Analog Signal Conditioner Using Fuzzy Logic Technique

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Abstract

An analog signal conditioner using fuzzy logic technique, which has multiple-input and multiple-output terminals, is proposed in this paper. The proposed signal conditioner can be employed to linearly translate the level of signals to a standard voltage signal (1-5V) and convert the form of signals to a standard current signal (4-20mA). The implementation method based on the use of a commercial 8-bit microcontroller, the analog-to-digital (A/D) converters, the digital-to-analog (D/A) converters and the voltage-to-current (V/I) converter. The simulation result and the experimental results are presented, which further confirm the feasibility of this approach.

1. Introduction

The signal conditioning provides the operations to transform a sensor output signal into a necessary signal to interface with other elements in the process-control loop. Some of the most frequently performed types of signal conditioning are buffering, filtering, signal-level translation, signal conversion and linearization. The use of all types or some type of signal condition depends on the required signal and the application. The simple method of signal conditioning is to translate the level of signal. The most common example is the necessity to either attenuate or amplify a voltage signal level [1]. Attenuation is generally accomplished with a resistive voltage divider network, whereas amplification requires an active device such as a transistor or an operational amplifier (op-amp). Due to the non-ideal characteristic of an op-amp causes input offset voltage and input offset current, therefore most of the op-amp circuits will include compensate components. Such the circuits are complex to design and usually operate only within narrow limits [2]. The modern approach to this problem by using Programmable Computing Unit, which base on the microcomputer [3]. Virtually any non-linearity of the output signal can be handle in this manner and, with the speed of modern microcomputers in nearly real time. Recently, there is great deal of interest in the use of fuzzy logic systems in control application [4]-[6]. The advantage of fuzzy logic for control applications arise from the fact that a proper nonlinear mapping that would lead to a superior controller performance can be described easily using fuzzy linguistic variables and fuzzy rules. The purpose of this paper presents the analog signal conditioner using fuzzy logic technique to linearly translate the level of signals to a standard voltage signal and convert the form of signals to a standard current signal.

2. Design of signal conditioner

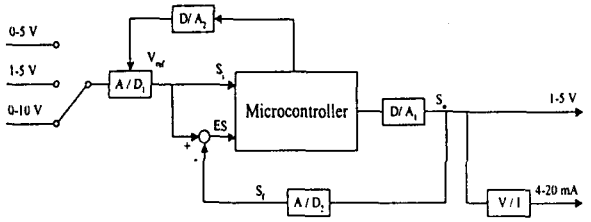

Fig.1. The basic configuration of a proposed signal conditioner.

The basic configuration of a proposed signal conditioner is shown in Fig. 1. In designing, the proposed signal conditioner has three input terminals (0-5V, 1-5V and 0-10V), where can be selected by using program to change the reference voltage (V_{ref}), and two output terminals (1-5V and 4-20mA). The input signal ($S_i(t)$) and the signal error (ES(t)) are taken as the inputs to the fuzzy-processor based on 8-bit microcontroller, the output signal ($S_o(t)$) is taken as the output of the D/A converter, and the feedback signal ($S_f(t)$) is taken as the output of A/D converter. There is given by

$$ES(t)=S_i(t)-S_f(t) \qquad (1)$$

Where ES(t), $S_i(t)$, $S_f(t)$ and $S_o(t)$ are the error signal, the input signal, the feedback signal and the output signal at time t, respectively. For the convenience, we term ES(t), $S_i(t)$, $S_f(t)$ and $S_o(t)$ as ES, S_i, S_f and S_o respectively.

The microcontroller based on fuzzy logic technique is composed of four basic block diagrams as shown in Fig. 2. A design procedure can be carried out as follows.