Project Title: Intelligent Structural Health Monitoring of Vehicular Bridges

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Project Summary:
After the catastrophic I-35W bridge collapse engineers have been seeking and pursuing alternative inspection techniques to monitor a bridge's structural health. One technology that has been proven successful for such a purpose is acoustic emissions (AE). Current AE inspection systems use piezoelectric sensors to "listen" to the structure. These sensors are costly as each of them requires a preamplifier. During inspections, it is not uncommon for inspectors to pick up local radio stations with these sensors as they are susceptible to electromagnetic interference. The sensors also have a limited operating frequency range so most AE technicians carry around a box of transducers to cover the full 30-1000 kHz wave band. Piezoelectric sensors sensitivity will also decrease overtime requiring a calibration prior to each use.

The proposed AE system utilizes optical Fiber Bragg Gratings (FBG) in place of piezoelectric sensors. FBG sensors offer numerous advantages compared to piezoelectric sensors for AE monitoring. FBG sensors are low cost and readily available, light-weight, immune to electromagnetic noise sources, and do not require preamplification. It is possible to set up a FBG array at great distances from the control box without any signal loss because the FBG are connected to the control box by fiber optic and not a cable. Having a significantly smaller footprint than the piezoelectric sensors, the FBG can also be mounted in areas with small tolerances. Since they are small, the FBG can be installed permanently to the structure and its fiber runs to each sensor can be concealed easily. This will allow for the inspector to leave the system in place to do SHM of the structure or to leave the sensors in place and simply hook up the demodulator box when a scheduled inspection is required. With this system inspectors are not required to set up, apply couplant, and recalibrate the piezoelectric sensors prior to each inspection. Finally, unlike piezoelectric sensors, FBG do not exhibit a reduction in sensitivity overtime.

The proposed research work would provide a pathway for transforming the sensing technique into a practical tool for monitoring damage evolution in vehicular bridges and the prediction of impending structural failure, which can lead to the loss of human life.