EPSC Abstracts
Vol. 6, EPSC-DPS2011-1102, 2011
EPSC-DPS Joint Meeting 2011

Identifying Lunar Craters using Texture

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Abstract

This paper demonstrates the *Texton* method of representing images of simulated lunar craters as a series of points in euclidean space for use in classification and segmentation of image data.

1. Introduction

For researchers to analyse large amounts of image data, a computational tractable model is required that can be used to compare parts of an image with one-another. Given the problem of view and illumination (phase) angle when automatically classifying lunar imagery, craters are simulated using a Digital Elevation Model (DEM) and ray tracing software. It is by representing a crater by a series of euclidean points, made up of various phase angles, that this model is formed.

2. Method

Varma and Zisserman [1] demonstrated that a number of clustered, row ordered $N*N$ kernels extracted from an image could represent texture. This follows the work by Leung and Malik [2] who used filter kernels instead. These clustered kernels are known as *Textons* and have been used for a variety of image segmentation and classification tasks. This method extracts $7*7$ kernels from the image and clusters them using the K-Means [3] algorithm to produce a series of *Textons*. A *Texton* can be considered as a point in Euclidean space and therefore its distance compared to other *Textons*.

3. Data

The method described above is applied to images of craters created using the Lunar Terminator Visualization Tool (LTVT) [4]. The LTVT allows phase angles to be set by the user. The LOLA64 DEM [5] was used with the LTVT and no colour or shading other than the ray tracing shadow effects were applied. 20 images of Copernicus, viewed from directly above, were created using sub solar point 0° and 180° local azimuth, each with local elevation angles of 0-45° in 5 intervals in relation to the center of the crater (see Figure 1). Each image contains the crater and is scaled to 200 x 200 pixels and normalised.

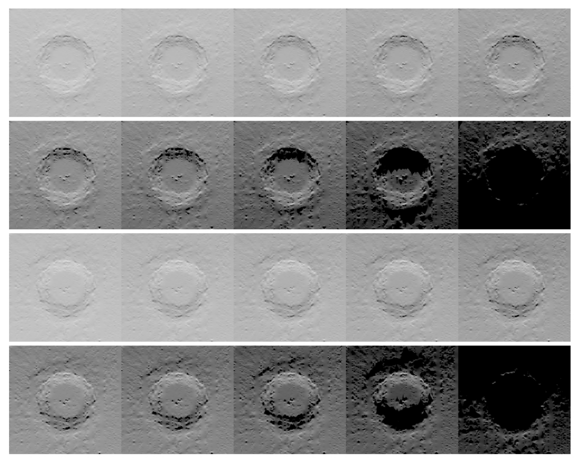

Figure 1: Images of Copernicus crater (10°N, 340°E) created using LTVT with LOLA64 DEM at various illumination angles.

4. Results

It is interesting to note in Figure 2 that even though the five *Textons* associated with each image are derived independently from one-another, there is a distinct similarity between them. For example, each image has a *Texton* that is a dark boarder around a light point (similar to a gaussian intensity peak). These can be seen in Figure 2 at $A1$, $B2$, $C1$, $D3$, $E2$ and $F5$. Similarly a pattern of a light top and dark bottom arises, e.g. $A3$, $A4$, $C4$, $C5$, $D1$, $E1$, $E4$ and $F4$. This is mirrored by a dark top and light bottom pattern seen in $A2$, $B4$, $C2$, $D2$, $D4$, $E3$ and $F1$.

Due to the random element in the K-Means clustering algorithm [3], one would expect there to be variations in the observed *Textons* as these represent local approximations of the kernels in Euclidean space.

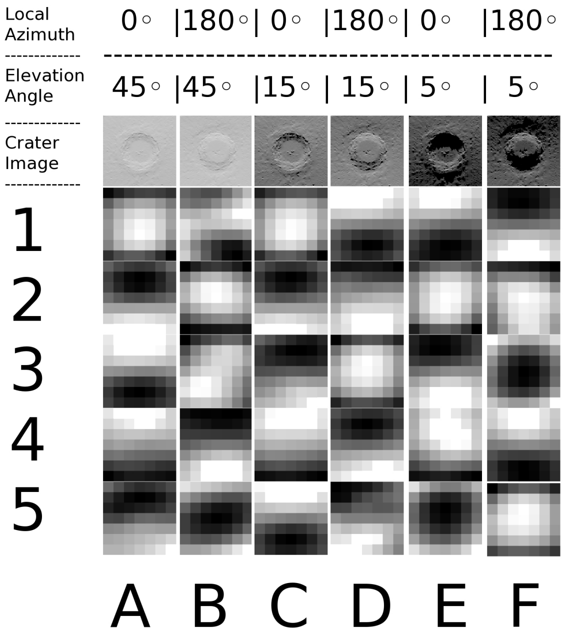

Figure 2: Six views of Copernicus crater with varying illumination angles and it's associated five $7 * 7$ *Textons*.

By creating *Textons* for all the 20 images of Copernicus, a *master* set of *Textons* are produced as displayed in Figure 3 (a). Note that not all of the *Textons* are used in the classification in Figure 3 (a).

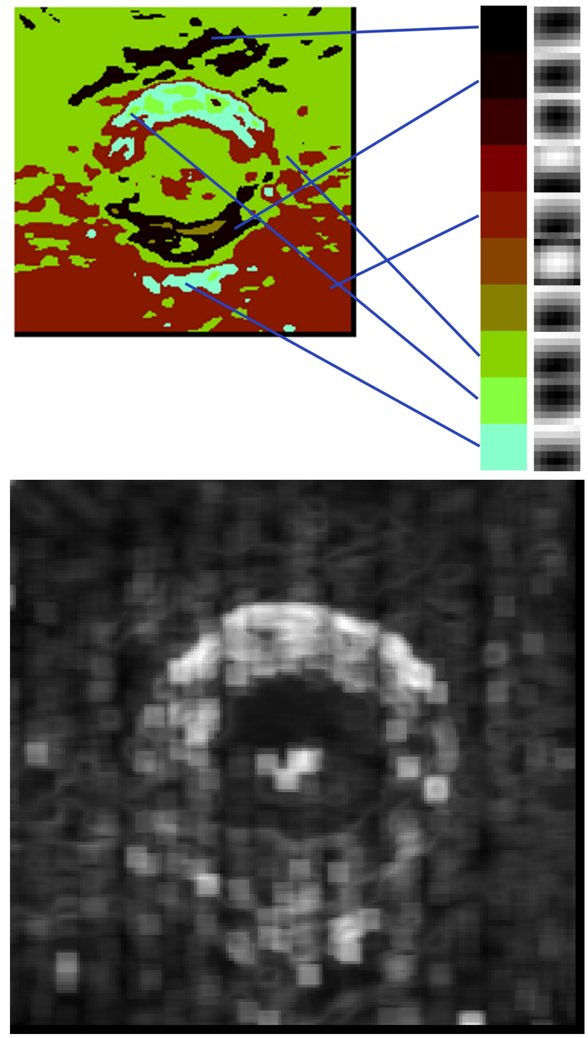

Figure 3: Copernicus crater. Illumination angle 0° local azimuth, 15° elevation. (a) Top: Shows the 10 most common *Textons* from all 20 images of the Copernicus crater created (as described above), mapped onto a colour coded image. (b) Bottom: A distance map showing the distance from each $7 * 7$ kernel to its closest *Texton*, the greater the intensity (whiter), the further away the kernel is.

5. Summary and Conclusions

The results presented in this paper demonstrate a technique to represent texture as a series of euclidean points. This can be used to search for textural features of interest, or order a collection of images based upon similarity, all of which can be useful to planetary scientists.

References

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