2016 UDOT RESEARCH PROBLEM STATEMENT

***** Problem statement deadline is March 14, 2016. Submit statements to Tom Hales at tahales@utah.gov. ******

Title: Developing a Method to Identify Horizontal Curve Segments with Worst Crash Histories Using the HAF Algorithm

No. (office use): 16.03.02

Submitted By: Mitsuru Saito & Grant G. Schultz

Organization: Brigham Young University

Email: msaito@byu.edu, gschultz@byu.edu

Phone: 801-422-6326, 801-422-6332

UDOT Champion (suggested): Scott Jones

Select One Subject Area

- ☐ Materials/Pavements
- ☐ Maintenance
- ☒ Traffic Mgmt/Safety
- ☐ Preconstruction
- ☐ Planning
- ☐ Public Transportation

1. Describe the problem to be addressed.

As part of the Traffic Safety Data Research 2014-2015 funded by UDOT, an algorithm to identify horizontal curves, their beginning and ending points and their radii, named the Horizontal Alignment Finder (HAF), was developed (Cook, Saito and Schultz 2015). This algorithm takes advantage of the horizontal alignment data provided by UDOT's LiDAR-based asset management program. Horizontal curve data provided by the contractor of the program were so segmented and were not ready to be used for crash prediction model development of the study. To deal with this inaccuracy in horizontal curve data and provide horizontal alignment data necessary for crash prediction modeling, the HAF algorithm was developed. Properly identifying the beginning and ending points and radius is the most important step to use such data in crash prediction modeling and curve segment hot spots.

For that past several years, BYU researchers have worked on development of Bayesian-based crash prediction models, including the Utah Crash Prediction Model (UCPM) and the Utah Crash Severity Model (UCSM), which reflect uncertainty in the identification and prioritization of hot spots. These models will help the safety engineer rank the hot spots of crash occurrence using the advanced statistical concept. At the moment, however, there is no automated or semi-automated method to identify whether such hot spots identified by the models are part of curve segments of highways. The HAF algorithm can help the safety engineers to identify horizontal curve segments with high crash histories on state highways.

However, the HAF algorithm was originally developed for rural two-way two-lane highways. Hence, it is necessary to test the robustness of the HAF for other highway types, both rural and urban areas. The accuracy of the current HAF algorithm is approximately 85 percent and how to deal with the 15 percent error is an issue when it is directly applied to the entire state highway systems. At the moment, in order to identify beginning and ending points and radii of curved segments, the current HAF requires human intervention to make sure the algorithm has correctly identified the horizontal curve segments.

In this proposed study, we develop an efficient and effective method that will incorporate the outcome of the UCPM and UCSM, which will help the user to deal with the issue of 15 percent error rate of the current HAF algorithm. At the same time, we investigate ways to improve the HAF algorithm to increase its accuracy and make it more robust to be applied to any types of highways, such as multi-lane highways and freeways both in rural and urban highways.

Reference:

A.A. Cook, **M. Saito** and G.G. Schultz. "A Heuristic Approach for Identifying Horizontal Curves and Their Parameters Given LiDAR Point Cloud Data." *Journal of Transportation Research Board*, in press.

2. Explain why this research is important.

Impact of horizontal curves on crash occurrence can be finally analyzed due to the availability of LiDAR-based asset management survey data that UDOT periodically conducts. The methodology developed in this research will be an added feature to UCPM and UCSM. When a listing of horizontal curve segments with worst crash histories needs to be prepared, say annually, the methodology developed by this proposed study can be used. The results of this study will help UDOT safety engineers to prepare a listing of curve segments with high crash occurrence histories and help them program safety related improvements.

3. List the research objective(s):

1. Develop a methodology to identify curved segments of state highways with worst crash histories using the HAF algorithm.
2. Improve the accuracy of the HAF algorithm and make it useable for other highways other than rural two-lane two-way highway.
3. List horizontal curve segments of state highways with worst crash histories identified using the current or improved version along with their radii, superelevation, lane width, shoulder width, and any other data pertinent to curve segment safety analysis.

4. List the major tasks:

1. Convene kickoff meeting and discuss general directions of conducting the study given the conditions used for developing the current HAF algorithm.
2. Conduct literature review on curve identification algorithms – any new methods that have been developed and published since the development of the current version of HAF algorithm (to prepare the research assistant to become familiar with the research objectives) will be identified.
3. Review the coding of the HAF algorithm that was originally developed to analyze rural two-way, two-lane highways to evaluate if the current HAF algorithm can be applied to freeways and multiple highways without any modifications. If yes, conduct Task 5, followed by Task 6; if not, conduct Task 4 first followed by Task 5, followed by Task 6.
4. Make necessary modifications to the HAF algorithm to make it other types of state highways in both rural and urban areas than rural two-way two-lane highways and at the same time develop steps to improve the accuracy of the HAF algorithm. Once this has been completed, conduct Task 5, followed by Task 6.
5. Develop a method to identify curved segments of highways with worst crash histories given the outcome of the UCPM and UCSM using the HAF algorithm.
6. Execute the method developed in Task 5 to identify and list curve segments with worst crash histories.
7. Prepare a list of curved segments of the highways with worst crash histories for the given crash data years.
8. Preparation the final report

5. List the expected results:

1. List of curved segments with worst crash histories by highway class with their radiuses, based on the outcomes of hotspots identified by the current HAF algorithm.
2. An improved HAF algorithm and the methodology to identify curved highway segments with worst crash histories.
3. Final report and technical papers.

6. Describe how this research will be implemented.

The product of this research can be immediately implemented. For the given crash data, the research provide UDOT with a list of curved segments with worst crash histories. The method developed in this research can be applied in the future for the next set of crash data, every time such listing of curved segments with worst crash histories is needed in the future. This method will be an additional feature of the UCPM or UCSM. The research also provides insight in the effect of horizontal curvature on crash occurrence trends.

7. Requested from UDOT: $60,000 **Other/Matching Funds:** $ **Total Cost:** $60,000
(or UTA for Public Transportation)

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

It is recommended that this project begin in September 2016 with the initial tasks of finalizing the project scope of work and detailed cost estimates, followed with the literature review. It is anticipated that the project would take 16 to 18 months, including a 4-month report review period.