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Investigation of Low Resolution Point Clouds for Illumination Correction in Pushbroom Hyperspectral Images

A thesis presented in partial fulfilment of the requirements
for the degree of

**Master of Engineering
in
Mechatronics**

at
Massey University, Turitea Campus
Palmerston North
New Zealand

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February 2018

ABSTRACT

Global food demand is predicted to double between 2015 and 2050. Current agricultural production is unable to facilitate this growth. Consequently, plant breeding must be accelerated to breed improved cultivars that can meet this demand. While technologies such as genomics are suitable for accelerating plant breeding, phenotyping lags behind and is currently considered the bottleneck. Consequently, imaging and remote sensing technologies are being used to provide quantitative, reliable phenotype information. One such technology; hyperspectral imaging can provide physiological, biophysical, and biochemical phenotypic information. While hyperspectral imaging has reached a substantial level of maturity in aerial and satellite based remote sensing applications, it is still underdeveloped in the close-range lab-based phenotyping scenario. In particular is the effect of illumination and complex plant geometry which affects the measured signal and is even more pronounced in the close range hyperspectral imaging. Methods for correction of illumination/geometry effects developed for aerial, and satellite-based imaging are unsuitable for close range hyperspectral imaging. Recently there has been an interest in fusing hyperspectral images with point clouds captured by 3D imaging devices to provide more comprehensive high dimensional phenotype information. However, one study focusses on the possibility of using 3D geometry of the plant to correct for the effects of illumination in hyperspectral images. This study investigates the use of low resolution point clouds captured with low cost devices for use in illumination modelling and correction of hyperspectral images acquired in close range lab-based scenario.

ACKNOWLEDGEMENTS

Firstly, I would like to thank my supervisor Ian Yule for providing me with this great opportunity to learn about the interesting topics of hyperspectral imaging, machine vision, and multiple view geometry and the unique experience of seeing New Zealand from the air while capturing aerial hyperspectral images over the north and south islands. I would also like to thank Ian for both providing me with a stipend and covering my course fees.

I would like to thank Gabor Kereszturi for the many invaluable discussions on all aspects of this project, and especially his excellent feedback and help with the editing of this thesis.

I would like to thank Gourab Sengupta for convincing me that completing a master's degree is a worthwhile endeavour, and for his input with regards to both experiments undertaken, and structure of the thesis.

I would like to thank Kate Saxton for helping to organise my supervisors and I and helping to quickly resolve any administrative issues.

Ian Thomas, Clive Bardell, Kerry Griffiths for their advice and help with manufacturing a precise calibration gauge which was used for assessing the calibration of the hyperspectral camera.

I would like to thank Jacques Johnston for our many interesting discussions regarding clear thinking, postgraduate life, and robotics.

Finally, thank you to my wife Lize for supporting me through the highs and lows of my master's degree.

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LIST OF ABBREVIATIONS

API:	Application Programming Interface
BRDF:	Bidirectional Reflectance Distribution Function
CAD:	Computer Aided Design
DAC:	Data Acquisition Computer
DEM:	Digital Elevation Model
DLT:	Direct Linear Transform
DN:	Digital Number
DSLR:	Digital Single Lens Reflex (Camera)
FOV:	Field of View
GIFOV:	Ground Instantaneous Field Of View
HU:	Hyperspectral Unmixing
IARR:	Internal Apparent Reflectance Ratio
ICP:	Iterative Closest Point
IR:	InfraRed region of the electromagnetic spectrum
LiDAR:	Light Detection And Ranging
NDVI:	Normalised Difference Vegetation Index
NGS:	Next Generation Sequencing
NIR:	Near infra-red region of the electromagnetic spectrum 700-1000nm
PCL:	Point Cloud Library
QTL:	Quantitative Trait Linkage
RANSAC:	RANdom SAmple Consensus
RGB:	Red Green Blue
ROI:	Region Of Interest
SAD:	Sum of Absolute Differences
SFM:	Structure From Motion
SIFT:	Scale Invariant Feature Transform
SLAM:	Simultaneous Localisation And Mapping
SNR:	Signal to Noise Ratio
SWIR:	Short Wave InfraRed region of the electromagnetic spectrum 1000-2500nm
VIS:	VISible region of the electromagnetic spectrum 400-700nm