*Vivace*Flow Prototype Development Progress Report

Project Timeline

The VeloStream Technologies Team has, over the past eight weeks, progressed through stage one and most of stage two in project development of the *Vivace*Flow speed measurement probe. Stage one consisted of the design stage, in which the development of the functional and design specifications of the device have been set. Progression into stage two occurred approximately two weeks later than planned due to an unanticipated increase in research required for the design stage of the project. Stage two consists of the following tasks:

- assembly of the mechanical body of the *Piccolo*Probe,
- integration of the sensing element into the body of the *Piccolo*Probe,
- design of the software for logging and displaying data in the *Unisca*Suite,
- design of the signal processing software in the *Unisca*Suite,
- assembly of the probe controller components in the *Genio*Box and,
- design of the controller software in the Microcontroller.

Currently, at the start of week nine, action items one, two, three, four and six from stage two are almost complete. The details of the current stage of these items are presented in more detail below. We have also begun stage three of our development. Integration between the UniscaSuite and the microcontroller in the GenioBox has begun. Assembly of the remainder of the GenioBox is still under way. Its integration with the Microcontroller will begin once the assembly is complete and the problem with the microcontroller (explained below) has been resolved. Integration between the sensing element of the PiccoloProbe and the controller is being developed concurrently with the assembly of the components.

Budget

To date we have spent approximately $411 in costs for the development of the mechanical portion of the PiccoloProbe, the Microcontroller for the GenioBox, an assortment of thermistor types and electronic components for the flow mechanism research, and all the equipment needed for the building of the power supplies. Our prototype development fund from Kardium Inc., of $1000, has covered the cost of these components.

*Genio*Box Progress

Microcontroller

Overall, Arduino MEGA2560 has all the features that satisfied the requirements such as serial connection to PC, 100 Hz sampling speed, analog-to-digital converters (ADC). All features have been individually tested and verified to work as expected. The problem comes during integration when ADC ports are connected to another circuit. The voltages acquired from ADCs do not match the voltage readings from voltmeter. The microcontroller's ports might be damaged.

Power Supplies

From the requirements, 20 volts and 9 volts power supplies are needed. Both 20V and 9V are converted from a single 24V AC adapter. The 20V power supply has been developed using a voltage regulator, LM317, on a breadboard and is currently using to power all op-amps. For 9V power supply, all the components ordered from Digi-Key were very small surface mount components. The PCB has been fabricated and few attempts has been made to solder the SMCs by hand but failed. The team has decided to use a different method that uses a hot plate and a solder paste to solder the components. An order has been made and we still wait for the solder paste to arrive.

*Piccolo*Probe Progress

Mechanical

Most of the parts of the probe have been purchased. The main challenge of this portion of the work is to assemble the parts as to ensure no leakage into the probe. So far there have been one attempt and there was no leakage. But the flow-thermistor was open circuited once. The next approach was to do a better job of soldering and coating with crazy glue in order to make sure that the connections will remain firm. Also, after many attempts it was concluded that due to the time restriction of the project the use of the extremely tiny thermistor is not practical. So we will remain with the current choice of glass ceramic thermistor in order to ensure a proper working condition of the probe.

Electronics

At this point, we have decided upon the use of a Honeywell 1k NTC thermistor as the flow sensing thermistor, and a 30k glass encapsulated, temperature-sensing thermistor to measure the fluid temperature. We ordered and received a variety of thermistor, which upon receiving started preliminary testing. We realized the characteristics most important for the thermistor used for this application is a very low dissipation constant, and very small size. The initial testing suggested that the method we have chosen may have frequency response limitations, so we have also been testing another method which uses a hot-wire as the flow sensing element. Since it was close to impossible to purchase tungsten wire of the small diameter necessary for a hot-wire anemometer, we tried to be resourceful by using the filament of an incandescent light bulb. This method looked promising in air, but as soon as we started testing in water, we ran into problems. As a result, it looks like the thermistor method is more reliable and the better option, although it does have some drawbacks. At the moment we are working to integrate the thermistor to the rest of the probe in order to start calibration of the each of the thermistors (i.e., determine their resistance-temperature curves) and then flow speed calibration.

*Unisca*Suite Progress

Most of the components of the *Unisca*Suite have been coded. The GUI and Logging mechanism have been created and both work to the specifications in our functional specification. A test script was developed to test the GUI and Logging mechanism. It produces a sawtooth waveform allowing us to test as to whether the GUI is able to correctly graph results and the logging mechanism is able to correctly log. Performance was found to be particularly lacking in the logging class, and significant reworking was performed in order to achieve acceptable behavior. Preliminary code for the serial port communication class has been coding. The mechanism has been coded to the communication specification in the design spec. The exact communication protocol will have to be changed for two main reasons.

- We found that there is no reliable way to get the current time on the microcontroller. We will likely change the timestamp from the current time to the number of milliseconds since the program was launched.
- Kardium would like the raw voltage data to be logged to the log file on the computer. This is not considered in the design specification, and we will have to adjust our communication protocol to allow these values to be sent.

Currently, the software does not handle the additional requirement specified by Kardium. The interface between the logging mechanism and the serial port mechanism will have to be adjusted to allow for it. Changes to the communication protocol will require much less drastic change as the relevant code is contained to one function.

Conclusion

Given the current state of the prototype detailed above, our device development is approximately one week behind schedule. With continued progress we expect to be caught up to our original schedule within the next two weeks. The next stage of our design, which we expect to begin within the next week, is the testing stage. Once integration is almost complete we will be going to Kardium in order to use their flow machine for calibration and validation of our device. The testing stage will continue for approximately two weeks after which the development of our prototype will be complete.