Ph.D. Candidate

Fatemeh Fathollahikalanpa

Graduate Academic Unit

Geodesy & Geomatics Engineering

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April 27, 2022

2:00 p.m. (Atlantic)

Virtual Defence

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Examining Board:
Dr. Shabnam Jabari (Geodesy & Geomatics Engineering)
Dr. Rakesh Mishra (Geodesy & Geomatics Engineering)
Dr. Julian Meng (Electrical & Computer Engineering)
Dr. Yun Zhang (Geodesy & Geomatics Engineering), Supervisor

External Examiner: Dr. Jonathan Li
Department of Geography and Environmental Management
University of Waterloo

The Oral Examination will be chaired by:
Dr. Patricia Evans, Associate Dean of Graduate Studies

BIOGRAPHY

Universities attended (with dates & degrees obtained):

2014 – present	Ph.D. candidate, University of New Brunswick
2013	M.Sc., Remote Sensing, University of Tehran
2009	B.Sc., Geomatics Engineering, University of Tehran

Selected Publications:

Fathollahi, Rezaee, M F., & Zhang, Y. (2021) Deep Joint Demosaicking and Denoising for RGBW Colour Filter Arrays. *IEEE Transaction on computational Imaging.*, Submitted.

Fathollahi, F., Jabari, S., Zhang, Y., & Rezaee, M. (2021) RGBW demosaicking using a collaborative interpolation between panchromatic and colour pixels. *Signal Processing: Image comunication*, Under review.

Fathollahi, F. & Zhang, Y. (2020). Adaptive band selection for pan-sharpening of hyperspectral images. *International Journal of Remote Sensing, 41*(10)

Jabari, S., Rezaee, M., **Fathollahi, F.,** & Zhang, Y. (2019). Multispectral change detection using multivariate Kullback-Leibler distance. *ISPRS Journal of Photogrammetry and Remote Sensing*, *147*.

DadrasJavan, F., Samadzadegan, F., & **Fathollahi, F.** (2018). Spectral and Spatial Quality Assessment of IHS and Wavelet Based Pan-sharpening Techniques for High Resolution Satellite Imagery. *Advances in Image and Video Processing*, *6*(2).

Jabari, S., **Fathollahi, F.,** & Zhang, Y. (2017). Application of sensor fusion to improve UAV image classification. *International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences - ISPRS Archives, 42* (2W6), 153–156.

Conference Presentations:

Fathollahi, F. Rezaee, M., & Zhang, Y. (2019). RGBW joint demosaicking and denoising using a CNN. *Presented at the Int. Conf. PIERS, Xiamen, China.*

Fathollahi, F. & Zhang, Y. (2017). Improving Spectral Quality Assessment of the PanSharpened Images using IHS-based SAM and SCM. *Presented at the Int. Conf. ASPRS IGTF, Baltimore, USA.*

Fathollahi, F., Zhang, Y., Jabari, S., & Rezaee, M (2017). Improving the Colour Distortion of the Hyperspectral Pan-Sharpening by Incorporating More Spectral Bands. *Presented at the Int. Conf. ASPRS IGTF, Baltimore, USA.*

Samadzadegan, F., **Fathollahi, F.,** & Rezaee, M. (2012). Comparing different IHS-based pan-sharpening techniques for worldview-2 high resolution satellite imagery. *International Geoscience and Remote Sensing Symposium (IGARSS)*, 2296–2299.

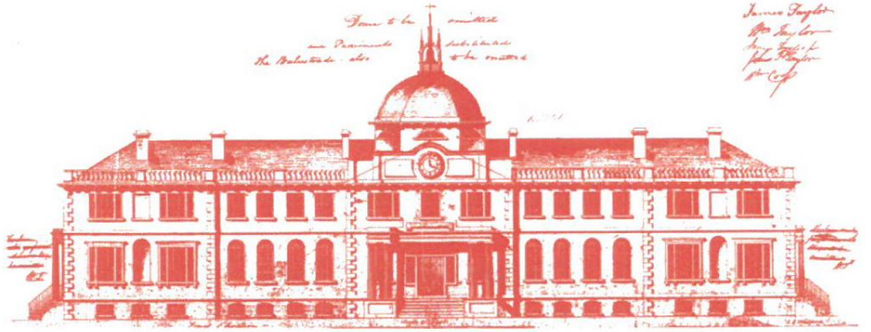
Improving Spatial Quality of Terrestrial and Satellite Images by Demosaicking and Fusion

Abstract

Improving the spatial quality of a colour image brings valuable benefits to all imaginable applications of the image. One method for such an improvement is to incorporate ‘panchromatic’ sensors into imaging. Panchromatic sensors provide images with higher spatial quality than colour images because they do not filter any complementary colours of the incoming light. Combining panchromatic and colour sensors has been employed in different fields. In remote sensing (RS), panchromatic and colour images are captured by two separate sensor chips and then fused through pan-sharpening techniques. In terrestrial applications, a single sensor chip is used to accommodate both panchromatic (or white, W) and colour (RGB) pixels using a Colour Filter Array (RGBW CFA). A ‘demosaicking’ procedure needs to be employed to generate RGB colour images.

Both pan-sharpening and RGBW demosaicking still have unsolved problems despite being used by the imaging industry for a while. In RS, most hyperspectral bands are not pan-sharpened, because they fall beyond the panchromatic spectral range, causing significant spectral distortion. For RGBW demosaicking, limited methods have been published which produce low-quality images, mainly because they demosaick panchromatic and colour images independently. Another issue is that existing approaches cannot handle images corrupted by noise, because they do not involve denoising.

This dissertation aims to overcome the above-mentioned obstacles in improving the spatial quality of the hyperspectral/colour images. For hyperspectral images, this research develops an adaptive band selection strategy to identify the bands across the entire spectrum that can be pan-sharpened without introducing high spectral distortion. For RGBW demosaicking, this research firstly proposes a collaborative interpolation between panchromatic and colour pixels. It significantly improves the spatial quality by reducing the zipper effects and retaining the spatial details. The research then proposes a deep learning-based approach for RGBW joint demosaicking and denoising, along with a procedure to prepare the required training dataset. Results show a considerable quality improvement over existing methods even for images corrupted by various noise levels. In summary, this research leads to improving the spatial quality of those hyperspectral bands, that were previously left unfused. It also increases the potential of using RGBW cameras in daily applications due to the significant quality boost.



Home of the School of Graduate Studies, Sir Howard Douglas Hall was designed by J.E. Woolford in 1825 and is the oldest university building in Canada still in use.

The University of New Brunswick recognizes that the university sits on traditional Wolastoqey territory. The river that runs right by our university – the St. John River – is also known as Wolastoq, along which live the Wolastoqiyik -- the people of the beautiful and bountiful river.

UNIVERSITY OF NEW BRUNSWICK

SCHOOL OF GRADUATE STUDIES

ORAL EXAMINATION

Fatemeh Fathollahikalanpa

IN PARTIAL FULFILMENT
OF THE REQUIREMENTS FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY