PHASE TWO OF MOROI NETWORK: CONNECTION WITH FRIPON AND PIPELINE DEVELOPMENT FOR STUDYING METEOROIDS

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Introduction: The availability of CCD sensors in the past decades has allowed a rapid increase of the number of recovered meteorites with recorded atmospheric trajectory. When the cameras are connected to form networks, and data is centralized, the strewn field computations can obtained at a faster pace (under 24 hours), thus facilitating the recovery of unweathered meteoritic material, and increasing the scientific value of the fall. This is the case of many recent meteorite recoveries, e.g.: [1, 2].

The network: The Meteorites Orbits Reconstruction by Optical Imaging (MOROI) network started in 2017, at the Astronomical Institute of the Romanian Academy (Bucharest, Romania), following the installation of the most eastern (at the time) station of FRIPON (Fireball Recovery and InterPlanetary Observation Network). Since then, the MOROI network extended gradually in Romania [3], and starting November 2020, newly installed cameras (averaging one every month) have been integrated directly with the FRIPON worldwide database [4], in Marseille, France. Currently, the network consists of 16 cameras, installed at observatories, science museums, institutions, etc; 7 of which are already connected to the central server, at Service Informatique Pythéas (Aix-Marseille University, France). Astronomical observatories continue to be excellent locations due to the dark sky, which allows more stars to be detected and used for calibrations [5]. Moreover, the obtained data can be used for sky quality studies [6].

Hardware & data processing: Each station consists of a camera based on the CCD Sony ICX445 sensor, adapted for an all-sky optical setup. This translates to a scale of 10 arcmin/pixel. The camera is connected on-site to an Intel Nuc computer, which temporarily stores the data. This is further transferred to the central server for processing.

For fireball detections, FreeTure [7] software is employed on all the stations. Additionally, the software grabs a long exposure capture every 10 minutes, which is further used to calibrate the astrometry and photometry [8, 3]. In addition to time interval coincidence, the detections are manually checked, to ensure there aren't fake detections which will alter the astrometric solutions. Objects having the luminous trajectory brighter than magnitude -8 (i.e. usually meteorite dropping fireballs), tend to saturate the closest camera [8]. To mitigate this effect, and better understand the effects of fragmentation, we implemented a saturation correction model. The strewn field is computed keeping track of the atmospheric wind profile, using a Monte Carlo approach for unknown parameters [9]. The orbit is obtained starting from the topocentric radiant of the trajectory, considering several perturbations (until the object reaches 10 lunar distances), thus obtaining an unbiased orbital state vector [10]. From the resulted Keplerian elements, backward integrations indicate the source regions, and can eventually lead to an association with the parent body. Several of the fore-mentioned models are designed to be portable, and will be adapted for FRIPON reduction pipeline. Combining the independent results, will help to better identify the sources of systematic errors, thus improving the final outcome.

Conclusions: The current pipeline holds the ability to process each event and compute the trajectory, strewn field and orbit. Several layers are also being developed to be implemented to FRIPON reduction pipeline, which already is processing data in real time [11, 8]. The plan is to extend the number of MOROI network stations, adding the fireball detections to the FRIPON central server, in Marseille. Thus, in the case of a meteorite dropping event, to be on the field in 24 hours, and start the search for meteorites.

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