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Research Summary

Transportation Infrastructure Asset Monitoring Through the Industrial Internet-of-Things

The Internet-of-Things (IoT) is a rapidly growing area of wireless communication technology that allows devices to communicate with computers and humans via the Internet. This technology goes far beyond simply connecting devices to the internet, it creates opportunities to combine data from these devices with automated systems for the purpose of analyzing, displaying, and predicting results.

The research goal of this project was to explore the current status and viability of Industrial Internet-of-Things (IIoT) technology for the purpose of asset management of transportation infrastructure or the actual built infrastructure distributed along the highway system in Missouri. The project was framed in two phases. Phase 1 (cmr20-011) focused on preliminary research to assess the readiness of IIoT for initial implementation on the transportation highway system (such as: bridges, pavements, retaining walls, signs, etc.). This project implemented Phase 2, a pilot project deployed on a limited number of assets to evaluate the technology.

A variety of sensors including tiltmeters, crack meters, piezometers, in-place inclinometers, vibration sensors, strain gauges, and accelerometers were deployed across a sampling of assets in the greater St. Louis Metropolitan Area including retaining walls, sign structures and crash barriers.

Market research was conducted throughout the sensing and IIoT industry to select a vendor that met a set of system design requirements such as relevant experience, capability to provide a full installation, software requirements, capability to instrument all asset types, and ability to offer cellular communications. Bridge Diagnostics, Inc. (BDI) was selected to procure all equipment and install half of the asset locations while MoDOT staff installed the remaining sites. Additional accelerometer test units were obtained from Pi-Lit to be installed on crash barriers simultaneously with the BDI equipment.

The data architecture designed for this project transmitted data from IIoT sensors to the cloud, filtered and processed data in the cloud, and shared the data with users via a Power BI dashboard. Refer to Figure 1 for a sample view of the dashboard.

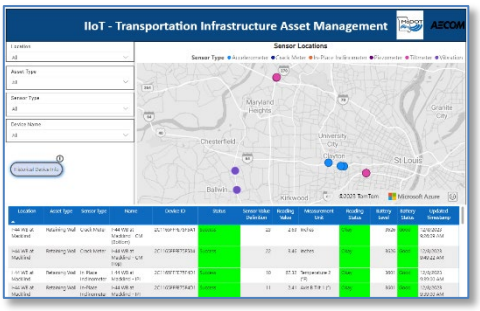

Figure 1

Through the one year of deployment, the project realized both successes and obstacles, leading to multiple recommendations and lessons learned to benefit future deployments. Real-time data has successfully been transmitted from IIoT sensors and is viewable via the shared dashboard, including historical data. Sensors deployed at crash barriers successfully detected a hit-and-run collision on May 28, 2023 at 3:13am at the WB I-64 Exit to Big Bend Boulevard. Notice of this impact was not communicated to MoDOT staff via other outlets. Crash detection technology proved to be the first method of notification and offers a promising future now that Emergency Response units are not present over weekends.

"Crash detection technology proved to be the first method of notification..."

Key lessons learned from this project offer insight to benefit deployment of IIoT systems in the future. Some sensors experienced communication errors during the project, resulting in loss of data. It is recommended that future IIoT deployments consider ongoing monitoring and proactive maintenance of these devices or engage third-party contractors to reduce down-time . A variety of other lessons learned are noted in the final report related to asset selection, system design, field deployment and data management.

Overall, this project confirms the viability of deploying an IIoT system for the purpose of monitoring transportation highway system assets. It is the opinion of the research team that this technology is suitable for further deployment for the purpose of asset management contingent upon the consideration of lessons learned presented in this report.

Project Information

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PROJECT COST: $266,850

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