

Langley
Research
Center

Pressure Sensitive Paint and Unitary Wind Tunnel Data Acquisition System

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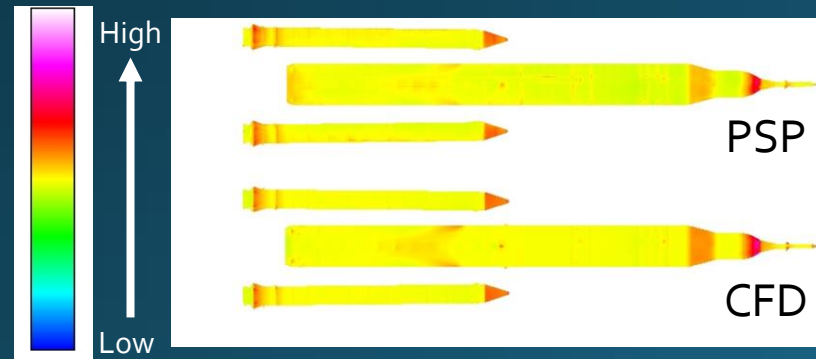


Pressure Sensitive Paint (PSP)

Pressure sensitive paint, or PSP, is a technique used to determine the immediate pressure over an entire surface as opposed to single point pressure gauges. As luminescent molecules in this paint absorb photons and transition into an excited state, they naturally seek to return to their ground state by releasing a photon of a longer wavelength in a radiative process. When reacting with oxygen, the transition is a non-radiative process called collisional quenching. This technique is used to determine the pressure of an entire surface that reflects the partial pressure of oxygen in its environment as oxygen is a key component of air.

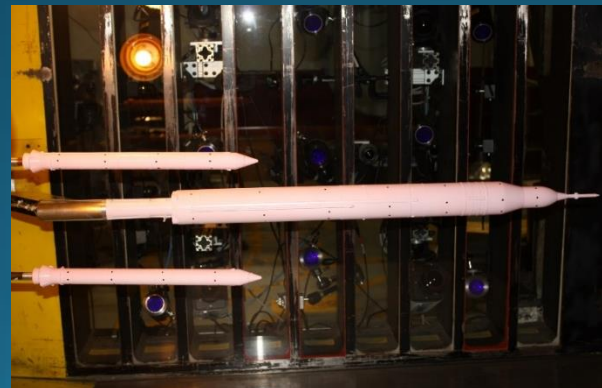
Eight cameras are used to capture images of painted, luminescent models in wind tunnels to determine the pressures at any point on the surface at a given time. The below images show the measured pressures using PSP and the calculated pressures determined by its Computational Fluid Dynamics (CFD). The PSP data was projected from the multiple cameras onto a grid surface to match the CFD.

Pressure



Project Description and Objective

All previous PSP testing done in the Unitary Plan Wind Tunnel (UPWT) have required a significant amount of manual operation of the system. This has resulted in decreased testing efficiency and precluded the ability to provide near real-time data analysis to the customer. The overall goal of this project is to integrate the PSP data acquisition system into the supersonic UPWT data acquisition system (DAS) and create an adaptive software platform from which PSP data acquisition can be triggered by the tunnel and critical testing conditions can be recorded in real time for rapid analysis of the PSP data. This analysis includes the mapping of up to eight camera views onto a surface grid for analysis and converting to pressure using parameters supplied by the DAS. To fully implement this solution, communication must first be established between the Unitary DAS and the PSP DAS. This will be done by employing multiple scripts written in Python and C++ and implemented on a Linux cluster. These will be demonstrated and refined on an upcoming test (December 2018), and the successful completion will result in the ability to have automatic collection of PSP images and near real-time analysis capabilities.



Personal Contribution

- Taught the requirements for PSP analysis on the Linux cluster by processing data acquired using 8 cameras
- In order to activate the cameras around Unitary during testing, a code was developed to communicate between the Unitary DAS and the cluster.
- Time was spent learning Python so the original code for acquiring PSP data manually could be modified. This modification involved removing the user interface and having it run continuously while interfaced to the Unitary DAS, supplying the PSP DAS with the required information for data acquisition.
- Code was also developed and tested that will scan the data parameters collected by the UPWT DAS and convert it to the necessary format for PSP data analysis.

Problems Encountered

During this project, the main issue encountered was the establishment of the communication protocol between the UPWT DAS and the PSP DAS. Initial laboratory testing was accomplished using a "simulator" program provided by the Unitary. However, the actual communication protocols required for the UPWT had some significant differences from the simulator. Failure to resolve this problem would have greatly hampered the implementation of the needed upgrade, and would have virtually eliminated the ability to provide any real-time feedback to the customer.

Outcomes and Future Plans

Over the course of this project, I have learned about the importance and complexity about data acquisition as I came in focused only on analysis. Not only have I learned specific skills in coding, but the real world application of coding and the problem solving skills necessary to resolve issues and adapt to unforeseen issues.

I would like to continue pursuing a career at NASA through pathway internships to become a civil servant after graduating with a B.S. in Chemical Engineering or pursuing a higher degree in Materials Science.