Development of a "Digital Bridge" Thermal Anemometer for Turbulence Measurements, Phase II Project

SBIR/STTR Programs | Space Technology Mission Directorate (STMD)

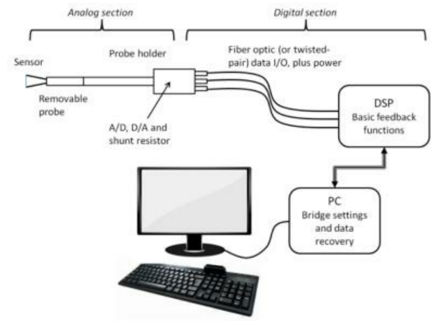
ABSTRACT

Thermal anemometry (a.k.a. hot-wire anemometry) has been a key experimental technique in fluid mechanics for many decades. Due to the small physical size and high frequency response of the sensors (resulting in excellent spatial and temporal resolution), the technique has been widely used for studies of turbulent flows. Even with the advent of nonintrusive techniques such as Laser Doppler Velocimetry (LDV) and Particle Image Velocimetry (PIV), hot wire anemometry is uniquely capable of extremely high frequency response and fine spatial resolution measurements. ViGYAN has demonstrated a fundamental change to the anemometer configuration, with two related aspects. First, the circuitry to power the sensor and establish its operating point is packaged immediately adjacent to the sensor, i.e. in the typical probe holder, removing the effect of the cable connecting the sensor to an external anemometer. Second, modern analog-digital conversion hardware has been employed to the maximum extent possible, including directly driving the sensor. Data transmission is fully digital, immune to environmental variations or electrical noise. Based on these results, the Phase II work will deploy this "Digital Bridge" system using a Digital Signal Processing (DSP) device connected via fiber-optic cable the miniaturized "probe holder" electronics. The DSP will be controlled by a generic PC with software to control the system and acquire/store data. A production-ready version will be developed and delivered; facilities, expertise, and resources are available to fabricate and deliver production units at the conclusion of Phase II. Production designs for ruggedized units will also be done for use in wind tunnels that operate at higher dynamic pressures and extreme temperatures.

ANTICIPATED BENEFITS

To NASA funded missions:

Potential NASA Commercial Applications: A primary objective of the Digital Bridge design is, of course, to improve the



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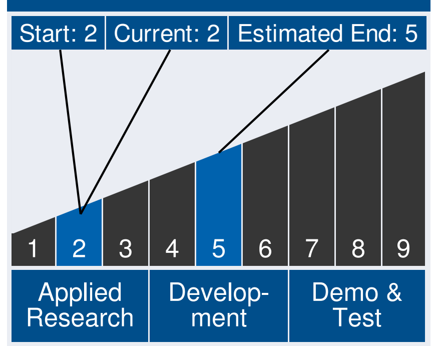
Technology Maturity



Management Team

Program Executives:

- Joseph Grant
- Laguduva Kubendran

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performance of thermal anemometry in demanding aerospace applications, particularly wind tunnels. Any NASA wind tunnel, from small low-speed facilities to highly complex installations such as the National Transonic Facility (NTF) at NASA LaRC are candidates for this technology. The miniaturized, localized, and substantially digitized electronics package could be used for acquisition and processing of signals from hot film arrays, often used for boundary layer studies in both wind tunnel and flight environments. Other potential research applications could include planetary atmosphere measurements. One of the key issues here has been the large number of sensors, but the digital bridge approach lends itself to effective multiplexing of a large number of sensors across a smaller number of anemometers. Such an approach would allow for the use of hot wire sensors analogous to the shift to electronically scanned pressure (ESP) transducers widely used in wind tunnels.

To the commercial space industry:

Potential Non-NASA Commercial Applications: There are many commercial and educational wind tunnels in the U.S. and around the world that could use the Digital Bridge. Looking to broader markets, the majority of air mass flow sensors for automotive applications rely on thermal anemometry in one way or another. The monitoring and control of heating, ventilation, and air conditioning (HVAC) systems is also done with thermal anemometry systems. A digital bridge approach will offer improved environmental tolerance and greater reliability for both applications, with its digital outputs being easily integrated into the overall automotive or industrial control systems used. There are a number of applications for hot wire sensors in medical instrumentation . It should be noted that a requirement in many of these systems is electrical isolation; our use of fiber optic instrumentation cables would be very useful in such environments.

Management Team *(cont.)*

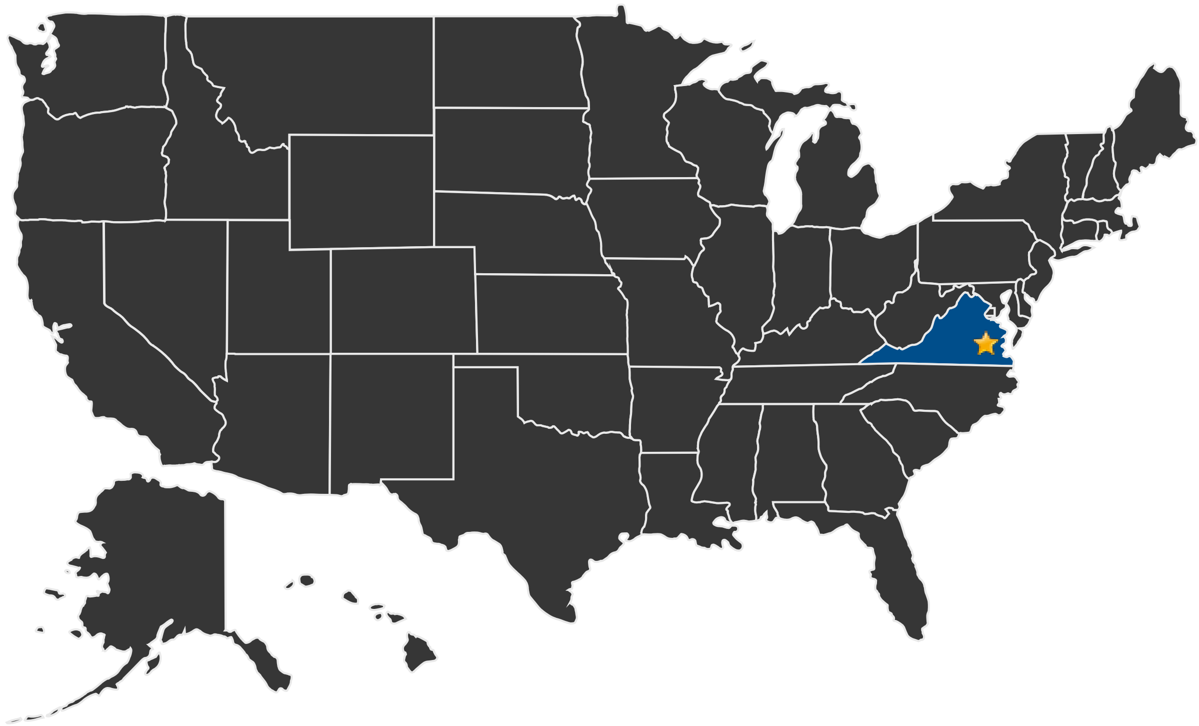
Program Manager:
- Carlos Torrez

Principal Investigator:
- Amber Favaregh

Technology Areas

Secondary Technology Area:
Science Instruments, Observatories, and Sensor Systems (TA 8)
└ In-Situ Instruments and Sensors (TA 8.3)

U.S. WORK LOCATIONS AND KEY PARTNERS



U.S. States With Work

Lead Center:
Langley Research Center

Other Organizations Performing Work:

- Vigyan, Inc. (Hampton, VA)

PROJECT LIBRARY

Presentations

- Briefing Chart
  - (http://techport.nasa.gov:80/file/18124)

DETAILS FOR TECHNOLOGY 1

Technology Title

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