Water Level and Temperature Control System using Programmable Interface Control

Htet Yee Thein, Thwe Mu Han
Computer University (Mandalay)
htetyeethein@gmail.com

Abstract

The aim of this system is to develop water level and temperature controlling system. The system can control not only water amount but also water temperature with an appropriate value. To construct this system, PIC16F84A microcontroller is used. The main aspect of this system is automatic control of filling tank using level switch sensor. It can be done by means of the position sensor which senses the position of the copper rod. The operations are measuring, heating and filling. Thermistor is used for temperature sensor. The user sets the required temperature by using manually preset control. To fill the water, AC motor is used. The circuit is activated by a start switch and the system is automatically filled the tank and stopped when it reaches the high level. When the water is reached the low level, this system opens heating coil to control set temperature of water. LEDs which use in this circuit are common output types. If water temperature is equal to the setting values, system turns on siren alarm. If water level is high, system is automatically closed to fill water into tank. This system is implemented by using Pic Basic Language.

1. Introduction

Liquid level sensing is the main theme of this system that especially considers for the automated operations. The main purpose is to reduce the human interference between machines and it can only be done if machines to operate in sequential steps belonging to the machines each other.

An automatic tank filling device which is operated on AC (alternating current), no complex PCBs (printed circuit boards) are needed for the system. Sensing is accomplished by position copper rod sensors. The sensors with the help of the water low level and water high level carries out the operation.

When water level is low, system starts to sense water temperature. LEDs which use in this circuit are common output type. If water temperature is equal to the setting values, system turns on siren alarm. If water temperature is less than set values, system opens heating coil to control temperature of water. If the heating water is reached the required temperature, alarm must be rung for closing the heating water.

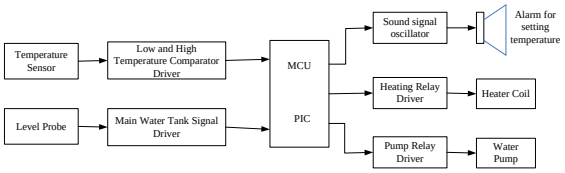

Figure 1. Overview system block diagram

2. Literature review of the system

2.1. Motor

Nowadays, the electronics devices are more powerful and more compact. But the prices are lower than the past model because of the technique of the production. There are various types of motors speed control system [3].

- Alternating current (AC)motor
- Stepper motor
- Servo motor
- Direct current (DC) motor

2.1.1. Alternating current (AC) motor. Single phase AC motor is known as a universal motor because this motor can also run with DC current. AC motors are usually sized in horsepower. AC induction motors are commonly used in industrial applications.

There are two types of AC motors, depending on the type of rotor used. The first is the synchronous motor which rotates exactly at the supply frequency or a sub multiple of the supply frequency. The magnetic field on the rotor is either generated by current delivered through slip rings or by a permanent magnet.

The second type is the induction motor, which turns slightly slower than the supply frequency. The magnetic field on the rotor of this motor is created by an induced current [3].

2.1.2. Stepper motor. A stepper motor is an electromechanical devices which converts electrical pulses into discrete mechanical movements. The speed of the motor shafts rotation is directly related to the frequency of the input pulses and the length rotation is directly related to the number of input pulses applied. Disadvantages are

- Resonances can occur if not properly controlled.
- No easy to operate at extremely high speeds.

2.1.3. Servo motor. Servo motors are used in radio controlled airplanes to position control surfaces like the elevators and rudders. Servos are extremely useful in robotics. The motors are small, have built in control circuitry, and are extremely powerful for their size.

2.1.4. Direct current (DC) motor. Direct Current electric motors operate under a basic principle of electricity: interaction between two magnetic fields positioned at an angle from each other will attract of repel resulting in movement. [5].

2.2. Water pump

AC pumps use much of the full capacity of the inverter, and come on at unpredictable times. Pumping and running a washer at the same time may require a relay to pause the washer, giving the pump priority when it runs. A submersible deep well pump of 1/3 or 1/2 horsepower with 120 volt motor can pump a 300 foot well and be powered by a 2500 watt or larger inverter [2].

If an AC pump is used, get 110 volt, 1/2 horse maximum, with external starting box. The start box must be relay start control, not solid state control, for non-sine wave inverters. Solid state start works with true sine wave. No surge, or soft-start pumps, like the Grundfos SQ series are best, if depth of water in the well is within their range.

2.3. PIC microcontroller

Microcontroller is a chip, which contains CPU, memory, timer, input ports, outputs ports and works a computer. So, microcontroller is also called a computer on a chip. Microcontroller is the main core of computer's CPU. It require the fast processing time. It always try the processing time is faster and faster. It also requires the larger amount of RAM.

A microcontroller is a small, low-cost computer-on-a-chip which usually includes: an 8 or 16 bit microprocessor(CPU),a small amount of RAM, Programmable ROM and/or flash memory, Parallel and/or serial I/O, Timers and signal generators, Analog to Digital (A/D) and/or Digital to Analog (D/A) conversion[1].

2.3.1. Architecture of PIC microcontroller. There are many types of Microcontroller. PIC microcontroller is Harvad Architecture [1]. Microcontrollers with Harvad architecture are also called "RISC microcontrollers". RISC stands for Reduced Instruction Set Computer.

Microcontrollers with Von-Neumann's architecture are called "CISC microcontrollers". Microcontroller can be divided into four groups by their architecture. They are Low-End architecture, Mid-Range architecture, High – End architecture and 18CXX [4].

2.3.2. PIC16F84A. PIC16F84A is a group of PIC16CXX family of low-cost, high performance, CMOS, full-static, 8-bit microcontroller. PIC16F84A microcontroller is mid–range architecture. It is flash memory. This IC is appropriate for repeated writing and deleting program.

PIC16F84A microcontroller is Harvard architecture. In this type, microcontroller's memory is divided into program memory and data memory. The separated buses are used to connect CPU[6]. General features of PIC16F84A are:

- RISC (Reduced Instruction Set Computer) 35 single word instructions
- 1KB Program Memory
- 14-b wide instructions
- 8-b wide data path
- Direct, indirect and relative addressing
- 1000 erase/write cycles

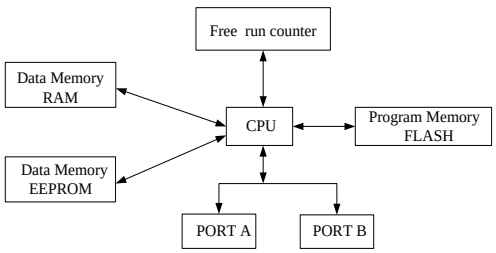

Figure 2. PIC16F84A microcontroller

2.3.3. Registers and ports. PIC 16F84A IC has two I/O ports, port A and port B. Each port concern with two registers, TRIS (Tristate) register and port register (address itself).

Setting a TRISA bit (=1) will make the corresponding PORTA pin an input a TRISA bit (=0) will make the corresponding PORTA pin an output. Setting a bit in TRISB register defines the corresponding port pin as an input pin, and resetting

a bit in TRISB register defines the corresponding port pin as the output pin[7].

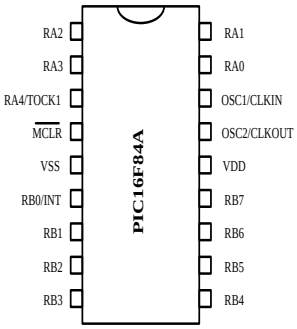

Figure 3. Pin diagram of PIC16F84A microcontroller

2.4. Sensors

A sensor is a device that measures a physical quantity and converts it into a signal which can be read by an observer or by an instrument. There are many types of sensors. They are magnetic sensor (reed switch), IR (Infrared) sensor and LDR (Light Dependent Resistor), Termistor sensor and so on [4].

2.4.1. Thermistor. Thermistors are temperature sensing devices that are similar to RTD's in that their resistance changes as temperature changes. Thermistors can be used from temperatures of –80°C to 300°C.

Thermistors are made by sintering various metal oxides together, attaching leads and packaging them in a small epoxy coated body. This thermistors is normally limited to a maximum temperature of 150°C.

Some of the different types of applications that utilize the self heated characteristics of the PTC thermistor include:

1. Self-Regulating Heaters
2. Over-Current Protection
3. Motor Starting
4. Constant Current
5. Arc Suppression
6. Time Delay

3. System operation

PIC cannot be directly be programmed and needs compiler software to program for it. This system intends to develop water level and temperature control system. Software implementation is designed by using PIC16F84A microcontroller. Program writing is a special field of work with microcontrollers and is called "programming". After the program is written, install the microcontroller into a device and run it. In order to does this measurement circuit need to add a few more external components necessary for its work.

Copper rod is used for water level sensor. If water level is contact with low level, copper rod describes 1 command to the program. If not, it describes 0 command to the program. To fill the water, AC motor is used. To open AC motor, pump motor must be described on state. (1 command to the portb.1). If not, pump motor is off. Thermistor is used for temperature sensor. For heating water, this system is used 1 command to the portb.0. If not, water heater is reached the set temperature. Siren alarm is used for required temperature, so 0 command gives to the portb.

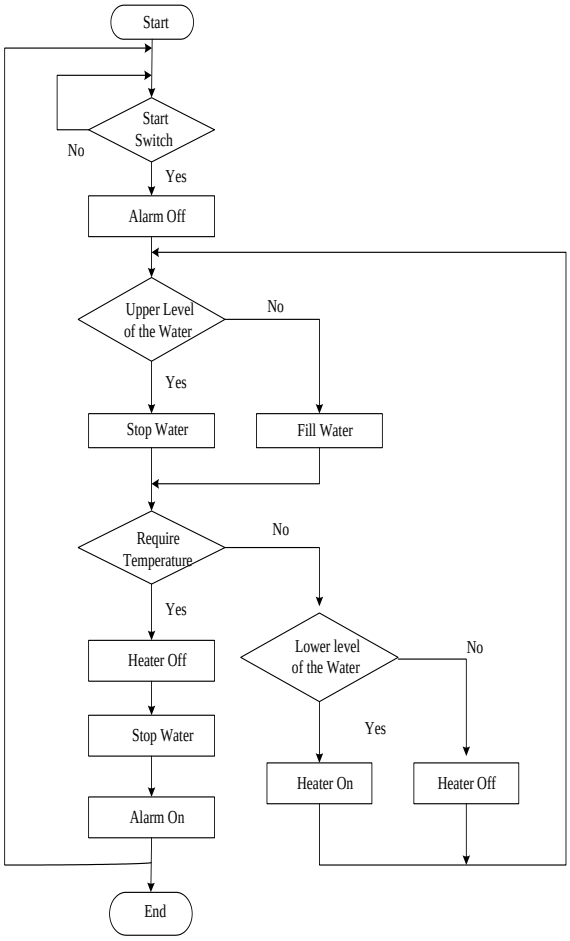

Figure 4. System flow diagram of the system

In this paper, the hardware controlling programs which are the filling process, heating process, and measuring process programming for both units are developed and written in PIC language.

Firstly, motor start switch is opened to fill water into tank. This system also controls the heating water. The control system incorporates circuitry for heating the setting temperature selected from preset

by manual. An actual water temperature sensed by a temperature sensing device called Thermistor. In this system, Thermistors can be used from temperatures of 70°C to 100°C.

The heating element of the water tank starts heating when the water is reached the low level of the tank. Copper rods are used for sensing water levels. The water low level is about 1 inch above the floor of the tank and the water high level is approximately 6 inches above the floor. When the water temperature is reached the setting temperature, the alarm must be rung. If the filling water is reached the high level sensor, the system must be automatically closed to fill water into tank. LEDs which use in this circuit are common output types.

The water temperature is automatically approached to the low temperature by means of the room temperature because the tank cannot be controlled the heating for a long time. That reduce temperature process does not dependent upon the level of the water tank.

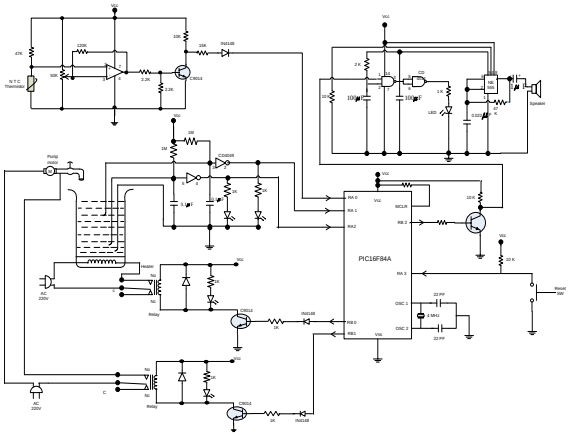

Figure 5. Overview circuit diagram

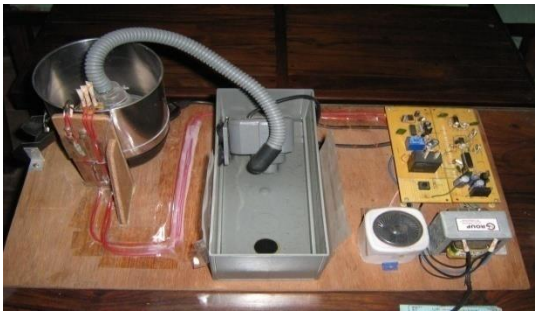

Figure 6. Testing of the system

4. Conclusion, limitation and further extensions

PIC16F84A microcontroller device and its associated peripheral modules have been presented initially. Also the alarm function is included in the circuit and it can only produce one sound to let the user know that the operating time has finished.

If the tank is remained the required temperature, the tank must not be filled water into it. Heating water is remained a short time because the tank must not be controlled the heat temperature, there is no storage of hot water for a long time. The tank can be modified any depth and width by using this system according to the requirements.

The design and construction of filling tank using level switch sensor includes three main sections electrical, mechanical and the concept of liquid level sensing. So the system cannot be perfect with theoretical knowledge alone. Upon request, this system can also perform custom modifications to the embedded software to meet specific user's requirements. This system can be modified as solar water heaters, hybrid water heaters and automatic filling system for hot and cold filling water applications.

5. References

[1]. Floyd Tthomas-L: "*Electronic Device*", 4th Edition, Prentice-Hall, Inc., 1996. ISBN: 0-13-398082-0

[2]. Jone Hewes: "*Fundamental of Electronic Devices*", 2009

[3]. N.Matic: "*PIC Microcontrollers*," 2000.

[4]. Paul E. Sandin, "*Robot Mechanisms and Mechanical Devices Illustrated*", McGraw-Hill Companies, Copyright © 2003

[5]. http://www.kpsec.freeuk.com

[6]. http://www.microchip.com

[7]. http://www.the-electronics-project.com