DRISI

Caltrans Division of Research, Innovation and System Information

Research Notes

Development of Data Collection Systems for Large Scale Particle Image Velocimetry (LSPIV)

A new method to measure the discharge, collect flow velocity (magnitude and direction) information, and estimate channel profiles.

Maintenance

JULY 2020

Project Title:
Development of Large Scale Particle Image Velocimetry (LSPIV) Data Collection Systems

Task Number: 3183

Start Date: October 1, 2018

Completion Date: June 30, 2021

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WHAT IS THE NEED?

Currently, California Department of Transportation (Caltrans) measures river surface flow using an acoustic Doppler sensor mounted on a manned boat. Launching a manned boat in flood conditions is time consuming and often unfeasible due to considerable risk to workers. To improve data collecting capabilities especially during high flow events, the research team will develop data collection systems to support Large Scale Particle Image Velocimetry (LSPIV) studies.

LSPIV studies measure surface water flow velocity, which is used in conjunction with riverbed topography to determine the river discharge, collect flow velocity (magnitude and direction) information, and estimate channel profiles. This new method needs to provide valid information over a large spatial extent (300 – 500 feet) and be quick to use, easily deployable, and safe for Caltrans personnel.

WHAT ARE WE DOING?

The researchers at the Advanced Highway Maintenance and Construction Technology Research Center will examine the hardware, software, and deployment options to best implement current LSPIV technology for estimating flood flows to meet Caltrans' hydraulic needs.

Specifically, the research team will investigate the most appropriate camera type, infrared (IR) and commercial off-the-shelf (COTS), the required camera accessories, post-processing LSPIV software, and the hardware needed for deploying the system using an unmanned aerial vehicle (UAV). This research will also include procurement of a multi-beam echosounder for bathymetric surveys to determine channel profile for flow rate

modeling.

WHAT IS OUR GOAL?

The goal is to review LSPIV-related COTS hardware. The research team will study the best practices for UAV-based LSPIV, LSPIV-related COTS systems, the key components such as UAV, thermal imaging, and red-green-blue cameras, and evaluate LSPIV post-processing software of the field testing data. The researchers will compile a summary of the findings regarding COTS systems in the final report and present it to the project panel for consideration.

WHAT IS THE BENEFIT?

The LSPIV system will allow Caltrans personnel to rapidly and safely collect important flow information during high flow events, which can assist the hydraulic engineers to accurately evaluate the existing and new bridges.

With improved evaluations, the new construction design could be more cost effective and safe for the motoring public. Additionally, eliminating staff from operating a boat in high flows improves worker safety and increases the number of sites that can be monitored in a day during flood conditions.

WHAT IS THE PROGRESS TO DATE?

- Evaluated available LSPIV software.
- Modified hardware (cabling and mounting) for the Pico Miniature Multibeam Echo Sounder (PicoMBES), which is used on large Caltrans dive boats. The system was tested on a small boat in Napa California on 02/05/2020.

Due to unforeseen circumstances affecting the schedule, the project completion date has been extended to June 30, 2021.

Next Steps:

- The research will repeat field testing and evaluation of the Seafloor Systems PicoMBES on Caltrans boats at the new Bay Bridge.
- Experiments will be designed for LSPIV UAV testing and data post-processing
- Available LSPIV softwar will be evaluated
- UAV pilot testing is planned to be conducted by the end of 2020

IMAGES

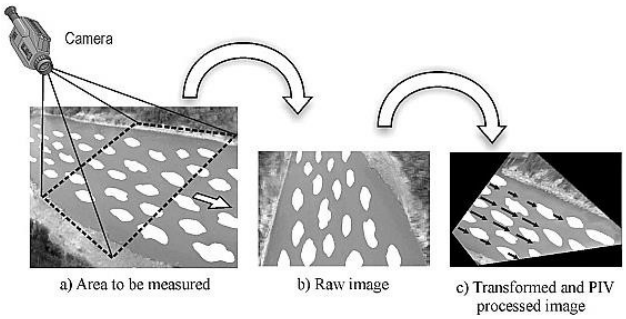

Figure 1: LSPIV measurement sequence

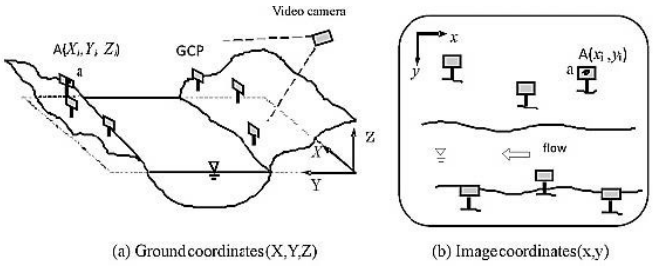

Figure 2: Relationship between the camera and field coordinate systems

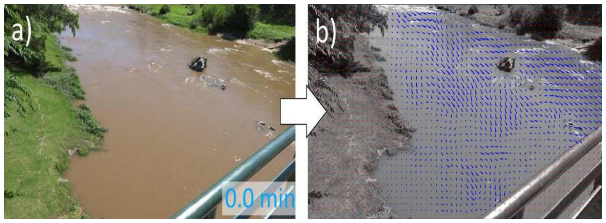

Figure 3: Results of LSPIV analysis process for a flash-flood event on a river.
a) Snapshot at the beginning of the event
b) Surface flow velocity distribution from LSPIV processing. The blue arrows indicate the surface flow direction and magnitude