric measurements are expected to be a secondary outcome. This is not the case for the re-entry events which can be captured by the AMOS system. Thanks to its geographical distribution and output data types, astrometry and spectra, the AMOS-Cam and AMOS-Spec in the AMOS worldwide network can be used to support reentry events modelling by monitoring the parent body’s fragmentation during the re-entry, calculating the fragments’ trajectories in the atmosphere and measuring their spectra by performing the spectral analysis of the fragments, analysis developed by FMPI.

In our work we will present the AMOS network and its sub-systems. The output data products will be discussed in detail and the focus will be put on AMOS’s application in space debris domain. We will discuss the astrometric and photometric reduction process, as well the procedures used for the spectrum and reflective spectrum analysis. The work will be demonstrated on several real cases captured during AMOS nominal operation.