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Climate Data Informed Conditional Assessment for Critical Infrastructures

Hongyu Zhou
University of Alabama in Huntsville

2017 Research and Creative for Undergraduate Students (RCEU) Proposal

TITLE: CLIMATE DATA INFORMED CONDITIONAL ASSESSMENT FOR CITICAL INFRASTRUCTURES

Mentoring Faculty Information
Hongyu Zhou, Ph.D.
Assistant Professor
Department of Civil and Environmental Engineering
The University of Alabama in Huntsville
5000 Technology Drive, Rm S244, Huntsville, AL35899
Email: Hongyu.Zhou@uah.edu
Phone: (256)824-5029 (Office) Fax: (256)824-6724

Project Summary

Inter annual, decadal and longer term climate variability are important to safety, operation, and functionality of civil infrastructural systems. To date, extensive research has been dedicated to the deterioration mechanism and modeling of construction materials and structures under various environments. One critical premise to the prediction of infrastructure's service life is to accurately capture and predict the environmental conditions that drive the deterioration processes. One way to correlate the environmental drivers to infrastructural assessment grading is by implementing new sensor technology that can concurrently measure structural (e.g., stress, deformation) and environmental variables (e.g., temperature, precipitation, freezing and icing); however, establishing new sensor networks is extremely time consuming and may be cost-prohibitive. In addition, information collected by new sensor networks becomes useful for statistical analysis only after decadal time scales.

There is evidence supporting that certain changes across multiple structures always occur together and form collective patterns that predict aging and deficiency. These spatiotemporal aging patterns of critical structures such as bridges often show correlations with local climates and weather condition. This research aims at studying the fundamental linkage between infrastructural deterioration and local climate condition/ change. Quantitative methods will be established to leverage weather/climate data acquired by National Oceanic and Atmospheric Administration (NOAA) for the condition assessment and service life prediction of our national infrastructures. In doing so, existing weather station networks, radar stations, and satellite data can be exploited in providing critical environment information needed.

Research Plan

In order to link the infrastructural conditions to local climate/weather pattern, we propose to use regression models will be used to analyze the collective pattern that correlates weather/climate history to the aging of transportation infrastructures. Upon successful development, this research will provide means to utilize existing climate data sources (such as NCDC) to provide the critical environmental inputs needed for infrastructural condition assessments. Practically, results of this preliminary study can be used to form decision-making tools for evaluation and maintenance planning of critical civil infrastructures, in considering local climate conditions as environmental stressors.

Student Duties

Students will work closely with higher level graduate students to analyze the structural condition data in the National Bridge Inventory (NBI) database, and to analyze weather/climate

data collected from published national database/datasets. Field trip maybe required for data collection and test case validation.

Tentative 10-week Schedule

(1) Weeks 1-3, familiarize with the database and learn how to mine useful information from the datasets;
(2) Weeks 4-5, learn computer software and algorithms that perform the data analysis and categorization;
(3) Weeks 6-9, perform analysis and compare the results to the model projection;
(4) Weeks 10, refine the analysis process and generate presentation materials.

Expected Student Background and Requirements

Students should have some basic background in computer programming; knowledge of data mining is advantageous; typically students with a major in Atmosphere Science, Computer Science, or Computer and Electrical Engineering should be ok. Pre-exposure to data analysis is a clear benefit.

It is expected that the students will work full-time (32-40 hrs/week) for 10 weeks during summer 2017. Students who consider pursuing the RCEU program may not register more than 6 credit hours of class during smr 2017 (i.e., two classes over the summer, or one class each mini-semester). Office space located in Technology Hall (OKT) and computers will be made available to the enrolled students. The students will have access to the newly established structural hazard mitigation and intelligent materials laboratory located in the high-bay area of Tech Hall.

Mentor Supervision and Interaction

The faculty mentor will oversee the project throughout the performance period, including supervising the student and design the testing protocols associated with this project to ensure all project objectives are achieved. The mentor will examine all student's work and provide the assistance and resources needed. The student will report (in written or oral format) to the mentor periodically on a weekly base, and the mentor will ensure the student is progressing as planned. It is expected that a brief research report will be generated towards the end of the project.