WEI FAN
BSc (Electrical and Information Engineering), University of Science and Technology of China (USTC), Hefei, China, 2006
PhD (Nuclear Technology and Applications), University of Science and Technology of China (USTC), Hefei, China, 2011

DEPARTMENT OF ELECTRIC AND COMPUTER ENGINEERING

TITLE OF THESIS:	Development and Application of the Finite Difference Time Domain (FDTD) Method
TIME/DATE:	9:30 am, Friday, December 8, 2017
PLACE:	Room 3107, The Mona Campbell Building, 1459 LeMarchant Street

EXAMINING COMMITTEE:

Dr. Puyan Mojabi, Department of Electrical and Computer Engineering, University of Manitoba (External Examiner)

Dr. Sergey Ponomarenko, Department of Electrical and Computer Engineering, Dalhousie University (Reader)

Dr. William Phillips, Department of Engineering Mathematics and Internetworking, Dalhousie University (Reader)

Dr. Zhizhang (David) Chen, Department of Electrical and Computer Engineering, Dalhousie University (Supervisor)

DEPARTMENTAL REPRESENTATIVE:	Dr. Christian Schlegel, Department of Electrical and Computer Engineering, Dalhousie University
CHAIR:	Dr. Mark Filiaggi, PhD Defence Panel, Faculty of Graduate Studies

ABSTRACT

Time-domain numerical methods are widely applied in modern engineering problems. In modeling electromagnetic structure problems, finite-difference time-domain (FDTD) method is one of the most well-known and widely adopted methods due to its algorithmic simplicity and flexibility. The major constraint of the FDTD method is, in its iterative solution process, that the time step is restricted by the Courant-Friedrichs-Lewy (CFL) condition. Simply to say, the finer the spatial discretization (often required by accuracy), the smaller time step that can be used. As a result, the computational speed and efficiency are limited. In the first half of this thesis, we analyze the FDTD method, review its instability and present its eigen-mode decomposition. Based on the finding, we then derived the analytic solution of the FDTD method, presenting an alternative non-iterative time-domain approach for electromagnetic problems. In the second half of the thesis, we focus on an important application of the FDTD method, the computational time reversal (TR) technique, which is an algorithm applied in inverse problems such as source reconstruction. The algorithm is thoroughly investigated in theory, a new condition is presented for precise source reconstructions, and a mathematical model is developed to reformulate the time-reversal process in an optimization manner. Finally, band-limited fields or signals are incorporated into the model to make the time reversal method practical. Initial numerical experiments are conducted and the results demonstrate the effectiveness and potentials of the proposed time-reversal method in source reconstructions and microwave structure synthesis in the future.