Augmented Reality Enhancing the Inspections of Transportation Infrastructure: Research, Education, and Industry Implementation

Using low-cost sensors and augmented reality to assist in critical decision making for repair and maintenance of transportation infrastructure

Highlight | Jan. 2019

Project No. 18STUNM03

PI: Dr. Fernando Moreu, Dr. Chris Lippitt (UNM)

POP: March 2018 – November 2019

The growing need for maintenance and management of our aging infrastructure cannot be addressed with current technologies. This has demanded development of new, cost-effective solutions for maintenance and management. One such technology is augmented reality (AR) which is rapidly changing the way we visualize information and revolutionizing the way we interact with our physical environment. AR has the ability to spatially map our surrounding and overlay virtual environments. Sensing built environment is an important task of conducting inspection and repair works. This research presents the main contributions achieved in the area of building and testing AR applications for transportation infrastructure maintenance and management and recommends specific prioritization of AR development for future field applications.

Background

Transportation infrastructure is aging a rapid rate; surpassing beyond their intended design life. The 2017 ASCE "Infrastructure Report Card" scores transportation Infrastructure a D+ (below average). Stakeholders are aware of this situation and eager to develop new technologies for maintenance and repair prioritization. There is growing need for regular inspection, maintenance and management of infrastructure assets. Yet, no cost-efficient solution exists in sensing, data acquisition and visualizing on site decision making repair works. With the advent of low-cost sensors, now, it is possible to use these technologies to build and deploy reliable yet cost-efficient technology at site for inspection, repair and maintenance works. This project focuses in developing such technology that can be rapidly deployed at site and collect data which can be used in time critical decision making.

Project Summary

In this project researchers fabricated low-cost sensors using off-the shelf materials. These sensors are built to measure physical dynamic properties such as accelerations, strain, angle/tilts, etc. To be able to deploy on site and transmit the acquired data to decision makers, the sensors were connected remotely to a server that was designed and developed for AR. These servers hold a database that can store acquired data and used for visualization. Figure 1 is a low-cost sensor prototype built to measure strain value and imposed load on a bridge circuit.

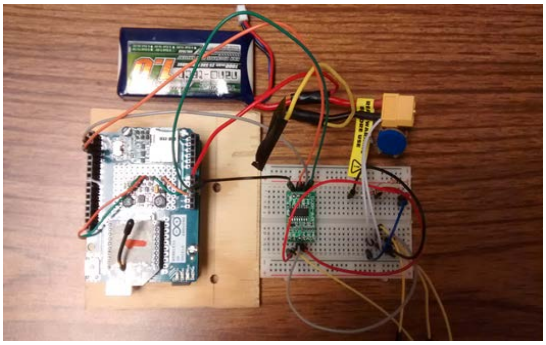

Figure 1. A low-cost sensor prototype powered by 7-volt battery for strain measurements.

This prototype is powered with a battery pack which has been designed to be connected to one portable solar panel. Hence, long term data acquisition is also possible with these sensors. These sensors are integrated to HoloLens, which is AR assisted head mounted device manufactured by Microsoft. Figure 2 shows a user giving a demo for viewing critical information from inspection reports stored in remote server location. Finally, researchers are optimistic about the features of AR technology to be improved in near future which will be able to provide seamless human infrastructure interaction experience. Further research could be done in this area to enhance the sensing capacity of field inspectors for intuitive experience and prompt decisions. The direct contact with owners and inspectors informs the practical applicability of this research for infrastructure inspections.

Status Update

The applications and hardware developed by the researcher group have been tested in one small scale laboratory setting. Now, researchers are in process of deploying it on site in coordination with

stakeholders, whose primary partner is the New Mexico Department of Transportation (NMDOT) and Los Alamos National Laboratory (LANL). The future work of this project includes the field testing of this new technology and benchmarking with other technologies.

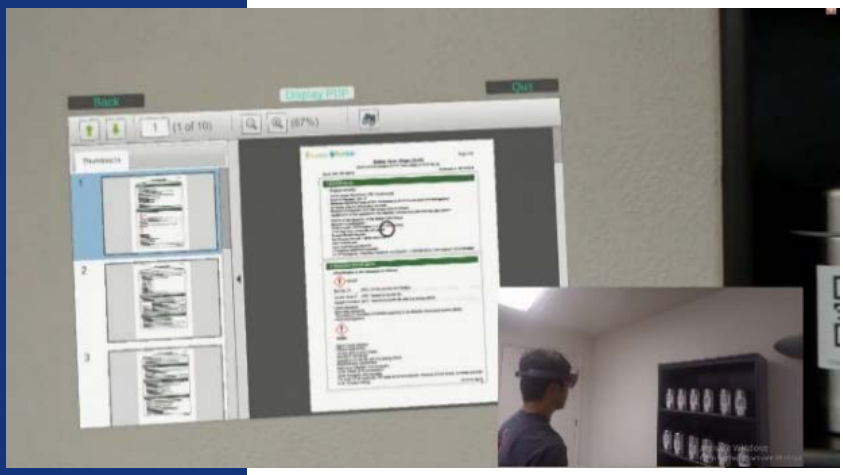

Figure 2. A user giving demo for using AR application for infrastructure inspection.

The technology could ultimately be used by field inspectors which not only provides value by reducing inspection and repair cost but also increases safety on site. The interest of infrastructure owners on safety has indicated to researchers of the need of testing safety of using AR by inspectors in the field. A case for Augmented Reality is presented for inspection works. Considering the concerns of infrastructure stakeholders, researchers propose to design and implement new technology to address the safety related challenges that are prevalent in construction industry. The effectiveness of this technology will be evaluated and further suggestions for the future direction of the study will be included in direct conversation with NMDOT.

Figure 1. Transportation infrastructure inspection using AR.

Impacts

The project strives to augment human perceiving capability for smart infrastructure sensing. It will ultimately benefit economy by increasing productivity in inspection works and reducing redundancy in repair and maintenance works. This is achieved by building network of low-cost sensors that can automatically feed information regarding the state of infrastructure and inform decision makers to act promptly. This research includes discussions in TRB annual conference (Washington DC), NMDOT bridge inspection group at Santa Fe, and the railroad industry.

Tran-SET

Tran-SET is Region 6's University Transportation Center. It is a collaborative partnership between 11 institutions (see below) across 5 states (AR, LA, NM, OK, and TX). Tran-SET is led by Louisiana State University. It was established in late November 2016 "to address the accelerated deterioration of transportation infrastructure through the development, evaluation, and implementation of cutting-edge technologies, novel materials, and innovative construction management processes".

Learn More

For more information about Tran-SET, please visit our website, LinkedIn, Twitter, Facebook, and YouTube pages. Also, please feel free to contact Mr. Christopher Melson (Tran-SET Program Manager) directly at transet@lsu.edu.