Rotation Invariant Classification of 3D Surface Texture Using Photometric Stereo

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To Dad and Mum

&

Carrie
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Abstract

This thesis presented a new three-dimensional surface texture classification scheme which was invariant to surface-rotation using photometric stereo. Many texture classification approaches had been presented in the past that were image-rotation invariant, however, image rotation was not necessarily the same as surface rotation. A classifier therefore had been developed that used invariants that were derived from surface properties rather than image properties.

Firstly, various surface models were considered and a classification scheme was developed that used magnitude spectra of the partial derivatives of the surface obtained using photometric stereo. A simple frequency domain method of removing the directional artefacts of partial derivatives was presented, and a 1D feature set of polar spectrum was also extracted from resulting spectrum. Classification was performed by comparing training and classification polar spectra over a range of rotations. Secondly, a new feature generator albedo spectrum was introduced to provide more information on surface texture properties, and an additional 1D feature set of the radial spectrum was employed too. In addition, by examining the effect of shadowing, a four-image photometric stereo method was developed to provide more accurate three-dimensional surface properties. Finally, a verification step was included in the classification where the 2D spectrum features were compared instead of 1D spectrum features.

The classification results using new-developed photometric stereo real texture database shown that combining 2D gradient and albedo data improves the classification's performance to provide a successful classification rate of 99%.
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