MULTI-PURPOSE ROBOTIC OBSERVATORY FOR NEAR EARTH OBJECT DETECTION.

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Introduction: In this paper, a new astronomical observatory designed to study meteors and artificial satellites is described. This multipurpose robotic observatory (hereinafter, Robotic Observatory) is constituted by a small autonomous observatory, a telescope and an all sky camera (both interchangeable), a meteorological station and a computer. The observatory is formed by a metal box of square section of 1.2 meters and 1.3 meters high, with a tilted roof divided into two equal parts, which can open and close the roof completely so that all-sky images can be taken. The opening/closing control of the observatory and the activation of the telescope and camera all sky to capture images is regulated through the PC and the meteorological station, which incorporates a Sky Quality Meter (sky brightness), an Anemometer (wind speed) and a Hygrometer (relative humidity). All instruments that are part of this observatory have been programmed through the control computer so that autonomous captures of meteor images and their spectra are made every night and can be stored on the hard drives [1].

Instrumentation and methods: The Robotic Observatory 1 (in this paper two versions of the observatory are presented) is configured to accept a double configuration. In the first case (Figure 1) a 127 mm aperture f/63 refracting telescope and an Atik 314 L+ CCD are available. With this system, it is possible to obtain images of meteors and satellite objects.

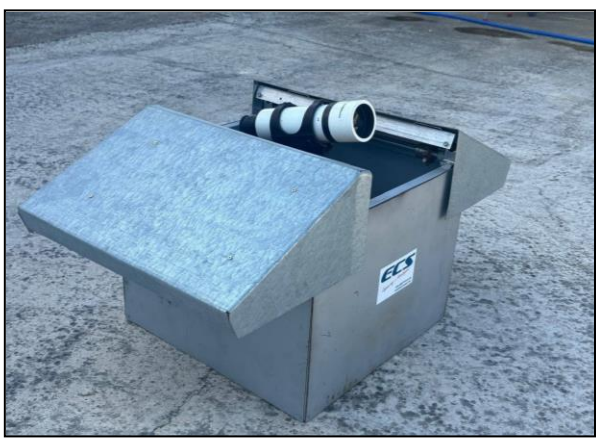

Figure 1. Robotic Observatory 1,with refracting telescope.

When integrating a wide-field camera or all-sly camera with a CCD, the configuration of the robotic observatory does not change. The image capture mode is the same, and only the integration times vary depending on the object to be captured.

The Robotic Observatory 2 (Figure 2) is equipped with a Nikon 50 mm f/1.2 lens providing a 15° field of view together with the Atik 11000 CCD camera.

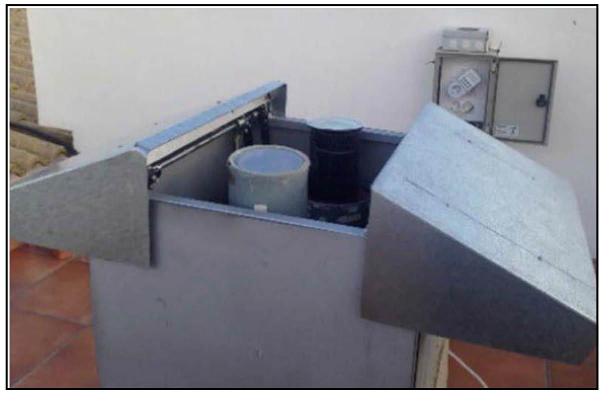

Figure 2. Robotic Observatory 2,with all-sky camera.

The optical systems integrated in the robotic observatory provide two equal observatories for capturing meteoroids as they enter the Earth's atmosphere and for tracking and monitoring artificial satellites.

Very short image integration times (1 second or less) are needed to image low-orbit objects, but for satellite objects in medium or geostationary orbit the times can be several seconds, as well as for imaging meteoroids. To analyze the images captured, MaxImDL™ software is available [3].

This type of observatory integrates all its systems under the Ascom protocol and has a weather station to monitor the state of the sky in order to open or close in the event of adverse weather. Due to its small size, the Robotic Observatory can be easily deployed to different geographic locations. Therefore, a network of several units can be harmonized, allowing efficient orbit calculation by triangulation of the objects whose images are taken [4].

Observations. The different possible optical configurations allow for conducting all-sky surveillance campaigns (meteors and artificial satellites), or to capture specific satellite objects whose orbit is known.

With Robotic Observatory 1, images of satellite objects were obtained with an integration time ranging from 1 to 5 seconds (Figure 3). With Robotic Observatory 2, the images are wide-field and, in addition to capturing satellite objects of artificial origin, they have a large capacity to capture meteoroids and fireballs.

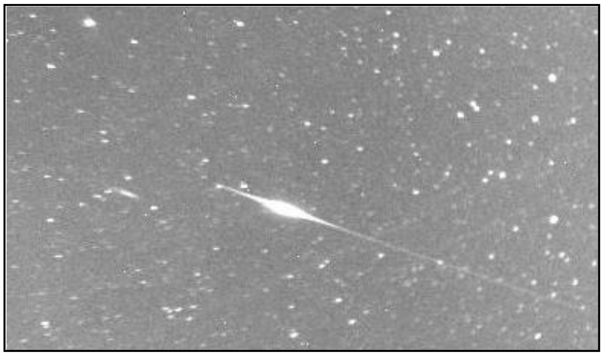

Figure 3. Image of an unidentified Iridium satellite.

Figure 4. Fireball captured by the observatory's wide-field camera 2.

Conclusions: The Robotic Observatory described in this paper has different and complementary optics to detect near-Earth satellite objects. It is a multipurpose system because it can capture images of very different objects, both natural and man-made. These observatories can work simultaneously at the same location or create a network to improve the orbital calculation of image-captured objects.

Their small size allows them to be moved and relocated, which helps to plan observation campaigns in different locations.

References: [1] Espartero F. et al. (2018), *Earth, Planets and Space,* 70, 02. [2] Espartero et al. (2024) *Remote Sensing*, *16*(22), 4206. [3] Espartero et al. (2019) *50th Annual Lunar and Planetary Science Conference* No. 2132, 1276. [4] Espartero, F. (2018), PhD Thesis, Complutense University of Madrid