Using Low-Cost Microcontrollers with eTape® for Measuring Streamflow

Improving Streamflow Measurements

Reclamation's Technical Service Center evaluated using eTape® and Arduino microcontrollers as a low-cost solution for continuous streamflow measurement applications. Continuous streamflow measurement data are critical for water resources planning. The availability of such data directly influences the confidence of hydrologic analyses used for land management and operational decisions. Although the U.S. Geological Survey (USGS) collects and publishes continuous streamflow data at many locations, hydrologic analyses can often benefit from additional data – even if only collected for a short duration. These additional data needs can be met with low-cost, easily deployed equipment. This investigation compared the eTape® with the microcontroller datalogger alongside three USGS gage stations.

Building and Deploying Streamflow Measurement Equipment

Streamflow is commonly measured indirectly using depth sensors, making eTape® a suitable candidate for collecting continuous data. The eTape® is a passive, linear depth sensor that resembles a ruler, that is used for measuring water depth (Figure 1).

Figure 1 – Photograph of an eTape® sensor (Courtesy of Mile Technologies, Inc.)

The eTape® sensor itself is fragile, therefore a protective housing was fabricated to allow water to enter through the bottom with minimal interference from debris and sediment. These sensors were tested alongside three USGS stream gages near the Denver Federal Center (Figure 2).

Figure 2 – eTape® sensor alongside USGS Stream Gage #06718550 – North Clear Creek near Blackhawk, CO

Figure 3 – Datalogger assembly using an Arduino microcontroller.

Dataloggers fabricated using Arduino microcontrollers were also tested at each of the USGS stream gage locations (Figure 3). Microcontrollers are programmable integrated circuit assemblies commonly used to accomplish a variety of tasks in many household electronics such as microwave ovens. Companies like Arduino have broadened the application of these microcontrollers and is included within the dataloggers. The Arduino microcontroller is programable, while the datalogging was modified by adding a battery-powered real time clock module along with a card reader for storing data.

Key Results

When functioning correctly, the eTape® strongly correlated with the recorded USGS depth measurements at each gage (Figure 4). Unfortunately, problems encountered during testing prevented the collection of long-term, continuous streamflow data.

The eTape® sensor must be oriented in an upright position, limiting its location in a stream to areas protected from high currents. Such areas typically have greater sediment deposits that can clog the eTape® sensor preventing water from entering or leaving the piping assembly. Several times during field testing, the eTape® sensor failed to properly measure the stream depth due to obstructions.

Although technical-savvy individuals might welcome the challenge of assembling and programming an Arduino microcontroller for datalogging, doing so takes considerable time. Purchasing a datalogger from a reputable company might be a better solution for reliably recording streamflow data.

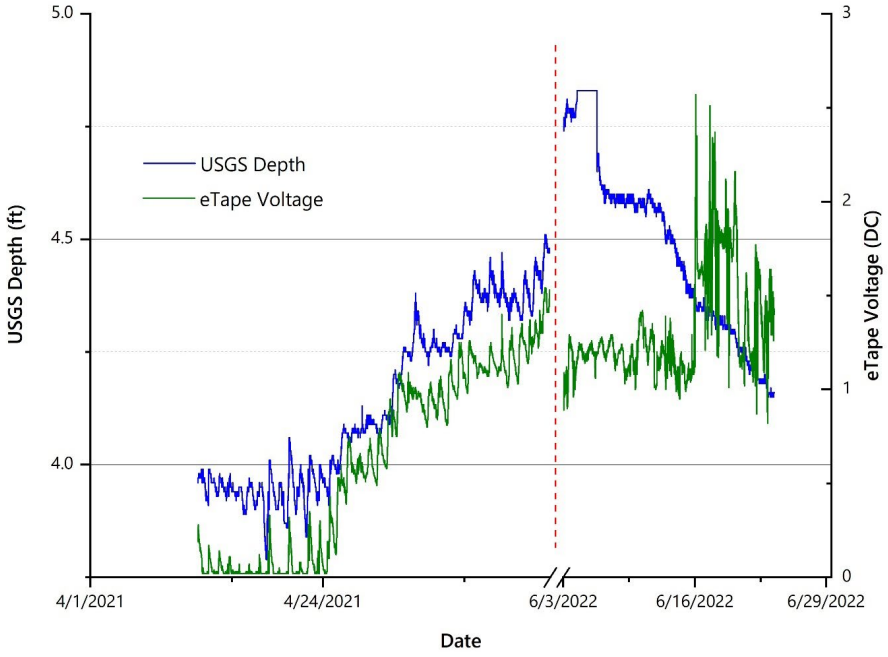

Figure 4 – Data results from the eTape® sensor alongside USGS Gage #06718550 – North Clear Creek near Blackhawk, CO

Lessons Learned

The eTape® sensor along with an Arduino microcontroller was not very reliable for long term continuous streamflow measurement. These results can help steer future investigations towards a more viable solution. The eTape® appeared to be a suitable sensor for measuring short duration streamflow in areas of low river currents with minimal sediment deposition, however, these areas are difficult to locate. The Arduino microcontroller by itself is not capable of datalogging. The cost of developing a datalogger from an Arduino microcontroller needs to be weighed against the amount of dataloggers needed. Development of such dataloggers is better suited for private industry.

Additional Information

Useful Links for Applied Science:

https://www.usbr.gov/watersmart/appliedscience/index.html

WaterSMART Website:

https://www.usbr.gov/watersmart

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