University of Southern Queensland

Development and Characterisation of a Modified Smartphone Camera for Determining UVA Aerosol Optical Depth

A Dissertation submitted by

Damien Igoe, BAppSci, BSc (Hons), BSpecEd, DipEd, MEd, MSc

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Supervisor: Professor Alfio Parisi

Associate Supervisor: Associate Professor Brad Carter

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Abstract

This research evaluates a specifically-written, calibrated and validated Android app installed on an inexpensive smartphone with bandpass and neutral density filters attached for measuring and quantifying direct solar UVA irradiances and aerosol optical depth. Currently, the equipment normally used to perform these observations is specialised, expensive and is available at a relatively small number of sites. The continuing proliferation of and the increasing number and type of sensors included in smartphones makes feasible the use of specifically designed apps as a cost effective supplementary means of monitoring direct ultraviolet A solar irradiance and air quality for research, education and community outreach purposes.

Most aerosols from both human and natural sources attenuate the UV wavebands; this has far reaching implications for UV irradiance studies and by extension, important public awareness metrics such as the UV index (UVI). Combined, closer observations and subsequent studies of aerosol optical depth and UVA irradiance are critical given that in recent studies, UVA irradiances have been found to be a major agent in skin cancer, photoaging and eye conditions. Therefore, this research involved the development, calibration and validation of a specifically written Android app on a smartphone in separate environments and across different seasons.

The smartphone camera image sensor's response to UVA was first tested in the laboratory using a monochromator. Once it was shown that the response could be characterised, calibration and validation tests of the response to solar UVA and aerosol optical depth (AOD) were performed, with correlations of over 99% and a maximum discrepancy of 10% observed respectively. *Android* automation was then developed, calibrated and validated with similar results.

The results obtained in this research show that a consumer smartphone image sensor, fitted with narrow bandpass and neutral density filters, automated using a specifically written app that uses the camera input produces direct UVA irradiances and aerosol optical depth data with comparable accuracy to that obtained from more expensive and specialised equipment, with correlations of over 0.98 and discrepancies only up to 4%. Such an outcome can promote a greater spatial resolution in monitoring UVA irradiance and air quality, allowing a greater awareness of individual UVA exposure and local air quality.

Certification of Dissertation

I certify that the ideas, experimental and field work results, analyses, software and conclusions reported in this dissertation are entirely my own effort, except where otherwise acknowledged. I also certify that the work is original and has not been previously submitted for any other award, except where otherwise acknowledged.

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Signature of Damien Igoe

Endorsement

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Signature of Professor Alfio Parisi, Principal Supervisor

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Signature of Associate Professor Brad Carter, Associate Supervisor

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