ROBOTIC SYSTEMS FOR METEOR OBSERVING AND LUNAR IMPACT FLASHES DETECTION IN SPAIN

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Introduction

Since November 2008, a new robotic observatory is being setup by the University of Huelva within the environment of the Doñana Natural Park, in the south-west of Spain. Most of the systems in this astronomical observatory operate within the framework of the Spanish Meteor Network (SPMN), which is an interdisciplinary project dedicated to study meteoroids streams and the interaction of these particles of interplanetary matter with the Earth's atmosphere. For this we employ a system consisting of an array of high-sensitivity CCD video cameras for automatic meteor detection. Besides, an automated system for lunar impact flashes detection is being setup in collaboration with IAA-CSIC. This is based on three robotic telescopes that monitor the impact of meteoroids on the surface of the Moon. An important synergy is expected from the results recorded by both systems. Besides, climate conditions in this area provide us about 320 useful nights per year for astronomical observation, which makes this location ideal for this research project.

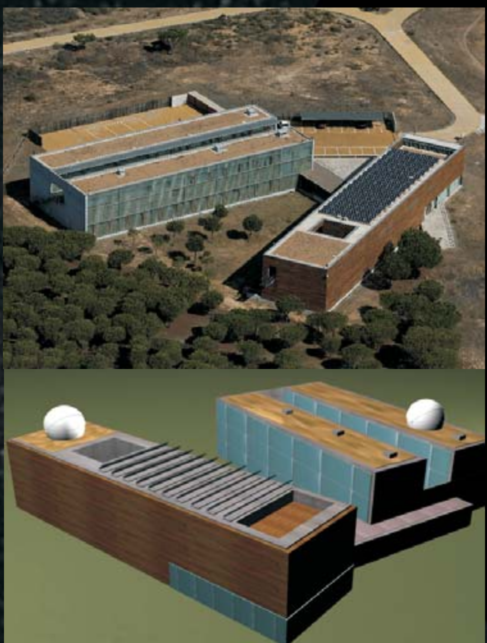

Figure 1. Aerial view of the research center (CIECEM) where the robotic observatory is been installed. Bottom: distribution of domes containing the telescopes for moon impact flashes detection.

Meteors observing station

This new automated station is coordinated with other meteor observing stations setup by the University of Huelva since 2006 in the south-west of Spain and with several more SPMN stations operating from other locations in this country [1,2,3]. It started operation in April 2009 and employs an array of 12 high-sensitivity CCD video cameras endowed with holographic diffraction gratings for obtaining meteor spectra. Fast aspherical lenses (f0.8 to f1.2) are attached to these cameras to maximize image quality and detect meteors as faint as magnitude +2/+3. Their focal length ranges from 3.8 to 12 mm. Thermoelectrical coolers are also attached to the cameras when operation temperature is above 25 degrees Celsius. The observing station is automatically switched on and off at sunset and sunrise, respectively. The images taken by the cameras at 25 fps and with a resolution of 720x576 pixels are continuously sent to PC computers through a video capture card. The computers run a software (UFOCapture, by SonotaCo, Japan) that automatically registers meteor trails and stores the corresponding video frames on hard disk. GPS time inserters include time information on every video frame. This allows us to measure time in a precise way (about 0.01 sec.) along the whole meteor path. The astrometric measurements are then introduced into our recently developed *Amalthea* software that has been tested with *Network* software, which provides the equatorial coordinates of the meteors with a typical astrometric accuracy of 0.01° [4]. By the method of the intersection of planes we reconstruct the trajectory and length of the meteor in the Earth's atmosphere. Time information needed for the calculation of the initial velocity, average velocity and deceleration is directly obtained from the video sequences.

Figure 2. Images of the control room and some of the high sensitivity CCD video cameras of the CIECEM meteor observing station.

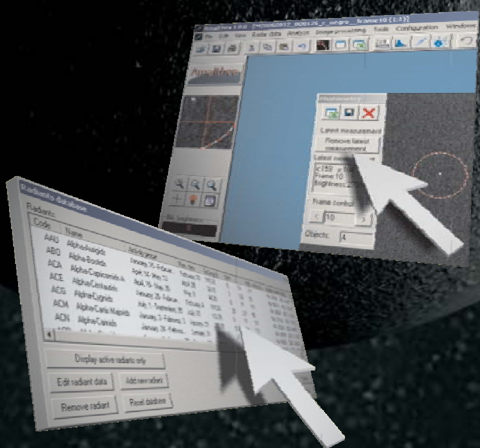

Figure 3. The software Amalthea has been developed the analyze meteor trails recorded by our CCD video cameras.

Impact flashes detection system

Two robotic 14-inches SC telescopes have been setup in the astronomical observatory to monitor the impact of meteoroids on the surface of the Moon. High-sensitivity video cameras working at 25 fps have been attached to them in order to record the faint flashes produced by these impacts. A third 11-inches SC telescope will be also used from Sevilla, at about 70 km from the other two. This array of telescopes are intended to monitor the same area of the dark region of the Moon when the iluminated fraction ranges from 0 to 60%. By using several telescopes at the same time we can discard flashes produced by other sources, as cosmic rays, space debris, satellites, etc. [5]. The system has just been installed and is ready to start operation.

The MIDAS software has been recently developed to identify lunar impact flashes produced by meteoroids. It allows for fast real time processing of the images obtained by the CCD video cameras attached to the telescopes. These are continuously analyzed to identify the flashes and calculate the corresponding selenographyc coodinates of the impact and which is the likely origin (meteoroid shower and radiant) of the meteoroid. A photometric analysis is also performed in order to obtain the mass of the impactor. When a telescope detects an event, it communicates with the other telescopes in the system via TCP/IP network protocol (up to 256 telescopes could be connected in this way). The other telescopes may then confirm or not the detected event. If the event is confirmed, it is automatically stored in a database. On the contrary, the event is ignored.

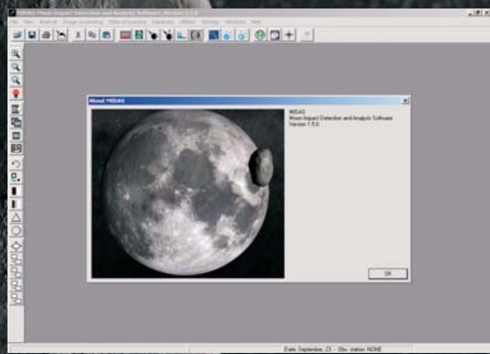

Figure 4. The MIDAS software performs an automatic analysis of the images provided by the lunar impact flashes system.

Synergy between both systems

An important synergy is expected from the results obtained by the lunar impacts detection system, which uses the Moon as a detector of meteoroids, and the meteor observing station, which uses the Earth's atmosphere for this purpose. Of special interest is, for instance, the detection of common events that might reveal the existence of associated meteoroids that could give rise to impacts on the Moon and also to very bright fireballs in our atmosphere or even to meteorite falls. These systems will also provide more accurate data related to the flux of interplanetary matter reaching the Earth.

References

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