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Real Time Ultrasonic Measurement for Suspended Sediment Concentration

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Introduction

A suspended sediment concentration is the most important information for hydrological characteristics to observe or even use in disaster prevention. Table 1 shows many methods are used to detect concentrations, while ultrasonic has been considered the better one. In the market, there are many ultrasonic measurement system products. However, small errors always exist in data transmission and the equipment is too big to be carried. To solve these problems, this paper proposes a novel measurement system to detect concentrations.

Table 1. A comparison table of detecting concentrations methods

Methods	Resolution	Particle Size Distribution	Non-destructive	Wide Measurement Area
Bottle sampling		✓		
Pump sampling		✓		
Acoustic	✓		✓	✓
Remote spectral reflectance			✓	✓

Experiments

Experiments were carried out by using two transducers with operation frequency at 1 MHz, In the transmitter, two input voltages controlled by a microcontroller were used to detect different ranges of concentrations. A receiving circuit structure included three parts, a filter, a logarithmic amplifier and analog to digital converters. A band-pass filter is to remove noise, increasing a ratio of signal and noise and signal will not be distorted in the subsequent signal processing. Then, a logarithmic amplifier is to envelope received signals and transform voltage into dB scale for detecting signal attenuation. The concentration could be determined by comparing the attenuation transform table and double checked by using Bottle Sample method.

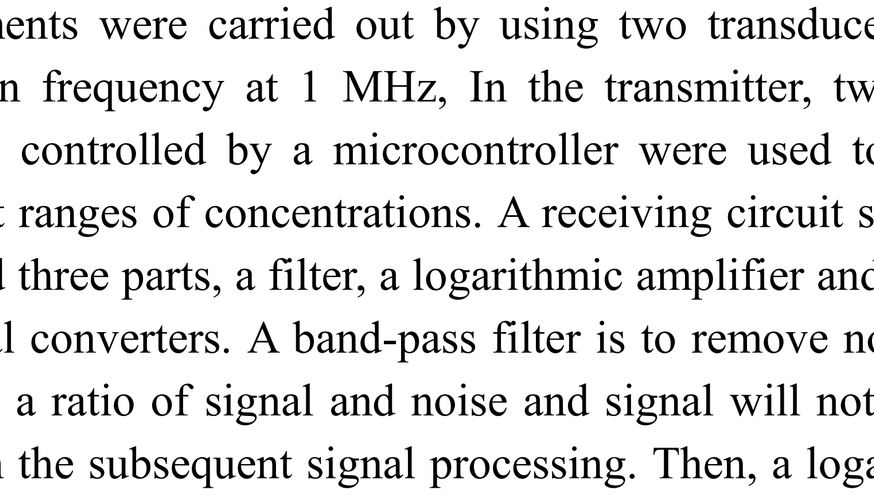

Fig 1. The block diagram of measurement system.

Results

This measurement has higher sensitivity and a range of 80 dBm for detecting signal attenuation. Figure 2 shows that a range of concentration can be determined from 0 mg/L to 450,000 mg/L and the relationship of signal attenuation in dB scale and concentration from high to low is linear. According to the linear fitting line, we can extend the experimental result of attenuation to 80dBm, and the maximum concentration attain to 450,000 mg/L. A user interface of the system is shown in Figure 3.

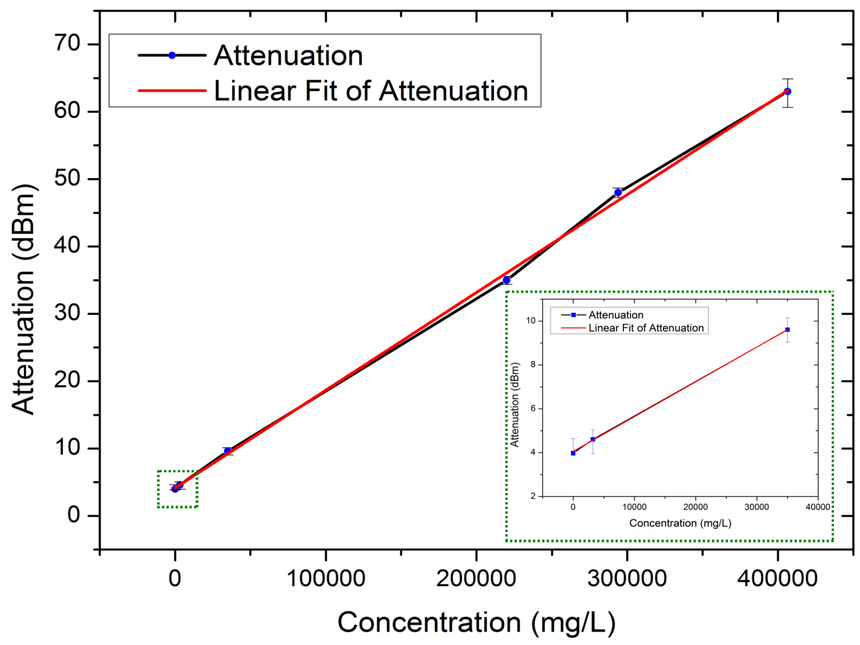

Fig 2. Concentration-attenuation curve of Zengwun Dam mud.

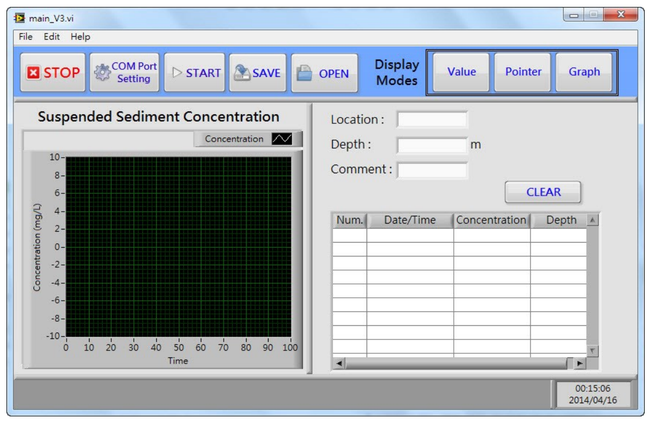

Fig 3. User Interface (Design using NI LabVIEW)

Conclusion and Discussion

- Experimental results show the concentration from 0 mg/L to 450,000 mg/L can be determined.
- The processed signal in receiving part can have reduced attenuation for a long transmission distance so that highly accurate determination system of concentration can be flexibly located, not limited to the neighborhood of transducers.
- Smaller size, wider range and lower cost are also the advantages of the proposed measurement system.

Reference

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