TIDC Transportation Infrastructure Durability Center AT THE UNIVERSITY OF MAINE

DEPARTMENT OF TRANSPORTATION UNITED STATES GOVERNMENT

Optical-Based Structural Health Monitoring of Truss Bridges

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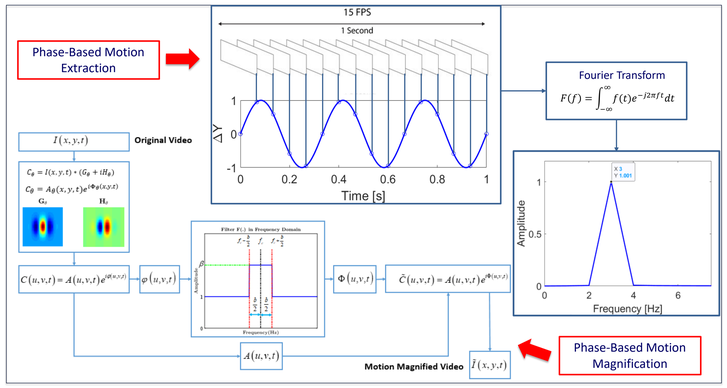
Motivation

The application of camera-based sensing techniques has been proved to be an effective way to extract structural heath monitoring (SHM) data. The use of accelerometers has the limitation of lack of full-field awareness for large structures, which is oftentimes critical to bridge inspections. Using video camera based inspection has the flexibility of accession dynamic information at any point of interest, compared to permanently installed sensors.

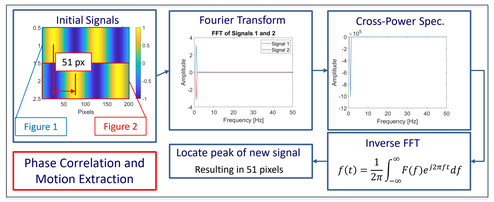
The objectives of the project are:

- Develop a portable and fast bridge inspection hardware platform at low cost
- Mining information from optical data on bridges under normal operation without influencing traffic
- Identify the potential of this technique for damage detection based on artificial intelligence

Video Motion Extraction



Flowchart of Phase-based motion extraction and magnification



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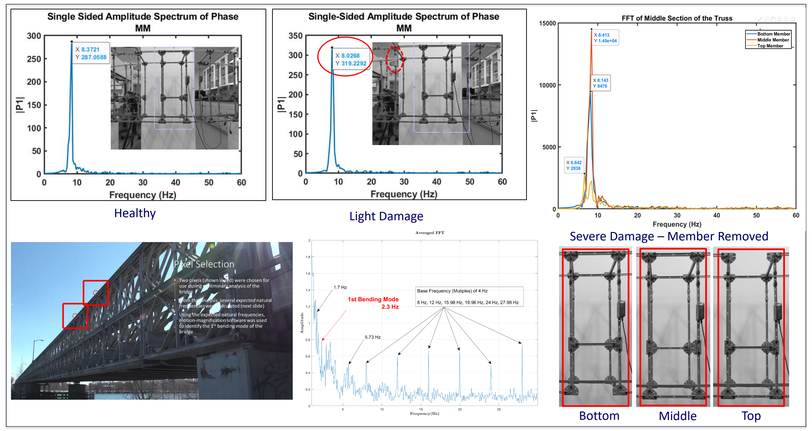
Learning with Purpose

Experimental Implementation

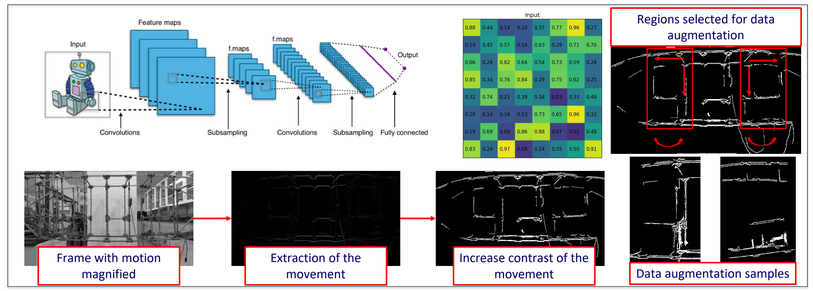
- Both lab-scale test and realistic bridges are adopted
- Artificial damages are introduced in the lab test
- Phase-based motion magnification demonstrates its capability of damage detection



Results for the healthy and damaged scenarios for the laboratory test and for the real truss bridge

Data Analytics via AI

- Convolutional Neural Network (CNN) is used to extract the pattern of the full-field mode shape under different conditions
- Improve the contrast of the frames and extract motions
- Use of data augmentation to enhance the algorithm accuracy



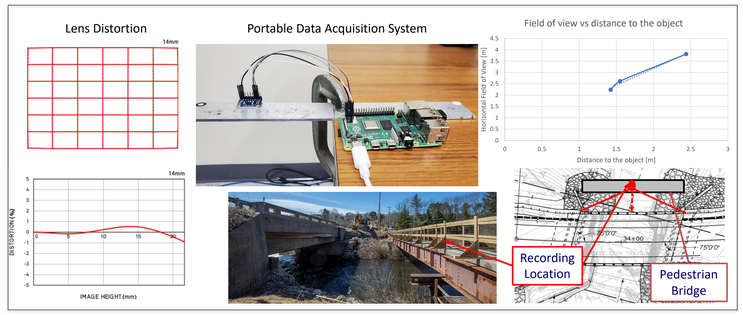
CNN algorithm scheme and pre-processing of frames for pattern recognition

Summary

- Non-contact sensing with video cameras is adopted for the development of a portable and fast bridge evaluation technology
- A good potential to extract information of complex structures.
- PME has as good accuracy compared to traditional sensing methods
- Camera-based sensing techniques enables full-field modal identification
- Integration of deep-learning and artificial intelligence would drastically enhance the damage detection accuracy

Currently Ongoing Work

- Testing on a new composite bridge in Hampden Maine
- Camera calibration and setup on a temporary pedestrian bridge next to the testing bridge
- Development of a portable data acquisition system to capture/compensate ground vibration using Raspberry Pi 4
- Use of multiple sensors and sensing modalities for redundancy and better data acquisition reliability



Test Preparations

Website of TIDC at UMass Lowell:
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