Design of Data Acquisition Unit Using Arduino from a Flow Velocity Meter for Tides in the River

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ABSTRACT

The Royal Irrigation Department is responsible for managing water availability in Thailand. Many instruments are used to read the data to obtain the needed hydrological data. The instruments that it has applied to measure the velocity of the tide are the flow velocity meters A-OTT C31 that compatible with the audio and numerical displayer Z 41-00. They have been used for 30 years, (1988 - 2018).

Design of Data Acquisition Unit Using Arduino from a Flow Velocity Meter for Tides in the River was presented in this paper. It was designed to use as a substitute for the audio and numerical displayer Z 4 1 -0 0 that were broken. The result of the design and the experimentation show the ability of working together with the flow velocity meters A-OTT C31 and the accuracy of the data acquired from this designed instrument are satisfactory.

Keyword: The Royal Irrigation Department, Flow Velocity Meter, Arduino

Introduction

1. Current meters

The water current velocities are measured by the tools that measure the speed of the tide and they are classified into two types [1-2].

1.1 Mechanical current meters

Mechanical current meters are mechanical devices that are the main components. The tools will move when the current flows and there are three types.

      1.1.1 Vertical axis current meters

      1.1.2 Horizontal axis current meters

      1.1.3 Pendulum current meters

1.2 Electronic current meters

Electronic current meters are electronic devices that work primarily on electronic devices. These tools work better than mechanical current meters and there are three types.

      1.2.1 Electromagnetic velocity meters

      1.2.2 Doppler velocity meters

      1.2.3 Optical strobe velocity meters

The tools that have been used by the Irrigation Department are A-OTT C31, the current flow meters, with Z 41-00, audio and numerical indicators. The A-OTT C31 current flow meter is mechanical current meter that is the type of horizontal axis current meter.

2. Arduino

Arduino is an open-source electronics platform based on easy-to-use hardware and software [3-4].In this paper, we use Arduino Due which is one of the Arduino family.

Arduino Due can be obtained signals in square wave form via digital pin. After that interrupt service function is called to count the incoming waveforms. The obtained values are stored in *p_count* variable and those values will be managed in various processes later.

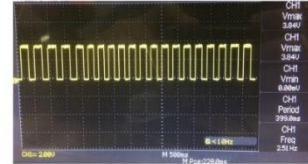## Materials and methods

1. Signal form A-OTT C31

Figure 1 A-OTT C31

Figure 2 A-OTT C31 Signal

The A-OTT C31, the original universal current meter for flow velocity measurement in rivers and open waterways. It has proven quality, precision and reliability [5].

Water flow causes rotation of the current meter propeller. Once per revolution, a magnet attached to the current mete propeller operates a water-tight sealed reed contact. The contact sequence is proportional to the velocity of the water at the measuring point. The sequence is captured by an attached counter and used for calculating flow velocity at the measuring point, based on the current meter equation [5].

The relationship between propeller revolution and flow velocity is determined by the following formula

$$v = k \cdot n + \Delta \qquad\qquad 1$$

Wherein:

k : Hydraulic pitch of the current meter propeller $[^m/_{rev}]$ which was determined by towing tests carried out in a rating tank.

n : Propeller rotation per second $[rps]$.

Δ : Current meter constant $[^m/_s]$ which was determined by towing tests carried out in a rating tank.

Since there are mechanical differences between the propellers caused by manufacturing tolerances and differences in bearing, the constants k and Δ are precisely determined individually for each current meter in the OTT rating tank (BARGO Test Certificate and BAREL Velocity Table) [5].
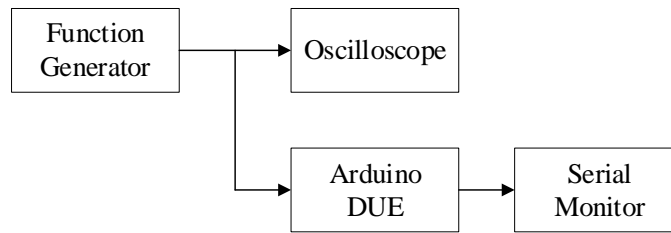
2. Block diagram

Figure 3 Block Diagram

The block diagram consists of 4 parts:

2.1 Function Generator that can supplies the square wave form in many frequencies. It has the signal form which is similar to the signal that can be measured from the A-OTT C31 universal current meter.

2.2 Oscilloscope is used to measure the supplied signal from the function generator. The results of the oscilloscope measurements are used to calculate the errors and uncertainties of the designed instrument.

2.3 Arduino Due is used to measure the supplied signal from the function generator at the same time with the oscilloscope. The results of the Arduino Due measurements are used to calculate the errors and uncertainties for comparisons with the results of the oscilloscope measurements.

2.4 Serial Monitor is used to display the results of the Arduino Due measurements. As Arduino starts to measure the signal, the frequency results of the measurements are sent out to the serial port. Then the frequency results will be display on the serial monitor.

3. Flowchart

To show the workflow of the designed process in this paper was presented in flowchart. When the program starts, it manages the hardware in its initial state and then it resets all of the variables before it enters the main loop. The main loop is controlled for a fixed time of 1 second per work cycle. In this way, the main loop period is constant so that the frequency can be determined by reading the value obtained from the interrupt routine. Every time an interrupt occurs, the value of the *p_count* variable is updated at runtime. When the program reaches the cycle of reading in the main loop, the value of the *p_count* variable will be taken to the *p_store* variable. This value will be calculated to frequency values and then the *p_count* variable is reset to 0. The program run in loop continuously.
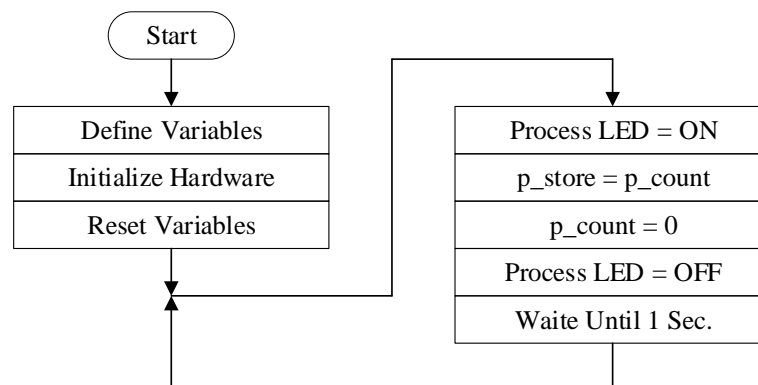

Figure 4 Flowchart

Results and discussions

1. Testing at 20 Hz, 200 Hz, 1 kHz and 2 kHz

Figure 5 Test bench.

Experimented by frequency input with a function generator at frequencies of 20 Hz, 200 Hz, 1 kHz and 2 kHz. Then measure the output signal with oscilloscope and Arduino to compare results.

Determine the number of random variant n = 15. To keep all raw data from a serial monitor. The results of all experiments are shown in Tables 1 to 4.
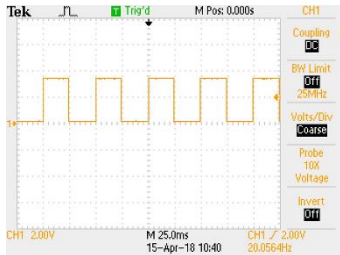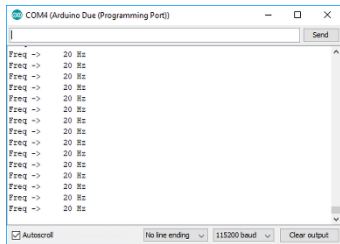
Table 1 Test results at 20 Hz

Oscilloscope	Serial Monitor	Summary
		Oscilloscope = 20.0564 Hz n = 15 Average = 20.0000 Hz SD = 0.0000 Ua = 0.0000

Table 2 Test results at 200 Hz
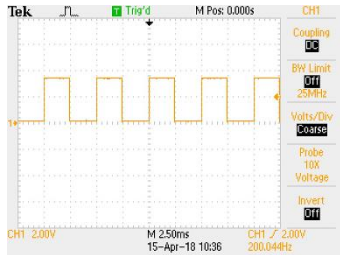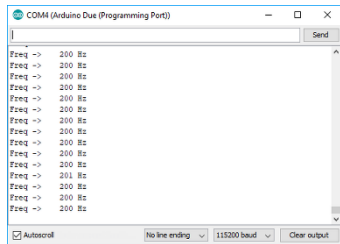
Oscilloscope	Serial Monitor	Summary
		Oscilloscope = 200.044 Hz n = 15 Average = 200.0667 Hz SD = 0.2582 Ua = 0.0667

Table 3 Test results at 1 kHz
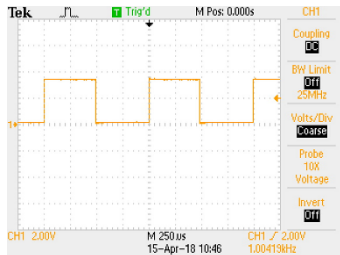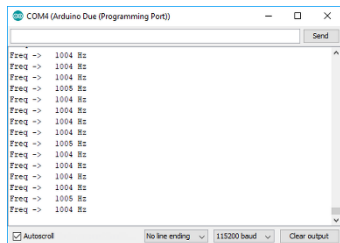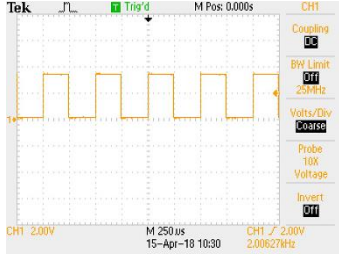
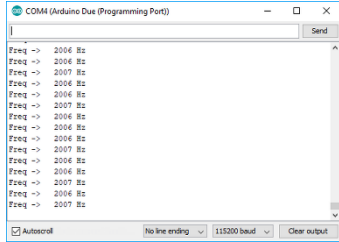| Oscilloscope	Serial Monitor	Summary
		Oscilloscope = 1004.19 Hz n = 15 Average = 1004.2000 Hz SD = 0.4140 Ua = 0.1069

Table 4 Test results at 2 kHz

Oscilloscope	Serial Monitor	Summary
		Oscilloscope = 2006.27 Hz n = 15 Average = 2006.3333 Hz SD = 0.4880 Ua = 0.1260

Conclusions

The experimental results show that this designed prototype can read four tested areas of the frequency range properly well. The application of this prototype will be applied to the A-OTT c31, the current flow meter, for replacing the damaged Z 41-00, the counter which is used to display as an audio and numerical output. It can be done simply by connecting only two wires. The prototype of this research will be developed as a tool to be used in fieldwork in the future.

Acknowledgements

References

[1] Polpananavee, Pramoht. 2011. Principle of Water Flow calculation through Irrigation Structures. Bangkok: Regional Irrigation Office 8. (in Thai)
[2] Leevajanakul, Kirati. 2000. Hydrology. Bangkok: Rangsit University Press. (in Thai)
[3] Arduino Language Reference [Online]. https://www.arduino.cc/reference/en.
[4] Makarn, Eakachai. 2009. Learn Understand and Use the AVR Micro controller family with Arduino. Bangkok: ETT Co., Ltd. (in Thai)
[5] OTT Hydromet. 2017. A-OTT C31 [Online]. Available: http://www.ott.com/products.