Implementation of Control Unit using SCADA System for Filling System

Aung Naing Myint, Hla Soe, Theingi, and Win Khaing Moe

***Abstract*—**Supervisory Control and Data Acquisition (SCADA) system was being used in industries to control easily and simply. It is a computer control and a software application. This paper describes implementation of control unit to control the filling system with modeling design. It aims a manufacturing system using SCADA control system. It has been designed to work on the computer for the process. The main purpose of this paper is to implement the hardware components for the filling process and to interface between master station and control unit for controlling the data. Microcontroller and control circuits have been used for control unit. This paper will support manufacturing systems to be easy, simple and accurate.

***Keywords*—**SCADA System, Control Unit, Manufacturing system, Motor driver, Microcontroller and Filling process.

I. Introduction

THIS paper implements the filling operation of pure drinking water plant, and this can be use other systems of various industries. It includes about how SCADA systems use in the industry. So, it includes SCADA components and protocols of the system. And it uses the facts that include how interface and monitor the process. It is mainly implemented SCADA software to apply for the control and monitoring between hardware processing and computer. It applies interfacing sever protocol when needed between the SCADA software and the hardware process. Filling process designs the model with nearly hardware devices. It uses dc motor drivers, sensing drivers, Programmable Interface Controller (PIC) microcontroller device and parallel port communication.

So, a typical SCADA control system consists of one or more remote terminal units (RTU or PLCs) connected to a variety of sensors and actuators, and relaying information to a master station. Fig.1 shows the control system of filling process using SCADA. According to SCADA control system, the hardware components of the filling process are implemented and interfaced between the microcontroller and master station. In this project, the control unit will be used for filling process. But, the four main components will not be used because it is difficult to get the PLC hardware component. So, it will use PIC 16E877A instead of PLC hardware and parallel port as interface communication.

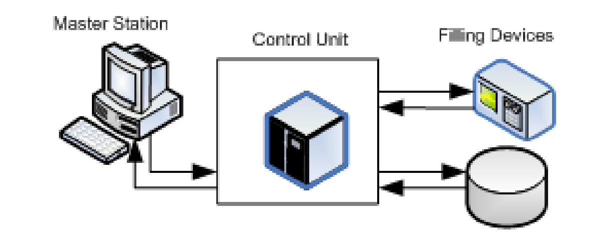

Fig. 1 SCADA system for filling system

II. Analysis of Control Unit

This system is two sections in filling process- one is control process of the water level in the tank. This control section will make only the water level. When the water level reaches at the upper level, the pumping motor is OFF from the running mode. On the other hand, it is ON when the water level is at the lower level. Second is the operation of the filling process. Firstly, the position sensor will sense the bottles to fill the water whether the specified position on the conveyor or not. If the bottle reaches at this position, the filling motor will be operated. Then, the counter motor will be operated when the bottles reach at the counter sensor to push on the second conveyor and count the number of the bottles to pack when there are ten bottles. If the bottles have not only at the position sensor but also at the counter sensor, it will operate the counter motor to drive the second conveyor motor after the position sensor has operated to drive the filling motor. If the counter has ten bottles, the counter will reset. The overview block diagram of this project is shown in Fig. 2.

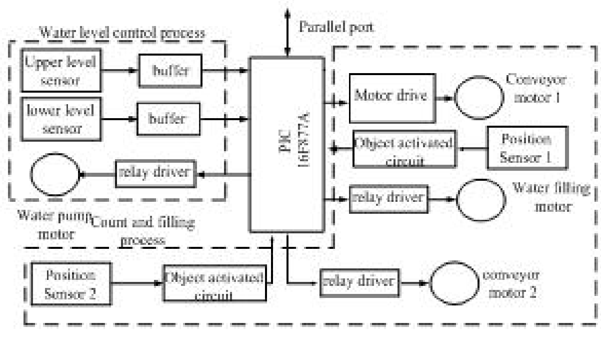

Fig. 2 Overall block diagram of control unit

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III. Implementation of the System

The hardware implementation, design consideration and control circuit will be described. In the complete circuit diagram of the filling process, there will be power supply unit, microcontroller to supervise and control data from the hardware and personal computer, light sensor drive circuit to sense the position of the bottles, filling pump drive circuits to fill the water to the tank and the bottle and conveyor motor drive circuit to operate the conveyor motor. By changing the value of resistors, the output DV voltage can get between 6.2V and 12.4V. But the value of resistors should not less than 1K. The input DC voltage must be greater or equal 2V than the output DC voltage. And then, these voltages are applied to the TIP3055 to be stable the output of the motors.

The output voltage, V_{out} = 12.4V

The minimum input voltage is greater than the output voltage plus 2.5V. The voltage-follower using LM324 in the control circuit is used to generate a voltage current which is used as a virtual ground for the oscillator. This is necessary to allow the oscillator to run off a single supply instead of a +/- voltage dual supply. For triangular-wave oscillator, reference voltage is half of supply voltage. For the voltage follower, the open loop circuit gain is 1. In this project, when Vref $_{=}V_{out}$ = 6V, supply voltage is +12V and to get V_{ref} = 6V, Thus, $R_1 = R_2$. Therefore, to get V_{ref} = 6V, R_1=R_2 =100K is chosen for the voltage follower. To operate the PWM circuit requires a steadily running oscillator. Two LM324 op-amps form a square/triangle waveform generator.

Triangular-wave oscillator utilizes an op-amp comparator to perform the switching, as shown in Fig. 3.

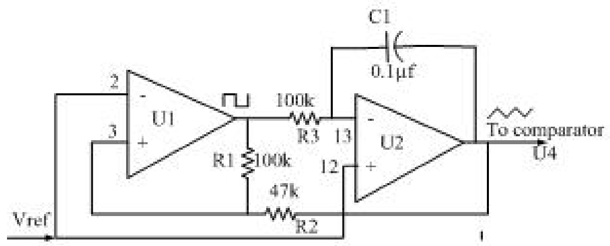

Fig. 3 Circuit diagram of triangular-wave oscillator

The peak value of the triangular wave is established by the ratio of resistors R_2 by R_3 and the saturation voltages. The frequency of both waveforms depends on the R_3C time constant as well as the amplitude setting resistors, R_1 and R_2. It has chosen R_3=100K (standard value). A comparator generates the variable pulse width. Pin 6 of the comparator receives a variable voltage from the pulse-width control circuit (potentiometer).

In Fig. 4, this compared to the triangular waveform from Pin 14 of the oscillator. By varying the voltage of Pin 6, the on/off points are moved up and down the triangular wave, producing a variable pulse width. The frequency values may be varied to change the behavior of the potentiometer.

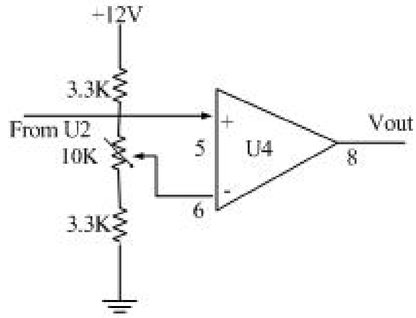

Fig. 4 Circuit diagram of a comparator

The comparator output switches back to the maximum negative level and the cycle repeats. The comparator produces a square-wave output. The output amplitude of the square wave is set by the output swing of the comparator, and the resistors R_1 and R_2 set the amplitude of the triangular output by establishing the UPT and LPT voltages. Where, the comparator output levels, $+V_{max}$ and $-V_{max}$are equal. In Fig. 5, IRF521 N channel power MOSFET driver is the power switch. When the driver is ON, it provides a ground path for the motor and when it is OFF the motor's ground is floating.

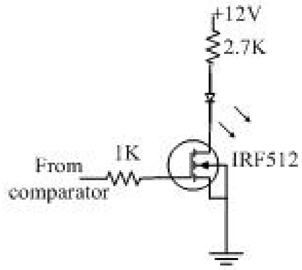

Fig. 5 MOSFET driver for power switching circuit

For this MOSFET circuit, supply voltage, $V_{DD\ =\ 12V}$, V_i= + 5.64V, R_i = 1K. The red LED is used simply for convenience, to simulate a DC motor for easy verification of circuit operation. In this project, transistor C945 switching circuit is used to operate the water pump DC motor. When the water level reaches at the upper level, the microcontroller will close the switch because of the water level control circuit ground is floating. The circuit diagram of pump motor drive circuit is shown in Fig. 6.

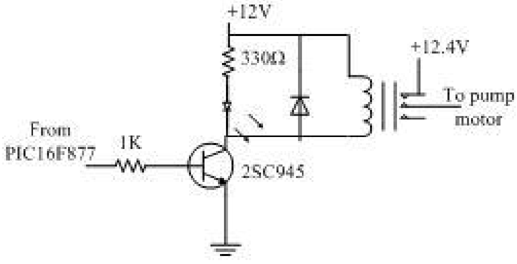

Fig. 6 Circuit diagram of pump motor drive

In Fig. 7, this uses to know the position of the bottles from the microcontroller. The output waveform of the circuit is low pulse signal. To generate this waveform, the two switching transistors are used to get the required input for microcontroller. When the bottle reaches in the light of the LED, the resistance of the LDR will be taken 1MΩ.

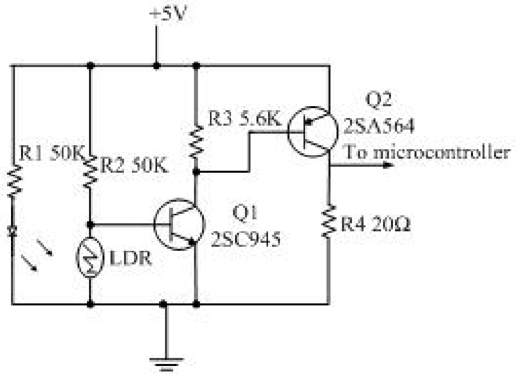

Fig. 7 Circuit diagram of position sensor drive

There are three probes in water level control system and a buffer CD40106 is used to control the water level. One probe is used as a ground. The other two probes are used as level sensors. These two pins are connected to the +5V supply. In water level control system, only when the water level reaches below the lower sensor probe, the supply will not flow to the ground. At the same time, its supply will flow to the buffer. So, the buffer output will be High state. In this time, the microcontroller will operate the filling motor to fill the water in the tank until the level reach the upper level sensor or the upper level buffer output is Low state. If the water level contact to the upper level senor probe, the supply power will flow to the ground. So, the supply of the upper level sensor will not flow to the buffer and its output will be Low state. The water level control circuit diagram is shown in Fig. 8.

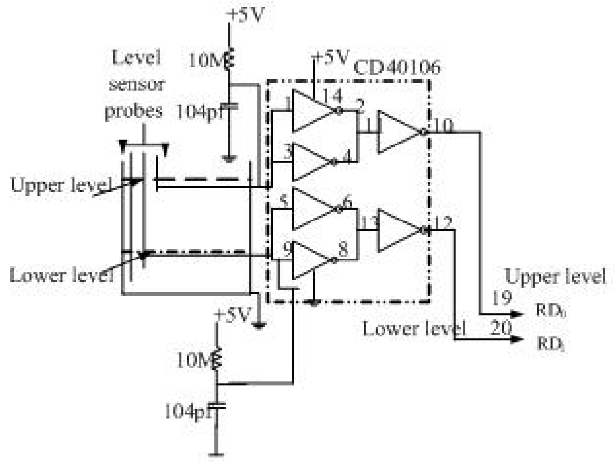

Fig. 8 Circuit diagram of water level control

The pin connections of the PIC 16F877A are important to control the different parts of the filling process and to work correctly. These connections is described Fig. 9. Pin 2, 3, 4, 5 from Port A is used as the counter output pins when the number of bottles is counted. After the number of bottles had counted to ten, the counting will reset.

And, pin 33 and 34 are also used as a filling motor and a pump motor because the conditions of rotating and stopping for the motors is wanted to monitor on the computer. Then, the output signals of conveyor motor and pushed motor are sent by pin 35 and 36 to the computer.

And then, port D is also used as the input signal pins in this project. Although there are 8-bits in ports, only six pins are used namely from pin 19 to 22 and, pin 27 and 28. These pins are used as upper level sensor, lower level senor, position senor, another position sensor and emergency signal. Pin 28 is also used through the OR gate for a start/stop signal. So, starting and stopping state for process can be made either manual or from computer. Only one pin 8 from port E is used as the emergency output signal. Other pins connections are shown in Fig. 9.

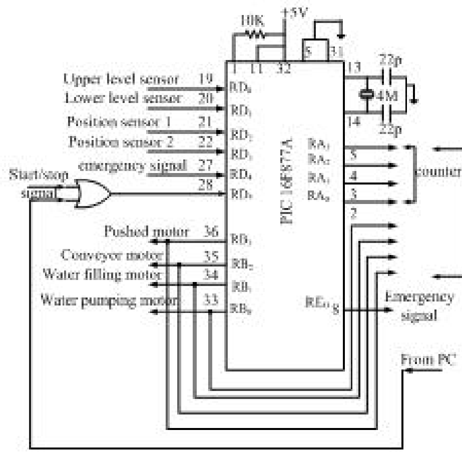

Fig. 9 Pin connection of PIC16F877A

IV. Program Flowchart for the Operation

In Fig. 10, When the position sensor 1 get the signal, the conveyor motor will be stopped and the filling motor will be opened. And when the time duration takes 5sec, this motor will be closed and will drive the conveyor motor again. Then, the position sensor 1 and 2 will be checked. If the two sensors get the input signal simultaneously at the same time, after the filling motor has opened, the pushed motor will be operated. And if a limit switch gets a signal, the pushed motor will be stopped. Finally, the number of bottles will count from the PIC. If the counter has complete 10 pieces, the operation will start again.

V. Experimental Results in Test-bed

The experimental results are shown in following. This project is to implement the control unit of SCADA system for filling process. In Fig. 11, the construction of control unit is shown by using the above controller circuits. It showed the overall circuit design with photo. In Fig. 12, the construction of hardware design for filling process is shown by using the motors, conveyors and other devices. It used to test the operation of filling process and connect the master station for SCADA system. In Fig. 13, the overall control system for SCADA is shown by photo. This figure is the SCADA control system for filling process. It connected with master station using personal computer to monitor the filling process. So, it includes the parallel port communication to interface between master station and control unit.

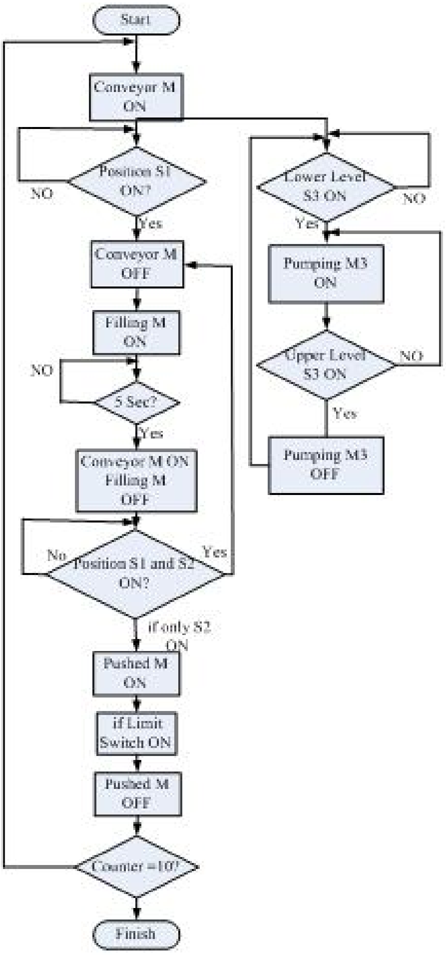

Fig. 10 Program flow chart of the filling process

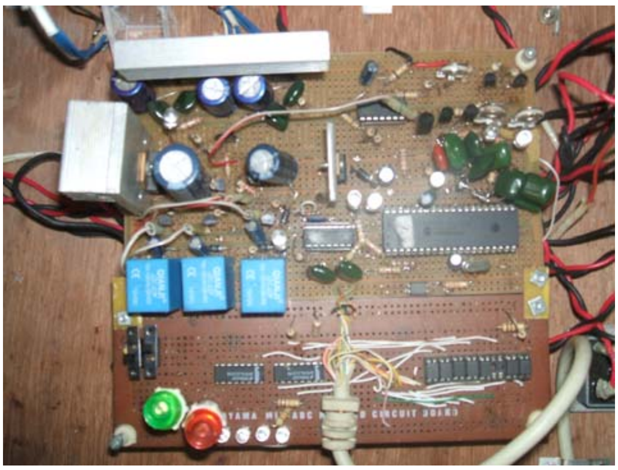

Fig. 11 Photo of control unit

Fig. 12 Photo of overall filling process system

Fig. 13 Photo of SCADA system

VI. Conclusion

This paper approached to implement control unit using SCADA system for filling process. It designed control circuits to operate the motors. This motors used for hardware mechanism of filling system. Microcontroller used for the operation of filling process and decision sequences of data. The operation of the system showed with the flowchart of programming. And the result showed with photos of hardware design. This paper designed for the manufacturing system by increasing the control systems.

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