THE FUNDAMENTAL CONCEPT, PRINCIPLES AND IMPLEMENTATION OF A MICRO-CONTROLLER OPERATION IN A PRESSURE DETECTOR SYSTEM

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***Abstract*: This study presents a vital research work on the concept, principles and implementation of a microcontroller operation in a pressure detector system. The work is aimed at the implementation of a wireless pressure sensor (Microcontroller Based) used for the detection of change in pressure in a liquid container (Tank). This introduces the concept of liquid monitoring within the context of the change in pressure level in the tank. This change in pressure is then transmitted and received by a receiver through a microcontroller. This is then automatically displayed on a liquid crystal display (LCD) board via a wireless connection and a mobile communication message alert. The model was successfully implemented and was found to be fundamentally functional and effective.**

Key terms: pressure, sensor, microcontroller, wireless, receiver.

INTRODUCTION

This study explores the applications of microcontrollers in circuit operations and the electrical characteristic of a pressure sensor (Transducer), transmitter and receiver systems.
Microcontroller is an integrated circuit which has in it a program memory, RAM and other support circuit components embedded on the chip.
It is essentially a circuit enabler especially with regards to circuit automation and smart operation. The mobile modem provides the communication mechanism between the user and the microcontroller system which is the pressure detector system in this case.

The force per unit area exerted on a surface is what is referred to as pressure. It's unit is either Pascal, psi or Newton per square meter. A sensor is a measurement instrument that receives an input signal and changes it to another form of control signal. Therefore a sensor applied in a pressure detector is a device for the measurement of gases or liquid pressure. The sensor significantly monitors the pressure and displays it in one of the units.

Taking the global petroleum industry as a case in point, this study explores various technical applications and advantages of the microcontroller in the pressure detector system as an anti-theft control mechanism for optimal production output in the industry.
Globally, the petroleum industry is very strategic to economic sustainability of various countries as oil and gas remains a viable product and a major foreign exchange among nations across the world.
To this effect, it behooves the government and various petroleum industries stakeholders and key players to leverage on microcontroller aided design and implementation of detector systems to be able to check the unscrupulous activities of hoodlums who may be interested in petroleum pipeline vandalism.
The effects of pipeline vandalism can be very devastating to the industry, economic activities of nations and the multiplier global ripple effects could also be monumental. Study carried out in the course of this work showed the following effects of pipeline vandalism.

- Several people including the vandals may have lost their lives as a result of oil pipe line vandalism or in the quest of siphoning fuel from broken pipe lines (explosion).
- The global economy has witnessed heavy losses in revenues as a result of losses in production output due to pipeline vandalism.
- The oil spill causes water pollution.
- Farmlands are polluted.
- Fire outbreak hazards could result from the activities of the oil pipeline vandals.
- The local and international investors often do not want to trade in the crisis prone regions due to volatile activities of vandals for safety of their lives.
- Per capital income of the nation is grossly diminished.
- Extra budgetary appropriation may be required in order to stem the tide of insecurity on the national asset.
- Foreign exchange value chain is distorted.
- There is imbalance between market forces of demand and supply.
- It may culminate at job losses as a result of facility operating below installed capacity.
- Utilization factor of installations is downplayed due to the various machinery units not being able to function to design specifications. e.t.c.

The aim of this study therefore, is to analyze the fundamental concept, principles and implementation of a microcontroller operation in pressure detector systems that can detect/sense pressure change (decrease or increase) of a liquid (including petroleum products) in pipes or tanks.
The objectives of the study include the study of the function of a pressure transducer and also to examine the applications of microcontrollers in pressure detector measurement systems. The electronic wireless monitoring device or system is both a portable and cost effective solution for monitoring liquid.
The wireless microcontroller- based sensor device is a useful and versatile device that is found in many applications as it is often applied in many industries and our homes to monitor the change in pressure of liquids at a position along a pipe.
A microcontroller unit in the circuit is the control room of the pressure detector system usually with A/D converter, equipped with internal timers, RAM and ROM, also with 20 bidirectional digital I/O lines, a serial port and two stepping – motor ports.
These characteristic features conveniently describes the microcontroller as a dedicated controller in the pressure detector instrument for smart control output.

MICROCONTROLLER TYPES AND PERIPHERALS

Microcontrollers are usually classified according to use and applications. These include microprocessors controller-types enabled with special features such as 80C31/51, 8052 microcontroller interfaced with hardware circuits, microcontroller chip interfaced directly with UART port, the 5V TTL range, the 8-bit memory types, the 5V microcontroller host connected directly to the UART RXD, e.t.c.

MICROCONTROLLER APPLICATIONS

The microcontroller unit is the base and control launch pad where the control program of the detector circuit is located. This program is written using assembly language.
A typical microcontroller hardware circuit is usually very flexible so that all the surrounding components are given a recommended range of values based on the data sheet while the programmer is at will to choose actual design values for effective control implementation.
Microcontrollers have various special features and advantages in circuits such as in control circuits.
These include considerable power-supply requirements, power density functions, suitability for integrated operation, reliability, maintainability as well as utilization factor and availability.
Microcontrollers are also used to enable automated process control, various multimedia support functions and largely for device interface and communication.

ROMs are nonvolatile memories which are used in most computer systems. They are read only and store data on permanent basis. This gives the operating system smooth running on universal operations.
RAMs are volatile memories that can store temporal machine instructions and can also be read and changed in any order, essentially to store machine codes.

MICROCONTROLLER OPERATION

We take the Motorola MC146805 CMOS controller for example. If it is specified for operation down to 3volts and includes on-board circuitry to go into WAIT mode, it runs on low power with oscillator and timer running.
If it is on STOP mode, then it runs on zero power and oscillator stopped and on reset via interrupt.
When run from 5volts, it typically uses 7mA running, 5 MHz clock and in WAIT mode and 5µA in STOP.
However, when run on 3 volts, the WAIT mode current drain is about 150µA with 1MHz clock.

A wireless network is used as an interface system between the detector system and the mobile station. The phone has a user interface which is written in special codes which enables effective and smart monitoring and control.
In microcontroller operations, it receives input signals from sensors which it converts into appropriate set of voltages to activate the switches and output devices such as display units, with respect to its instruction codes stored in the program.

Taking all design parameters into proper circuit application perspective, the instrument usually incorporates the design specification of the microcontroller for effective output delivery.
The microcontroller is a very versatile device and largely electronic circuit's enabler for smart operations.

PRESSURE SENSING UNIT

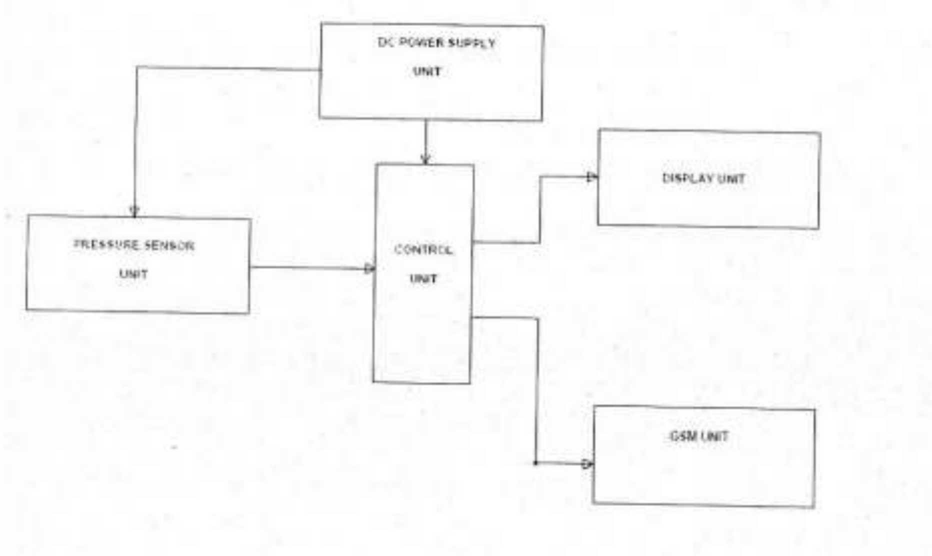

Fig. Block diagram of the pressure sensing unit.

This integration drastically reduces the number of chips and the amount of wiring and circuit board space that would be needed to produce equivalent systems using separate chips.

Furthermore, on low pin count devices in particular, each pin may interface to several internal peripherals, with the pin function selected by software. This allows a part to be used in a wider variety of applications than if pins had dedicated functions.

Microcontrollers have proved to be highly popular in embedded systems since their introduction in the 1970s. Some microcontrollers use a Harvard architecture: separate memory buses for instructions and data, allowing accesses to take place concurrently.

Where Harvard architecture is used, instruction words for the controller may be a different bit size than the length of internal memory and registers; for example: 12-bit instructions used with 8-bit data registers.

THE DESIGN OF THE PRESSURE SENSOR UNIT

The pressure sensor used in the implementation of the design is the MPX4250 pressure sensor. The sensor output a differential analog signal of 0.2 to 4V for a pressure range of 0 to 250KPA.

Typically, mpx4250 sensor is used as signal input to a differential amplifier which consists of

OP-AMPs, U2b, U2c, resistors R1 ,R2,R3,R4 variable resistors RV1 and RV2.

The output of the circuit amplified pressure sensor of 0.2 to 4V for a pressure range of 0 to 250KPa is determined. The output of this unit is used as signal to the control unit.

THE DESIGN OF THE CONTROL/DISPLAY UNIT

The control unit is implemented with a PIC16f873a microcontroller. The program code that runs this operation is burned into the microcontroller.

The microcontroller unit receives signal from the pressure sensor and then processes the signal from the pressure sensor and displays it as pressure on a 16 x 2 LCD screen.

CIRCUIT OPERATION

The circuit operates with an AC voltage. The AC voltage (220V AC) is stepped down to 12volt AC with a step down transformer. The 12volt AC is converted to 12volt DC through a full wave bridge rectifier and filter with a capacitor to take away any ripples present. A voltage regulator is used to regulate the voltage to 5volts supplied to the circuit.

To demonstrate the operation of the microcontroller-based pressure detector system, a tank is filled with the desired liquid to create the pressure. In this case petroleum crude oil is channeled into the tank.

Under this tank, two valves are installed, the sensor is connected to one of the valves and the other valve is used to create the artificial pressure change that will trigger the circuit to perform its function.

The LCD unit displays the total force per unit area in the tank. When the second valve is opened to create the pressure change in the tank, this change in pressure is then sensed by the pressure sensor under the tank, it then gives an alert or a beep as specified in the circuit .

This is a function of a buzzer connected to the microcontroller which in turn is controlled by a switching transistor. The light emitting diode will be driven to ON state indicating that the detector is on enable mode.
With the UART terminal enabled, communication is established between the control circuit and the mobile network while output signal is displayed in the display unit.
With this circuit arrangement and the microcontroller operations, an expected level output can be accurately monitored.
If a reduction in the liquid volume is sensed at any point in time, it apparently signals an interception and illicit activities of some unscrupulous elements to which an emergency response is initiated by the appropriate authorities to resolve the challenges.

TESTING AND RESULTS

Each of the modules was built and tested to ensure that a functional system was implemented. The tools and materials used for the construction of the units are digital millimeter, soldering iron, long nose pliers, wire stripper, cutter, Perspex Vero board, super glue, nuts and bolts, e.t.c.

The components were placed in the proper manner based on the arrangement that will minimize the PCB and adequate safety measures were properly observed.
The soldering was done with a 40W soldering iron and at a temperature not more than 260 degree Celsius. Any temperature higher than the above value may damage the components.
The developed system effectively generated and sent alert signal from the sensor through the control unit to the output display unit.

CONCLUSSION

Pressure detector is a sensor device for pressure measurement of liquids and gases.
From the foregoing, the concept, operation and applications of the microcontroller were sufficiently analyzed and the implementation of the pressure detector system incorporating the microcontroller was successfully actualized.
The pressure sensor acted as a transducer by generating a voltage as a result of pressure exacted on the fluid and was displayed.
The principle of piezoelectric effect was leveraged on as the voltage generated was as a result of the pressure application. The hydrostatic pressure was measured at the sensor.

With respect to the size of tank and the specific gravity of the petroleum fluid, the amount of liquid is usually pre-determined to ascertain the level of liquid available at any time for monitoring and observation.

Having analyzed and implemented the microcontroller in the overall circuit and in synergy with other designed circuit components and units, the microcontroller operation and entire pressure detector system proved to be a standard and reliable security control mechanism for attainment of optimal production output capacity in petroleum products and in liquid level monitoring in general.

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