Design, Modelling and Application of Microcontroller (MCU) on Compressed Air System

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ABSTRACT
Onboard a ship, compressed air is used for several purposes. On the basis of application, different air compressors are kept for a particular usage.

- Air compressor is used to provide the starting air to various machines and main engine.
- Other than the main engine other systems also require compressed air. These systems are Control valves. Throttle controls and other monitoring systems which work on pressurized air.
- This compressed-air controls many operations in the auxiliary engine as well.
- In pneumatic tools like cleaning, devices compressed air is required to keep the devices running and serve the purpose efficiently.
- In whistling operation of ships also compressed air is employed and the fog horns operate on the compressed air.
- Hydraulic jack in the ship also uses compressed air to perform lifting operations.
- Many times boilers; refrigerants and heat exchangers in ship are started using compressed air.
- Sometimes compressed air is used in kicking the propellers of the ship manoeuvring system.

In this paper, described simple design on a low-priced system, and application of the microcontrollers unit (MCU) based system. These design were simulated using the Proteus .

KEY WORDS:*PIC microcontroller,Air Compressor Motors.Compressed Air Botlles, Alarm system, MCU,sensors*

NOMENCLATURE

CPU	*Central Processing Unit*
LED	*Light Emitting Diode*
LL	*Low – Low Level*
MCU	*Microcontrollers*
N	*Normal Level*
PDLP	*Plastic Dual In line Package*
PIC	*Peripheral Interface Controller*
RISC	*Reduced Instruction Set Computing*
UMS	*Unattended Machinery Space*

1.0 INTRODUCTION

Air Compressor produces pressurized air by decreasing the volume of air and in turn increasing its pressure. Different types of air compressors are used according to the usage.In a more technical language, an air compressor can be defined as a mechanical device in which electrical or mechanical energy is transformed into pressure energy in the form of pressurized air.Air compressor works on the principles of thermodynamics. According to the ideal gas equation without any temperature difference, with an increase in gaseous pressure, its volume reduces. The air compressor works on the same principle on which it produces compressed air, by reducing the volume of air this reduction in volume results in an increase in air pressure without any temperature difference.

Unattended Machinery Space, or UMS class vessels is a way of operating automatically controlled by the machinery of a vessel. A newtopics has been included covering the operations management and safety, which reflects changes in the seagoing engineer's duty. Modernized maintenance management is another new subject turning out to be more vital as a result of the wide utilization of unattended machinery spaces [1].
On vessels there is numerous parameters to be measured or

observed frequently, these includes: the pressure, position of vessel, temperatures, level, flow control, torque control, viscosity, speed, current, voltage, equipment position (open / closed) and machines status (on / off).

1.2 Current System

Current Automation and Controls covering numerous parts of the vessel operation that incorporates the plant operation, power administration operation on the auxiliary engines, assistant on machine operations, freight on-and-off-stacking operation, route and administration of support and purchasing of spares, however most of the Air systems on the vessels are being controlled and monitored automatically by relays and switches. The air system are fully automated. Most of the vessels uses the limit or float switches to activate or deactivate the main Air Compressor Motor on board.

1.3 Proposed System;

A modest, inexpensive, configurable, easy to be operated electronic control system is proposed to deliver a beneficial assistant and backing for the ship crews.

1.4 METHODOLOGY

A Microcontroller will constantly observe the Air Pressure in the Main Air Bottle; sensors will be attached to the main Air Bottle. 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 serves as display purposes could be installed on the panel boards. This system could be realized by using lesser amount of mechanisms, the controllers also offers great performances with dense sized and low price MCU. If the Air Pressure in the Air Bottle gets lower the motor will automatically be activated, to pump the Air to the reservoir tank. The motor will be controlled by the MCU through a relay[5].

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 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.

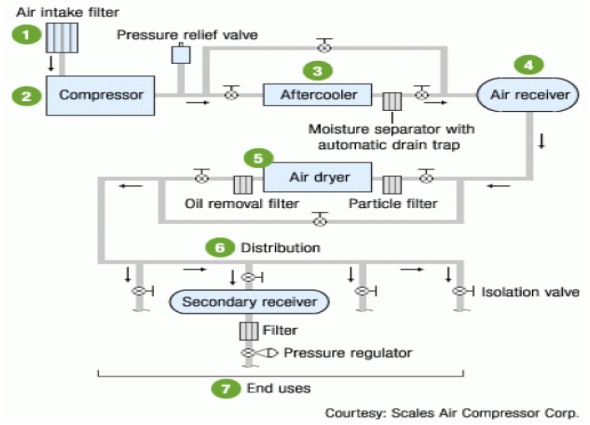


Figure 1: Simplified Schematic diagram

2.2Operations

The operation concept is described below:

- If Air compressor not cut in ,When low air Pressure occurs in the main Air bottle, the LED and Alarm will be triggered.
- When the Air Pressure reaches at cut in set position , the system will sense LED will On and give signal to compressor motor to Start and fill up.
- When Air Pressure reaches at maximum set limit ,It will give signal to Motor to stop and also LED will On .
- When the Pressure reaches at High (LL), LED will be ON, the Alarm will be triggered and the Motor will stop.

Table 1, shows the logic of the operations.

Table 1: Truth Table

Simulation switch When Power Source On					Simulation switch When Power Source Off				
	H.P	Cut Out	Cut In	L.P		H.P	Cut Out	Cut In	L.P
Al	1	0	0	1	Al	1	0	0	1
Comp	0	0	1	1	Comp	0	0	0	0
H.P	1	0	0	0	H.P	1	0	0	0
Nor	0	1	1	0	Nor	0	1	1	0
L.P	0	0	0	1	L.P	0	0	0	1

2.3Microcontrollers

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.

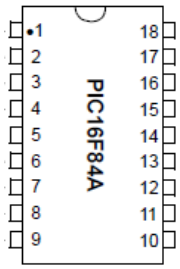


Figure 2 : PIC16F84A Microcontroller Pin assignment (PDLP)

2.4Software

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.

2.5Programming Description

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

```
#define power pin_a0
#define highpress pin_a1
#define compcutoff pin_a2
#define compcutin pin_a3
#define lowpress pin_a4
#define lowredlight pin_b2
#define normalgreen pin_b1
#define aircomp pin_b6
#define highredlight pin_b0
#define buzzer pin_b7

Void main()
{

for(;;)

if(input(power)==1)
{
if(input(highpress)==1)
{output_high(buzzer);output_high(highredlight);output_low(aircomp);output_low(normalgreen);output_low(lowredlight);}
if(input(compcutoff)==1)
{output_high(normalgreen);output_low(aircomp);output_low(highredlight);output_low(lowredlight);output_low(buzzer);}
if(input(compcutin)==1)
{output_high(aircomp);output_high(normalgreen);output_low(buzzer);output_low(highredlight);output_low(lowredlight);}
if (input(lowpress)==1)
{output_high(aircomp);output_high(buzzer);output_high(lowredlight);output_low(normalgreen);output_low(highredlight);}
}
else
{
if(input(highpress)==1)
{output_high(buzzer)&& output_high(highredlight);}
{output_low(aircomp)&& output_low(normalgreen)&& output_low(lowredlight);}

if(input(compcutoff)==1)
{output_high(normalgreen);}
```

Figure 3: C++ Coding

2.6System Flow

This system works in sensing the level of Compressed Air from Main Air Bottle, sensors which are attached to the Bottle will then sense the pressure level of the Bottle, 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 or triggering the Alarm to allow the person in charge on the vessel to take further action (Figure 3).

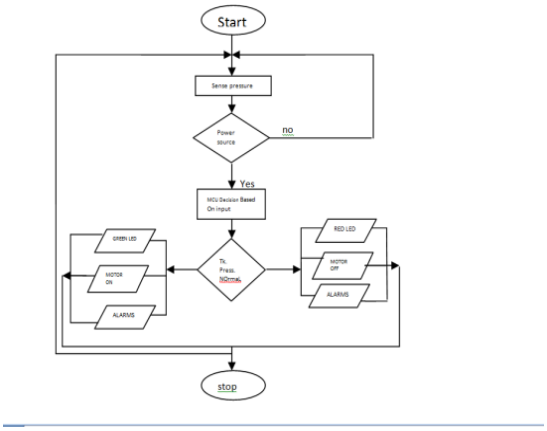


Figure 3: Flowchart of the system

2.7Circuit

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

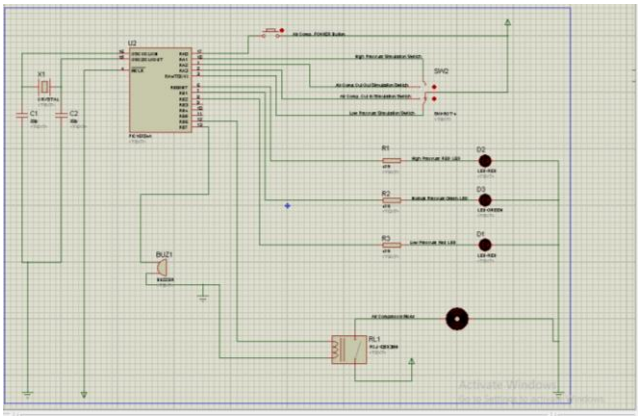
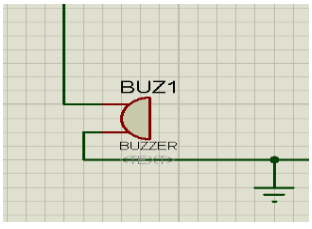


Figure 4 : Complete Circuit Diagram

As in figure 4, all the 5 input sensors are connected using the Port A, and all the output of the system are connected using the Port B including the display units (LEDs).



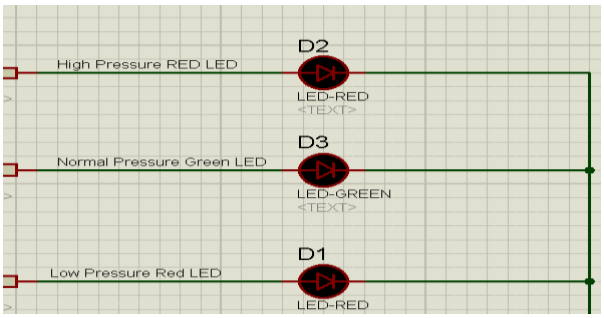


Figure 4 : Alarm Circuit & LED Indication

Once the Pressure in main tank reaches Full (F), or it is at the Low – low Level (LL), the alarm will automatically trigger by the MCU, to indicate an immediate attention is needed by the crew of the vessel. The MCU will be connected to the Alarm through a relay as in figure 5.

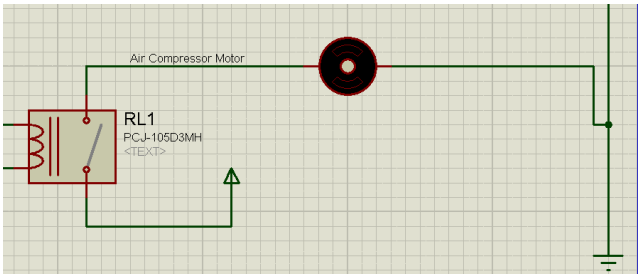


Figure 6 : Air Compressor Motor Circuit

The filling AIR Compressor motor, will start automatically, when the Air Pressure in Air Reservoir level yet to reach to sensor , and eventually stopped automatically when the sensors in reservoir reaches to the desired level (Figure 6).

2.0 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 RA4 pins (using Port A) of the microcontroller while the outputs of the system were connected RB0 throughRB3 for the display units (LEDs), and RB4 is connected to the alarm (figure 5), and finally the RB5 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

In this paper, the author presented the operation of customary Air Pressure controller. Besides, it is demonstrated to utilize a savvy I/O sort MCU as the part to a circuit for air pressure detection and controls. This circuit checked and controlled the air pressure of a Air Bottle, and utilized LED for signals. From the equipment circuit, only few external peripherals are used. In addition, the MCU could be reprogrammed to suit the regular regulation changes on board. Every one of these components are controlled and intelligently decided by the PIC16F84A - MCU and more application cases could be further explored.

5.0CONCLUSIONS

Thus, this proposed system will ensure the occupational safety on board by minimizing the needs for the crew to frequently moving to view the status of each tanks by themselves and the protection of the equipment or machines as well.
This system could further be improved in near future. Upcomingsystem could be focused on enhancing the visual aids, by integrating Liquid Crystal Display (LCD) to the system, allowing the crew to know exactly the level of the liquid in the tanks and even allowing the crews to be alerted wirelessly through a wireless module connected to the MCU.

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