

UTC Project Information	
Project Title	MPC 460 – Technology and Workforce Development for Remote Sensing of the Transportation Infrastructure
University	North Dakota State University
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Brief Description of Research Project	<p>Maintaining the transportation system in a state of good repair is critical to sustaining our nation’s economic well-being, and serving both the mobility and lifestyle of its citizens. However, monitoring performance and detecting risks across a vast transportation network is costly, time-consuming, complex, and requires a wide variety of expertise. The transportation infrastructure is a complex, expansive, expensive, and extremely open system that integrates multiple modes that move people and goods of all types across roads and bridges, railways, waterways, and the airways. Additionally, a complex network of aboveground and underground pipes moves critical resources such as oil, gas, and water.</p> <p>The ability to accurately assess resource needs and make effective decisions requires enhanced visibility of the growing levels of transportation and logistics activities. Sensor technologies continue to evolve at a rapid pace to provide greater visibility, but we currently know very little about how to integrate and apply most of them to enhance the safety, security, and efficiency of transportation systems.</p>

Agencies have deployed wired and wireless sensor technologies, but only in sparse quantities because their high cost, size, and energy demands limit their ability to cover the entire expansive, multimodal, and intermodal transportation infrastructure (HPMS 2012). Remote sensing technologies that use satellite and manned aircrafts with multispectral sensor payloads can provide greater coverage but are limited in the type of information obtainable from their data sets. For example, the typical multispectral sensors cannot detect hydrocarbon spills and other hazardous materials underground (Otten, et al. 1998). Hyperspectral imaging offers a greater potential for improved remote sensing capabilities but their present size and cost limit are limiting factors for widespread deployment (Hart, Slough and Rafert 1998).

Research Objectives:

The primary goal of this study is to assess and develop means of optimizing hyperspectral remote sensing for use with lightweight (less than 50 pounds) unmanned aircraft systems (UAS) and to provide the relevant training necessary for future practitioners to construct and deploy full solutions. A secondary objective will be to investigate the use of ground or vehicle based hyperspectral systems. A variety of knowledge domain experts in signal processing, image analysis, data mining, data management, geospatial analysis, optics, rules-based engines, cloud computing and mobile computing are needed to implement complete solutions. Effective implementations will generally merge cross-disciplinary expertise to analyze the fusion of data from a variety of sources to quantify performance and assess risks, threats, and vulnerabilities in the transportation system (Bridgelall 2014). The transformation of remote sensing data into actionable information requires forms of signal processing and data analysis that are still evolving and/or not yet fully understood. The associated decision-support platforms and asset management systems rely on tailoring multidisciplinary aspects of the full solution to remote sensing applications for maximum effectiveness in realizing their potential benefits while reducing the complexity of human interfaces. Educators have placed little, if any, attention on inventorying the skill sets and workforce availability for personnel who can process and derive actionable information from these data sources.

To achieve this goal, the team will execute the following objectives:

- 1) Conduct a utility study to catalog current practices and high-priority emerging opportunities for hyperspectral sensing.
- 2) Identify emerging and related sensor technologies for inclusion in future transportation infrastructure needs assessments.
- 3) Formulate means that MPC members can utilize to build upon their existing curricula and ensure a properly trained workforce with relevant skills and understanding within those domains.

<p>Describe Implementation of Research Outcomes (or why not implemented)</p> <p>Place Any Photos Here</p>	<p>Simulations of the rapid hyperspectral image classification method of the remote sensing framework demonstrated that an agile and real-time detection system is possible with small unmanned aircrafts. Such a capability will enable many new applications in transportation planning and performance evaluations. A detailed application scenario for the rapid detection of hazardous spills reveals the potential for significant improvements in cost and effectiveness over existing approaches.</p>
<p>Impacts/Benefits of Implementation (actual, not anticipated)</p>	<p>Practitioners who utilize the framework and associated models to implement affordable remote sensing platforms will benefit from greater situational awareness to make informed decisions in transportation systems development, operations, and maintenance. Small and agile unmanned aircraft systems with hyperspectral imaging can see beyond the human ability. This new capability will reduce the cost of deploying hundreds of millions of dollars of traditional non-destructive evaluation equipment to achieve similar benefits. Finally, educators have expressed the desire to incorporate the products of this research into new curricula focused on Intelligent Transportation Systems.</p>
<p>Web Links</p> <ul style="list-style-type: none"> • Reports • Project Website 	<p>http://www.ugpti.org/resources/reports/details.php?id=853</p>