Damage Assessment in Aging Structures using Augmented Reality

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Introduction

- Existing methods to perform structural inspections in bridges are high in cost, time-consuming and risky.
- Inspectors use expensive equipment to reach a certain area of the bridge to inspect it, and at different heights, this can pose a risk to the inspector's safety.
- Assessing damages manually using current devices takes a long time.
- This study introduces a cheaper, faster, and safer approach for damage inspection using Augmented Reality (AR).
- Existing literature (Al-Sabbag et al. 2022 and Karaaslan et al. 2022) lacks a multiclass detection model and are computationally expensive.

Methods

The proposed AR system consists of three steps:

- Damage detection model training.
- AR app development using Unity engine.
- Structural Health Monitoring (SHM) and visualization using Microsoft HoloLens 2 (HL2) AR headset.

Figure 1: The Microsoft HoloLens 2 AR Headset

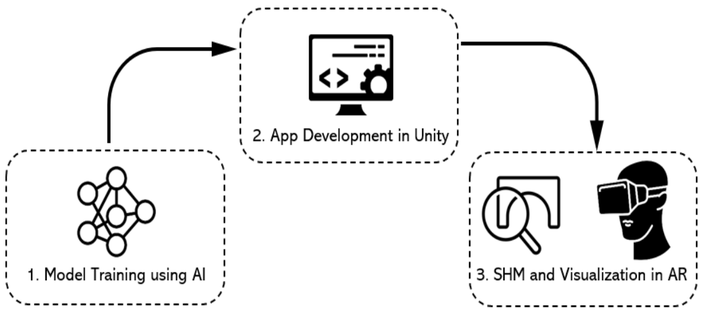

Figure 2: Workflow of proposed technology using HL2

- The AR damage inspection system takes an image of the region under assessment and classifies the damage.
- The system allows inspectors to calculate the length, area, and perimeter of the damage to assess its severity.

Figure 3: Damage assessment on the sidewalk using HL2

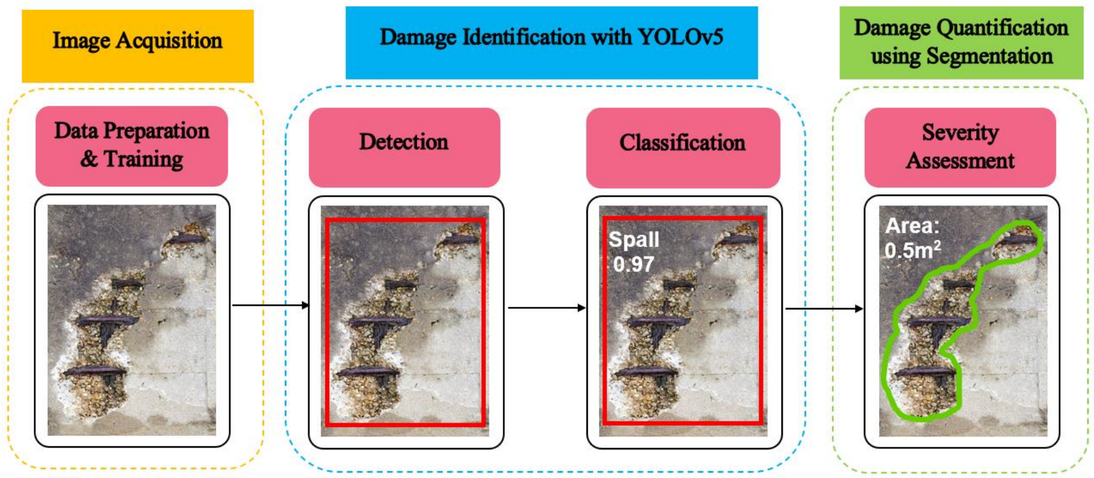

Figure 4: Summary of the proposed damage inspection system

Results

The damage detection model achieved about **85%** precision and the classification accuracy for the type of damage varies between **90%-99%**. Also, the damage quantification is done in less than 2 seconds from when the inspector prompts the system to start the computation step.

Figure 5: Classification result of four classes (crack, concrete joint, spall, and pitting) using HL2

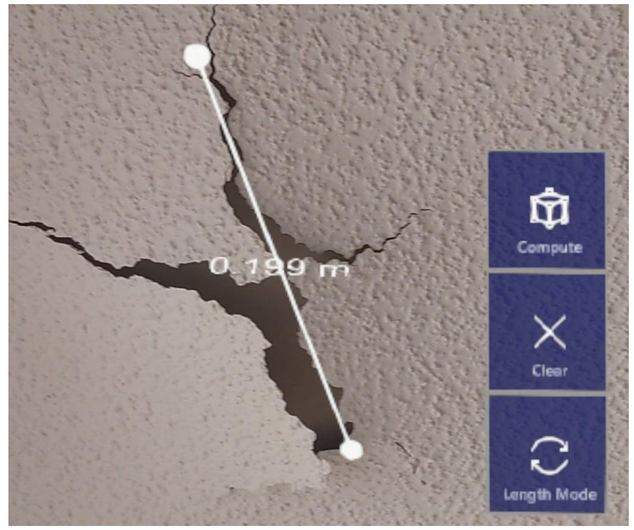

Figure 6: Length measurement of a crack using HL2

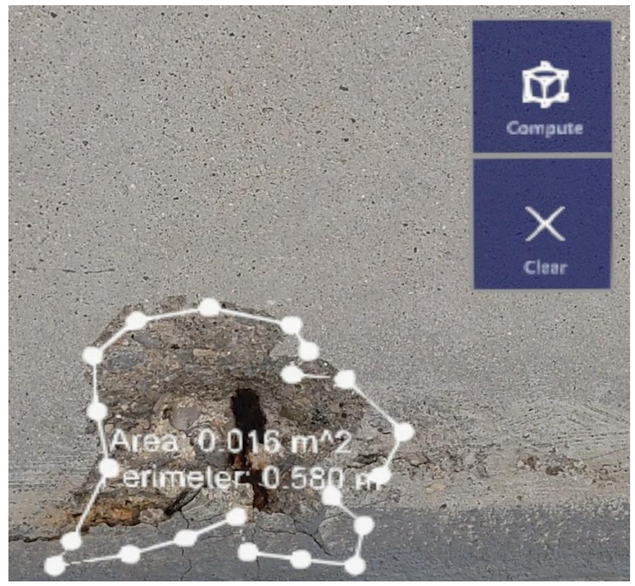

Figure 7: Area/Perimeter measurement of a spall using HL2

Conclusion

The use of AR technology in structural inspections achieved high accuracy and fast performance. The accuracy of the system did not show significant change when the inspector moves further from the damage, this reduces the need to reach risky heights to perform inspections. Future steps for this work will explore depth calculation of damages and remote collaboration between inspectors using multiple HL2 devices.

Acknowledgments

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Related Literature

Al-Sabbag, Z., Yeum, C., Narasimhan, S. (2022), "Interactive defect quantification through extended reality", *Advanced Engineering Informatics,* Volume 51.

Karaaslan, E., Bagci, U., Catbas, F. (2022), "Artificial Intelligence Assisted Infrastructure Assessment Using Mixed Reality Systems", *Transportation Research Record,* Volume 2673(12), Pages 413-424.