Measurement Device Calibration with Light detection and Ranging and CFD

Scoping Summary Research Project #5505

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As described in the research agreement for S&T Project ID 5505 the objectives of this scoping project was to 1) conduct a literature review to determine the best practices in LiDAR and photogrametry to obtain accurate 3D computer models of existing or new structures. 2) Determine the accuracy of photogrametry and LiDAR in creating detailed 3D models in laboratory and field conditions. 3) Contact and develop personal relationships at Reclamation, State, University and Consulting facilities that are willing to provide in kind services with their LiDAR equipment and software to create 3D models. 4) Contact area offices throughout Reclamation and other agencies (USGS, state and county water distribution, NRCS) to determine sites that are in major need of correcting or obtaining accurate flow measurement

Several things were learned during this scoping project. First, the literature review uncovered a mass of information regarding both LiDAR and photogrammetry and their use to create 3D models individually and together. In reviewing the abundance of articles, it was apparent that best practices and accuracies were specific and unique to the equipment, manufacturer and programs selected. To better utilize project funds completing a literature review on all the available equipment was abandoned until the method and specific equipment to be used were determined. As such, research engineers set out to develop personal relationships at Reclamation, state, university and consulting facilities that are willing to provide in kind services with their LiDAR or photogrammetric equipment and software to create 3D models.

After exhausting several efforts no consulting, state or university facilities were identified as willing to provide in-kind services for collecting photogrammetric or LiDAR data and creating the associated 3D models. Reasons were made that if companies provided this type of service for free it would be unfair to their other clients that are paying for similar services. Considering this, researchers focused on in house (TSC and Reclamation wide) capabilities for acquiring as-built dimensions and construction of 3D solid models.

Three main offices were identified as having the capabilities to generate accurate as-built 3D models using both LiDAR and photogrammetry. The first two offices are the MP-220 and

LC-6520 which have terrestrial LiDAR scanners (Leica ScanStation) as well as point cloud processing software (Cyclone). The ScanStation hardware is capable of generating point cloud data accurate to 6 mm in position and 4 mm in distance. The Cyclone software provides a complete and automated set of tools for accurately modeling 3D point clouds as CAD geometry or as meshes. The third office is the Technical Service Center (TSC) in Denver which has high-end photogrammetric instrumentation including cameras, calibration sticks, poles, flashes and 3DM Analyst software. The hardware allows high quality sets of images to be taken of the desired object. 3DM Analyst software matches the pixels from image sets and computes a point cloud and DTM of the object that can be imported into CAD software to create solid 3D models.

Even though the MP-220, LC-6250 and TSC all have the capabilities to create the necessary 3D models, researchers determined that using photogrammetry would be easier to coordinate modeling efforts considering that the equipment and software are located in the researcher's office and are readily available. In addition the MP-220 and LC-6250 offices are both fee for service organizations that require additional funds to perform the scanning and post processing. Once the in-house capability was identified, researchers worked to generate trial 3D models and import them into Flow3D. After several attempts to import the raw 3D point cloud into Flow3D, researchers determined that it was necessary to filter the point cloud data generated using photogrammetry and create actual solid models in CAD before importing. Among other problems, Flow3D was unable to process every point in the raw data and down sampled between random points resulting in large errors. However, if point cloud data were converted to a solid model in CAD prior to importing it into the CFD software, errors seemed to be small and the importing process was seamless.

As part of this scoping work a quick start guide was developed for creating accurate 3D point clouds using photogrammetry and the 3D analyst software. However these quick start guides are for users of the software who have been trained but only use the software sparingly.

In addition to the above lessoned learned during this scoping project research engineers continually looked for sites throughout reclamation and other projects that would benefit from creating as-built rating curves of flow measurement devices. Several sites were identified that would be ideal locations for creating new ratings. The sites identified include; a non-standard Parshall flume below Calamus Reservoir near Burwell Nebraska, a non-standard Parshall flume measuring the mixed flow discharge from the USBR desalination plant near Yuma AZ, and a flume in the FRICO irrigation district that has poor approach hydraulics. Although no confirmed dates for making site visits and collecting data have been arranged Mike Wells who manages the Calamus Reservoir was excited to have accurate ratings for his non-standard Parshall flume.

In addition to identifying the several sites that would benefit from accurate ratings created using CFD modeling several individuals were identified that were willing to aid in the generation of as-built geometries and solid 3D CAD models. Among those interested in helping are Dale Lentz and Rudy Campbell from the Hydraulic Investigations group of the TSC. Tom

Gill, another TSC employee, indicated that he knew of several individuals who would be excited to see this type of service be provided by the TSC. If photogrammetry proves to be problematic at a specific sight, Alejandro Orosco from the LC region and Mark Morberg from the MP region both indicated that they were willing to collect LiDAR data if provided with adequate funding.

To help aid area offices and Reclamation water users have accurate flow measurements, researchers have proposed to develop updated ratings of three sites throughout Reclamation. The proposed sites were selected randomly and will help prove the technology works and provide a means for marketing this service to other areas and projects. The detailed future plans can be found in a separate Science and Technology Research proposal ID 4467.