2019 UDOT RESEARCH PROBLEM STATEMENT

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

Title: Assessing Close-Range Photogrammetry as an Alternative for LiDAR Technology at different UDOT Divisions
No. (Office Use): 19.06.01

Written By: Abbas Rashidi **Organization:** University of Utah **Email:** abbas.rashidi@utah.edu **Phone:** 801.581.3155

Submitted By UDOT Employee: Abdul Wakil **Email:** awakil@utah.gov **Phone:** 801.633.1034

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:

LiDAR (Light Detection and Ranging) is a mature and efficient technology currently used by various divisions of UDOT (asset management, traffic control, pavement, construction, etc.). Some of the current applications of LiDAR at UDOT (as well as other DOTs) include: asset management for roads and buildings, quality control of pavements and other infrastructure surfaces, 3D as-built documentation of constructed facilities, structural health monitoring, etc. While effective, there are some limitations in using LiDAR as a common spatial sensing tool: The technology is pretty expensive; certain levels of expertise and training are required to use LiDAR scanners for data collection and processing results, and finally it might not be available for all units and individuals.

Close-range photogrammetry is another emerging technology that could be considered as a potential alternative for LiDAR scanning devices. The technology is based on processing images and videos simply captured by off-the-shelf cameras or smartphones. Unlike LiDAR, close-range photogrammetry is very cost effective, simple, and easy-to-use. There is no need for extra hardware settings and almost everyone has a smartphone or a digital camera, so collecting and processing data is very feasible.

Within the last decade, several software packages in the area of close-range photogrammetry have been devised for research, education, and commercial purposes. Some examples of those packages are Autodesk Recap; Agisoft Photoscan; 3DF Zephyr; VisualSFM; and Photomodeler. The outputs of both LiDAR and Photogrammteric technologies are in the form of dense point clouds. While the output of the two methods are similar, there might be differences in levels of accuracy, quality and density of the generated point clouds. In addition, each method might work differently under certain conditions such as scanning shiny and reflective objects, sharp edges, etc.

Despite the increasing popularity of close-range photogrammetry, it has not been considered as a practical 3D scanning tool by UDOT divisions yet. This project aims to address this important issue by exploring the feasibility of using this technology for various applications currently handled by LiDAR at UDOT. To achieve the project goals, at least four applications of LiDAR at UDOT will be considered: 1) Highway assets management; 2) Pavement assessment; 3) As-built documentation of buildings; and 4) Structural health monitoring and maintenance purposes. For each application, 1-2 case studies will be selected and the corresponding scenes will be scanned using different photogrammetric software packages. The generated point clouds will be compared with point clouds of the same scenes produced by laser scanners. A couple of comparison metrics such as accuracy, density, quality (for edges, corners, etc.), ease-of-use, processing and post processing time and level of difficulty, etc. will be set for comparison purposes and specific areas in which photogrammetry could be considered as an alternative solution for LiDAR technology will be identified.

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

To evaluate the feasibility of using close range photogrammetry as an alternative for LiDAR technology at different UDOT divisions.

3. Explain why this research is important:
(In response, consider addressing specific UDOT goals, applicability in Utah or other states, etc.)

UDOT is a pioneer DOT in terms of implementing emerging technologies that are cost-effective, easy-to-use, and efficient. Currently, several UDOT divisions use LiDAR as a major scanning tool for capturing spatial information of built infrastructure. Depending on specific applications, the expected levels of accuracy and density of the generated point clouds are different among various UDOT divisions. For applications such as “assessing flatness of pavement surfaces”, accuracy is a major concern, however, for some other applications including highways and roads assets management, less accurate results might also be acceptable. For some of these applications, close-range photogrammetry could be considered as cheaper, more accessible, and easier-to-use solution for capturing 3D information of objects and scenes.

This project is an attempt to evaluate quality, density, and accuracy of generated point clouds by photogrammetric software packages and further assess potential applications for this technology within different UDOT divisions. The PI has thorough knowledge and technical background on processing images and videos for 3D modeling of civil infrastructure. If successful, the project will provide an appealing alternative solutions for laser scanners at certain UDOT divisions. In addition, the results of the project could be used by contractors and consultants who work with UDOT and need to capture spatial information of built environment.

4. List the major tasks:

1. Conducting a literature review and preparing a list of available photogrammetric software packages
2. Interacting with different divisions of UDOT who currently use LiDAR technology and specifying their expected levels of accuracy, density, and quality from point clouds
3. Identifying specific case study projects
4. Collecting necessary data, conducting experiments and generating point clouds using various photogrammetric software packages
5. Data analysis, post processing generated point clouds, and evaluating results
6. Second round of experiments, data collections, and processing (if necessary)
7. Draft report complete
8. Report revision

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

1. A set of generated point clouds by using different photogrammetric software packages for different case study projects
2. A final report including the results of comparison studies

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

Results of this project could be used by various UDOT divisions and employees as a road map for using close-range photogrammetry as an alternative technology for LiDAR. As indicated earlier, several divisions of UDOT including construction, pavement, highway and road asset management, maintenance, and structures could be benefited from results of this project. Other that UDOT divisions and employees, results could be also implemented by contractors and consultants who work on UDOT projects and need to scan projects and collect spatial information. Necessary guidelines about using different photogrammetric software packages will also be provided.

7. Requested from UDOT: $30,000 **Other/Matching Funds:** $10,000 **Total Cost:** $40,000
(or UTA for Public Transportation)

8. Outline the proposed schedule, including start and major event dates:
The project is scheduled for one year. The following list summarizes major dates for events and milestones:

Project start date: **August 1, 2019**
Conducting a literature review and preparing a list of available photogrammetric software packages: **August & September 2019**
Interacting with different divisions of UDOT who currently use LiDAR technology and specifying their expected levels of accuracy, density, and quality from point clouds : **September–October 2019**
Identifying specific case study projects: **October 2019**
Collecting necessary data, conducting experiments and generating point clouds using various photogrammetric software packages: **October 2019–February 2020**
Data analysis, post processing generated point clouds and evaluating results: **December 2019–March 2020**
Second round of experiments, data collections, and processing (if necessary): **February 2019–April 2020**
Draft report complete: **May 2020**
Report revision: **June & July 2020**