

ON THE DEVELOPMENT OF ROBOTIC CCD VIDEO METEOR OBSERVING STATIONS IN SPAIN.

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Introduction: Since 2006 the Spanish Meteor Network (SPMN) has set up several automated video stations in Spain for increasing the atmospheric coverage of the already existing low-scan-rate all-sky CCD systems [1, 2]. However, in spite of their initially thought complementary nature, high-sensitivity CCD video cameras have provided very valuable information related to meteor activity [2, 3, 4] and, so, these systems have been continuously improved and new video observing stations have been setup along the country [5]. A significant improvement has been recently made with the development of new software dedicated to robotize the whole observing process. This has been very useful, for instance, in order to operate fully autonomous video meteor observing stations from remote locations or to handle the huge volume of data provided by these systems.

Description of the SPMN video observing stations: The first two SPMN video observing stations were setup in Andalusia by the University of Huelva in 2006. Nowadays, about a dozen of these stations are active in Spain. These consist of an array of 3 to 10 high-sensitivity CCD video cameras manufactured by Watec (Watec Corporation, Japan) and endowed with fast aspherical lenses (f0.8 to f1.0). These can detect meteors as faint as mag. +3/+4 without using any image intensifiers. A software package (Ufocapture, by Sonotaco, Japan) automatically identifies meteor trails and stores the corresponding events on hard disk. These video cameras are also dotted with holographic diffraction gratings of 600 or 1200 grooves/mm for obtaining meteor spectra.

For data reduction we employ our *Amalthea* software [4]. This package follows the method of the intersection of planes to reconstruct the trajectory of the meteor in the Earth's atmosphere. This software provides radiant and orbital parameters for meteor trails that are simultaneously recorded from at least two different observing stations. It also provides chemical information for the corresponding meteoroids when their emission spectra are available.

Development of new robotic systems: Since 2006 the number of video meteor observing stations in Spain has increased continuously. This has resulted in the necessity to address two main issues that have arisen from this situation: the establishment of a system to check the huge volume of data provided by

these observing stations and the necessity to locate several autonomous meteor observing stations in remote locations or in places where no direct human intervention is always possible. Thus, during 2009 new software has been developed by us in order to achieve a fully robotic operation of new video meteor observing stations. These new packages also allow the systems to be remotely controlled through an Internet connection. A prototype robotic video station was setup by the University of Huelva in the environment of the Doñana Natural Park (south-west of Spain) in April 2009 [5, 6]. This station was fully operative till the robotic system was completely developed in August 2009. Nowadays, three robotic video meteor stations are operative in the south of Spain. Two of them are located in the western area of Andalusia, in the provinces of Huelva and Sevilla. The latest one has been setup in Sierra Nevada (Granada), in the eastern part of this region.

The PC computers that control the new robotic stations have been configured so that they are automatically switched on and off when data acquisition must start and finish, respectively. When the PCs are started, one of our recently developed software packages starts the data acquisition software (Ufocapture) and monitors that this application is properly working during the whole observing session. We have also developed another software package that automatically checks the meteor trails recorded by the system. Then, if a very bright fireball is detected (mag. -12 or brighter) which could give rise to a potential meteorite fall, an email is automatically sent to the operator together with the corresponding images.

These robotic stations provide a huge volume of data, as they are currently an average of over 1000 meteors per month. In order to handle this information, we have also developed a software package that is automatically started when the observing session is over. Then, this application checks every meteor trail recorded on hard disk. These data are compressed and sent to a FTP server for further processing. The application also checks other data stored by this FTP server, as data from different robotic stations are also placed there, and identifies which meteor trails have been simultaneously recorded from at least two different locations. The operator receives an automatic email with these data, which can be reduced to obtain the

atmospheric trajectory of the corresponding meteoroid and also radiant and orbital information.

Conclusions: A continuous effort is being made in order to improve and expand our meteor observing stations based on high-sensitivity CCD video devices. The increasing volume of data and the possibility of installing these systems in remote locations made necessary the development of robotic systems that are able to operate in a fully autonomous way and also to notify the occurrence of remarkable events. Several software packages have been developed in order to accomplish these tasks.

References: [1] Trigo-Rodríguez J.M., et al. (2004) *Earth, Moon and Planets* 95, 553-567. [2] Madiedo, J.M. and Trigo, J.M. (2008) *Earth, Moon and Planets* 102, 133-139. [3] Trigo-Rodríguez J.M et al. (2007) *Mon. Not. Royal Astron. Soc.* 380, 126-135. [4] Trigo-Rodríguez J.M., Madiedo J. M., Williams I.P., and Castro-Tirado A.J. (2009) *Mon. Not. Royal Astron. Soc.* 392, 367-375. [5] Madiedo J.M. et al. (2008) *EPSC*, abstract #00319. [6] Madiedo J.M. et al. (2010) *Advances in Astronomy* 2010, doi: 10.1155/2010/167494.