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# A texture-based algorithm for automated crater detection

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## Abstract

In this study we represented a new algorithm of automated detection of craters in planetary images using their texture features. We apply this algorithm to detect small craters of heavily-cratered areas on the anti-Mars and sub-Mars sides of Phobos. We also compared craters detected by our crater detection algorithm (CDA) with catalogs of manually picked craters. Our algorithm was able to find many small craters, not identified manually. In general, the accuracy of our algorithm is about 80% comparing to manual detection result.

## 1. Introduction

In planetary science some of the most studied features are impact craters. They are structures formed by collisions of meteoroids, asteroids or comets with a planetary surface. A crater is a bowl-shaped depression in a planetary surface and appears in an image as a pair semi-circular regions, illuminated or in shadow. Automated detection of craters is a complex task because the “visibility” of craters in an image depends on not only the quality of the image but also on the morphological character of these craters (presence of central peaks, peak rings, central pits, wall terraces, etc.), their level of degradation, their sizes. Craters may also overlap with other craters.

An overview of different available crater detection algorithms is given in two recent papers [1, 2]. As is shown in these papers, the existing algorithms often cannot detect craters with indistinct boundaries because they do not take into account image texture features which can reliably discriminate craters from other objects (or collection of objects).

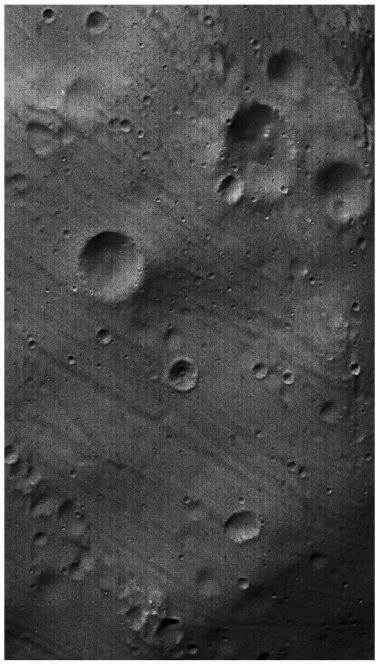
## 2. Algorithm

To correctly detect craters with indistinct boundaries in planetary images, in paper [3] we suggested to use a texture-based algorithm, which consists of two main steps: detection arc fragments of crater boundaries in the images using specific masks; reconstruction of crater boundaries from their arc fragments using the circle Hough transform [4]. A key characteristic of craters is the circular shape, realized by patterns of shadow and lighting. For their detection, we propose to use circular mask-features. Each such mask is a circular region subdivided into two parts by an arc passing through its centre. By changing the sizes, directions and positions of the masks, a large number of arc fragments of crater boundaries can be identified. After automated crater detection an expert verification and correction of the set of the detected craters can be carried out.

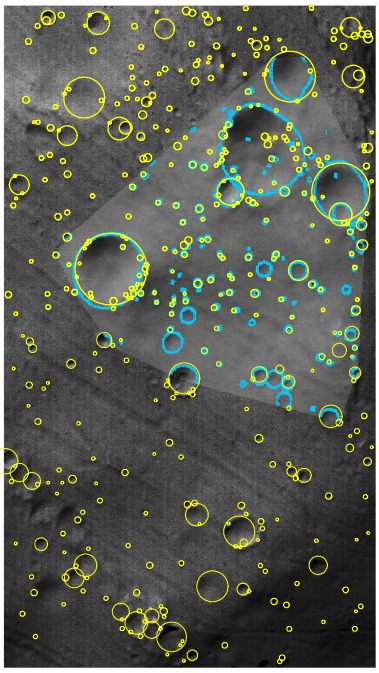
## 3. Results

In this study we applied our algorithm for the detection of craters in areas on the anti-Mars and sub-Mars sides of Phobos using high resolution images of Phobos obtained by the HRSC camera on Mars Express. To test our CDA, we used HRSC images obtained under different illumination of the Phobos surface. We could detect craters larger than 30 m in diameter. During expert inspection, falsely detected craters, less than 3%, were removed from obtained set of the detected craters. We compared craters detected by our CDA with catalogs of manually picked craters. To evaluate the accuracy of our algorithm, we used quality factors from [5]. In general, the accuracy of our algorithm is about 80% comparing to manual detection result.

The area of the HRSC image of the anti-Mars side of Phobos with craters correctly detected by our CDA is shown in Fig. 1. For comparison, this figure also demonstrates manual detected craters from the global crater catalog of Phobos [6]. As seen in Fig. 1, our algorithm found many small craters (with diameter about 35 m) not listed in the manual catalog, but it fails to detect some heavily degraded craters and non-circular craters.



*a*



*b*

Figure 1: *a*) Area of HRSC nadir-channel image of Phobos (orbit 7915) with a resolution of 4.4 m/p and *b*) the same image with craters correctly detected by our CDA (yellow circles) and craters from the catalog of manually picked Phobos craters (blue circles) [6].

## 4. Summary and Conclusions

We present a new robust algorithm of automated detection of craters in planetary images taking advantage of their texture. This algorithm can detect large numbers of small craters in heavily-cratered areas, not listed in manually derived crater catalogs. Thus, we can conclude that our CDA has a great potential for planetary surface mapping and chronology studies. We plan to use our CDA to update the existing catalog of Phobos craters and estimate ages of different areas of the Phobos surface.

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