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Variable ratio threshold and zero-crossing detection based signal processing method for ultrasonic gas flow meter

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Abstract: Ultrasonic gas flow meter has unique advantages and good application prospects for measuring the gas flow rate in medium to large diameter pipelines. However, there is energy attenuation in the ultrasonic wave propagation process, and the propagation path of the ultrasonic wave will shift with the gas flow rate increasing, which makes it difficult for the commonly used transit-time method to determine the feature point and obtain the accurate measurement results. Therefore the characteristics of the ultrasonic echo signal are studied, and a variable ratio threshold and zero-crossing detection based digital signal processing method is proposed for ultrasonic gas flow meter. The ultrasonic echo signal is normalized, and the ratio value is used as the threshold value to determine the feature point. Based on the analysis of the amplitude of the extreme points under different flow rates, the threshold value is determined according to the intersection of the amplitude interval of the extreme points. According to the feature point, the zero-crossing method is adopted to calculate the ultrasonic wave propagation time. This digital signal processing method is implemented in real time in the digital system with the FPGA (Field Programmable Gate Array) and the DSP (Digital Signal Processor) as the double cores, and the gas flow calibration experiments are conducted to verify the effectiveness of the proposed digital signal processing method and developed system.

Index Terms: Ultrasonic gas flow meter; digital signal processing; transit-time method; feature point; variable ratio threshold; zero-crossing detection.

1 Introduction

Compared with orifice plate flow meter, turbine flow meter and vortex flow meter, the ultrasonic gas flow meter has unique advantages, such as no moving parts and no pressure drop in the gas flow measurement [1-4]. Especially, it is suitable for the gas