Observation and Analysis of Particle Image Velocimetry

Ethan Makuck, Mechanical Engineering, Junior

Maria-Isabel Carnasciali, Ph.D., Assistant Professor, Mechanical Engineering

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Introduction

The purpose of the work and research I conducted during SURF 2014 program was to evaluate the capability of the THERMOFLOW™ and FLOWCOACH™ setups and the associated FLOWEX™ software recently acquired by the Mechanical Engineering Department at UNH.

The experimental setups enabled the visualization and analysis of fluid flows over various objects subjected for testing. This measurement technique is known as Particle Imaging Velocimetry (PIV) and is a useful tool to investigate complex flows, for instance, those which arise in models of artificial organs, MEMS devices, over wind turbines and many other applications.

Methodology

The methods used during this research consisted of mapping out the quality of measurements obtained from the PIV setups dependent on geometry and patterns of the testing features. This was done by seeding the test fluid with very small neutrally buoyant particles known as microspheres and tracking their displacement with cameras and lighting. The samples tested in the FLOWCOACH™ were printed out of ABS plastic using the uPrint® 3-D printer; dimensional accuracy was measured using the Galileo™ AV metrology system – both of which are accessible in Buckman 225. For the THERMOFLOW™ setup, samples must be made of a heat resistant material and as such will be CNC machined at the Mechanical Engineering Machine Shop.

PIV Process – Excerpt of Developed Manual

Setup
- Make all necessary connections to apparatus, computer, and network.
- Add seeding medium to fluid.

Software
- Boot up FLOWEX software.
- Set up *General*, *PIV*, and *PIV* parameters according to machine used.

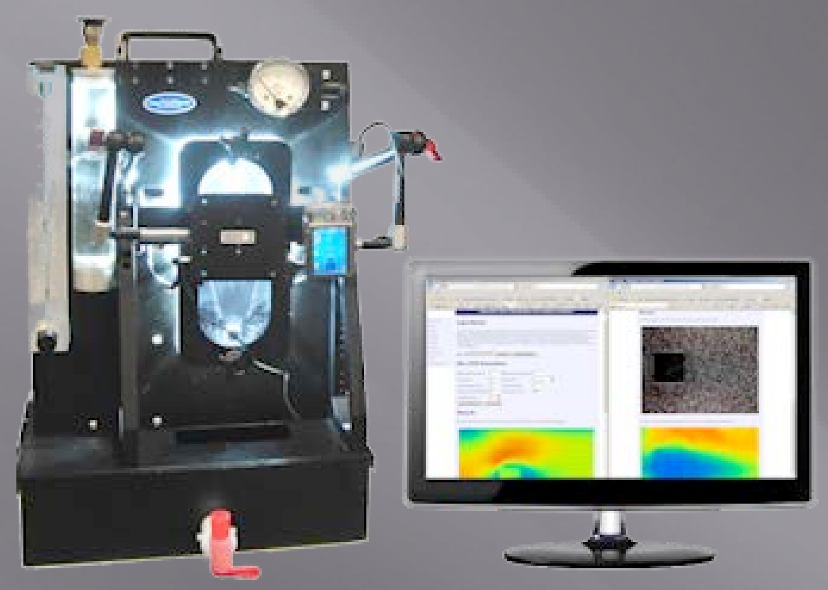
Camera Setup
- Choose USB or PIV camera.
- Adjust camera settings to clear image.
- Adjust frame rate and *dt* settings.

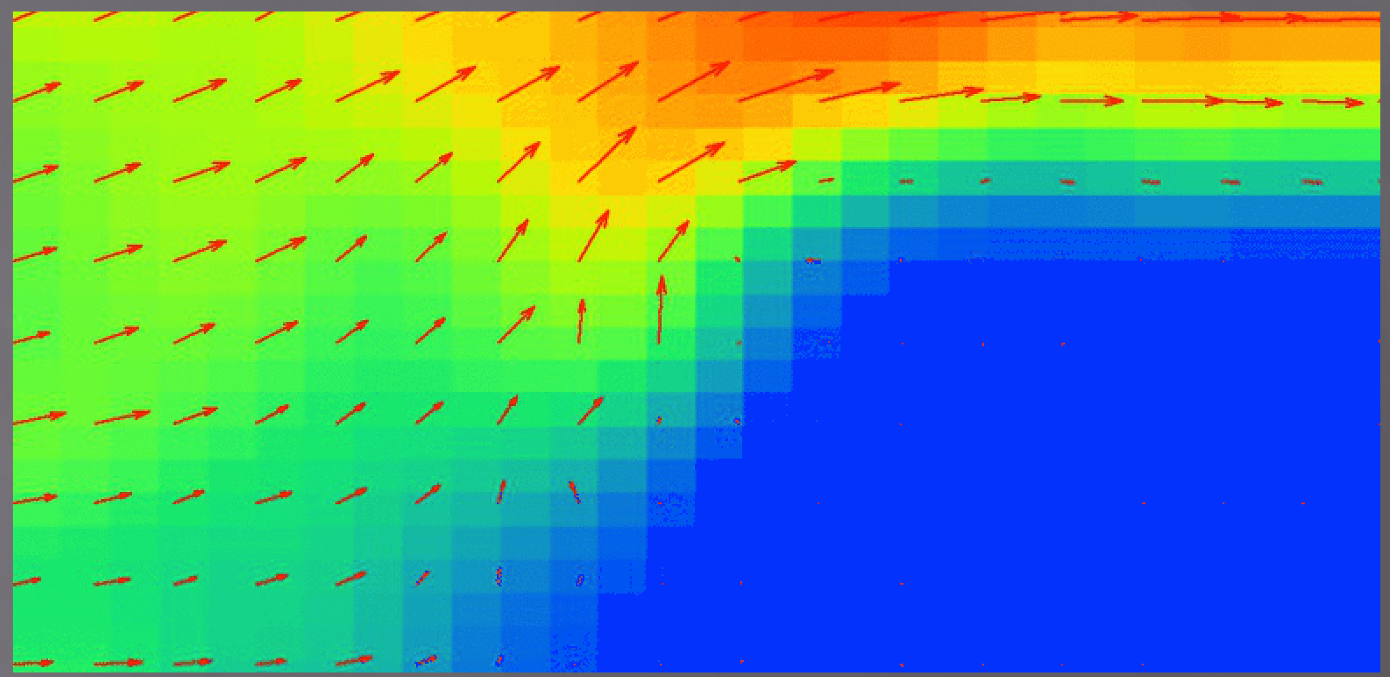
Record
- Run apparatus.
- Tailor camera settings and frame rate.
- Record video.
- View preview.

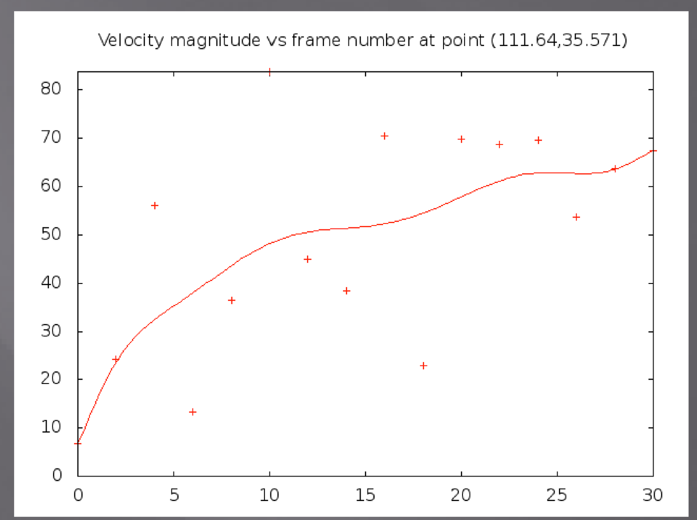
Analyze PIV
- Adjust parameters:
  - Pre-Process.
  - PIV Parameters.
  - Post-Process
- View PIV results and data.

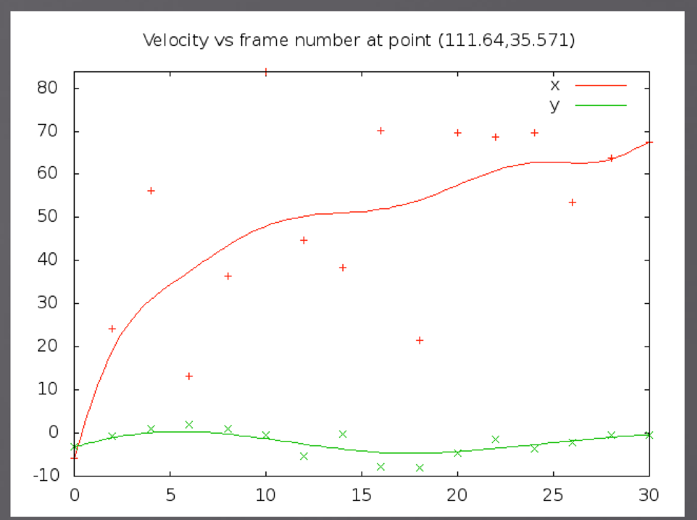
Results

Seen below are sample results of the PIV process after multiple trials of parameter adjustments needed to tailor the calculations to the unique geometry, fluid properties, lighting conditions, and camera settings chosen for FLOWCOACH™ testing. Vector Fields with corresponding Velocity vs. Frame graphs were produced.









Conclusions

It became clear during research that it was critical to apply the correct settings in both the software and camera parameters to obtain consistent and accurate results. Much of the research consisted of running tests changing one parameter at a time to see the deviation in results computed by the PIV software. The capabilities of the equipment and software used were seen to the extent the SURF time frame allowed for.

Future Work

There is the potential for continuation of the research. Various samples will be designed and built using the same processes to gain further data. Other elements will be added as well, including the addition of heat to the flow inserts in the THERMOFLOW™ device. The use of lasers and strobes synchronized with the camera will also be an added feature. Finally, a brief instructional operator's manual will be created for the setup of the equipment and provided to future users in laboratory or classroom environment.

Literature Cited

- Interactive Flow Studies. "THERMOFLOW Heat Transfer and Fluid Mechanics." Interactive Flow Studies Corporation, 2012. 1-6. Print.
- *IFS – Interactive Flow Studies*. Interactive Flow Studies Corporation, 2014. Web. 4. March 2014. <http://www.interactiveflows.com/>

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