Textural Analysis to aid Automated Classification of Lunar Craters

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Abstract

1. Introduction

Craters that are formed from projectiles impacting the Moon are of great interest to lunar scientists. Large craters constitute a large proportion of the lunar surface and have later been sites of sizemic activity, exposing material from beneath the lunar surface [5]. Furthermore, due to the Moon's stable, less varied surface processes, the lunar surface contains a record of impacts over the last 3 b.y. which gives an insite into the history of the Earth and solar system. The most recent lunar mission is the Lunar Reconnaissance Orbiter which is equipped with the Lunar Reconnaissance Orbiter Camera (LROC). In the first six months of operation LROC has returned over 100,000 detailed images of the lunar surface totalling ~10 Terrabytes thus highlighting the need of automated techniques to process this vast amount of data.

2. Methodolgy

The work presented in this paper expands on previous work conducted using machine vision techniques to classify lunar craters [4]. This methodology involves image region modelling techniques on segmented images in order to create a hierarchical data structure for the display of large quantities of self similar textures.

2.1. Weighted Texton

Many models exist that analyse texture [7]. The Texton approach introduced by Caelli and Julesz [2], made operational by Leung and Malik [6], provides a model that is both computationally tractable applicable to heterogeneous image data.

Unlike Texton techniques that rely upon pre-trained texture dictionary, such as the Leung and Malik [6] methodology, the weighted Texton model (WTexton) proposed by Gibbens has no such reliance [4].

The Texton method proposed by Leung and Malik [6] involves filtering a series of textures to create a model. These responses are then clustered and the vector quantized filter responses to this model are used to create train a dictionary (e.g. the CUReT textural database [3]). Given a 'novel' texture, it's response to the model is then compared to the dictionary and thus identifying it's closest training class.

A WTexton requires each texture to be filtered and clustered to produce a set of vector quantized filter responses. This was achieved by using a cluster analysis methodology such as K-mediod or agglomerative clustering, and results in the creation of a Texton set which was then compared to other sets without the need of a pre-trained dictionary.

2.2. Taxonomy

There is much research available which discuss the optimal way that humans can view large quantities of image data [1]. A taxonomy is a way that one can structure objects within an image in a meaningful way. Hierarchical clustering, such as the agglomerative clustering technique, provides a level of similarity as a series of subsets (1). A taxonomy of image regions is created thus aiding undirected browsing.

3. Lunar Reconnaissance Orbiter Camera data

The LROC is an instrument on board the Lunar Reconnaissance Orbiter (LRO) which was launched in June 2009. It consists of a wide angle (WAC) and a narrow angle camera (NAC). For our initial tests we have manually segmented the data to encompass the target crater. Using the WTexton method previously outlined in 2.1 a series of clustered filter responses have been calculated from several crater images which can then be compared with oneanother in order to create a taxonomy as described in 2.2.

4. Initial Results

5. Summary and Conclusions

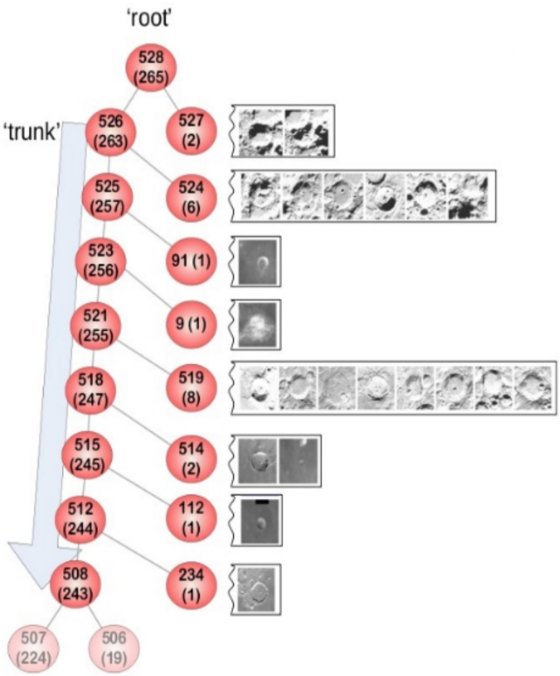

Figure 1: A Progression of clusters from the root of the taxonomy, cluster IDs shown with cluster size in parentheses.

Acknowledgements

This work is funded by NERC and in collaboration with Institute of Geography and Earth Sciences at Aberystwyth University. A Rawlins and T Knight (IMAPS, University of Aberystwyth), P Bunting and D Clewley (IGES, University of Aberystwyth).

References

[1] Bhatia, S.: Hierarchical clustering for image databases. In 2005 IEEE International Conference on Electro Information Technology, pp. 6–12, 2005.

[2] Caelli, T.M. and Julez, B.: Experiments in the visual perception of texture. Biol. Cybernetics, 28: 167–175, 1978.

[3] Dana, K.J., and Nayar, S.: Correlation model for 3d texture. In International Conference on Computer Vision, pp. 1061–1067, 1999.

[4] Gibbens, M.: Taxonomies for Image Set Analysis. Ph.D thesis. University of Nottingham, UK, 2008.

[5] Heiken, G., Vaniman, D., and French, B.(Eds.): Lunar Source-book, Cambridge University Press. 1991.

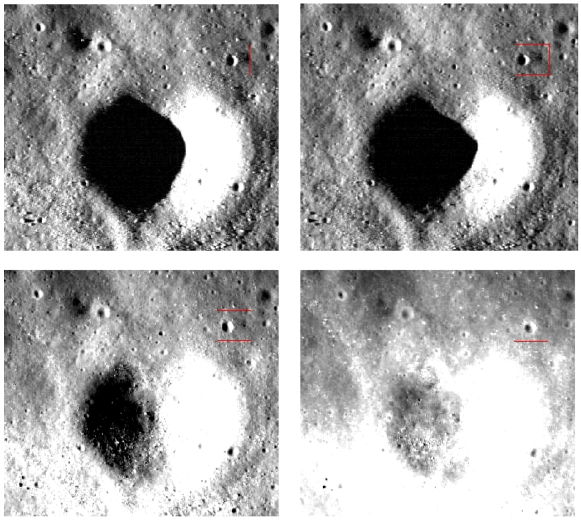

Figure 2: Four LROC-NAC images taken of the same crater at different view and illumination angles

[6] Leung, T.K. and Malik, J.: Representing and recognizing the visual appearance of materials using three-dimensional textons. International Journal of Computer Vision, 43: 29–44, 2001.

[7] Picard, R.W. and Kabir, T.: Finding similar patterns in large image database. Proc. IEEE ICASSP Conference, 5: 161–164, 1993.