Notice of the Final Oral Examination
for the Degree of Master of Applied Science

of

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“Implementation and Performance Analysis of 3D Cone and Frustum Filters”

Department of Electrical and Computer Engineering

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Engineering and Computer Science Building
Room 467

Supervisory Committee:
Dr. Pan Agathoklis, Department of Electrical and Computer Engineering, University of Victoria (Co-Supervisor)
Dr. Hari Reddy, Department of Electrical and Computer Engineering, UVic (Co-Supervisor)

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Chair of Oral Examination:
Dr. G. Cornelis van Kooten, Department of Economics, UVic

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In this thesis, new effective and efficient implementations of three-dimensional (3D) spatio-temporal (ST) Finite Impulse Response (FIR) uniform and non-uniform cone and frustum filters using well-known filter banks are investigated. The performance of the newly-implemented 3D ST FIR uniform and non-uniform cone and frustum filters are investigated for 3D broadband beamforming in radio astronomy applications.

First, the implementation of two 3D ST uniform FIR cone filters are investigated. The 3D cone filters are designed by cascading either the well-known uniform quadrature mirror cosine-modulated (QM-CM) filter bank or directly designed filter banks (DDFBs), with 2D low-pass circularly-symmetric spatial filters. In addition, two 3D ST uniform FIR frustum filters are derived from the cone filters by implementing partial bands of the filter banks with corresponding 2D spatial filters. The performance of the newly-implemented 3D ST uniform QM-CM and DDFBs cone and frustum filters are evaluated in broadband beamforming signals in radio astronomy applications. The performance of the QM-CM and DDFBs cone and frustum filters shows improvement in terms of Signal-to-Interference-plus-Noise radio (SINRs) over existing 3D ST cone and frustum filters. In addition to their effective performance, the newly-implemented 3D ST uniform QM-CM and DDFBs cone and frustum filters are efficiently implemented; with equivalent or less computational complexity when compared to existing methods.

Second, the implementation of two 3D ST non-uniform cone filters are explored. The two 3D ST non-uniform cone filters are achieved by cascading either QM-CM or DDFBs non-uniform filter banks, with 2D low-pass circularly-symmetric spatial filters. Moreover, two 3D ST non-uniform frustum filters are derived from the cone filters. The objectives of implementing the 3D ST non-uniform cone and frustum filters are, 1) to study the approximation of non-uniform cone and frustum filters, as they have not been intensively studied or investigated; and, 2) to investigate their performance in selective filtering of broadband signals in cases where the signals of interest are nearly intervening with radio frequency interference in radio astronomy applications, and compare their performance with uniform 3D ST cone and frustum filters. Indeed, the performance of the newly-implemented 3D ST non-uniform QMCM and DDFBs cone filters shows some improvement in such an application when compared to the 3D ST uniform cone filters.