Impactful Resilient Infrastructure Science and Engineering (IRISE) - Project Scope of Work - (FY 2020-21 Annual Work Program)

SUMMARY PAGE

Project Title: Remote-Controlled Technology Assessment for Safer Pavement Construction and QA/QC

Person Submitting Proposal: Lev Khazanovich and Lucio Salles

Proposed Funding Period: 11/01/2020 - 11/01/2021

Project Duration: 12 months

Project Cost: $93,794 ($72,892: PennDOT, $20,902 Other IRISE Members)
Project Title: Remote-Controlled Technology Assessment for Safer Pavement Construction and QA/QC

Problem Statement: Pavement quality assurance/quality control (QA/QC) and other field testing and evaluation processes often require active workers’ presence at the construction site, thus increasing the potential for accidents due to traffic interaction. As work safety is one of the most important aspects of pavement construction and evaluation, there is a high demand for remote-controlled techniques and processes that would keep pavement workers away from direct harm while also assuring highly effective QA/QC and testing operations. Recent developments in drones, robotics, artificial intelligence, and other remote-controlled related areas offer opportunities for development and implementation of safe pavement QA/QC and field-testing processes that are also productive and cost-effective. Many transportation agencies and institutions in the United States and around the world have been conducting active research and development in this area. Some of the emerging technologies have been implemented or are ready for field trials while others still require additional research and development.

Project Objectives: We propose to identify and review new and emerging remote-controlled processes with focus on pavement QA/QC, testing and evaluation recently developed in the U.S. and abroad that can potentially be implemented by the IRISE members. The project will inform the IRISE members on the latest developments and facilitate implementation of the emerging pavement technologies in order to develop safer and more effective pavement construction and evaluation methodologies.

Project Scope: Firstly, we will conduct a literature/data review to determine what types of accidents are most frequently occurring at construction work zones. We will also identify and rank procedures of pavement construction and QA/QC that the IRISE members deem most important for improving safety optimization through remote controlling. We will, then, research remote-controlled technologies that can be implemented for IRISE needs. Examples of such technologies are the use of drones for evaluation of earthwork volumes, automated testing for asphalt air void content, and robotics for general pavement surveying. In addition, ultrasound and magnetic tomography technologies will be evaluated since they offer an opportunity for safe, efficient, and nondestructive determination of concrete and asphalt thicknesses and asphalt strength. In the proposed study, promising remote-controlled technologies will be identified and evaluated. The best alternatives will be selected. A workshop with the industry experts in development and implementation of pavement construction inspection with focus on the selected technologies will be organized. Priority will be given to technologies ready for implementations. Testing and additional development will be proposed for potential technologies not yet ready for implementation or in need of significant improvements.
**Task Statements:**

The objectives of this project will be realized through the completion of the following tasks:

**Task A: Remote-controlled technology scan for safe pavement QA/QC**

A literature/data review will be performed to determine the most frequent types of accidents occurring at construction site zones. A broad technology scan will be conducted to identify promising remote-controlled technologies for pavement construction, testing and evaluation. The search will be primarily focused on – but not limited to – improving safety and efficiency of QA/QC testing and field testing activities, such as earthwork quantity assessment, quality and uniformity of compaction of unbound and hot mix asphalt layers, quality of concrete placement and curing, etc. The vendors, developers, and transportation agencies developing and/or implementing these technologies will be identified. The task will also involve internal surveys and brainstorming sessions of IRISE members. The information collected from the literature will be shared with the IRISE team members and their help will be solicited to identify the current construction inspection, testing and evaluation processes, including QA/QC operations, that could potentially benefit from incorporating remote-controlled operations and gaging interest in further exploring the identified technologies. The technologies with the greatest potential for implementation and development for Pennsylvania conditions will be identified and selected for a more detailed analysis.

**Task B: Literature review and classification of selected remote-controlled technologies and processes**

The technologies selected in Task A will be evaluated by an in-depth review. The advantages and limitations of each of these technologies will be identified. This includes potential benefits of implementation, cost, readiness for implementation, and needs for further development and improvements. The research team will also identify major impedances for implementation or utilizing the full benefits of these technologies, such as needs for specification changes or modifications of pay factors. In addition to the literature review, the research team will contact the developers and/or vendors of these technologies. The transportation agencies that have conducted field trials or that are planning the implementation of these technologies in the near future will be identified and their testimonials will be collected. Based on the results of this evaluation, the technologies will be classified in the following groups:

- Technologies ready for immediate implementation;
- Technologies requiring addition development, but able to be implemented in the near future;
- Technologies promising significant benefits, but requiring substantial enhancement prior to implementation.

**Task C: Technology transfer workshops**

A technology transfer workshop will be proposed and organized for the IRISE community with focus on the technologies that are ready for implementation. The workshop will feature national and international leaders in development and implementation of automated and remote controlled technologies (tools and methods) for pavement condition evaluation and construction inspection. They will brief the IRISE on the latest improvements in the field, share their experiences in implementation of these technologies, and
provide their perspectives on the future trends in this area. In additional to the presentation, the workshop will have round table discussions.

Task D: Develop recommendation for implementation
In this task, the recommendations for short- and long-term improvements of safety and efficiency of construction inspection and related technologies and will be prepared. These recommendations will also include the information on the potential benefits and associated cost, as well as possible specification limits. A brainstorming meeting with the technical panel and other representatives of the IRISE members will be organized to confirm IRISE members’ interest in the technologies identified as promising. For the technologies ready for implementation by the IRISE members, technology transfer materials will be prepared. If feasible, provisional specifications will be recommended. For the technologies requiring addition development, the recommendations for additional technology improvements will be made. Potential partners for improvements of these technologies (researchers, vendors, and transportation agencies) will be identified.

Task E: Draft Final Report
A draft final report will be prepared to document the project activities, selected technologies and processes, findings and recommendations. For each technology, steps to implementation and potential cost savings and increase in safety will be discussed.

Task F: Final Report
A Final Report taking into consideration comments that were received on the Draft Final Report will be prepared.

Deliverables:
The following deliverables will be provided based on completion of the above tasks.

- **Deliverable #1** – A memo describing the IRISE survey, technology scan, and summary of the selected technologies for Task B, due 3-months after project initiation.
- **Deliverable #2** – A memo summarizing the literature review and classification of the selected technologies, due 6-months after the project initiation.
- **Deliverable #3** – A workshop with the industry experts.
- **Deliverable #4** – A memo report with the recommendations and technology transfer materials for technologies ready to use as well as the recommendation for additional improvements for promising technologies, due 10-months after project initiation.
- **Deliverable #5** – A draft final report, due 11-months after project initiation.
• **Deliverable #6** – Final report, due 12-months after project initiation.

**Key Personnel:**

*Principal Investigator*: Dr. Khazanovich is to provide the technical expertise, project management and oversight on all project activities.

*Other Key Staff*: Dr. Lucio Salles de Salles will assist the PI in project management and oversight on all project activities.

**Other Personnel:**

Two graduate students will contribute to the successful completion of this research effort as described below.

Grad Assistant 1 (TBN) is a graduate student who will assist in tasks A, B, C, E, and F.

Undergraduate student 1 (TBN) will assist in examples for Tasks A, B, C, and E.

**Proposed Person-Hours by Task:**

<table>
<thead>
<tr>
<th>Team Member</th>
<th>Task A</th>
<th>Task B</th>
<th>Task C</th>
<th>Task D</th>
<th>Task E</th>
<th>Task F</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Key Project Team Members, Estimated Hours Per Task</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dr. Lev Khazanovich, PI</td>
<td>16</td>
<td>16</td>
<td>16</td>
<td>16</td>
<td>16</td>
<td>8</td>
<td>88</td>
</tr>
<tr>
<td>Dr Lucio Salles</td>
<td>80</td>
<td>160</td>
<td>120</td>
<td>144</td>
<td>120</td>
<td>40</td>
<td>664</td>
</tr>
<tr>
<td>Dr. Lucio Salles</td>
<td>156</td>
<td>436</td>
<td>186</td>
<td>160</td>
<td>281</td>
<td>88</td>
<td>1307</td>
</tr>
<tr>
<td><strong>Other Project Team Members, Estimated Hours Per Task</strong></td>
<td>40</td>
<td>160</td>
<td>40</td>
<td>0</td>
<td>124</td>
<td>40</td>
<td>404</td>
</tr>
<tr>
<td>TBD, Grad Student</td>
<td>20</td>
<td>100</td>
<td>10</td>
<td>0</td>
<td>21</td>
<td>0</td>
<td>151</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>312</td>
<td>872</td>
<td>372</td>
<td>320</td>
<td>562</td>
<td>176</td>
<td>2614</td>
</tr>
</tbody>
</table>
**Schedule:**

<table>
<thead>
<tr>
<th>Months</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Task A: Remote-controlled technology scan for safe pavement QA/QC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Task B: Literature review and classification of selected remote-controlled technologies and processes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Task C: Technology transfer workshops</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Task D: Develop recommendation for implementation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Task E: Draft Final Report</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Task E: Final Report</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Budget:** The total project cost is $93,794

**Acknowledged By:**

Lev Khazanovich  
Principal Investigator  
09/16/2020