Ph.D. Candidate

Mohammad Rezaee

Graduate Academic Unit

Geodesy & Geomatics Engineering

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February 11, 2019

2:30 p.m.

Head Hall
Room E-13

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Examining Board:
Dr. Yun Zhang (Geodesy & Geomatics Eng.)
Dr. Monica Wachowicz (Geodesy & Geomatics Eng.)
Dr. Fan-Rui Meng (Forestry & Environmental Mgt.)
Dr. Julian Meng (Electrical & Computer Eng.)

External Examiner:
Dr. Jonathan Li
Dept. of Geography & Environmental Management
University of Waterloo

The Oral Examination will be chaired by:
Dr. Kevin Englehart, Acting Associate Dean of Graduate Studies

BIOGRAPHY

Universities attended (with dates & degrees obtained):

2013 – present	PhD candidate, University of New Brunswick
2012	MS in Geomatics Engineering (Remote Sensing), University of Tehran, Iran
2009	BS in Geomatics Engineering, University of Tehran, Iran

Publications:

Accepted

- Jabari S., **Rezaee M.**, Fathollahi F., Zhang Y. "Change Detection Using Multivariate Kullback-Leibler Distance", ISPRS Journal of Photogrammetry and Remote Sensing, 2018
- **Rezaee, M.**, Tong F., Zhang Y., Mishra, R., Tong, H., "Using a VGG-16 Network for Individual Tree Species Detection with an Object-Based Approach". 10th International Workshop on Pattern Recognition in Remote Sensing (PRRS 2018)
- Mahdianpari, M., Salehi, B., **Rezaee, M.**, Mohammadimanesh, F., & Zhang, Y. Very Deep Convolutional Neural Networks for Complex Land Cover Mapping Using Multispectral Remote Sensing Imagery. Remote Sensing, 10, 1119, 2018. (Feature paper)
- **Rezaee, M.**, Zhang Y., Mahdianpari, M. "Deep Convolutional Neural Network for Complex Wetland Classification Using Optical Remote Sensing Imagery", IEEE JSTAR, 2018
- **Rezaee, M.**, Zhang Y. "Complex Wetland Classification in Optical Remote Sensing Imagery Using Deep Convolutional Neural Network". Geoscience and Remote Sensing Symposium (IGARSS), 2018 IEEE International
- **Rezaee, M.**, Zhang Y. "Detecting Road and Building using a fully convolutional network in aerial images", The Imaging and Geospatial Information Society (IGTF) 2017, ASPRS
- **Rezaee, M.**, Zhang Y. "Road and Building detection using a patch-based deep network for aerial images", The Imaging and Geospatial Information Society (IGTF) 2017, ASPRS
- **Rezaee, M.**, Zhang Y. "Road Detection Using Deep Neural Network In High Spatial Resolution Images", Joint Urban Remote Sensing Event (JURSE) 2017, IEEE
- **Rezaee, M.**, Zhang Y. "Processing Large Scale Data for Urban Road Detection with Deep Networks", Geomatics Atlantic, 2016
- **Rezaee, M.**, Abouhamzeh, A., Zhang Y. "A heuristic land-cover based image enhancement for satellite imageries". Geoscience and Remote Sensing Symposium (IGARSS), 2014 IEEE International
- **Rezaee, M.**, Mirikharaji, Z., Zhang, Y. "Using Locality-constrained Linear Coding in Automatic Target Detection of HRS Imageries". International symposium on digital earth, 2015.
- **Rezaee, M.**, Samadzadegan, F. and Homayouni, S. (2012). "Clustering Evaluation Using Worldview-2 Imagery in Urban Area" Journal of Geomatics Science and Technology. Vol. 1, No. 6

Submitted

- **Rezaee, M.**, Tong, F., Mishra, R., Zhang, Y. (2018). Detection of Individual Tree Species Using an Optimized Deep CNN in an Object-Based Approach. Remote Sensing of Environment.
- **Rezaee, M.**, Zhang Y. "A Study on Generality of Convolutional Neural Networks in Object Detection of Geospatial Images", Photogrammetric Engineering & Remote Sensing, ASPRS, 2017

Certifications and Awards:

- Artificial Intelligence for Earth Grant, Microsoft, 2018
- Diploma in University Teaching, UNB, 2014

Developing a Deep Learning Network Suitable for Automated Classification of Heterogeneous Land Covers in High Spatial Resolution Imagery

Abstract

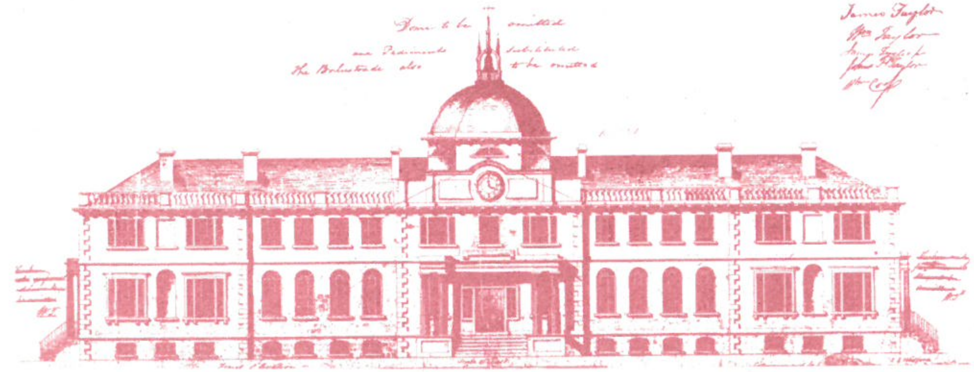
The incorporation of spatial and spectral information within multispectral satellite images is the key for accurate land cover mapping, specifically for discrimination of heterogeneous land covers. Traditional methods only use basic features, either spatial features (e.g. edges or gradients) or spectral features (e.g. mean value of Digital Numbers or Normalized Difference Vegetation Index (NDVI)) for land cover classification. These features are called low level features and are generated manually (through so-called feature engineering). Since feature engineering is manual, the design of proper features is time-consuming, only low-level features in the information hierarchy can usually be extracted, and the feature extraction is application-based (i.e., different applications need to extract different features).

In contrast to traditional land-cover classification methods, Deep Learning (DL), adapting the artificial neural network (ANN) into a deep structure, can automatically generate the necessary high-level features for improving classification without being limited to low-level features. The higher-level features (e.g. complex shapes and textures) can be generated by combining low-level features through different level of processing.

However, despite recent advances of DL for various computer vision tasks, especially for convolutional neural networks (CNNs) models, the potential of using DL for land-cover classification of multispectral remote sensing (RS) images have not yet been thoroughly explored. The main reason is that a DL network needs to be trained using a huge number of images from a large scale of datasets. Such training datasets are not usually available in RS. The only few available training datasets are either for object detection in an urban area, or for scene labeling. In addition, the available datasets are mostly used for land-cover classification based on spatial features. Therefore, the incorporation of the spectral and spatial features has not been studied comprehensively yet.

This PhD research aims to mitigate challenges in using DL for RS land cover mapping/object detection by (1) decreasing the dependency of DL to the large training datasets, (2) adapting and improving the efficiency and accuracy of deep CNNs for heterogeneous classification, (3) incorporating all of the spectral bands in satellite multispectral images into the processing, and (4) designing a specific CNN network that can be used for a faster and more accurate detection of heterogeneous land covers with fewer amount of training datasets.

The new developments are evaluated in two case studies, i.e. wetland detection and tree species detection, where high resolution multispectral satellite images are used. Such land-cover classifications are considered as challenging tasks in the literature. The results show that our new solution works reliably under a wide variety of conditions. Furthermore, we are releasing the two large-scale wetland and tree species detection datasets to the public in order to facilitate future research, and to compare with other methods.



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.

UNIVERSITY OF NEW BRUNSWICK

SCHOOL OF GRADUATE STUDIES

ORAL EXAMINATION

Mohammad Rezaee

IN PARTIAL FULFILMENT
OF THE REQUIREMENTS FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY