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A New Design for Liquid Mixing System

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Abstract. The thesis introduces a new design for liquid mixing system, which can replace the liquid mixing system based on the PLC or numerous meters. The fact proves the new design have lower cost, smaller volume, higher control accuracy and quick response.

Introduction

Automatic Liquid Mixing System can mix the different liquid components according to the process requirement and is widely used in the industry process. The Automatic Liquid Mixing System is based on several constructions, such as PLC or numerous meters. The former cost is often high because of PLC cost; the latter often occupies more space with huge volume. The thesis will introduce a new design for compact volume and higher accuracy.

Design idea

The Automatic Liquid Mixing System is consisted of three main blocks: control part, driving part, HMI(human machine interface) part. The control part is responsible for acquiring the weight signal of the liquid and determines the time for turning on the driving part. Driving part provides the abundant energy to open or close the valves which control the liquid flow. HMI communicates with control part and indicates the status parameters and receives the instruction of the operator.

The Control Part

The construction of control part is illustrated in Fig.1.

Bridge driving circuit provides the driving voltage and current. The weight sensor is full bridge of strain gauge and with the driving the bridge will produce the weak voltage which is proportional to the liquid weight. PGA(programmable gain Amplifier) will amplify the weak signal in order to match the reference voltage. The analog-to-digital converter converts the analogy signal to digital signal; the microprocessor receives the data and decides the control action.

In the design, we choice ADS1216 [1] chip produced by Texas Instruments Corporation as the analog-to-digital converter. The chip owns the PGA, voltage reference except standard analog-to-digital converter. PGA range is from 1 to128 by 2's step and the voltage reference has lower noise and high initial accuracy, which can reduce the volume of the design. The analog-to-digital converter can reach the 24 bits resolution, which guarantees the measurement accuracy.

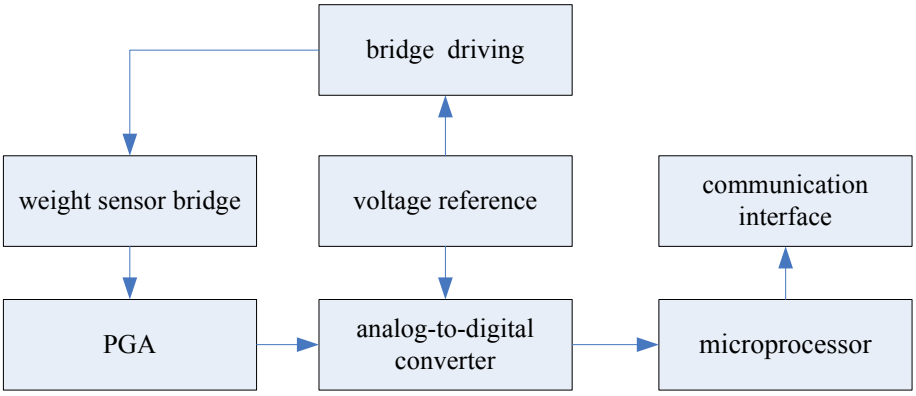

Fig. 1. The construction of the control part

The microprocessor is C8051F314 type [2], which works faster than common MCS-51 series microprocessor and modifies the parameter in real time.

Driving Part

The driving part contains a series of SSR(state solid relay) [3],which realize the isolation between the microprocessor and solenoid valve. The SSR can be classified as DC(direct current) and AC(alternate current) type and can be selected according to the need. If necessary, the freewheeling diode is needed to parallel connected with DC SSR or R-C absorb circuit is needed to parallel with AC SSR. In order to avoid the trouble for designing AD to DC converter, we choose the AC SSR and AC solenoid valve to control the liquid flow. When the microprocessor drives the input voltage to low level, the solenoid valve will turn on.

HMI

We choice the HMI of FUJI ELECTRIC Corporation, which supports the common communication protocol. With RS-232 interface, the microprocessor can exchange data with the HMI, so the HMI indicates the parameters such as liquid mass or state of the solenoid valve obtained by the microprocessor and microprocessor can scan the operator instruction from the HMI.

Control strategy

Because of the length of liquid flow pipe, when solenoid valve is off the additional liquid will fall into the can, so the control accuracy is not well. Here we take the Smith Predictor as control strategy [4,5]. The delay time constant of controller can be decided by the follow equation

$$t=L/V. \quad (1)$$

In above formulas:

L is the length from solenoid valve to the liquid level surface;

V is the liquid flow velocity in the pipe;

In application the controller will modify the delay time constant in real time and the liquid level can be determined by the total liquid weight. The fact proves it is an effective method for the automatic liquid control.

Conclusion

With recording the operation parameters, we find out the mix accuracy is higher than 0.5%, which is higher than usual mixing system and the mixing system volume is smaller. So we draw the conclusion: the new liquid mixing system can replace the usual liquid mixing system.

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