

2019 UDOT RESEARCH PROBLEM STATEMENT

*** Problem statement deadline is Feb. 6, 2019. Submit statements to UTRAC@utah.gov. ***

Title: Infrared thermography for ice/snow detection at high speed intersections

No. (Office Use): 19.03.07

Written By: Xuan (Peter) Zhu, Xianfeng Terry Yang

Organization: University of Utah **Email:**

xuan.peter.zhu@utah.edu **Phone:** (801)585-7961

Submitted By UDOT Employee: Jeff Williams

Email: jeffwilliams@utah.gov **Phone:** (801) 887-3735

UDOT Champion (if different):

Email: **Phone:**

Select ONE Subject Area Materials/Pavements Maintenance Traffic Mgmt/Safety Structures/Geotech
 Planning Perf Mgmt/Data Analytics Public Transportation Other

1. Describe the problem to be addressed:

Remote surface temperature and road surface state sensors have been implemented for road surface characterization. Their measurement area (at a distance of 32 feet) is typically limited within a circle with diameter of 59.1 inch for temperature sensor, or of 7.87 inch for surface state sensor. Generally, current commercial sensors output point measurement on temperature/surface state by averaging over small measurement area, in which important global features are missing. For instance, accumulated snow or ice nucleation beyond sensing area will not be identified or reported, but they can still impose threats of car accidents due to longer brake distance. Therefore, a full field mapping on ice/snow condition at high-speed roadway and intersections is highly desirable.

In this project, we aim to develop a road ice/snow detection algorithm, using infrared cameras, that can help assist the safety measure at high-speed intersections. The implementation of the detection system can help identify the high-risk spots which are affected by ices and snows. Particularly, the algorithm will adopt machine learning technique to distinguish ice and snow, which appear with similar temperatures but can lead to significant differences of road frictions.

2. Write the project objective (25 words or less):

This study will develop a large-area ice/snow detection system reinforced by machine learning algorithms and demonstrate its effectiveness through laboratory and field studies.

3. Explain why this research is important:

(In response, consider addressing specific UDOT goals, applicability in Utah or other states, etc.)

USDOT FHWA safety data from 2005 to 2014 reported an average of 1,836 deaths and 136,309 injuries per year due to snowy and icy roads. Icy and snowy roadway can significantly lengthen vehicle braking distances, and thereby induce risks on car crashing during winter season. Specifically, ice would affect road safe more severely compared to snow. Therefore, it is essential to perform snow plowing/de-icing service on time at high-risk roads and intersections (especially high-speed intersections). While current available remote surface temperature sensor and road surface state sensor provide point measurement on the road surface, an infrared thermography system is proposed to conduct full-field temperature measurement, along with robust ice/snow detection algorithm to make more informed decision on high-priority snow plowing/de-icing service zones.

4. List the major tasks:

1. Literature review on ice/snow detection on roadway
2. Identify the optimal data collection configurations and guidelines
3. Numerical simulation and experimental data collection
4. Supervised/unsupervised learning framework development and validation for robust ice/snow detection

5. List the expected deliverables (reports, manual, specification, design method, training, etc.):

1. Report on literature review, with a focus on data collection practice
2. Report on numerical and experimental studies, especially comparing with non-invasive road sensors
3. Report on supervised/unsupervised learning framework for improved accuracy on ice/snow detection

**6. Describe how the research results will be implemented:
(In response, consider addressing UDOT leader support, process or standard improvement, etc.)**

With successful implementation, it will provide an unprecedented full-field ice/snow mapping on high-speed roadways and intersections for accelerated data collection and decision making.

**7. Requested from UDOT: \$50,000
(or UTA for Public Transportation)**

Other/Matching Funds: \$0

Total Cost: \$50,000

8. Outline the proposed schedule, including start and major event dates:

Project month 4: Report on literature review and guideline submission
Project month 8: Report on numerical and experimental studies submission
Project month 12: Final report submission