MASSIVE PHOTOMETRY OF LOW-ALTITUDE ARTIFICIAL SATELLITES ON MINI-MEGATORTORA

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RESUMEN

Favor de proporcionar un resumen en español. If you are unable to translate your abstract into Spanish, the editors will do it for you. The nine-channel Mini-MegaTORTORA (MMT-9) optical wide-field monitoring system with high temporal resolution system is in operation since June 2014. The system has 0.1 s temporal resolution and effective detection limit around 10 mag (calibrated to V filter) for fast-moving objects on this timescale. In addition to its primary scientific operation, the system detects 200-500 tracks of satellites every night, both on low-altitude and high ellipticity orbits. Using these data we created and support the public database of photometric characteristics for these satellites, available online.

ABSTRACT

The nine-channel Mini-MegaTORTORA (MMT-9) optical wide-field monitoring system with high temporal resolution system is in operation since June 2014. The system has 0.1 s temporal resolution and effective detection limit around 10 mag (calibrated to V filter) for fast-moving objects on this timescale. In addition to its primary scientific operation, the system detects 200-500 tracks of satellites every night, both on low-altitude and high ellipticity orbits. Using these data we created and support the public database of photometric characteristics for these satellites, available online.

Key Words: astronomical databases: miscellaneous

Our many years experience of observations with single-channel FAVOR monitoring system (Karpov et al. 2005, 2010) has shown that such systems are a well-suited instruments for studying low-altitude artificial satellites of Earth. The Mini-MegaTORTORA (MMT-9) what started its operation in mid-2014 (Karpov et al. 2013; Beskin et al. 2014; Biryukov et al. 2015) is a nine-channel system having both wider field of view (900 square degrees), better temporal (0.1 s) and angular (16″ per pixel) resolution, and a deeper detection limit. One of its tasks is the study of artificial satellites.

The accuracy of coordinate determination of MMT real-time transient detection pipeline (Karpov et al. 2010), which is typically 5-30″, is quite enough for reliable identification of satellites on low and medium-altitude orbits, and due to it we have already collected an unprecedented amount of unique high resolution photometric information for these objects. To publish it, we created and support the online database[6]. Its public part contains all the satellites observed by Mini-MegaTORTORA what have been launched by countries other than Russian Federation and have been identified using publicly available orbital elements (US Department of Defence 2015; McCants 2015). After the first year and a half of operation, the database contains the information for 4503 low- and medium-altitude satellites.

The database includes the following parameters for every satellite track observed: light curves in apparent and standard (calibrated to 1000 km distance and 90° phase angle) magnitudes, distance and phase angle over time, whether the satellite was inside the penumbra, and a light curve period if it displays a periodicity. For every satellite it also contains the general information and classification of activity taken from public sources (active, inactive, debris etc), as well as variability type estimated by us (periodic variability, variable but aperiodic, non-variable). Among 4503 objects in database 1631 are aperiodic and 849 are periodic.

Periodicity of satellite light curve may be caused by either rotation of an object as a whole (which is

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[6]The database is published at `http://mmt.favor2.info/satellites` and `http://astroguard.ru/satellites`

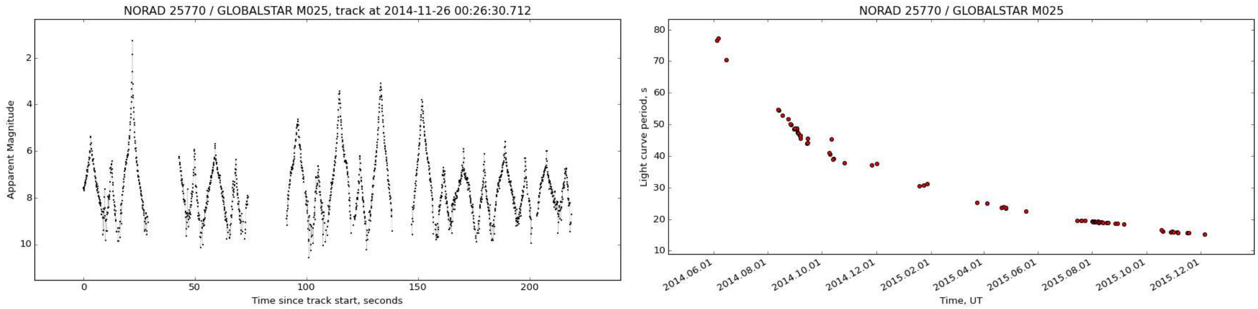

Fig. 1. Light curve of an inactive satellite and its period evolution over time.

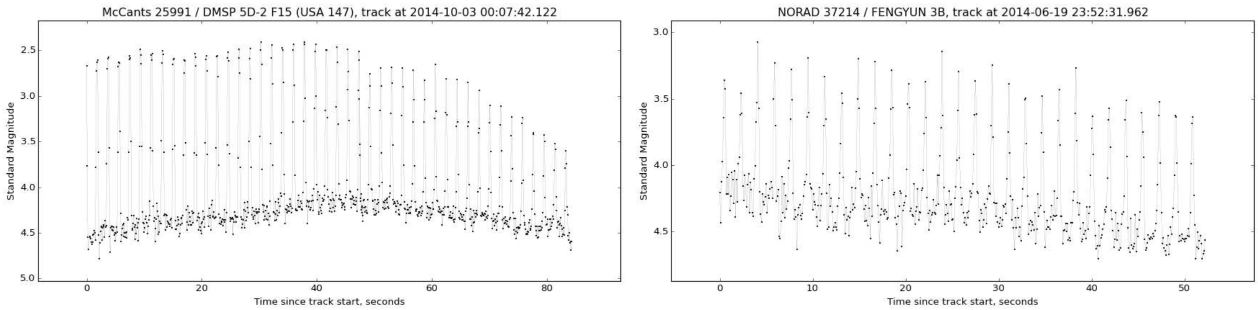

Fig. 2. Rapid variability of active satellites due to antennae rotation with 1.8 seconds period.

typical for both inactive satellites, upper stages or debris, see Figure 1, and active satellites stabilized by rotation), or some rotating element like an antenna (see Figure 2). The rotation period of inactive objects often changes over time (see right panel of Figure 1) due to either interaction with the atmosphere or some residual technological processes inside the object itself.

The database presents all this information in an easy to use and fully searchable manner, and we hope it will be useful to various tasks of a space surveillance.

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