Electromagnetic Detection and Identification of Concrete Cracking in Highway Bridges

Maryam Abazarsa, Department of Civil and Environmental Engineering, University of Massachusetts Lowell
Advisors: Tzuyang Yu

Introduction

The problem we are trying to solve is the detection and monitoring of aging civil infrastructure components and systems in New England by using visual information and subsurface images in a virtual reality (VR) environment for data visualization and machine learning (ML) for nondestructive testing (NDT) data interpretation. Material aging and structural deterioration of selected candidate structures (e.g., highway bridges) will be frequently (from twice a day to once a week) inspected to develop large amount of sensor data for condition assessment using machine learning.

Objectives

- Condition assessment of high-frequency NDT data using ML and artificial intelligence (AI)
- Correlation between high-frequency NDT data (e.g., Ground Penetrating Radar (GPR) B-scan images) and material aging and structural deterioration
- Development procedure of 3D bridge VR models and VR platform

Fig. 1: a) VR chamber with a desktop computer; b) Point cloud data (PCD) models of bridge components; c) GPR field data collection; d) and e) The RC column (E3) for sample collection; e) GPR mini LT.

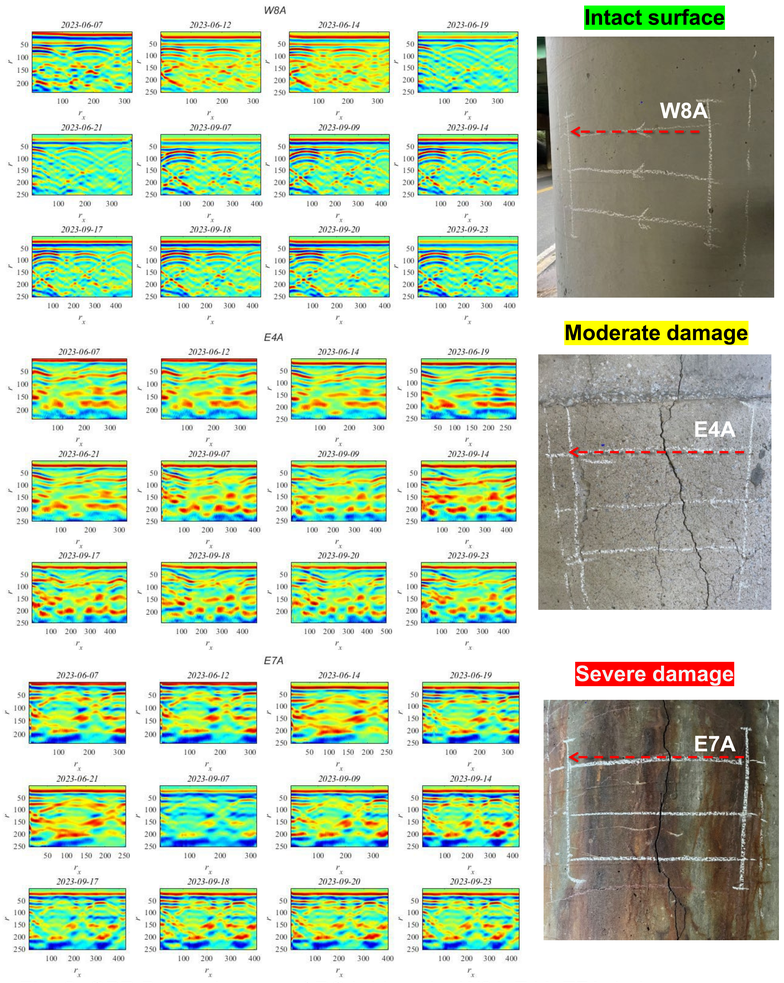

Fig. 2: GPR B-scan images of RC bridge pier W8A-E4A-E7A during 06/07/23 and 10/02/23.

Results

- Fig. 2 shows our high-frequency GPR B-scan images collected from a reinforced concrete (RC) bridge pier(W8A intact surface column, E4A moderately damaged column. E7A severely damaged column) of I-495 in Chelmsford, MA, during 06/07/23 and 10/02/23.

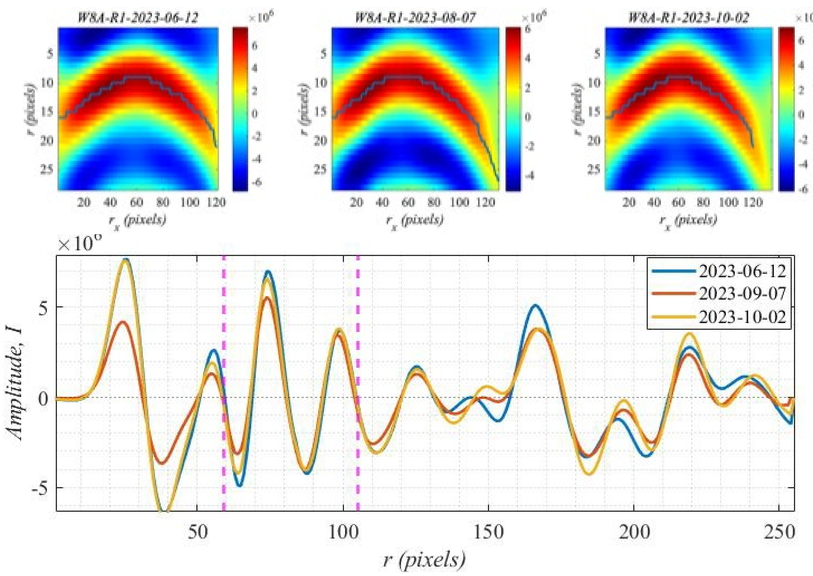

Fig. 2: Compare GPR A-scan of W8A in 3 different dates

Fig. 3 displays our A-scan plot collected from a reinforced concrete (RC) bridge pier (W8A) on different dates, illustrating the changes in rebar amplitude over this period.

Conclusion

- GPR B-scan images of RC bridge piers can be affected by environmental conditions (temperature, moisture).
- GPR can be used as a NDT method to evaluate the rebar condition (for corrosion).

Publications

- K. Raisi, N.N. Khun, and T. Yu (2022), SPIE, DOI: 10.1117/12.2613083
- K. Raisi, R. Batchu, and T. Yu (2023), SPIE, DOI: 10.1117/12.2657731
- R. Batchu, K. Raisi, and T. Yu (2023), SPIE, DOI: 10.1117/12.2658173
- T. Yu, K. Raisi, and R. Batchu (2023), SPIE, DOI: 10.1117/12.2657741
- N.N. Kulkarni, K. Raisi, N.A. Valente, J. Benoit, T. Yu, and A. Sabato, (2023), AIC, DOI: 10.1016/104784

Acknowledgements: Funding for this research is provided by the TIDC at UMaine under grant 69A3551847101 from the U.S. DOT UTC Program.
We thank Mr. Gregory Kirkoris (MassDOT) (Project Champion) and for helping us identify the I-495 bridge to collect high-frequency NDT data and Mr. Bibhuti Aryal, Burak Boyaci, Scott Becher (Bentley Systems) for the development of a 3D bridge PCD model.