Design and Modelling Ship Automatic Emergency Bilge System with Application of Microcontrollers

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ABSTRACT

Shipping industry has always been the main driving force for trade and commerce around the world. Every country relies on maritime transport to sell what it has and buy what its needs. Most of the things we use or eat might travelled from other side of the world and it is transported by the sea via a ship [1]. So, safety and survivability of a ship is very crucial**.** Until now, there is still lots of cases of ship accidents that causes ship to capsize and sunk in the sea. The purpose of this project is to describe a simple design on an affordable system, and application of the micro controller unit (MCU) based system. This design is simulated using the Proteus software and to be implemented to the hardware models. The program has then compiled in PIC C Compilers, and is programmed into the microcontroller using a programmer for PIC 8 -bit microcontrollers. This project will propose the ship Automatic Ship Emergency Bilge system that will act as a way to control flooding of water in engine room in case of emergency. The model of the system functioned well using the simulator software.

KEY WORDS: *PIC Microcontrollers, MCU, Ship Emergency Bilge system*

NOMENCLATURE

MCU	*Microcontrollers*
PDLP	*Plastic Dual in Line Package*
PIC	*Peripherals Interface Controllers*
LED	*light emitting Diode*
HL	*High Level*
NL	*Normal Level*
RISC	*Reduced Instruction Set Computing*

1.0 INTRODUCTION

Bilge acts as a drainage system onboard the ship that all the machinery or cargo tank leaks will accumulates in it. The bilge system is arranged to drain all the water or oil content in the bilge by discharging it overboard through an oily water separator. The bilge system also equipped with emergency bilge suction that used to prevent engine room flooding in case of emergency. It is a direct suction from the engine room machinery space bilge to the emergency bilge pump that completely independent unit and capable of operating even if in submerged condition.

1.1 Current System

The current Emergency Bilge System is very useful and practical to prevent flooding of the ship. The system is simple and direct where bilge content can be discharge to overboard in case of flooding happens. However, the system is manually operated. In some cases, the emergency bilge suction valve is locked by the crew to avoid accidental discharge of bilge into the sea. These actually might delay the process of preventing engine room flooding. Moreover, there is high tendency of human error when a system is manually operated, especially during emergency.

1.2 Proposed System

A simple, affordable, practical and easy to be operated electronic control system is proposed to deliver a beneficial assistant and backing for the ship crews in case of emergency.

2.0 METHODOLOGY

A Microcontroller will continuously observe the bilge fluid levels; sensors will be attached to bilge area. The Sensors will be acting as the switches to complete the circuits, and eventually the MCU will then decide on the next course of action. Warnings will then be triggered by the MCU through its ports and ultimately will activate the external peripherals

that it is attached to. This warning could be some combinations of LEDs and buzzers. Such LEDs which serve as display purposes could be installed on the panel boards. This system could be realized by using lesser number of mechanisms, the controllers also offers great performances with dense sized and low price MCU. If the liquid level in the bilge gets high than normal level the pump and suction and discharge valve will automatically be activated, to discharge the fluid from the bilge to overboard. The motor of the pump and suction and discharge valve will be controlled by the MCU through a relay [2].

2.1 Component

The components of the system consist of (1) PIC16F84A [6], this Microcontroller come with only 18-pins. The Plastic Dual In Line Package (PDLP) that would perform as the brain of the system, (2) 4N25 Optocoupler to be used to safeguard the microcontroller from electricity over supplies, (3) light emitting diodes (LEDs) to act as a visual alarm, (4) Buzzer which function as hearing alarm, and (5) Sensors that is installed to the tank top, (6) Motor that will be activated when sensors detected high fluid level, (7) Relay which will be used to control the Motor and the Buzzer. Figure 1 illustrates the schematic diagram of the system design.

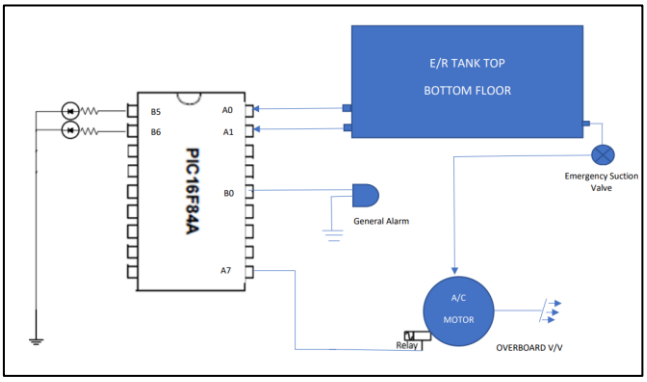

Figure 1: Simplified Schematic diagram

2.2 Operations

Table 1, show the logic of the operation

INPUT PORT		OUTPUT PORT			
NL A0	HL A1	NL.LED B5	HL.LED B6	ALARM B0	MOTOR B7
1	0	ON	OFF	OFF	OFF
0	1	OFF	ON	ON	ON

Table 1: Shows the logic of the operations

- When fluid is at high level (HL), the HL LED, Alarm, Motor will "ON" and the NL LED will "OFF"
- When fluid is at Normal Level "NL" the Normal LED will "ON", and the HL LED, Alarm and Motor will "OFF".
- When the sensor detected high bilge level the Motor, Alarm and HL LED will triggered and pump will instantly discharge the fluid overboard.
- When the sensor no longer detected high Bilge Level after discharged overboard, the Motor , the HL LED and Alarm will automatically "OFF". And the NL LED is turned "ON".

2.3 Microcontrollers

A Microcontroller is a compact microcomputer which comprises of processor, memory and peripherals [3]. for this system, we use PIC16F84A (Figure 2) This MCU is used as the brain of the system, it has the ability to function independently without needing attachment of any other sophisticated and complex modules. PIC is a family of reduced instruction set computing (RISC) microcontrollers manufactured by the Microchip Technology which is resultant from the PIC1650 that is formerly developed by General Instrument's Microelectronics Division. PIC is the integrated circuit which was usually used to develop in controlling external devices and reducing the load from the main CPU in the system. Mimicked as a human brain the main CPU control the whole system and the PIC is same like an autonomic nervous system. Hence, it is recommended that 8-bit PIC16F84A microcontroller which is sufficient enough to act as the central control of the system.

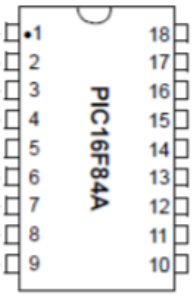

Figure 2.1: PIC16F84A Microcontroller Pin assignment (PDLP)

Figure 2.2: How real PIC looks like.

2.4 Software

The "C compiler for the PIC MCU," is utilized for composing, editing, compiling, and programming the codes for the microcontroller. This compiler, which empowers the microcontroller to be customized in high level programming languages, together with PicKit2 programmer. The algorithm of the codes will decide the state of the parts by actuating the microcontrollers input - output ports taking into account the particular tasks. The fundamental capability of the entire system is to allow a timed with micro-seconds interim, to acknowledge the sensor inputs.

2.5 Programming Description

The program used to control the entire process is embedded in PIC16F84A microcontroller's C language. All the codes have been compiled and tested using CCS compilers.

2.6 System Flow

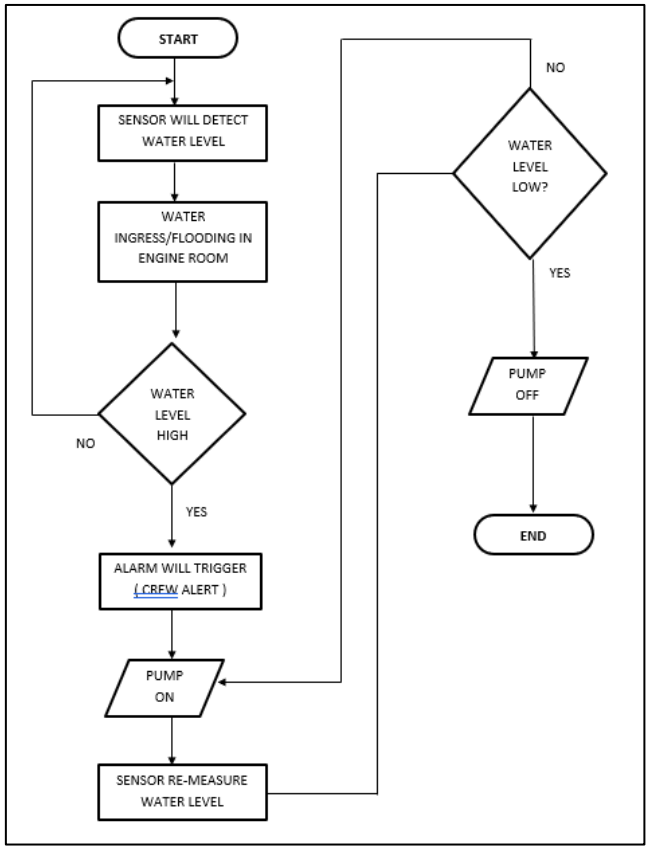

Figure 4. Flowcharts of the system

The emergency bilge system works in sensing fluid level on the tank top, sensors which are attached to the tank top then will continuously sense the current level of the tank top, and send the signal to the Microcontroller Unit. The MCU then will intelligently decide on the next course of action, either activating the Motor automatically and triggering the Alarm to automatically discharge the overflowing bilge overboard.

2.7 Circuit

The circuit comprises of four main essentials: the power source section, microcontroller segment, which consist of the system input parts, and the output parts. All these modules are integrated to the MCU unit.

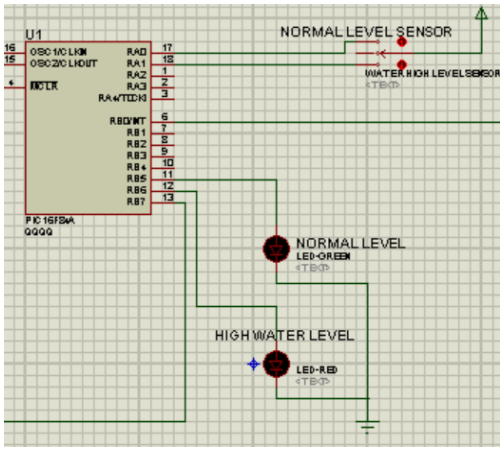

Figure 4. Input and Outputs

As in figure 4, the 2 input sensors are connected using the Port A, and all the output of the system are connected using the Port B including (LEDs).

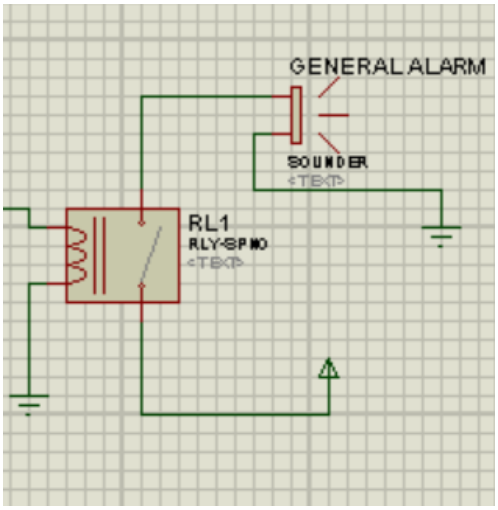

Figure 5. Alarm Circuits

The alarm will be triggered when the sensors detected high bilge level. It is automatically signaled by the sensor to the MCU and the MCU will decide whether to turn the Motor, Alarm and Led "ON"

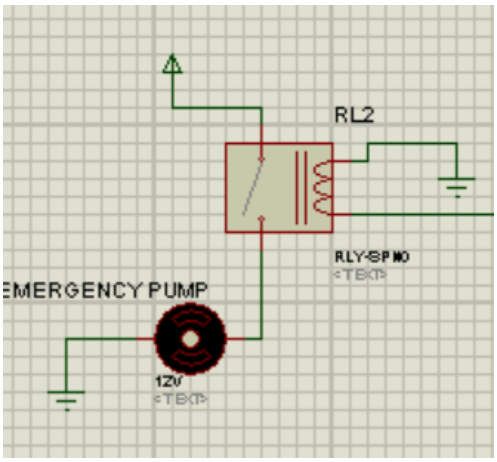

Diagram 6. Emergency Pump Circuits

The emergency pump will start automatically when the Motor start by signal from MCU. And the Motor will only stop if the bilge level is down to the set safe level.

3.0 CIRCUIT DESIGN SIMULATION

The circuit was then replicated in the software Proteus v7.6. In this software, the entire components of the circuit which is essential were carefully chosen from the software library and the connections were done by lines. The program was later compiled using CCS C compiler. The output, hex file of the program is loaded into PIC microcontroller using the PicKit2. Finally, the simulation is tested for all the conditions. The circuit used for simulation is given in Figure. 4. The connection to the microcontroller separated into 3 parts of circuits. The inputs from the sensors were connected to RA0 till RA1 pins (using Port A) of the microcontroller while the outputs of the system were connected from RB5 and RB6 for the display units (LEDs), and RB0 is connected to the alarm (figure 5), and finally the RB7 is used to connect to the AC Motor relay (figure 6). All the output pin is connected through (Port B) of the controller.

4.0 RECOMMENDATIONS

The authors presented operation of modified fluid level controller. Besides, it is displayed to utilize a practicality of I/O sort MCU as the part to a circuit for fluid level detection and controls. This circuit monitor and controlled the water level of the tank top, and utilized LED and for alarms. From the equipment circuit, only few external components are used. In addition, the MCU could be reprogrammed or modified to suit the regular regulation changes on board. Every one of these components are controlled and wisely decided by the PIC16F84A - MCU and more application scenarios could be further invented.

5.0 CONCLUSIONS

Last but not least, this proposed system will ensure the safety and survivability of the vessel during emergency or in specific incident of flooding in the engine room by minimizing the effort of the crew to discharge overflowing bilge level. The system is fully automatic which reducing the chance of negligence or human error. Its is also very simple and the process is very fast to activate but yet very safe. The system could be applied to all vessel or set as a crucial requirement onboard in the future with further modification and improvement.

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