Design and Implementation of Liquid Level Control System for Real Time Data Acquisition

Enweliku D.M.[1], E. A. Edicha[2]
[1,2]*Department of Electrical and Electronic Engineering, Petroleum Training Institute, Effurun Delta State, Nigeria*

***Abstract*— The liquid level controller for real-time data acquisition is a model that uses a microcontroller unit, a transmitter (low pressure sensor) which senses the hydrostatic pressure of the liquid in the tank, and a digital to analogue converter (ADC) all interconnected and interfaced via a RS232 level converter to the computer. The computer served as a display terminal for monitoring and controlling changes in the variable through a visual basic (VB-6.0) developed program which has manual and automatic modes. The microcontroller does the work of controlling the inlet and outlet pumps, the alarm unit and communicates with the terminal computer (PC) software via the max232 level converter. The software provides the user platform to interface the hardware and the operator. The changes are finally visualized real-time on the terminal (PC). The resulting value of the variable obtained is further stored on a database with reference to time.**

***Keywords*- Microcontroller, Personal Computer, Hydrostatic, Data Acquisition, Automatic Control System, Set-point level converter.**

I. INTRODUCTION

The quest for man to regulate the process around his environment brought about process control. This was done by observing a parameter in the environment, comparing it to some desired value, and initiating a control action to bring the parameter as close as possible to the desired value.

Various forms of data acquisition have been commercially available for decades, but technologies and techniques continue to evolve. For example, voltmeters that periodically print results, tape recorders that are optimized for multi-channel recording, and strip chart recorders that make hard-copy graphs have been used.

Modern days, it is becoming increasingly advantage in carrying out processing and control functions using digital method. It is well known fact that the digital control system can offer high accuracy and high-speed response. Hence the motivation toward the design and implementation of the automatic level control system with real time data acquisition.

The system design is center around the personal computer, a popular commercial micro controller PIC 16F877A, pressure transducer and pump. The main benefit of the project is to be able to employ as an educational tool for teaching and demonstrating in the control engineering laboratory. The implementation and experiment result are shown to demonstrate the usefulness of the proposed control scheme.

Importance of Level Measurement

Level measurement is important in the industry as it gives information about the quality of inputs and the finished product available. It enables manufacturers to know the amount of quantity of various inputs, chemical, liquid, solid etc available for production and therefore to determine how long they will operate before the next supply is due. In the petroleum and petrochemical industries, level measurement is important in sales of crude and finished products.

Also, level measurement is essential in Water Company since it allows for automatic control and packaging quantity of water. When liquid is to be sold, its volume is measured in quantity and a price tag is attached accordingly.

II. METHODOLOGY

In the quest to a successful level measurement, level control using hydrostatic pressure with IOT was fully taken into consideration. The project work was commenced by studying other various projects done in relation to this very project.

III. SYSTEM DESIGN

The technique of liquid level controller for real-time data acquisition concentrated with some basic parts which are softly aggregated together. Figure 1 and figure 2 shows the block diagram of level controller with real-time data acquisition and Process and Instrumentation Diagram (P&ID) respectively.

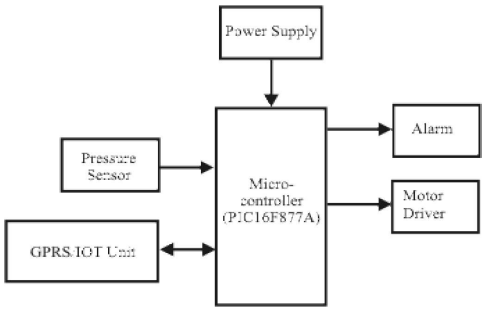


Fig 1. Block diagram of Level Controller with Real-Time Data Acquisition

Description Of Block Diagram

The Pump Unit: This unit represents the 220V AC Water Pump that lifts the process (water) from the storage tank into the process reservoir.

Level Sensor: The level sensor is hydrostatic level sensor, it is a submersible pressure transmitter that has a pressure diaphragm where the inner side of the diaphragm is vented to atmospheric pressure through a vent tube in the cable and the outer side is in contact with the liquid and measuring the static pressure of the liquid column above the transmitter. This static pressure is basically caused by the weight of the fluid on top of the transmitter and is used to calculate the level of the liquid.

Microcontroller: The microcontroller (PIC16F84) takes the digital signals from the output of the analogue to digital converter (ADC), processes it and displays the value on the display circuit.

IOT: The internet of things, or IoT, is a system of interrelated computing devices, mechanical and digita l machines, objects, animals or people that are provided with unique identifiers (UIDs) and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction.

Display: the display used for this design is the liquid crystal display (LCD). It displays whatever has been processed by the micro controller and the display shows when the processes are above or below the set point on the liquid crystal display (LCD).

Power supply unit: the power supply unit provides the needed voltage for the circuit to operate. Power supply is basically made up of the transformer, rectification circuit, smoothing circuit and a voltage regulation circuit.

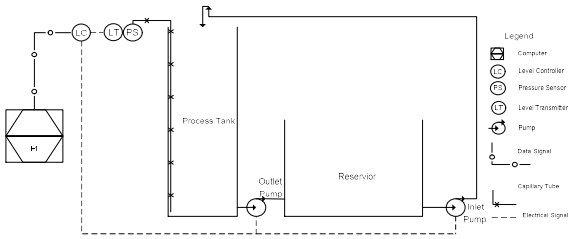
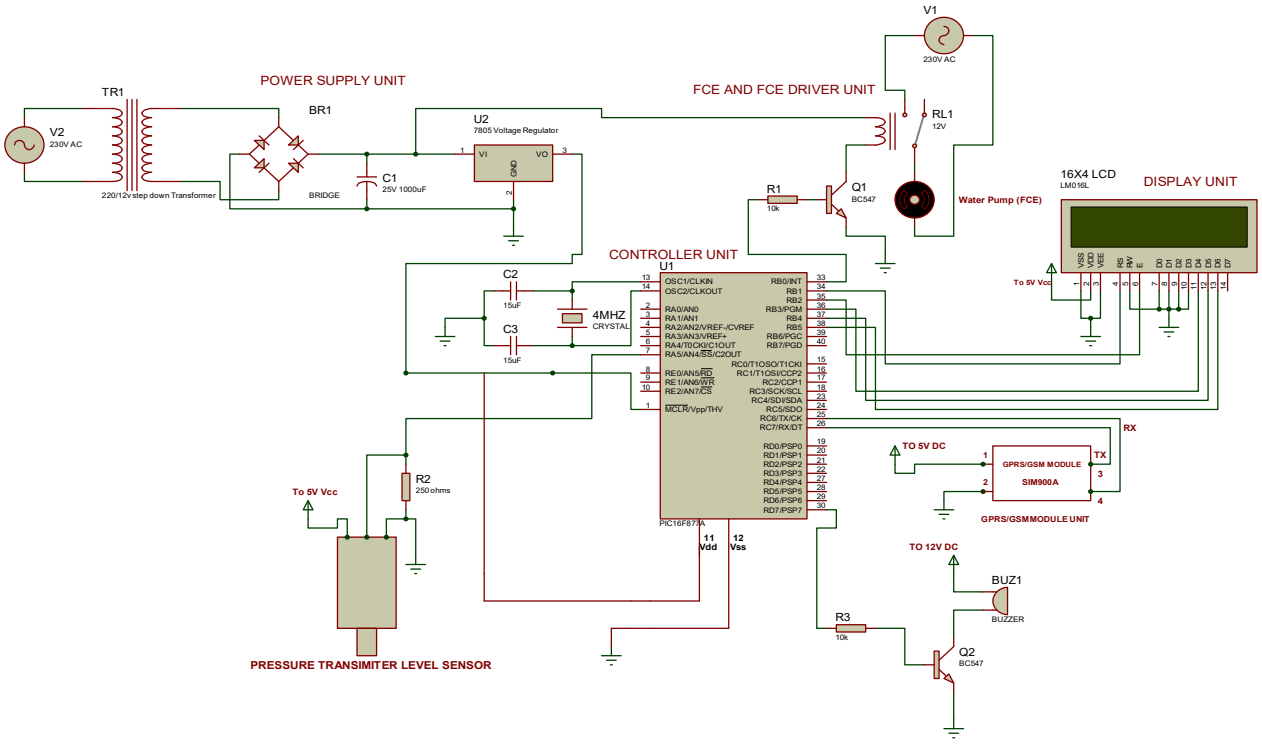


Fig 2 Process and Instrumentation Diagram (P&ID)

In this circuit design, we have the microcontroller as the central focus. The pumps, computer interface RS-232 (serial) communicator, pressure sensor and alarm unit are all connected to the microcontroller. The PIC16F877A comes with analogue to digital converter embedded in it. This project has a reservoir tank, graduated tank, inlet and outlet pumps, pressure sensor that senses the hydrostatic pressure of liquid in the graduated tank. The liquid level in the process tank is controlled using the hydrostatic pressure sensed by controlling the pumps. The acquisition of sensed pressure data, the controlling of the pumps, the controlling of the alarm unit and the communication with the computer program is done by the microcontroller program. We used MPLAB programming software to write into PIC16F877A memory.

Software Development

The computer application used in controlling and acquisition of liquid level data in real-time was written in visual basic programming language (VB6.0). Figure 3 shows the flow chart of the computer application.



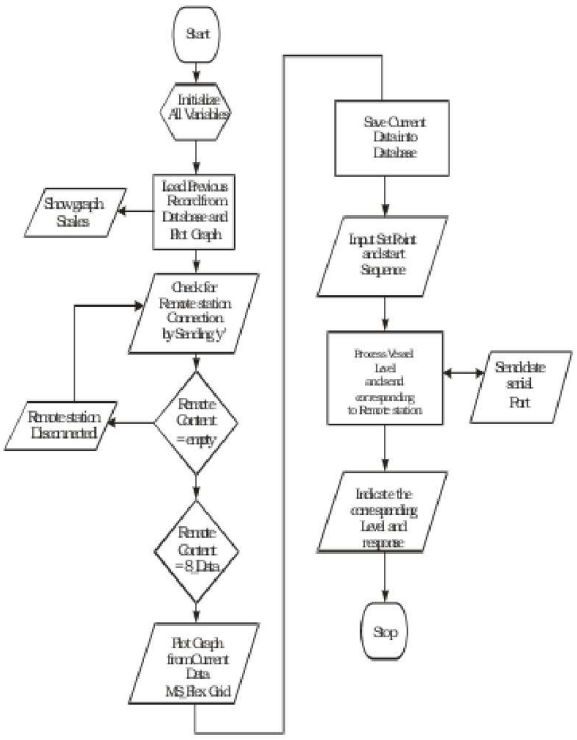


Figure 3: Flow Chart on VB-6.0 Program

Principle of Operation

This project uses a microprocessor unit (MPU) together, a transmitter (low pressure sensor), a Digital to Analogue Converter (ADC) all interconnected and interfaced via a RS232 level converter to the computer. The computer serves as a display terminal for monitoring and controlling changes in the variable through a Visual Basic (VB-6.0) developed program.

From the block diagram, the pressure sensor senses the pressure of the liquid in the tank using a capillary tube. The analog pressure signal is then sent to the analog to digital converter (ADC) which in turn sends the converted digital signal to the microprocessor unit or controller. The microprocessor unit does the work of controlling the inlet and outlet pumps, and communicates with the terminal computer (PC) software via the max232 level converter. The terminal computer (PC) unit is a set of computer with any operating system to run the software written in visual basic 6.0 version. The software provides the user interface to interface the hardware and the software. The power supply unit supplies regulated voltage to the circuits that needed power. In case of fault the alarm unit gives an audible sound.

IV. RESULT AND DISCUSSION

The graphical user interface the project is shown in figure 4. The project works in two modes, manual and automatic mode. In the manual mode, it will require the user to control the inlet and outlet pumps as the alarm indicates the excesses of the set-point values. While in the automatic mode, the user will have to initialize the process and the inlet and outlet pumps are controlled automatically with reference to the set-point values of the variable. The pumps are the final control elements in this project.

The changes are finally visualized on real time on the terminal (PC). The resulting value of the variable obtained can then be further stored on a database with reference to time of capture.

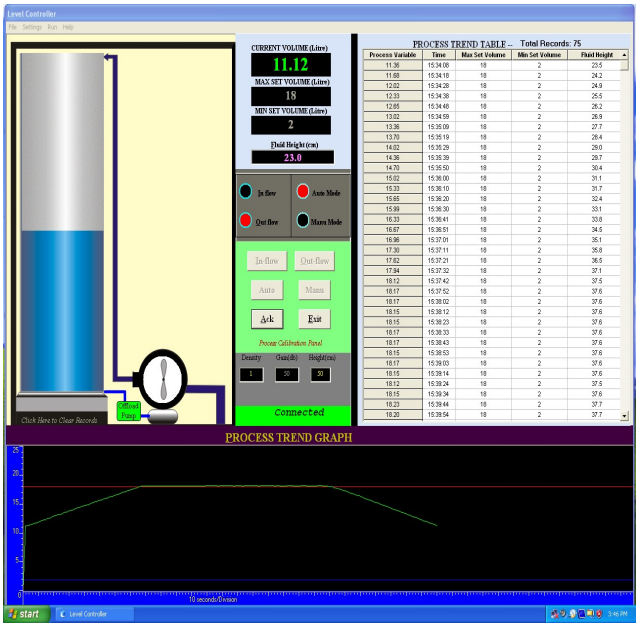


Fig 4: Graphical user interface of the computer application.

V. CONCLUSION

The intension of this research work was to establish a flexible, economical and easy configurable system which can be used as an educational tool for teaching and demonstrating liquid level control. We have used a low cost PIC16F877A microcontroller in this project which is the key point to reduce cost. We have successfully experimented the project in lab and experimental results show that the system operation agrees very well with expected values.

ACKNOWLEDGEMENT

This research work was supported by the staff and students of Electrical and Electronic Engineering Department, Petroleum Training Institute, Effurun.

REFERENCES

[1]. Bergquist C. Guide to PICMICRO Microcontrollers. Sams Technical Publications. Indianapolis. (2001)
[2]. Bonnie S. Electronic Instrument Handbook - Introduction to Electronic Instruments and Measurements. McGRAW-HILL Book Companies. (2004)
[3]. Bristol, E.H. Process Control: An Application Theorist's View on Control. IEEE Control Systems Mag. 2(1), 3-8. (1982).
[4]. David I.S. An Introduction to Programming Using Visual Basic 6.0, Fourth Edition. Prentice-Hall, Inc. A Pearson Education Company. (1999).

[5]. Fred C. Electronic Instrument Handbook - Data-Acquisition Systems. McGRAW-HILL Book Companies. (2004).
[6]. Instrument Society of America. Special Report on Process Computer Control. ISA, Research Triangle Park, North Carolina (1959).
[7]. Martin P.B.; Lucio D.J.; Chuck H.; Dogan I.; John M.; Smith D.W.; Tim W. and Jack S.. PIC Microcontrollers, UK: Elsevier Inc. (2008)
[8]. Microchip MPLAB C Compiler for PIC32 MCUs User's Guide. Microchip Technology Incorporated, U.S.A. (2009).Microchip.com. PIC16F877A.. http://www.microchip.com (2006)
[9]. Morton J. PIC Your Personal Introductory Course. Newnes. Boston. (1998).
[10]. Nichols, N.B. Optimum settings for automatic controllers. Trans. ASME 64, 759-68. (1942).
[11]. Nigel G. An introduction to programming the Microchip PIC in CCS C. U.S.A. (2002).
[12]. Noel M.M. (1974). Control Engineering Second Edition. McGRAW-HILL Book Company (UK) Limited. 151.
[13]. Steven H. Visual Basic 6 Black Book. The Coriolis Group. (1998).
[14]. Sydenham P.H.; Peter P. and Stevenage Z.J.G. Measuring Instruments: Tools of Knowledge and Control. Stevenage UK ; New York : Peregrinus in association with the Science Museum London. (1979).
[15]. Vincent H. Visual Basic for Electronics Engineering Applications, Second Edition. (2005).
[16]. Enweliku David Maledo "Design and Implementation of Level Control Rig for Real Time Data Acquisition" International Journal of Latest Technology in Engineering, Management & Applied Science-IJLTEMAS vol.8 issue 4, April 2019, pp.176-182 URL: www.ijltemas.in/DigitalLibrary/Vol.8Issue4/176-182.pdf