WAETER LEVEL CONTROL USING Z-80 MICROCOMPUTER

Masanori Sugisaka

Department of Electrical and Electronic Engineering
Oita University, 700 Oaza Dannoharu, Oita 870-11 Japan

ABSTRACT

This paper presents a water level control method using Z-80 microcomputer. The process considered in this paper is one tank sytem which is described by an unknown nonlinear differential equation.

The water level is measured by the end of bar installed at a float passing through 8 pair of photointerrupters located at equal distance. Therefore, the input data to 8255 which is interface between Z-80 and photointerrupters is discrete value, namely, value under 1, values from 1 to 8, and value upper 8.

The water is pumped into the tank from a reservoir by swiching on a relay connected to a moter and pump driving system. The pumping is stopped by swiching off the relay.

Experimental studies for two types of controllers are performed in order to investigate the control performance of water level of the water pumping system.

1. INTRODUCTION

Level control of liquid in tank systems is now in practical use in industrial applications. The level control in industrial manufacturing is considered as important factor in automation.

In this paper water level control design(hardware and software)for one tank and one reservoir system is considered using Z-80 microcomputer. The water level control system consists of tank with a valve, reservoir, water level measurement equipment, motor and pump driving system with relay, water tube connected from pump in reservoir to the entrance of tank, input and output interface(8255), and controller(Z-80).

The water level is measured by the end of bar installed at float passing through 8 pair of photointerrupters located at equal distance. Hence, the input data to the 8255 is discrete value, namely, value under 1, values from 1 to 8, and value upper 8.

The water is pumped into the tank from the reservoir by switching on the relay connected to the motor and pump driving system. The pumping is stopped by switching off the relay. The on-off switching time of the relay is controlled by control laws evaluating the error between desired level and actual level measured from the photointerrupters.

The software for controllig water level consists of the 8255 I/O setting, the stack-pointer setting, initial value setting, the output subroutine(driving the relay), the input subroutine including software timer subroutine (measurement of the water level), and the data processing unit(subroutine for controlling the water level to follow for a desired value). Hence the software is able to measure the water level and process the measured data according to the control purposes and drive the relay. This process is repeated in order to achieve the control specifications.

The experimental study for two types of control strategies is performed in order to investigate the control performance of water level of the system. One is that the desired value of water level is constant. The other is that the desired value is changing trapezoidary. The data obtained from the experiments by using different sampling time is analyzied to test the performance of Z-80 controller.

2. EXPERIMENTAL EQUIPMENT

The I/O interface 8255 for 8 bit microcomputer Z-80 has three ports A, B, C[1,2]. In our experimental equipment C port receives the data of water level read by photointerrupters and port B sends the output data of switching on and off signal to the relay which drives motor.

Figure 1 shows brief configulation of the equipment. In this figure NEC PC-9801 is a device to develope control programs written by the machine language for 8 bit microcomputer(Z-80). The water level is measured or detected by the end of bar installed at float passing through 8 pair of photointerrupters located at equal distance on boad.

Figure 2 shows relay circuit to drive the motor which switchs on and off pump. The relay circuit is designed such that the following equations are satisfied:

$$E_2=V_{CE}+R_2 I_C$$
$$E_1=V_{BE}+R_1 I_B$$
$$I_C=hI_B$$

Here, E_1[V] is output voltage of outport(B port), E_2[V] is voltage supplied for the relay, V_{BE}[V] is voltage between base and emitter of transister, V_{CE}[V] is voltage between collector and emitter, I_B[A] and I_C[A] are base and collector currents of transister, respectively, R_1[Ω] is resistance between output(B port) and base of transistor, R_2[Ω] is resistance of coil, and h is the current amplification factor.

The specifications for instruments used in this equipment are as follows:

distance between transistors=1[cm]
ability of pump=10[l/min]
radius of tank=12.5[cm]
bottom area of tank=490.9[m^2]

3. DETECTION OF WATER LEVEL AND ON-OFF CONTROL ALGORITHMS

The method for detecting the water level is illustrated in Fig.3 when the water level is upper 7 and is equal to 2. The bit of measurement data for the water level in A register which is inported from C port is converted and is sifted to the right. By checking whether the carry is zero or one, the number of the sifts to the right is counted and then the water level is detected.

The controller used in this equipment is on-off controller by relay. The voltage feeded to the motor is zero or a constant value, namely, binary value. In other words, the certain voltage is feeded to the motor by turning on the switch(relay) when the water level is below a desired level and is not feeded to the motor by turning off the switch when the water level is upper the desired value. The control law used is digital and simple. The flow chart of soubroutine for classifying on or off switching action in the control algorithm is illustrated in Fig.4. In this subroutine, the data for water level stored in HL address is compared with the desired level stored in (HL+1) address. The 00H(stop feeding water) is set in (HL+2) address for the cases where HL>(HL+1) and HL=(HL+1). The 01H(start feeding water) is set in (HL+2) address for the case where HL<(HL+1). The flow chart of the control program is shown in Fig.5 briefly.

4. EXPERIMENTS FOR CONTROL STRATEGIES

Two types of control strategies are performed by microprocessor Z-80.

(1) The desired value of water level is constant.

(2) The desired value is changing trapezoidaly.

Some of the experimental results for case (1) is shown in Figs.6-7 for the cases where the desired level is changed and sampling time is increased and volume of water at the outlet of tank is increased. Also the results for case (2) is shown in Fig.8.

5. CONCLUSIONS

In this paper two types of control strategies are performed for the water level control system based on Z-80 microprocessor. From the experimental results, it is seen that the water level oscillates quickly near the desired level when the sampling interval is small and vice versa for the case where the flow rate from the outlet of tank is constant.

The reason for that the period of oscillation of the water level is not constant is due to incorrect measurerment of the water level which changes quickly by quick increase of flow rate. In this paper, two simple control algorithms were invesigated from an applicational point of view. More sophisticated control laws can be considered for cotrolling the water level. this is future study.

REFERENCES

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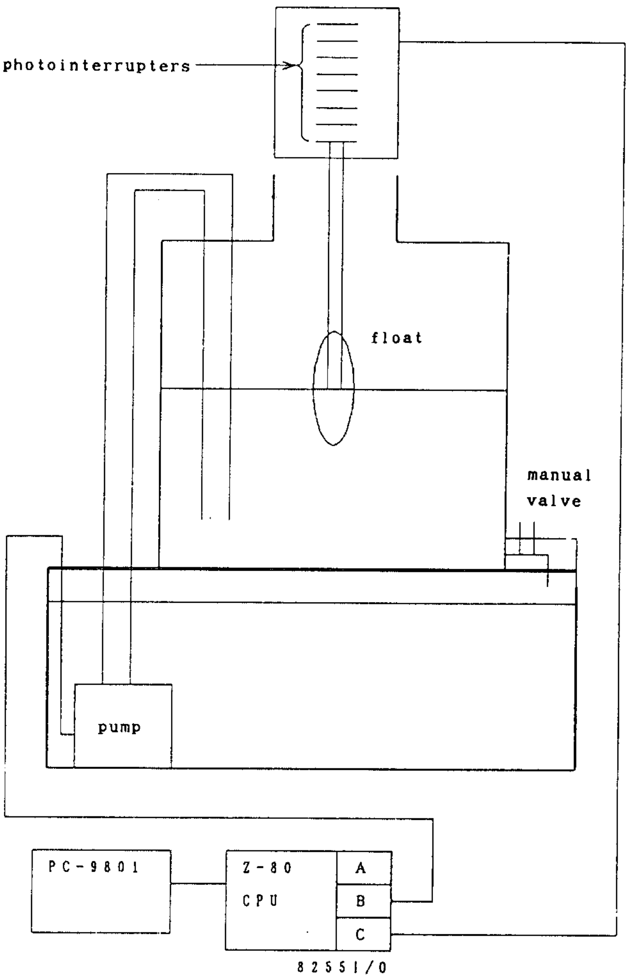

Fig.1 Brief configulation of experimental equipment

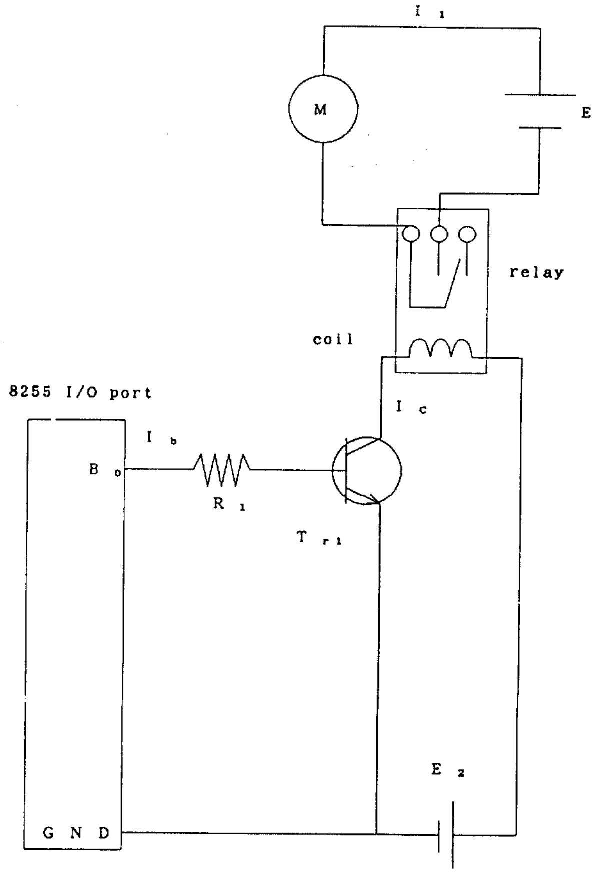

Fig.2 Relay circuit driving motor

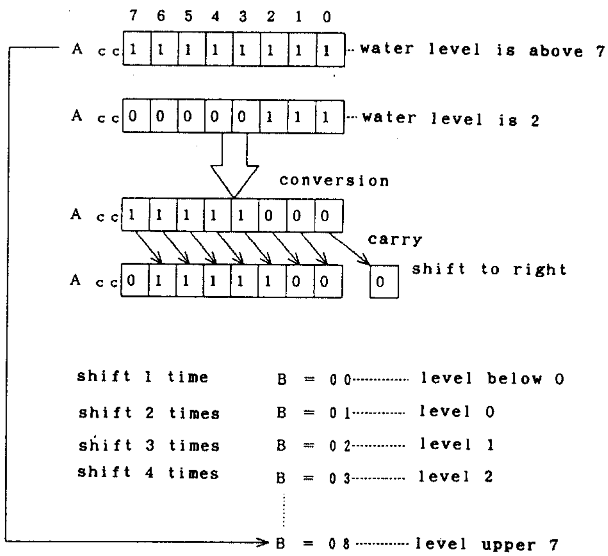

Fig.3 Detection of water level

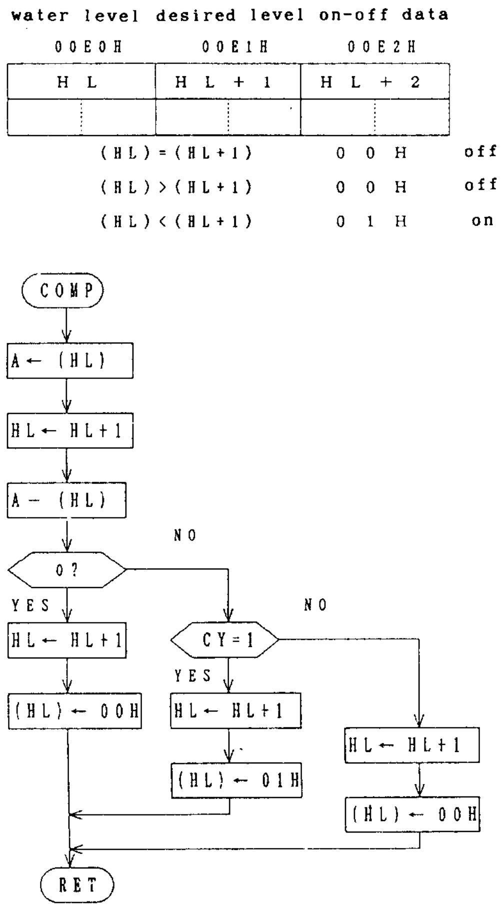

Fig.4 Flow chart for classifying on-off switching action

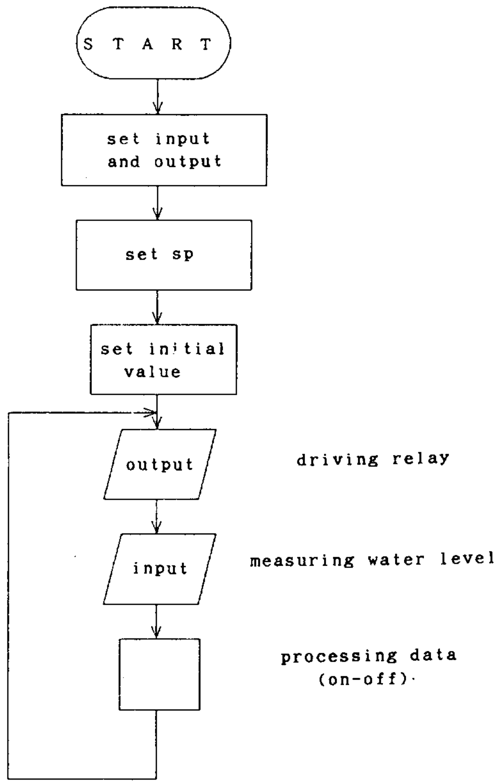

Fig.5 Flow chart of control program

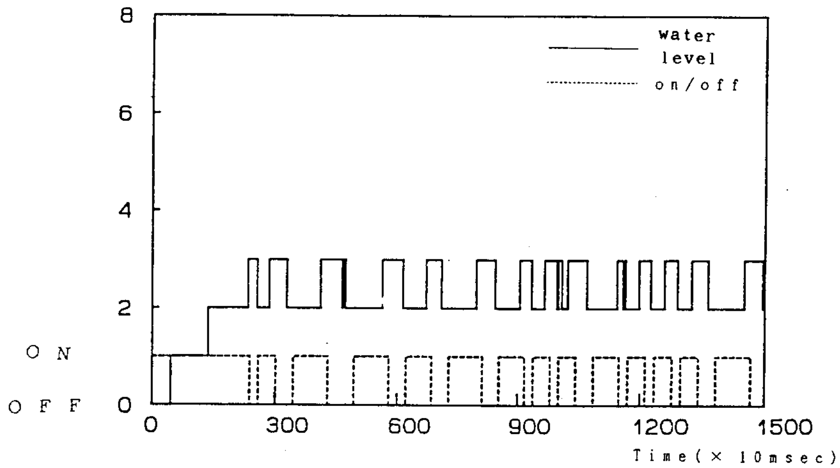

Fig.6 Output of water level (sampling time T: small)

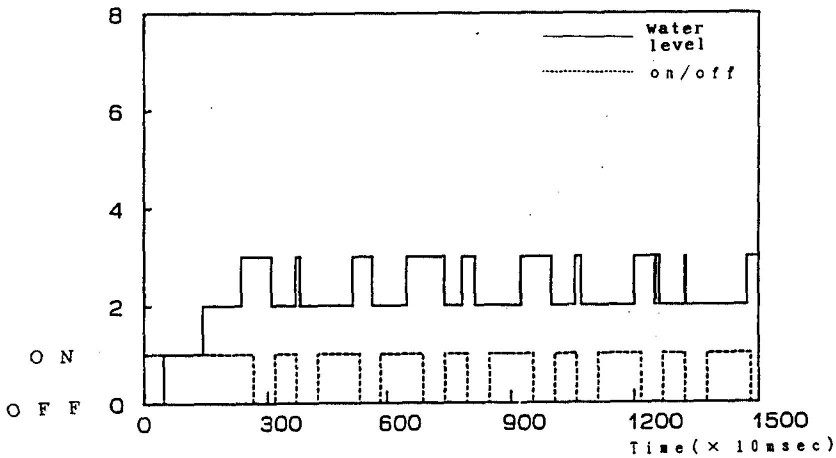

Fig.7 Output of water level
(sampling time T: large)

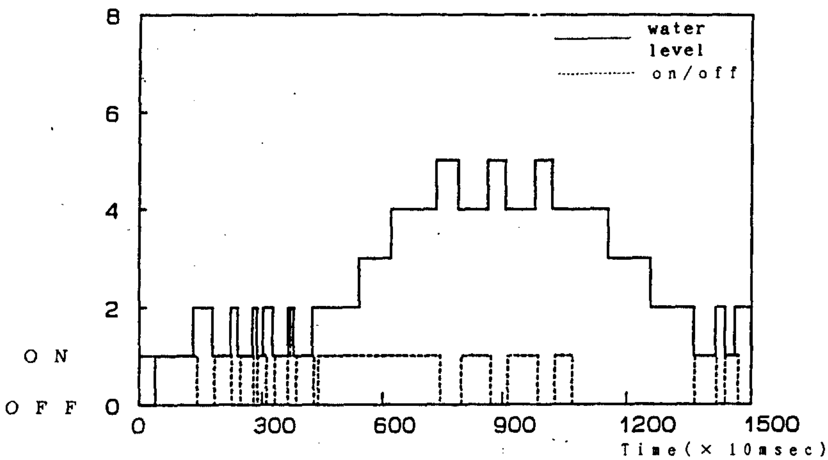

Fig.8 Output of water level
(desierd level:trapezoidal)