Searching for Noah's Ark: Analysing the Ararat Anomaly

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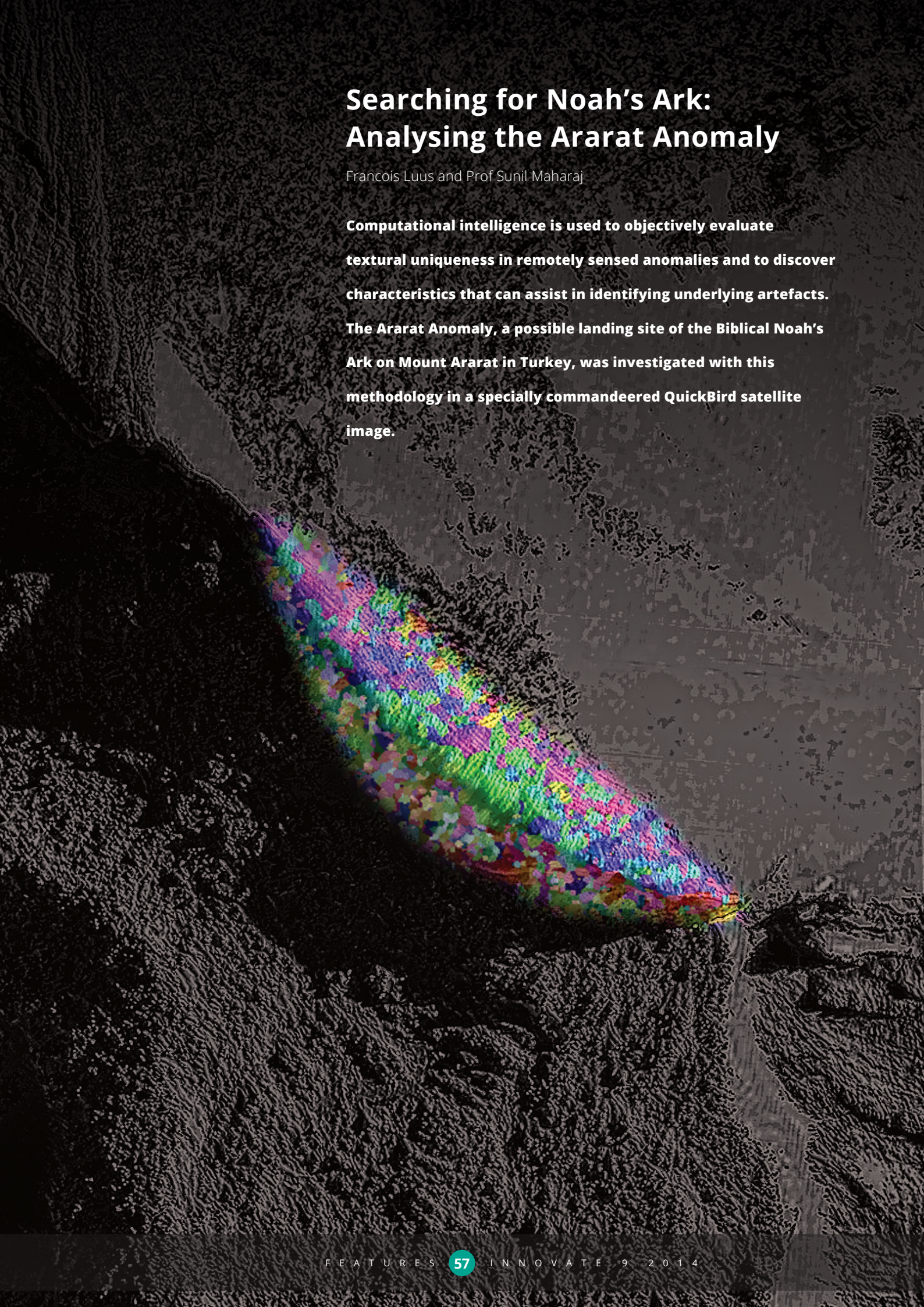
Computational intelligence is used to objectively evaluate textural uniqueness in remotely sensed anomalies and to discover characteristics that can assist in identifying underlying artefacts. The Ararat Anomaly, a possible landing site of the Biblical Noah's Ark on Mount Ararat in Turkey, was investigated with this methodology in a specially commandeered QuickBird satellite image.



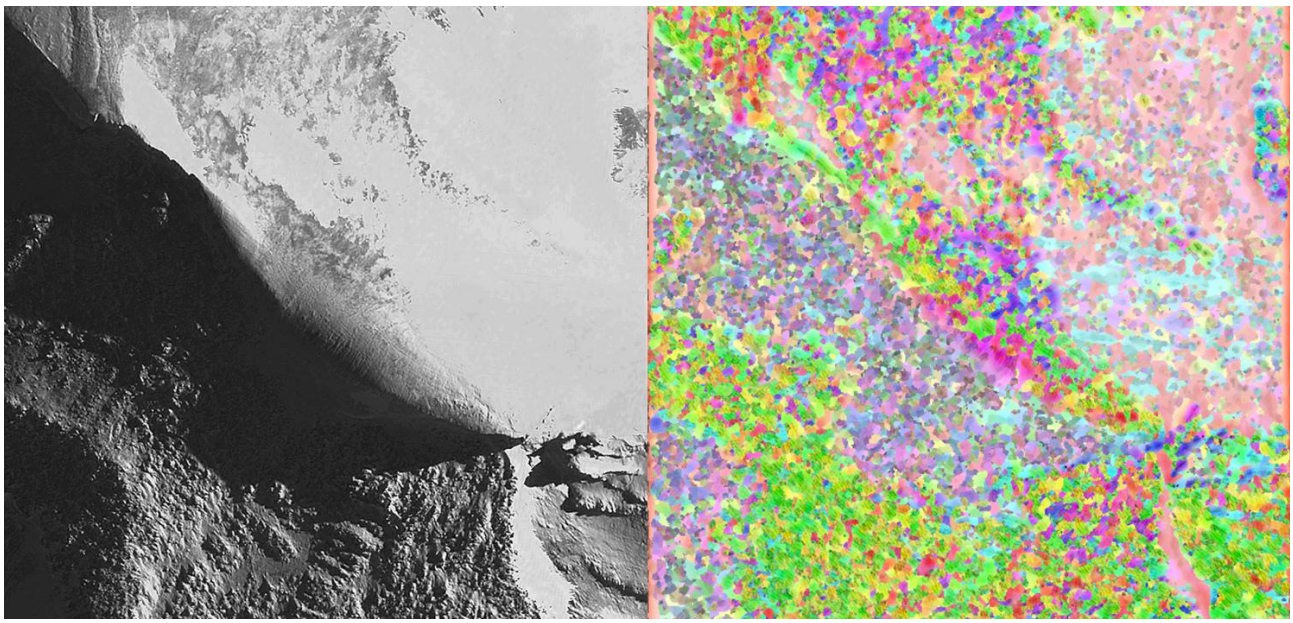


Figure 1: QuickBird February 2003 image of the Ararat Anomaly (left), © 2014 DigitalGlobe Inc., and an illustration of the dominant Gabor wavelet filter responses (right).

The data used in this study is one of the best available remote sensing images of the anomaly. This image is a panchromatic QuickBird electro-optical image that was acquired in February 2003.

The objective of this study is to quantify the novelty of textures on the anomaly, at least in terms of the textures found in the surrounding area. This data can provide a more objective starting point for further analysis of the anomaly and could possibly serve as supporting evidence of an artefact underlying the anomaly, which is covered by glacial ice.

This textural uniqueness measure is an important contribution in detailed remote sensing analysis, since it describes a low computational complexity implementation that emphasises the uniqueness of prominent and useful texture components. The original QuickBird February 2003 panchromatic acquisition of the Ararat Anomaly is shown in Figure 1.

Topaz Adjust 5 image-enhancing software was used to enhance the original with standard brightness increase and adaptive exposure maximisation with minimum region size, which balance the exposure of local regions in the image. Maximal shadow and highlight protection was used to recover all the fine detail in the shadows and highlights of the image. Maximum detail enhancement with independent detail processing was also used, without any detail boost to prevent the exaggeration of details.

Textural uniqueness

Textural uniqueness is a scalar measurement that indicates the relative scarcity or probability of a particular texture occurring relative to a set of available textures.

This measurement can be used in an unsupervised manner to detect and indicate novel textures in remote sensing imagery, such as the Ararat Anomaly images. In this way, machine intelligence can find interesting parts of the anomaly.

The uniqueness measurement is only relative and it is subject to the way in which texture and texture similarity are defined.

The similarity of two texture features can be measured by taking the Euclidean distance between the two features in the multidimensional feature space, after preprocessing each feature dimension to have a range magnitude reflecting the amount of variation accounted for by the dimension.

In unsupervised clustering, such a similarity measure is used to group very similar features together in a unique cluster, and different clusters are distinguished only as a result of the initial grouping based on the similarity measure.

To measure relative dissimilarity with an Euclidean distance measure does not guarantee that textures found to be unique will be well defined or interesting in terms of the intended application.

Gabor texture features

Gabor wavelet filter features have been used to incorporate a relative measure of texture prominence in the uniqueness search. Linear Gabor filters model the visual cortex of mammalian brains and are used for edge detection.

A filter response with a relatively large magnitude indicates a more well-defined and prominent texture and a set of filters is used to cover all edge orientations and scales. This results in a feature vector that is automatically categorised in a manner that makes sense to human visual perception.

A depiction of the dominant filter responses is given in Figure 1. The hue describes the dominant orientation, the saturation describes the response magnitude and the intensity value gives the dominant scale for each texture centred at each pixel.

A larger Euclidean distance between two Gabor texture features means that there is likely to be more prominence and novelty in one of the textures. The Gabor wavelet scales were selected by measuring the total response energy at different scales and including the appropriate scale range for the given image.

The exact wavelets that have been used for this study include seven different scales, each with 32 different orientations to obtain 224 Gabor feature dimensions. The feature dimensions are left unscaled to preserve relative response magnitudes over different scales to favour higher energy scales.

Unique textures

Locality-sensitive hashing was used to efficiently approximate the nearest neighbours, or most similar textures, for every texture descriptor vector centred at every image pixel.

By obtaining the most similar textures for every texture, the relative uniqueness of the particular texture can be measured as the average of the Euclidean distances to the nearest neighbours. Locality-sensitive hashing with eight-dot products per hash, 40 independent projections and quantisation bin widths of 0.001 is used.

The most unique textures found on the anomaly are shown in Figure 2, which includes 12 texture patches that could be considered novel in a Gabor feature sense, relative to a large range of different textures as provided by the surrounding image.

There are a number of unique texture points on the anomaly itself, which involve larger unique wavelet combinations centred at the detected points of uniqueness. If the textural uniqueness was evaluated over an even larger image, the probability of the occurrence of an overall uniqueness would be proportionally reduced, given an approximately equal textural coverage profile.

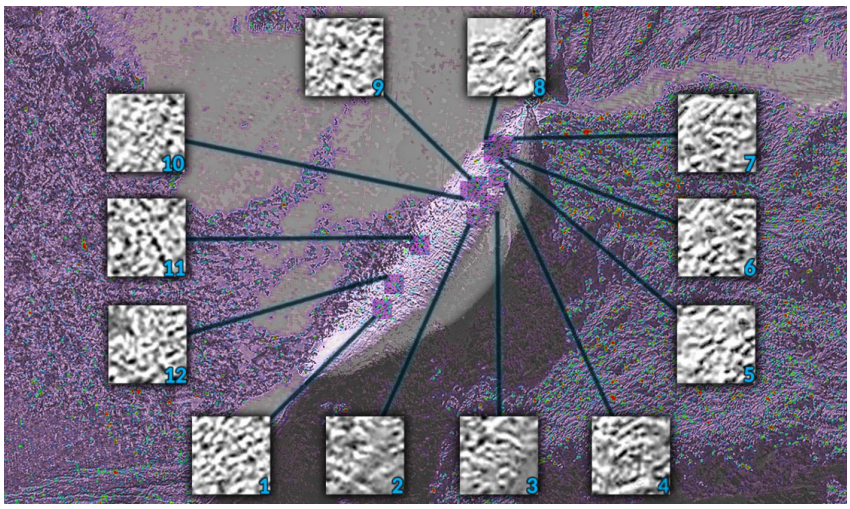


Figure 2: Twelve unique textures found in the enhanced QuickBird February 2003 image of the Ararat Anomaly.

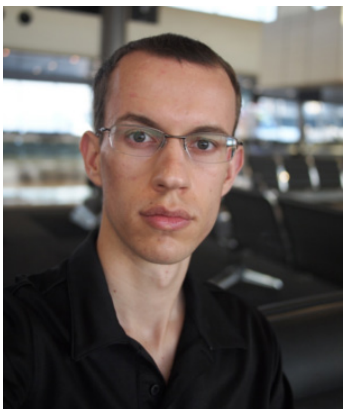
Further study may consider the locations pinpointed by the uniqueness search to ascertain whether there might be clues that can give credence to an artefact underlying the anomaly.

Acknowledgements

The authors would like to acknowledge Prof Porcher L Taylor III from the University of Richmond for introducing them to the problem and for utilising their methods in the news articles that headlined on Space.com, Discovery.com, as well as the science pages of Yahoo and Fox News. Prof Taylor is the lead investigator of the Ararat Anomaly.

The authors also acknowledge DigitalGlobe, a leading commercial vendor of space imagery and geospatial content, as well as an operator of civilian remote sensing spacecraft. DigitalGlobe has flown numerous missions over the anomaly on Prof Taylor's request.

Prof Sunil Maharaj *is the new Dean of the Faculty of Engineering, Built Environment and Information Technology at the University of Pretoria, former Head of the Department of Electrical, Electronic and Computer Engineering and holder of the Sentech Chair in Broadband Wireless Multimedia Communications (BWMC).*



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