Notice of the Final Oral Examination  
for the Degree of Master of Arts  
of  
BROSnan Yuen  
BEng (University of Victoria, 2018)  
“Applications of Machine Learning”  
Department of Electrical and Computer Engineering  
Monday, August 10, 2020  
1:00 P.M.  
Remote Defence  

Supervisory Committee:  
Dr. Tao Lu, Department of Electrical and Computer Engineering, University of Victoria (Supervisor)  
Dr. Mihai Sima, Department of Electrical and Computer Engineering, UVic (Member)  

External Examiner:  
Dr. Xuekui Zhang, Department of Mathematics and Statistics, UVic  

Chair of Oral Examination:  
Dr. John Husson, School of Earth and Ocean Sciences, UVic  

Dr. Stephen Evans, Acting Dean, Faculty of Graduate Studies
Abstract

In this thesis, many machine learning algorithms were applied to electrocardiogram (ECG), spectral analysis, and Field Programmable Gate Arrays (FPGAs). In ECG, QRS complexes are useful for measuring the heart rate and for the segmentation of ECG signals. QRS complexes were detected using WaveletCNN Autoencoder filters and ConvLSTM detectors. The WaveletCNN Autoencoders filters the ECG signals using the wavelet filters, while the ConvLSTM detects the spatial temporal patterns of the QRS complexes. For the spectral analysis topic, the detection of chemical compounds using spectral analysis is useful for identifying unknown substances. However, spectral analysis algorithms require vast amounts of data. To solve this problem, B-spline neural networks were developed for the generation of infrared and ultraviolet/visible spectras. This allowed for the generation of large training datasets from a few experimental measurements. Graphical Processing Units (GPUs) are good for training and testing neural networks. However, using multiple GPUs together is hard because PCIe bus is not suited for scattering operations and reduce operations. FPGAs are more flexible as they can be arranged in a mesh or toroid or hypercube configuration on the PCB. These configurations provide higher data throughput and results in faster computations. A general neural network framework was written in VHDL for Xilinx FPGAs. It allows for any neural network to be trained or tested on FPGAs.