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Estimating the Obstructed Portion of the Night Sky.

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Meteor showers occur when the Earth crosses the orbit of a comet and small dust particles enter the Earth's atmosphere [7]. The number of meteors observed in a meteor shower depends on the following: climatic conditions, the degree of light pollution in the observer neighborhood, the latitude of the observation location, etc. For this reason, observers from different locations, when looking at the same meteor shower, can see very different situations.

One way to allow comparisons between observations made in different parts of the world is, for example, the use of the Zenithal Hourly Rate (ZHR) [2], which is a parameter that informs the rate of meteors that would be observed per hour with ideal observation conditions, with clear sky (objects visible up to magnitude 6.5) and with the observer positioned so that the radiant of the meteor shower is at its zenith. For the computation of the ZHR, among other variables, it is necessary to estimate the obstructed portion of the sky in the field of view. This is a problem, and a bare eye estimate is often performed. Also, a good estimate of the percentage of the observer's field of view which is obstructed could be very useful in discussing meteor shower records in studies such as [3, 4, 7].

Thereby, this work brings a proposal to quantitatively measure the proportion of the night sky covered by clouds from images of meteor records. All images used in this study are from the EXOSS Network database, particularly from the UVP1 and UVP2 meteor monitoring stations.

The percentage of clouds in an image was calculated using two different methods, however both use Python with Opencv [1] library. Applying an average filter (also know as normalized box filter) for noise smoothing, with a *blur* function, the image was converted to gray scale. Pixel intensities above 100 are counted so a proportion between this number and the total number of pixels can be made. We call this procedure the gray count method.

Another approach was used because of the low contrast between the clouds and the sky. In this case a gray scale image pass through a contrast limited adaptive histogram equalization process, using CLAHE [6] function. This method divides images into small blocks, then each block is histogram equalized maintaining an intensity limit, after that every block is combined removing its artificial limits using a linear interpolation. Then applying a bilateral filter (bilateralFilter) [1], a Otsu limiarization [5], and a morphology filter. These steps serve as a form of edge-preserving smooth technique, furthermore a method which binary separate clouds from background regions. Finally, the number of white pixels are counted and its proportion, regarding the entire image, is used as the cloud coverage percentage. We call this procedure the threshold count method.

Figure 1 shows the process steps using an image from the database, where the gray count was obtained from step (a) and the threshold count is obtained from step (c). In this case, the resulting percentage was 32% gray count, and 39% threshold count. Figure 2 shows some results of the application of the proposed processes.

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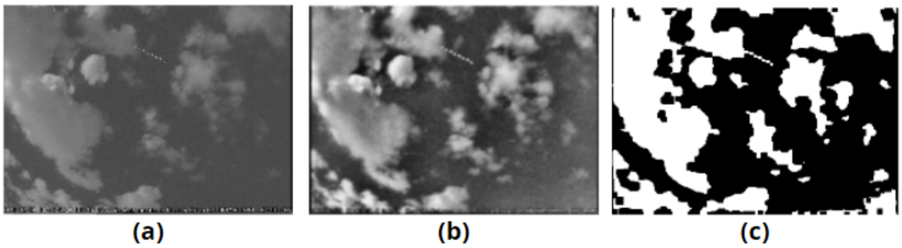

Figure 1: Example of process steps: (a) original image, (b) filtered image, and (c) threshold binary image.

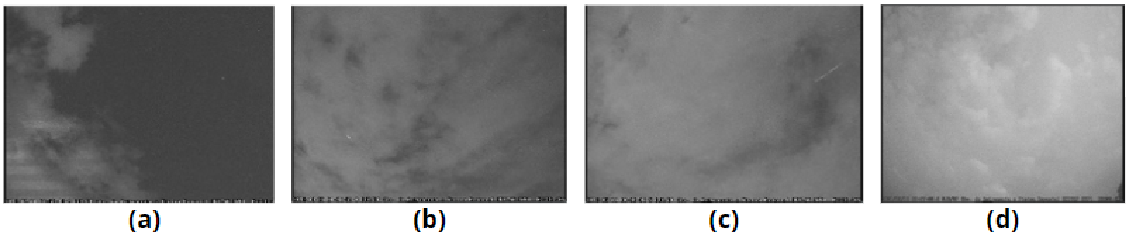

Figure 2: Examples of evaluated images. The percentages for threshold count and gray count obtained were, respectively, (a) 21%, and 9%; (b) 61%, and 53%; (c) 85%, and 84%; (d) 94%, and 95%.

These initial results were selected from 228 images in a database previously classified by an expert with "few", "many" or "no" clouds. The tool is under development and it is intended to continue experiments in order to identify the best way to combine the proposed counting methods. Additionally, it is expected to provide an executable to aid future research.

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