Gas Pipeline Monitoring system for Hospitals

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ABSTRACT

Medical gas monitoring systems in healthcare industry keeps track of regular monitoring of various essential gases like oxygen, carbon monoxide, nitrous oxide, nitrogen and medical gas with proper alarm systems. The safe operation of a medical gas pipeline system relies on skilled staff who understand the system and who can liaise with clinical users to ensure continuing patient safety. Centralized medical gas monitoring system measures the pressure level of gas with a pressure sensor and the value is given to a Digital Signal Processing (DSP) microcontroller for processing the digital signal. The decoded digital value with respective psi will be displayed in a 16 bit Liquid Crystal Dispaly (LCD) screen. As per the pressure range, it alerts the technician. This measured range of gas is transmitted to a Personal Computer (PC) from main manifold which has Visual Basic (VB)platform. In this way, the various pressure parameters from distant part of hospitals can be transmitted wirelessly through a Zig Bee into PC. These values with respective date and time will be stored in the computer database of manifold PC.

Since it is an overall gas monitoring system, all the mobile gas cylinders can be integrated to PC. It is of prime importance that staffs and nurses may not be always vigilant and aware of replacing diminishing gas levels of mobile cylinders at regular intervals. Therefore our system indicates the gas volume with proper alert mechanisms if pressure comes below a threshold range .So the concerned staff can replace the cylinder with no troubles.

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CHAPTER 1

INTRODUCTION

The medical gases used in a hospital are life-supporting element that gives direct influence in maintaining the life of a patient. Therefore, at the sections where the medical gases are used, the medical gas must be clean, highly pure and supplied under stable pressure. Medical et al. (7801) A Medical gas monitoring system is installed to provide a safe, convenient and cost-effective system for the provision of medical gases to the clinical and nursing staff at the point of use. It reduces the problems associated with the use of gas cylinders such as safety, porterage, storage and noise. The safe operation of a medical gas pipeline system relies on skilled staff who understand the system and who can liaise with clinical users to ensure continuing patient safety. The pipeline systems contain gas under pressure, which can present a hazard to staff. As shown in the figure1.1 , gas pipeline system is distributed along Intensive Care Unit (ICU), wards,

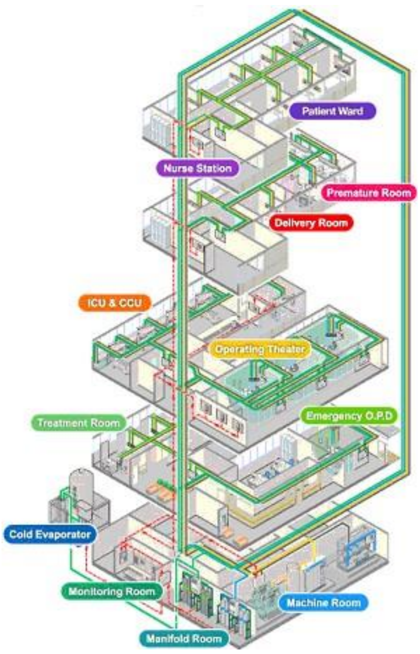

Figure 1.1: Medical gas pipeline system from the manifold

delivery room, Operation theater etc.

1.1 NEED FOR THE PROJECT:

Commonly used Medical gas Monitors in hospital manifold just keep track of the measured pressure value and alerts the technician if there is a caution. Our centralized gas, monitoring system measures the pressure values from various sensor sources like wards and ICU and the data are transmitted wireless to a PC in VB platform in the manifold chamber. All the Mobile gas cylinders in hospital can be integrated to the main system through wireless communication device. The concerned technician gets all the data regarding the process in his PC with necessary databases.

1.2 SCOPE OF THE PROJECT:

This project presents the idea of centralizing different Gas modules wirelessly to a |acpc platform. Since the manifold gas chamber is being computerized it eases the workload of manifold technicians. Therefore the system has an immense scope in the field of Medical gas supply installation.

1.3 EXISTING LITERATURE:

Bhowmik et al. (2012)presented a model which will keep track of the oxygen levels centrally in the cylinders present in a hospital and moreover it measures oxygen level in the cylinder and a buzzer beeps when the oxygen level in the oxygen cylinder is dropped below a pre-decided value.

One of the earlier pressure alarm devices was presented by De Pasquale and co-workers Muhammad et al. (1985) They developed a pressure indicator and alarm system to provide an audible and visual warning when the gas supply in a cylinder is exhausted and requires replacement. This was achieved by incorporating a pin through the lens of the pressure gauge, at a location corresponding to the gas pressure level below which the cylinder required replacement.

Muhammad et al. (1985)resented a more advanced pressure monitor and alarm system for high pressure gas cylinders used in medical or industrial sectors. The device was designed to allow removable mounting and integration between the pressure regulator and outlet tank of the cylinder. The device incorporates an electronic pressure switch to continuously monitor the pressure of the gas in the cylinder. Muhammad et al. (1985) presented a monitoring, alarm and automatic adjustment system for oxygen and compressed air delivery cylinders . The system is able to monitor and adjust the oxygen or compressed air flow rate to the user based on their requirements, which are estimated by measuring pulse and blood oxygen concentration levels. It calculates how much time the user has left with the cylinder and alerts the user of low or depleted pressure levels by providing tactile feedback.

CHAPTER 2

AIM AND OBJECTIVE

2.1 AIM:

The main aim of this project is to design a centralized medical gas monitoring system that ease the working of manifold gas chamber in hospitals with adequate data bases.

2.2 OBJECTIVE:

The objective of the project are as follows

1. This system centralize the different medical gas monitoring systems present in a hospital to a common pc.
2. The system integrates data from various mobile gas cylinders present in a hospital to central monitoring systems main hub.
3. Analyze the obtained information in the central computer about nature of alarm signals.

CHAPTER 3

MATERIALS AND METHODOLOGY

3.1 BLOCK DIAGRAM:

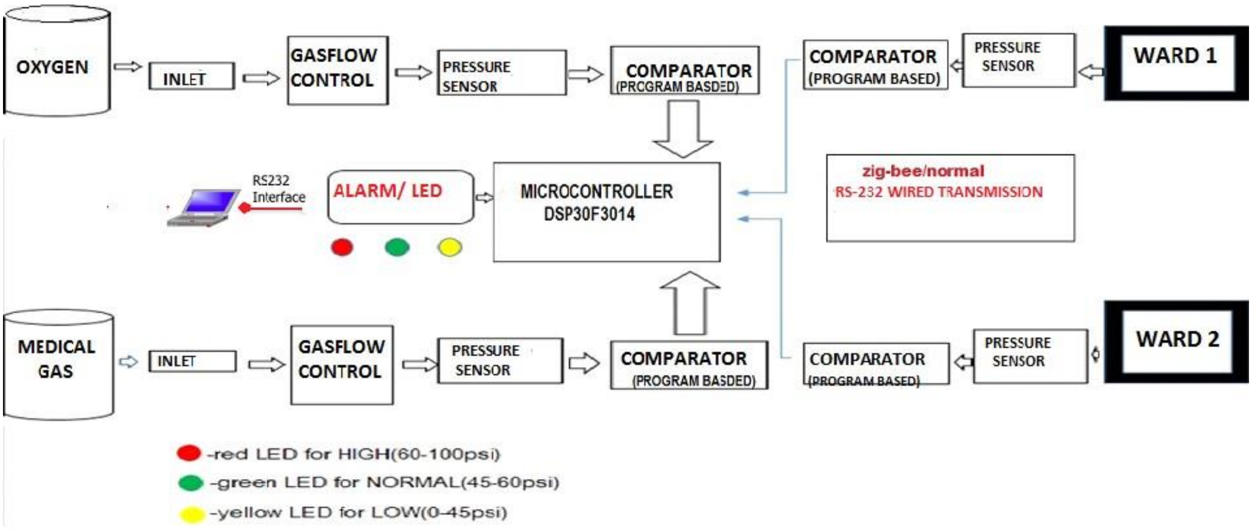

Figure 3.1: Block diagram of proposed model.

3.1.1 BLOCK DIAGRAM DESCRIPTION:

Oxygen gas from the gas plant comes into the inlet with regulated pressure below 100 psi. As shown in the figure3.1 , the module has a digital pressure sensor to measure the pressure range. The value is given to a DSPIC30F3014 to process the signal. The DSP, LCD , RS232 board has Alternating Current (AC) to Direct Current (DC) converter circuit which gives a 5v regulated .The decoded digital value will be displayed in a 16 bit LCD display.RS232 chip gives a serial communication with PC. The value from the main manifold is connected through wired RS232 to Universal Serial Bus (USB) cable to the system. Centralizing the monitoring system makes pressure values will be taken from various sensor sources like different wards and ICU will be wirelessly transmitted to a VB platform.

3.2 SOURCES OF GAS SUPPLY:

A Medical gas monitoring system comprises mainly of 5 sources: Bhowmik et al. (2012)

1. Oxygen (O_2); 0
2. Nitrous oxide (N_2O);
3. Nitrous oxide/oxygen mixture ($N_2O/O_2 : 1/1$);
4. Medical air (MA_4) at 400 kPa for respiratory applications, and at 700 kPa (SA_7) for surgical tool applications;
5. Helium/oxygen mixture ($He/O_2 : He = 79; O2 = 21$);
6. Medical vacuum at a pressure of 400 mm Hg (53 kPa) below atmospheric pressure.

3.2.1 OXYGEN:

Bhowmik et al. (2012)

1. For oxygen systems, the source of supply can be bulk liquid oxygen in a vacuum-insulated evaporator, liquid or gas cylinders, or an oxygen concentrator system. As shown in the figure3.2 , is how the oxygen gas is taken from primary and secondary sources.

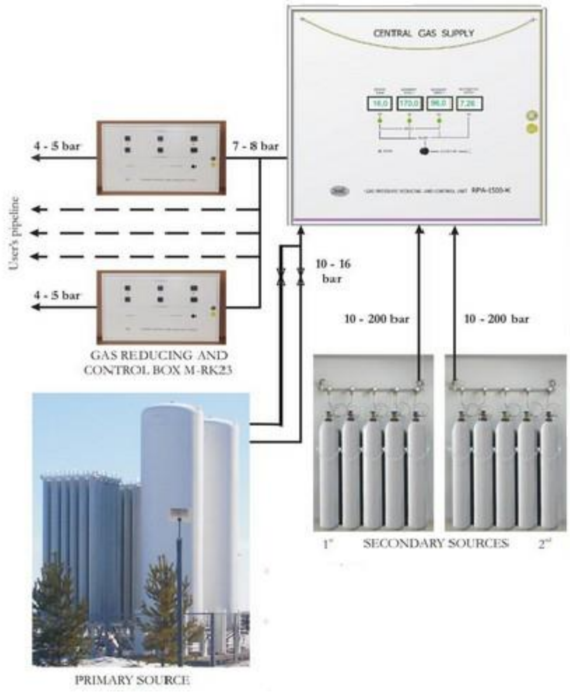

Figure 3.2: Primary and Secondary oxygen gas supply.

2. For oxygen the controlled range is 45 to 60 psi below and above of this range comes under alert range.

3.3 AC TO DC CONVERTER CIRCUIT:

As shown in the figure3.3 , module has an AC to DC converting circuit which begins with transformer which gives output as 9V with 1A current. The AC mains voltage rectified to produce high voltage DC with rectifier circuit consisting of diodes. The 9V supply from rectifier is regulated to 5V with IC7805. These converters, in general, provide a great amount of efficiency and can also source high-power loads. These are the sorts of supplies we use in cell phone chargers to laptop and desktop computer power supplies.

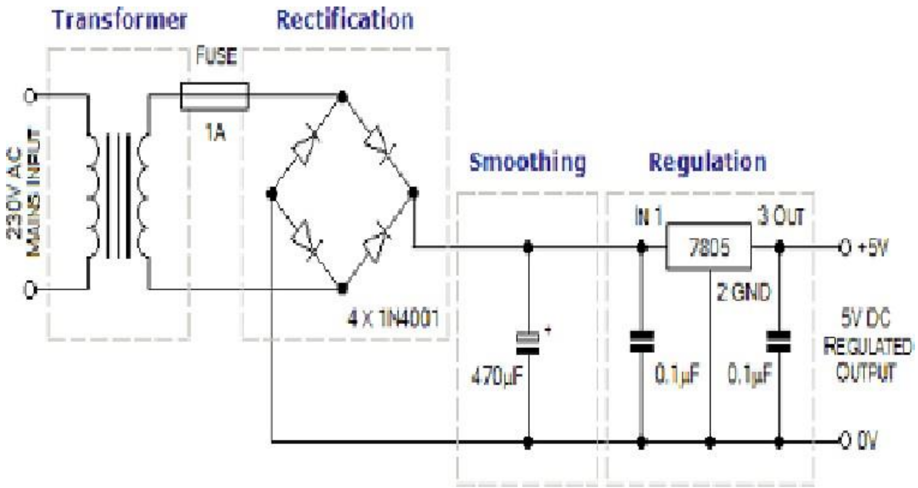

Figure 3.3: AC to DC converter circuit.

3.4 PRESSURE SENSOR (SPD100GD):

SPD100gd pressure sensor has a digital output. The sensor is compensated for offset, sensitivity, temperature drift and nonlinearity. The sensor is an absolute type available in the ranges 1 to 100 psi.

3.4.1 Communication

The digital interface protocol is based on bit serial Manchester code output. In data transmission, Manchester encoding is a form of digital encoding in which data bits are represented by transitions from one logical state to the other. The chief advantage of Manchester encoding is the fact that the signal synchronizes itself. This minimizes the error rate and optimizes reliability. The main disadvantage is the fact that a Manchester-encoded signal requires that more bits be transmitted than those in the original signal. Figure3.4 , represents a signal duty cycle of 75 is a logical 1 and a duty cycle of 25 represents a logical 0. Below in little drawing the Manchester code is depicted.

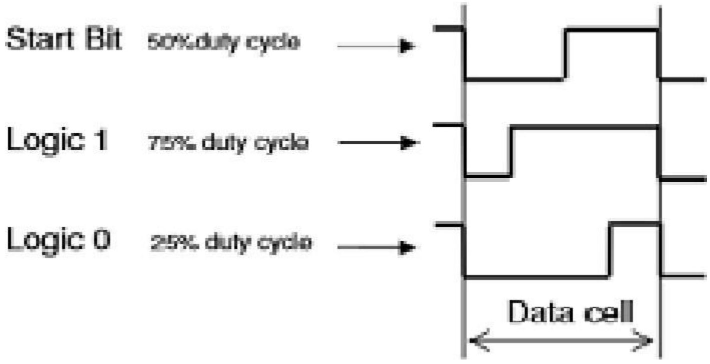

Figure 3.4: Duty cycle.

3.4.2 Output Format

As shown in Figure3.5 , the output of the sensor is a two byte word. The first byte contains the most significant 6 bits of the 14 bit output word and the second byte represent the least 8 significant bits of the 14 bits output. The first two bits of the first byte are zero. The format of the pressure sensor output is depicted below: The software has to

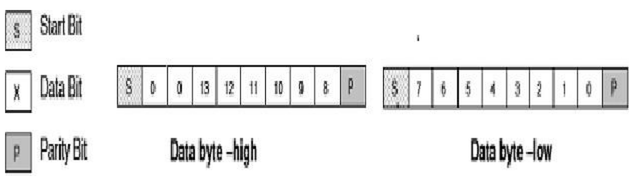

Figure 3.5: Two byte output word.

determine the digital output speed by the Start Bit. This Start bit is 50% low and 50% high. Based on this in formation the speed of the incoming data can be interpreted. The parity is defined as even meaning in case the number of 1 in the word is even the parity is zero and in case the number is odd the parity bit is 1. Between the high and lower byte there is a stop bit, level 1, with the length of half the data.

The pressure is presented as a 14-bits digital word. The digital word is between 0 and 3FFF in Hexadecimal or from 0 to 16383 in decimal. In general the upper 10% and the lower 10% of the numeric range of the 14 bits are outside the pressure range.

The relation between the pressure and the output digital word can be calculated as given below: In case a 0 to 100 psi sensor the lower end of the scale will be decimal 1683 (= 10% of the full scale of 16383 and the 100 psi value will be 14,745 (= 90% of 16,383) This means the 100 psi range will be transferred to 13,107 decimal values (= 14,745 to 1683). This means each psi will be equal to 131.07 decimal points.

$$pressure(psi) = [Output(dec) - 1,683]/131.07 \tag{3.1}$$

3.4.3 DSP IC30F3014

DSPIC30F3014 is a specialized microprocessor that has an architecture which is optimized for the fast operational needs of digital signal processing. A Digital System (DS) can process data in real time, making it ideal for applications that cant tolerate delays.DSP take a digital signal and process it to improve the signal into clearer sound, faster data or sharper images. The signals are processed so that the information contained in system can be displayed or converted to another type of signal.

3.4.4 FLOW CHART:

3.5 ZIG BEE

Zig Bee is a wireless technology developed as an open global standard to address the unique needs of low-cost, low-power wireless Modem 2 Modem (M2M) networks. The Zig Bee standard operates on the Institute of Electrical and Electronics Engineers (IEEE) 802.15.4 physical radio specification and operates in unlicensed bands including 2.4 GHz, 900 MHz and 868 MHz.

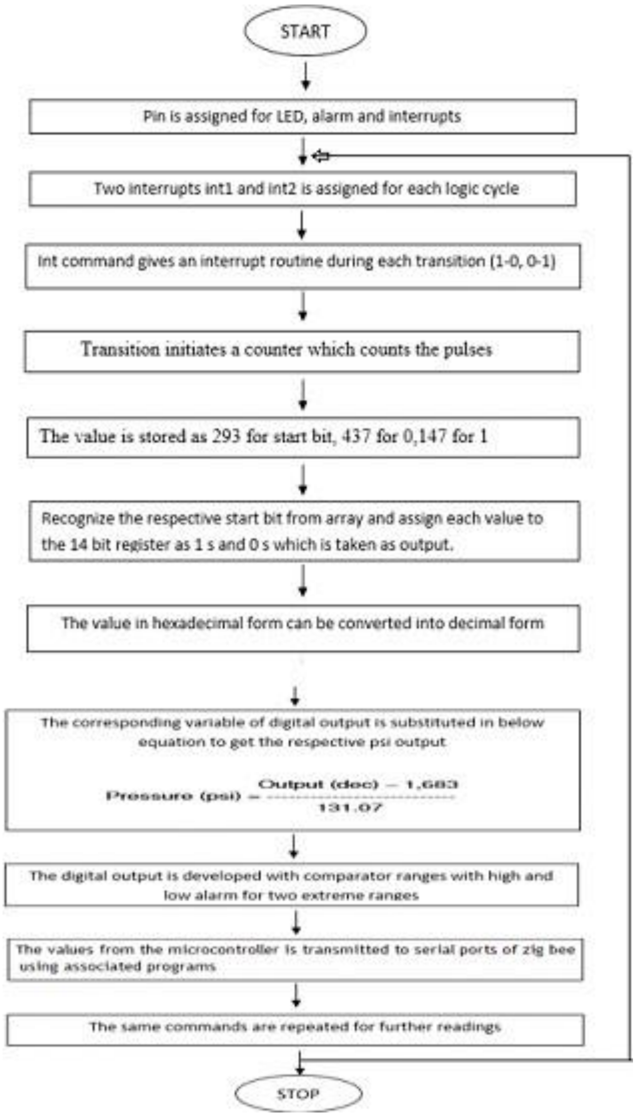

Figure 3.6: FLOW CHART FOR DSP PROGRAMMING

3.5.1 ZIG BEE [TARANG P20]

Tarang modules are designed with low to medium transmit power and high reliability wireless network. The modules require minimal power and provide reliable delivery of data between devices. The interfaces provided with the module help to directly fit into many industrial applications.

3.5.2 MODES OF OPERATION

P20 model operates in four different modes:

1. Idle mode.
2. Active mode.
3. Sleep mode.
4. Command mode.

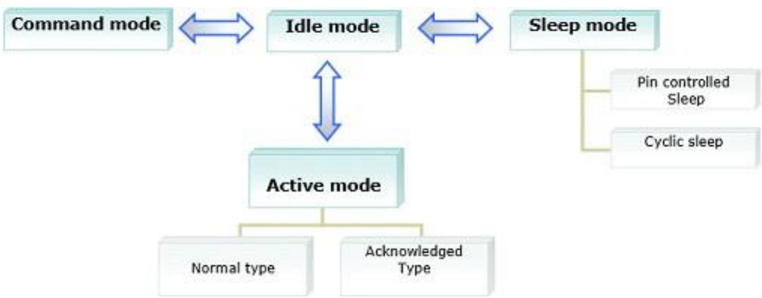

Figure 3.7: Modes of operation

3.5.3 Idle Mode:

When zig bee is in idle mode, no operations are carried out. The module shifts to other modes under following circumstances .However, the module continues to receive the Radio Frequency (RF) data in this mode.

3.5.4 Active Mode:

The active data transmission and reception takes place in this mode .The module communicates with acknowledged and normal type.

3.5.5 Command mode:

During this mode command sequence is received. The tarang model expects command in hexadecimal form.

3.5.6 Sleep mode:

Sleep mode enables RF module to enter into a state of low power consumption when not in use.

3.6 VISUAL BASIC PLATFORM:

VB is a third generation event-driven programming language and Integrated Development Environment (IDE)from Microsoft for its COM programming model first released in 1991.Microsoft intended VB to be relatively easy to learn and use.Visual basic was derived from BASIC and enables the Rapid Application Development (RAD) of graphical user interface applications,access to databases using Data Access Objects,Remote Data Objects,or Active X Objects,and creation of Active X Controls and Objects.

3.7 WIRELESS OXYGEN MONITORING FOR MOBILE GAS CYLINDERS:

This part of project aims in integrating all mobile gas cylinders which is present in hospitals to a main module wirelessly through zig bee .Bhowmik et al. (2012)It measures the gas level in the cylinder and a buzzer beeps when the oxygen level in the oxygen cylinder is dropped below a pre-decided value so that technician in the manifold gets an alert message As shown as in the figure3.8 , the pressure is measured with a digi-

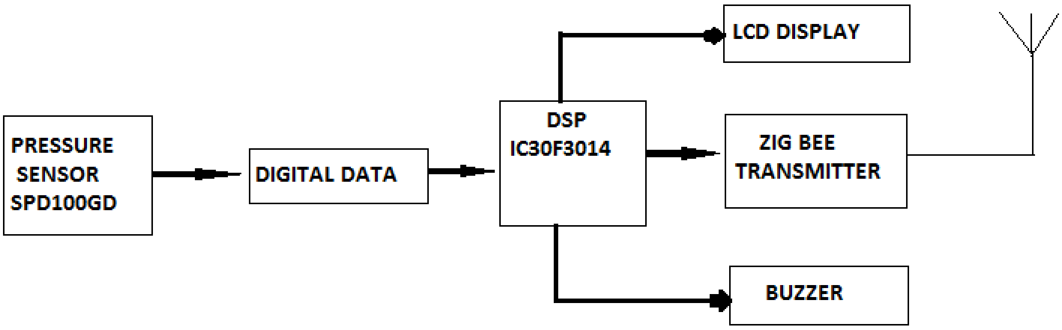

Figure 3.8: Wireless Monitoring of Cylinders

tal sensor SPD100GD, a microcontroller DSPIC30F is used in cascade to process the signal and display the pressure of oxygen cylinder. Also a buzzer is given whenever the level of oxygen is not in pre-decided value. The signal is further transmitted to the monitoring station through a zig bee module to a pc platform The wireless monitoring

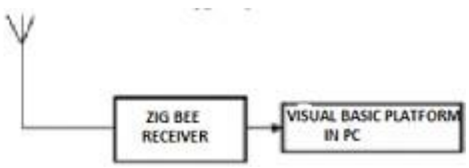

Figure 3.9: PC and Zigbee representation

system gives alarm when the pressure level becomes lower than 20 kg/cm^2.Patients who require oxygen supply may suffer from illness due to pulmonary or cardiovascular conditions and hence are highly reliant on being provided with a reliable supply of oxy-

CHAPTER 4

RESULT

The experimental results shows that the proposed method of designing a centralized medical gas monitoring system has been successfully completed with available requirements. This manifold needs testing and research for several years for getting into a conclusion about its durability factor since its being installed for a span of several years. But the proposed method could be done in a better way if there is a proper commercial backup.

4.1 EVALUATION AND ANALYSIS OF VISUAL BASIC OUTPUT:

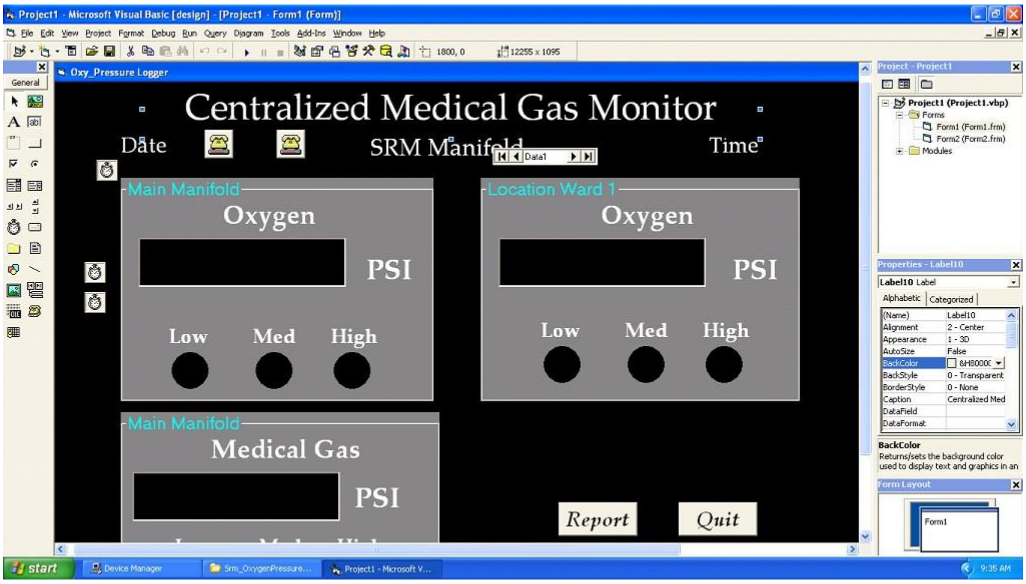

Figure 4.1: VB platform

Figure4.1 , shows the primary visual basic platform which shows the parameters from main manifold in the left side of screen and the right side shows the output which is central monitored. The values are measured in psi. Oxygen gas is being regulated in a specific range of 45 to 60 psi below 45 psi which comes in a lower range and above

60 psi comes in upper range. There are 3 indications to represent low, medium and high ranges. First indication from the figure4.2, represents the medium level range with no

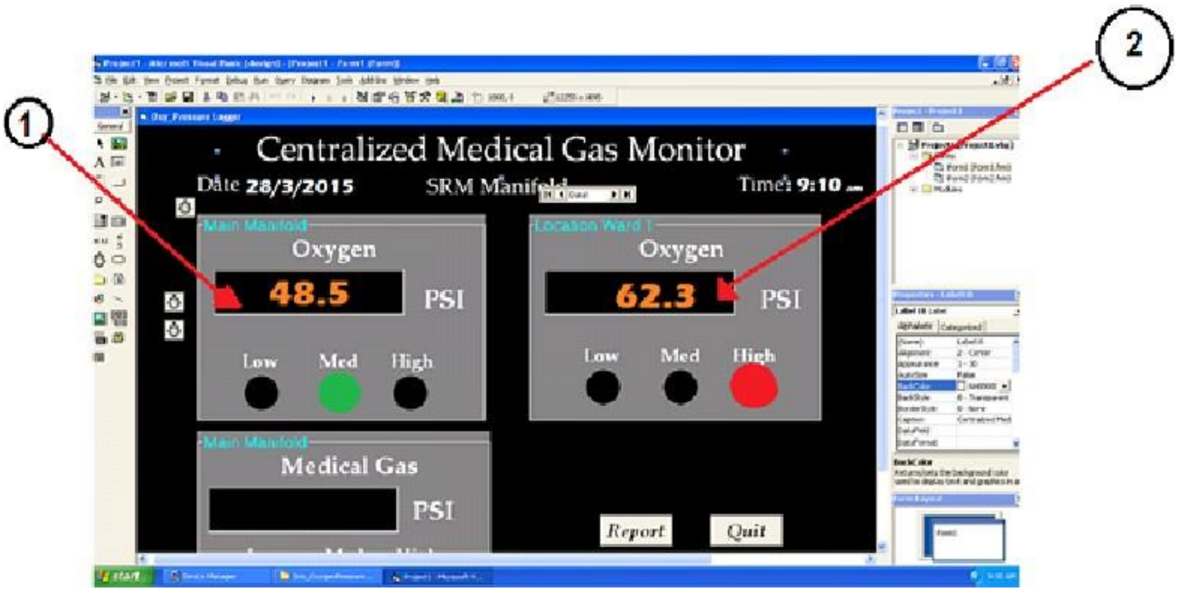

Figure 4.2: Indicating pressure changes.

buzzer. The green indication shows the pressure level in a moderate Range. Second one represents the higher range psi with red indication and buzzer.

4.2 MODULE BEING TESTED IN MANIFOLD DEPARTMENT:

As the figure4.3 , shows the current oxygen manifold system with our module.

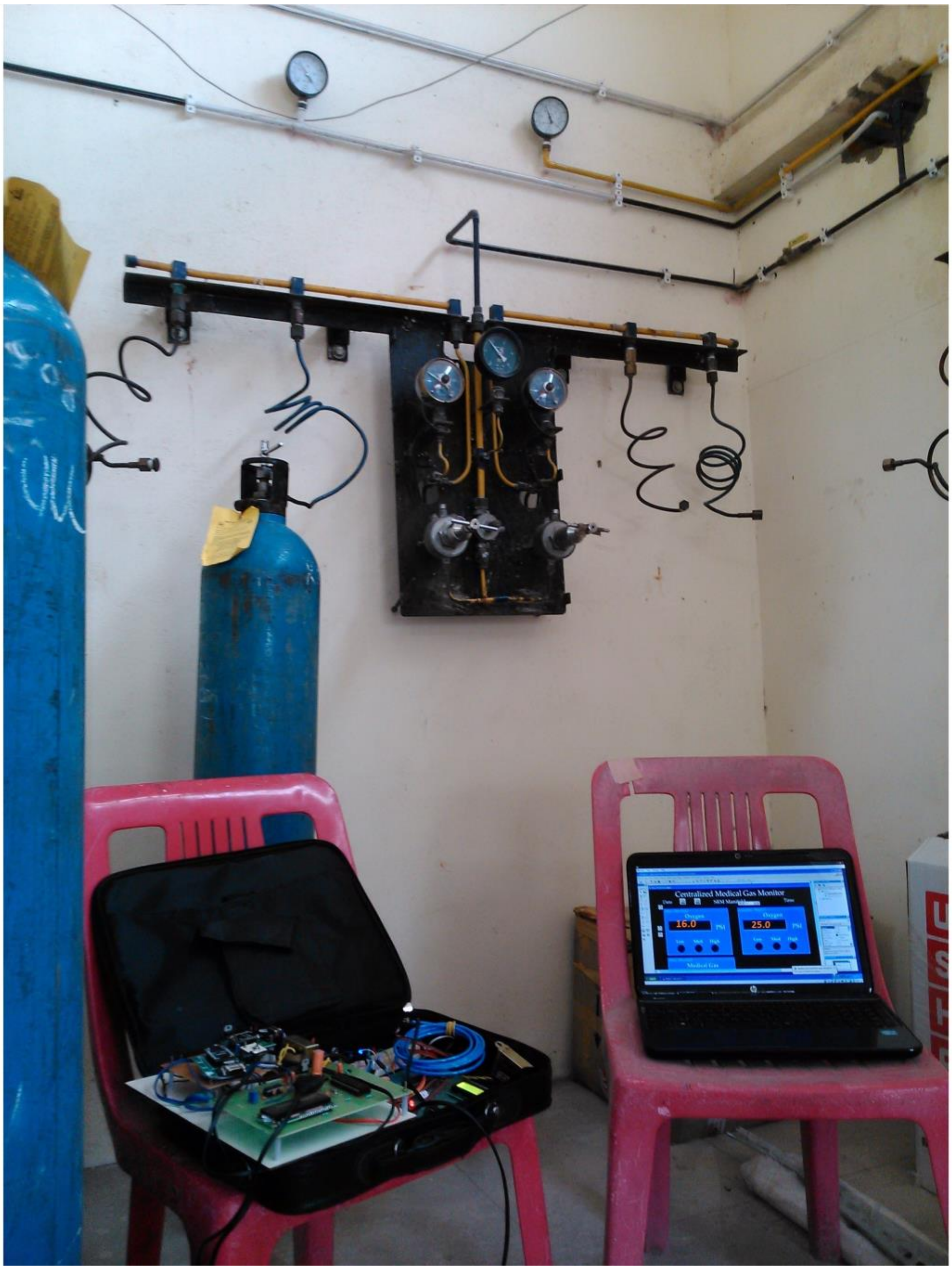

Figure 4.3: Testing in manifold.

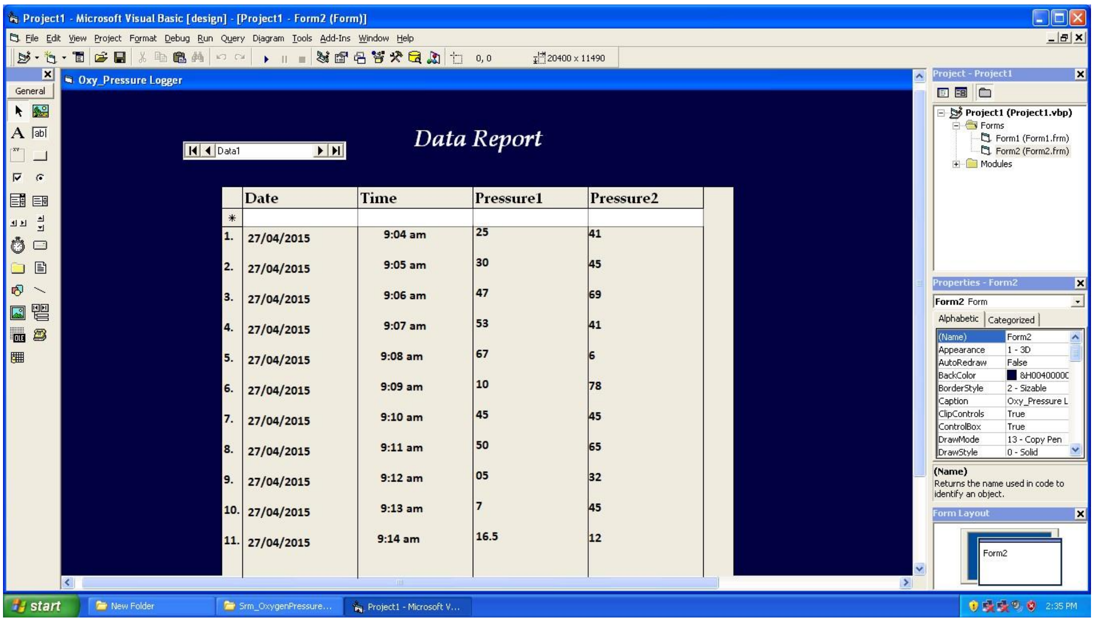

Figure 4.4: Pressure analysis report.

As shown in the figure4.4 the vb platform shows the pressure analysis with respective time and date.The pressure 1 column indicates the data from main manifold and pressure 2 column indicates the data retrieved wirelessly through zig bee.

Demo of our project can be viewed in: http://youtu.be/qssctOlyVX4

CHAPTER 5

DISCUSSIONS, CONCLUSION AND FUTURE ENHANCEMENT:

The design of Centralized Medical Gas Monitoring system is a device that eases the work load of manifold technician. The device provides an audible feedback to alert technician and their staff when the pressure ranges becomes unstable. This device can be easily interfaced with high-pressure portable medical cylinders through wire-less communication system. The costs for producing such a device are also low due to the use of readily available materials and standard manufacturing techniques. These are important considerations in global health care settings where the burden of technology costs are high while patient safety is still paramount. Further work can be done in future for making it more compact with portable battery backup. Additional experimental test-ing of the device will also be carried out to establish performance reliability. Selection of suitable pressure sensor plays a vital role in the durability of module.

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