Automated ME FW Filling for Expansion Tank

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ABSTRACT

Fresh water expansion tank has been an important part of the cooling system for the main engine. It helps to cool down the jacket cooling water temperature through circulation and gravity. The tank is normally found at a high distance away from the main engine. However, it is not very safe and efficient as we have to top up the fresh water in the tank periodically due to evaporation, not to mention that the tank is fit in a tight and uncomfortable space. This paper is aim to design a system where the level in the expansion tank can be filled automatically with the help of microcontroller unit based (MCU) system. The system is simulated with Proteus software and the program has been compiled in the PIC C compiler. This paper will offer a system where Fresh water will be refilled automatically to expansion tank without any manual help. [1]

KEY WORDS: *PIC Microcontroller, Tank water level control, MCU, Auto refilling*

NOMENCLATURE

UMS	Unmanned Machinery Space
MCU	Microcontrollers
LCD	Liquefied Crystal Display
LED	Light Emitting Diodes
CPU	Central Processing Unit
MCU	Microcontrollers
L	Low level
LL	Low Low level
H	High level
HH	High High level
FW	Fresh water

1.0 INTRODUCTION

Marine jacket cooling water system has always been a key part in Marine industry, and also a vital part in any vessel's system. To ensure it works efficiently, there are both sea water and fresh water jacket cooling water system. The fresh water will absorb the heat produced by the main engine through heat exchange while the sea water will cool down the fresh water through the same way. The sea water will then be discharged back to the sea whereas the fresh water will continue to circulate back to the tank. This completes the cycle of cooling water system for Main engine.

1.1 Similar system

Similar systems are used in household applications on land. There are other researches trying to do automatic refilling through sensors and weight sensing. For example, once the weight of the tank goes down below certain point, the controller will start the motor, which will refill the tank to a certain point where it matches the calibration in the sensor.

1.2 Current system

The current system we use on board is through gravity and by refilling it manually. Due to the flow and speed of Fresh water, the tank has to be located at a high position for maximum efficiency. Besides that, the tank has to be manually refilled every few days to ensure the tank is not at an alarming level, which would affect the cooling system of the Main Engine.

1.3 Proposed system

A plain, rational, configurable, and easy-to-use electronic control system is proposed to provide assistance to marine engineering officers and support staff working in engine rooms. This system should also be able to work with existing engine room control systems.

2.0 Methodology

The control of the fresh water expansion tank level is a vital part of this design. The expansion tank is equipped with four level sensors. The level sensors also serve as a switching system, allowing the MCU to complete the circuit and provide the next course of action. The MCU will then send out warnings through

its ports before turning on the external peripherals it is connected to. To function as an alarm or reminder, any combination of LEDs and buzzers can be associated. LEDs of this kind could be placed on panel boards for display purposes.

When the expansion tank is at low level, the pump will start to fill up to high level. Once it reaches high level, the pump will stop filling water fresh water into the expansion tank. The LL level and HH level sensors are placed as a secondary safety switch in case the high level and low level sensor does not work properly. The buzzer is only connected to the HH level sensor and LL sensor, for alarm purposes. The MCU will control the motor through a relay. [2]

2.1 Component

The components of the system consist of

- This Microcontroller, PIC16F84A, comes with just 18 pins. The Plastic Dual in Line Package (PDLP) would serve as the system's brain.
- LCD (LM016L) Interfacing **of 16x2 LCD with our PIC16F84A**
- To transform light emitting diodes (LEDs) as a visual reaction.
- A buzzer that acts like a hearing aid.
- The switch/sensors are located on the expansion tank.
- Motor that will be triggered when necessary.
- Relay to trigger the motor and the buzzer.

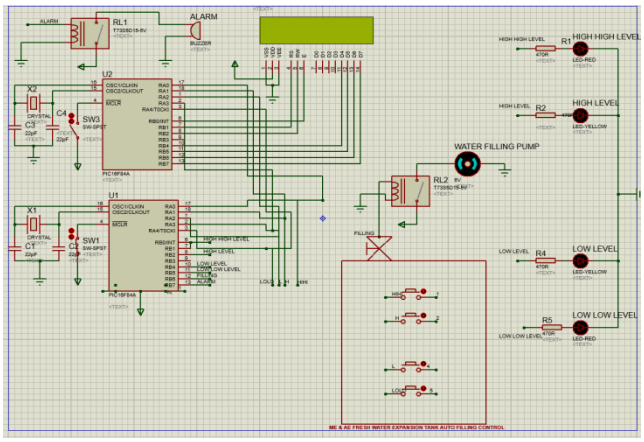

Figure 1: The schematic diagram of the system design.

2.2 Operation

The operation of the system controller is described as below:

- A switch controls the switching on of the water filling motor.
- When the expansion tank is at the low level, the LED low level is switched on, motor will start running.
- When the expansion tank is at the high level, the LED high level is switched off, motor will stop running.
- When the expansion tank is at the LL level, the LED LL level is switched on, buzzer will be ringing, motor will continue running.
- When the expansion tank is at the HH level, the LED HH level is switched on, buzzer will be ringing, motor will stop running. [3]

Table 1: Truth table

RB4(L)	RB2(H)	RB5(LL)	RB0(HH)	Motor	Alarm	Filling
1	0	0	0	1	0	1
0	1	0	0	0	0	0
0	0	1	0	1	1	1
0	0	0	1	0	1	0

2.3 Microcontroller

PIC16F84A (Figure 2) is used for this system. As the brain of the device, this MCU can operate without the attachment of other sophisticated modules. PIC is a microcontroller family of reduced instruction set computing (RISC) manufactured by Microchip Technology resulting from the PIC1650, formerly developed by the Microelectronics Division of General Instrument. PIC is the integrated circuit used to establish external device control and lighten the load from the main system CPU. The main CPU acts as a brain, and the PIC is the same as our autonomic nervous system when compared to a human being. [4]

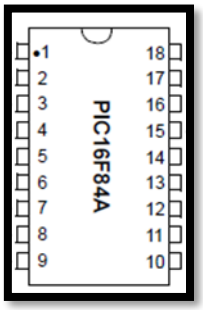

Figure 2: PIC16F84A Microcontroller Pin assignment (PDLP)

2.4 Software

The microcontroller codes are written, edited, compiled, and programmed using the "C parser for the PIC MCU." This compiler aids in the configuration of the Microcontroller and PicKit2 programmer into high-level programming languages.
By actuating the microcontrollers' input-output ports and taking into account the individual tasks, the programming algorithm will decide the parts' conditions. The fundamental ability of the entire system is to activate microsecond interim timing, identify the sensor's inputs, and trigger the outputs by triggering the alarm or motor. [5]

2.5 Programming Description

The code used to govern the whole operation is encoded in the PIC16F84A & PIC 16F877A microcontroller's C language. All the codes were compiled using CCS compilers and checked.

2.6 System Flow

Sensors connected to the expansion tank can detect the current level of the tank and transmit the signal to the Microcontroller Device. This machine operates by detecting the level of fresh water from the FW expansion tank. The MCU will then settle on the next course of action intelligently, either automatically activating the motor or triggering the alarm so that the person in charge of the vessel may take more action.

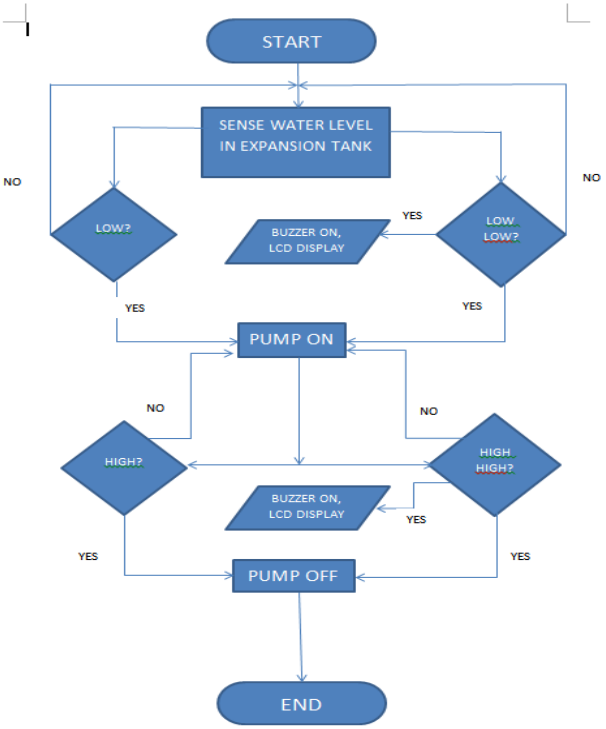

Figure 3: Flowchart of the System

2.7 Circuit

There are 4 main components of circuit: the power source component, the microcontroller portion, the input sections of the device, and the output parts. The MCU device is combined with all these components.

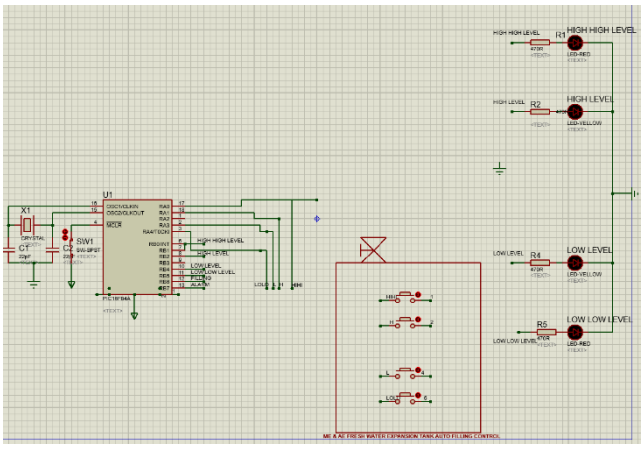

Figure 1: Input & Outputs for Main MCU Controller

U1 is used to attach all four input sensors at the tank and purifier MCU output, as shown in Figure 3. U2 is used to protect all aspects of the device, including the display units (LEDs).

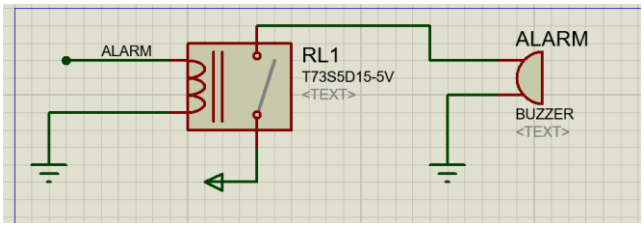

Figure 4: Alarm Circuit

As in figure 4, when the expansion tank level reaches the LL level, Main MCU will automatically trigger the engine Room alarm to alert the crew and reminding them something is wrong with the low level sensor. A relay is used for the alarm buzzer, as shown above.

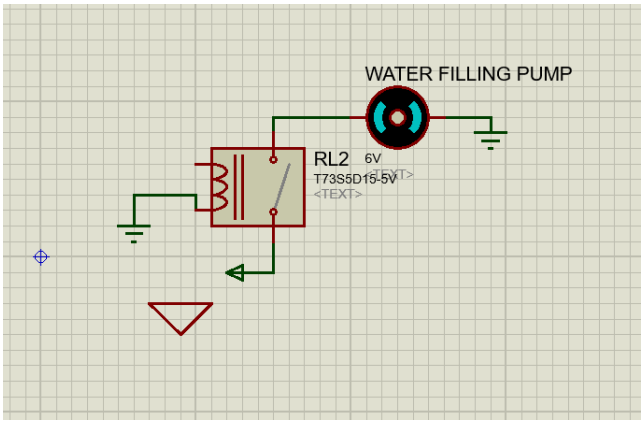

Figure 5: Water filling pump

The water filling pump will start automatically when the fresh water in the expansion tank level reaches low level, and eventually stop automatically when the sensors in expansion tank reach the high level. The pump will start automatically too if the level reaches LL level, and stop automatically if it reaches HH

level, with a difference that LL and HH level are connected to a buzzer.

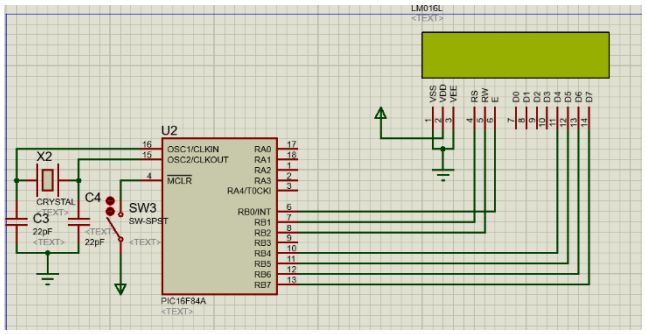

Figure 6: LCD Display Circuit.

Figure 6 is the LCD display circuit .When the sensor senses the level and motor activation; it receives data from the MCU unit, and it shows the current action of the motor and water level, which helps the crew to understand the situation better. [6]

3.0 CIRCUIT DESIGN AND SIMULATION

The circuit was created using the Proteus Version 8.9 programme. To complete the course, all components are wisely selected from the programme catalogue, according to the scheme. Once all of the necessary components have been arranged, all connections are made in the proper order. After the coding is over, the CCS C compiler is used to compile the programmes for all MCU units. After that, a hex file will be developed, and the plans will be uploaded using the PicKit2 to the PIC microcontroller.

4.0 RECOMMENDATION

The researchers suggest that the MCU can be used to run an automatic water refilling device in this project. The circuit is programmed to detect the level of the expansion tank and transmit signals to the pump. This concept can also be applied on safety features of the existing equipment to prevent massive machinery breakdowns. Apart from that, an alarm system circuit with a smart I/O type MCU and an LED for a signal is demonstrated. Onboard revisions to the basic rule can be handled by reprogramming the MCU. The PIC16F84A-MCU controls and intelligently determines each of these elements, allowing for further applications to be investigated.

5.0 CONCLUSION

The protection of the main engine cooling system is the priority of this project. The main goal of the device is to automatically sense the water level in the expansion tank and transfer the resulting data to the MCU for further operation of the water filling pump using a set of sensors installed in the port. The aim is to exclude human interference from the fresh water refilling process. The installed framework would also provide an audible alarm if the system failed. The designed circuit has shown that the PIC16F84A Micro-Controller Unit can receive and transmit signals to monitor the different machines onboard the vessel systems based on simulation data.

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