Faculty Name: Ali Hussein

Project Title: CN Tower Lightning Characteristics

Description of Project (Provide ½ page project description)
Although lighting flash density in Toronto is about 2 flashes/square km/year, Canadian National (CN) Tower, standing at 553 m, usually receives dozens of lightning flashes yearly. Therefore, CN Tower offers one of the best few options in the world to study tall-structure lighting, including its optical characteristics, the current and the lightning-generated electromagnetic pulse (LEMP). The development of lightning return-stroke models and the evaluation of the performance characteristics of the North American Lightning Detection Network are also important objectives of CN Tower lightning investigations. In 1990, five measurement stations started to operate to simultaneously record the return-stroke current at the tower, the corresponding LEMP (2 km north of the tower), the return-stroke velocity, and two 2-dimensional images of the lightning flash trajectory. Since 1996, expansions of the measurement facilities have been taking place, including the acquisition of a 1000-frame/s digital imaging system, a noise-protected current measurement system, two LeCroy high-speed digitizers and four Global Positioning Systems for time synchronization of all measurement stations. One of the major objectives of observing CN Tower lightning strikes is deriving statistics regarding tall-structure lightning parameters, which assists in the establishment of more sophisticated lightning protection procedures, especially for wind turbines and power lines routed through mountainous terrains, where lightning is mainly upward-initiated. Although this proposal deals with measurement and analysis of CN Tower lightning data, it focuses on the analysis of optical characteristics of CN Tower lightning flashes (flash duration, flash components, number of return-strokes per flash, inter-stroke time, initiation direction, branching, strike distance from the tip of the tower, etc.) and compare them with the simultaneously-recorded current derivative signals. Because of the large amount of optical data, the statistical analysis of their characteristics would be fundamental to researchers working in the area of protection and for international organizations developing standards related to lightning, such as Conseil International des Grands Reseaux Electriques (CIGRE) Working Group C4.410 “Lightning Striking Characteristics for Very High Structures.”

Responsibility of Student (Specify the duties and responsibilities of the student)
The student taking this research internship (RI) position will participate in the operation and programming of state-of-the-art equipment (please see the list below). The main duties include lightning data acquisition during the summer of 2015, as well as the processing and analysis of new and previously acquired data for the eventual goal of deriving statistics concerning CN
2015 Research Internship

Tower lightning optical characteristics. The applicant is to directly supervise the RI student. The student will be first directed to briefly study the lightning phenomenon and acquire a general understanding of various aspects of CN Tower Lightning Project. The RI student will interact with applicant's graduate students, as well as his research associate. Meetings are held with the applicant's research team members, in which everyone present a progress report concerning his/her achievements. Thus, every member of the research team gains awareness of the work of other members. Research students are encouraged to submit papers related to their activities to relevant national/international conferences. It is worth mentioning that the applicant has fully supervised two RI students (2013 and 2014), eleven NSERC USRA students at Ryerson University and University of Toronto since 1998. Also, two full-time URO (Undergraduate Research Opportunities Scholars Program) students, and seven full-time and 11 part-time RA Ryerson undergraduate students were fully supervised by the applicant, 2004-2014.

**Instruments:** Phantom v5.0 digital high speed imaging systems (1 ms resolution); Sony HDR PJ790VB camera; Two-channel LeCroy LT342L high speed digitizer (2 ns); 2-channel National Instruments PCI-5114 digitizer with an extended memory; Two Rogowski coils placed at the tower at different heights; NanoFast OP2000A Optical Transmission System; Global Positioning System (GPS) units for time synchronization of recording instruments.

**Specify Requirements (Please state any specific requirement of this position)**

Completion of the fourth semester is important but not necessary. Practical orientation and computer literacy are required. Previous research experience, especially in related fields, is a great asset.