Design, Modelling and Application of Microcontroller (MCU) on Bilge Pump Automatic Start

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ABSTRACT

Due to the negligence of watchkeeper / late response during flooding on-board is a very common phenomena. The bilge pump on-board is operated manually and due to this manual operation, the bilge pump during collision / grounding will cause the ship to experience flooding situation. One of the example situation is Ms. Herald of Free Enterprise was a RORO ferry which capsized due to human negligence [1]. The aim of these paper is to describe a simple design and application of the microcontrollers unit (MCU) based system. These design were simulated using the Proteus software and then later to implement and test in the hardware models. The program has then compiled in PIC C Compilers, and were programmed into the microcontroller using a programmer for PIC 16-bit microcontrollers. These design for bilge pump automatic start will alert the crew in charged through alarm signals and increase time for crew to troubleshoot the leaking problem.

KEY WORDS: PIC microcontroller, , MCU, Float switch

NOMENCLATURE

CPU	Central Processing Unit
H	High Level
N	Normal Level
LED	Light Emitting Diode
MCU	Microcontrollers
B	Buzzer

1.0 INTRODUCTION

Oily waste means oil residues (sludge) and oil bilge water. Oil residue (sludge/ bilge) tanks are the tanks which hold oil residue (sludge/bilge) directly from which may be disposed through the standard discharge connection or any other approved means of disposal. [3]

The bilge main is arranged to drain any watertight compartment other than ballast, oil or water tanks and to discharge the contents into separate tank or via Oily water separator to overboard. . The emergency bilge suction is used to prevent flooding of the ship. On vessels it requires bilge sensors and bilge wiring to notify the crew how much and where the bilge water is rising. [2]

1.1 Similar System

This design refers to a concept of submersible pump. A submersible is a centrifugal pump which is attached to an electric motor and operates automatically when the high level float is lifted up. Each impeller in the series forces water through a diffuser into the eye of the one above it.

1.2 Current System

All bilge suctions is fitted with suitable strainers, which in the machinery space would be mud boxes positioned at floorplate level for easy access. A vertical drop pipe would lead down to the bilge.

It is operated manually and completely independent unit capable of operating even if submerged. A centrifugal pump with a priming device used, driven by an electric moor housed in an air bell. The power supply is arranged from the emergency generator for emergency bilge pump.

The various pumps and lines are interconnected to some extent so that each pump can act as an alternative or standby for another.

For self-propelled vessels with engines or boilers located in two or more spaces, bilge pumps must be distributed throughout these compartments. For other vessels where two or more bilge pumps are prescribed, the bilge pumps must be located in separate watertight compartments to the extent practicable.
[4]

1.3 Proposed System

The design for bilge pump automatic start will start automatically when the water / bilge level reaches the high level float and it will also trigger an alarm to alert the crew to take an immediate action. Having these design made onboard will increase the time to troubleshoot the pipe leak and it is an easy automatic control system to deliver a beneficial assistant and backing for the ship crews.

2.0 Methodology

A microcontroller will constantly observe the level of the float in the system. A button send the signal into the MCU for decision making. 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, buzzers, motor, and LCD. Such LEDs which serves as display purposes. Once the floats is above, the pump would run and pumping out the bilges water to tank until the float back to normal position.

2.1 Component

The components of the system consist of (1) PIC16F84A [6], this Microcontroller come with only 18-pins[5]. 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 turn as visual response, (4) Buzzer which function as the hearing response aids, and (5) Sensors that is installed to the main tanks , (6) Motor that will be activated when needed, (7) Relay which will be used to control the Motor and the Buzzer. Figure 1 illustrates the schematic diagram of the system design.

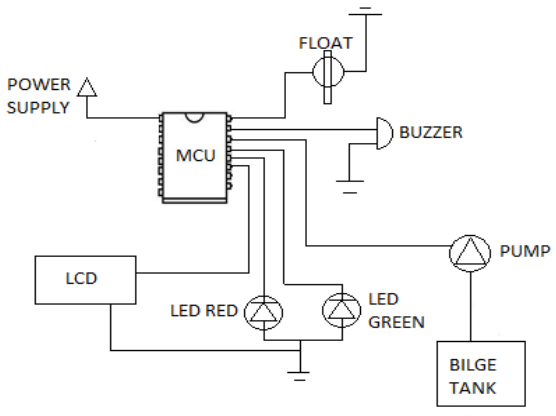


Figure 1. Simplified Schematic Diagram of Circuit.

2.2 Operations

The operations concept is describe as below:

- When in Normal Condition (N.C.) the float will stay at is position. The LED Green light would be indicating the normal condition.
- When in High condition (H.C.), the float move upwards, the LED Red, Buzzer and Motor is activated.

TABLE 1: TRUTH TABLE

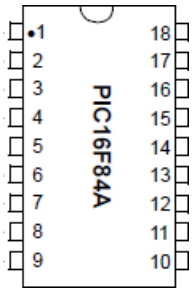
Table 1: Truth table of the operation

INPUT PORT	OUTPUT PORT				
Button	**LED G**	**LED R**	**MOT**	**BUZ**	**LCD**
0	1	0	0	0	1
1	0	1	1	1	1

2.3 Microcontrollers

PIC16F84A (Figure 2), is used for this system. This MCU is used as the brain of the system, it has the ability to function without other sophisticated modules to be attached. 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 frequently used to develop in controlling exterior devices and lightening the load from the main CPU in the system. Matched to a human being, the main CPU act as a brain and the PIC is same to our 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: PIC16F84A Microcontroller Pin assignment (PDLP).



2.4 Software

The "C compiler for the PIC MCU," is utilized for composing, editing, compiling, and programming the codes for the microcontroller. These 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, and to activate the outputs with enacting the Alarm or the Motor.

2.5 Programming Description

The program used to control and monitor the operation of the system is program onto PIC16F84A microcontroller's C language. All the codes have been compiled and tested using CCS compilers.

2.6 System Flow

This system works by the position of the level of the float in bilge tank. The position of the float level would be sent to the Microcontroller Unit for processing. The MCU would then monitor and decide the next course of action by activating the LED, alarm and buzzer.

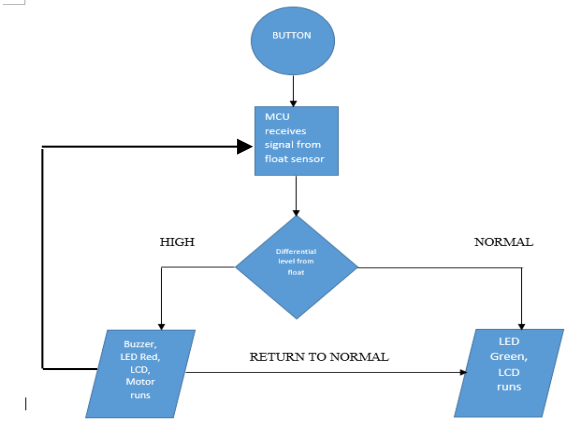
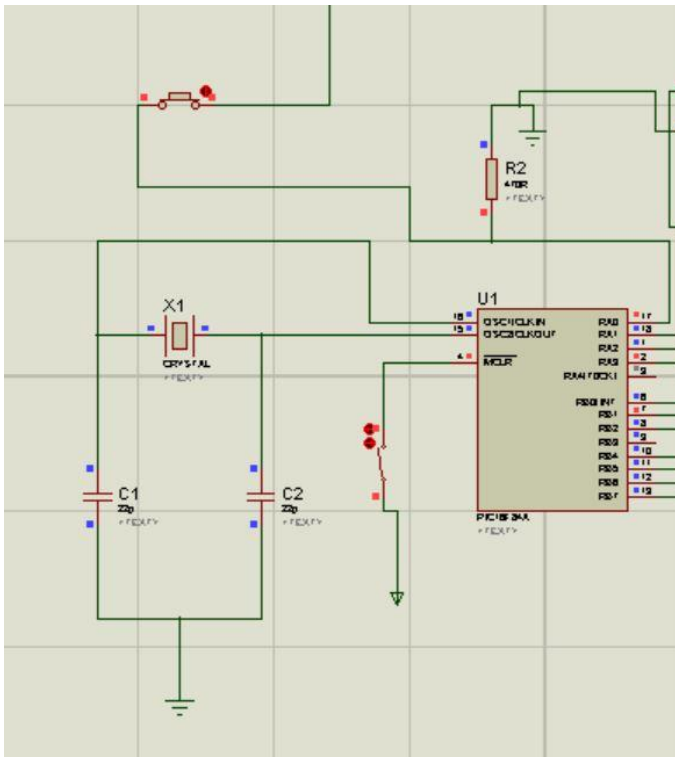


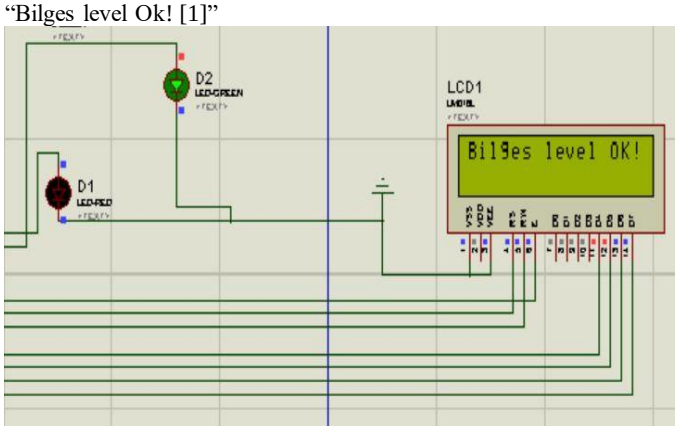
Figure 3 :Flowchart of the system.

2.7 Circuit

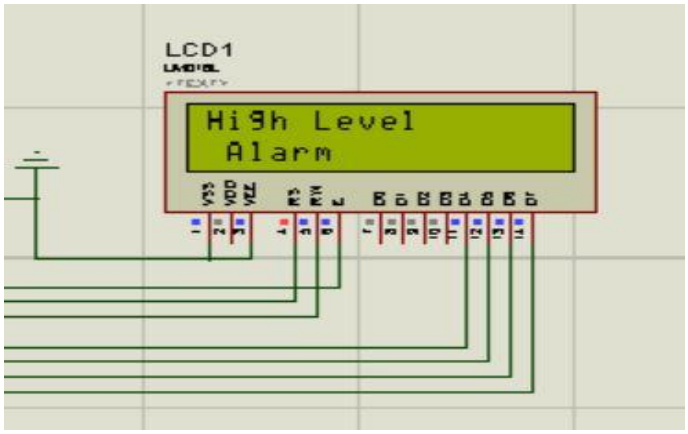
The circuit consist of elements as such:
The power source section, microcontroller segment, which comprises the system input parts, All these modules are integrated to the MCU unit.

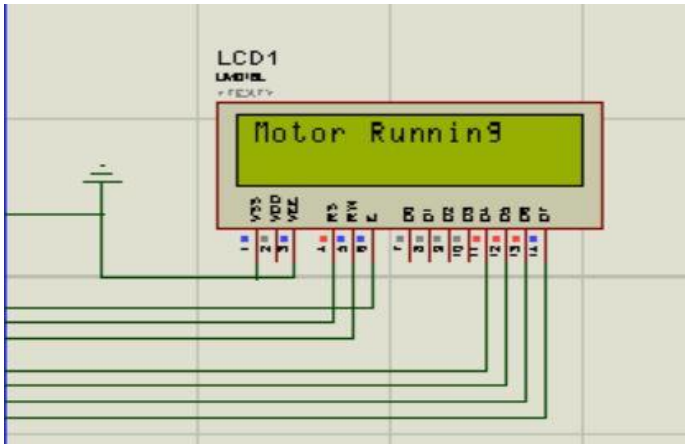


In normal condition Green led lighted up in and LCD display "Bilges level Ok! [1]"

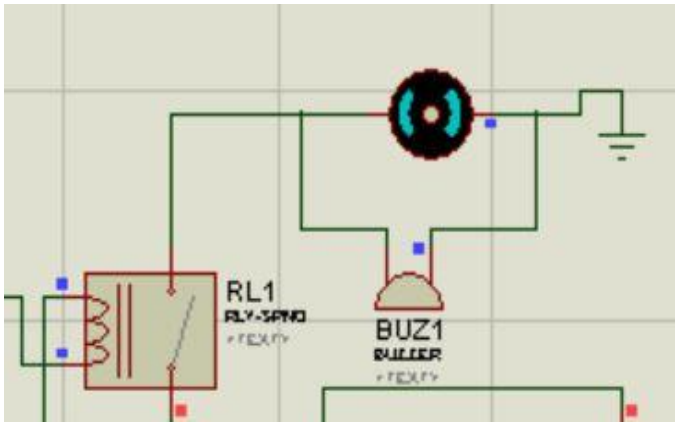


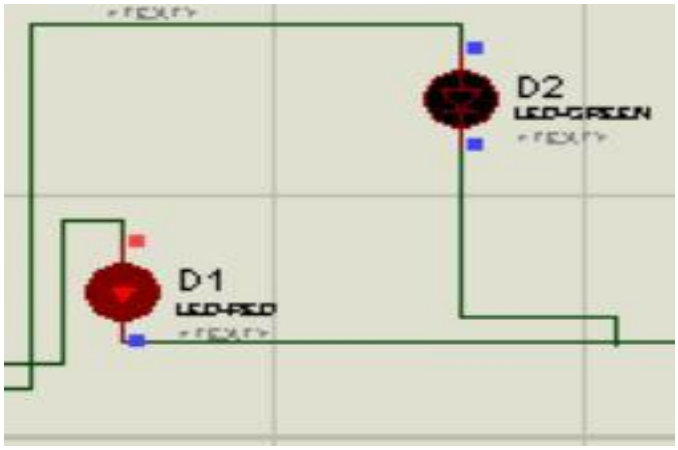
When button is pressed (float detect high bilges). LCD display "High Level Alarm" and "Motor Running"





Motor, and buzzer start running together with red led which blinks as per set delay.





2.8 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. Finally, the simulation is tested for all the conditions. The circuit used for simulation is given in Figure above. The connection to the microcontroller is separated into 2 parts. The inputs from the sensor which is the float is connected to RA0. While the outputs of the system were connected
RA1 for LED Red and RA2 for LED Green and finally RA3 is connected to the DC Motor relay, motor pump and buzzer. Port B is connected to the LCD for indication.

2.9 RECOMMENDATIONS

In this paper, we presented the operation of bilge pump automatic start. This circuit has a float whereby it detects the high level alarm and will start the pump automatically which will give time for the crew to troubleshoot any pipe leakage. Every one of these components are controlled and intelligently decided by the PIC16F84A - MCU and more application cases could be further explored.

3.0 CONCLUSIONS

Thus, this proposed system will ensure the occupational safety on board by giving more time for the crew to troubleshoot the leakage problem.
This system could further be improved in near future. Upcoming system could be focused on automation system.

References

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[2] International Maritime Organization, "2008 revised guidelines for systems for handling oily wastes in machinery spaces of ships incorporatting guidance notes for an integrated bilge water treatment system," MEPC.1/Circ.642, London, 2008.

[3] D.A.Taylor, Introduction to Marine Engineering, Butterworth-Heinemann: Elsevier, 2006.

[4] U.S Coast guard marine Safety Center Plan Review Guideline, "Review Of Bilge and Ballast Systems," J.J.Min, U.S, 2020.