2016 UDOT RESEARCH PROBLEM STATEMENT

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

Title: A Data Fusion Approach for Extracting Highway Maintenance Features **No. (office use):** 16.02.05

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Select One Subject Area

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

1. Describe the problem to be addressed.

UDOT's Maintenance Feature Inventory primarily relies on the mobile LiDAR (Light Detection and Ranging) data collected by Mandli Communications. In a recent UDOT project, the research team at Utah State University (USU) investigated whether aerial LiDAR data can be a more cost-effective means than the mobile counterparts to identify highway features in areas where large-scale changes may have occurred, and a way to keep the feature inventory current. In the airborne data collection conducted by USU in 2015, both aerial LiDAR point cloud and high-resolution aerial imagery data were obtained. Four highway sections in Utah were covered: one section on I-84, two sections on I-15, and one section on US-191. Preliminary results show that aerial LiDAR is a promising technology in detecting some highway features, such as guardrails, medians, and light poles, as well as large road signs. In particular, aerial LiDAR data provide a view of the roadway from a different perspective. As a result, it allows features that may have been hidden from the mobile platform to be viewed and identified. For example, culverts and bridges can be effectively detected using aerial LiDAR data. However, due to the lower data resolution, smaller highway features, such as speed limit signs, are difficult to be identified accurately by aerial LiDAR data.

In the previous study, we also found that georeferenced high-resolution aerial imagery data can be used as an alternative means to identify highway features. Moreover, aerial imagery data are particularly suitable for developing automated procedures for highway feature extraction, which offers great potential in time and cost savings when updating the feature inventory. With the advent of Unmanned Aerial Vehicle (UAV) technology, high-resolution aerial images will be much more affordable and easily accessible for transportation agencies in the future. Although the current multispectral aerial image data set was collected with a fixed-wing plane, the methodology developed for the current data set will be readily transferable to any UAV-based data collection platform. However, aerial imagery data do not contain any elevation information, which is critical for identifying some highway features.

To achieve the maximum level of accuracy and completeness, it is imperative to develop a data fusion approach that utilizes both aerial LiDAR and aerial imagery data to compensate for the limitations of both methods. Also, automated feature extraction is an important aspect of large scale applications. Therefore, we propose to conduct a study to take advantage of the unique data set obtained from the recent UDOT study by developing an efficient workflow for automatic extraction of highway maintenance features.

2. Explain why this research is important.

Most studies investigating highway feature extraction in the literature focus on a single source of data, e.g., aerial LiDAR or imagery data. Based on our previous studies, we found that each data collection method has its advantages and limitations. The most effective approach to achieve the maximum level of accuracy and completeness is probably to combine data collected from multiple sources. The data set obtained from our recent UDOT study contains both aerial LiDAR and aerial imagery data, and provides us with a unique opportunity to pursue this research direction.

3. List the research objective(s):

1. Develop an efficient workflow that utilizes both aerial LiDAR and aerial imagery data to compensate for the limitations of both methods
2. Propose an automated feature extraction procedure for large scale applications

4. List the major tasks:

1. Conduct a comprehensive literature review of highway feature extraction using aerial LiDAR and imagery data
2. Develop an image processing algorithm to process the high-resolution aerial imagery data
3. Propose a data fusion procedure that combines the advantages of both data sets
4. Evaluate the effectiveness of the data fusion approach by comparing the accuracy and completeness of highway features with the previous study.

5. List the expected results:

1. An efficient workflow that utilizes both aerial LiDAR and aerial imagery data
2. An automated feature extraction procedure for large scale applications

6. Describe how this research will be implemented.

Results from this research are expected to help UDOT in updating maintenance feature inventory more efficiently and more effectively. It will provide additional highway features that are not covered by current data collection methods, such as light poles and culverts. Ultimately, the study will help UDOT better use limited maintenance budgets for asset management.

7. Requested from UDOT: $50,000 **Other/Matching Funds:** $50,000 **Total Cost:** $100,000
(or UTA for Public Transportation)

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

The proposed research will be carried out in a period of 12 months with an estimated start date of July 2016. The project will follow the schedule below:

- Literature review: 2 months.
- Image processing algorithm development: 3 months.
- Data fusion of aerial LiDAR and imagery data: 3 months.
- Performance evaluation: 2 months.
- Report writing: 2 months.