# 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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