

A RESEARCH USING REMOTE MONITORING TECHNOLOGY FOR PUMP OUTPUT MONITORING IN DISTRIBUTED FUEL STATIONS IN NIGERIA

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ABSTRACT

This research paper discusses a Web Based Monitoring System that enables effective monitoring of fuel pump output and sales volume from distributed fuel stations under the domain of a single company /organization. The traditional method of operation by these organizations in Nigeria is un-automated and accounting for dispensed product is usually approximated and manual as there is little or no technology implemented to presently provide information relating to the state of affairs in the station both to on-ground staff and to supervisory staff that are not physically present in the station. This results in unaccountable losses in product and revenue as well as slow decision making. Remote monitoring technology as a vast research field with numerous application areas incorporating various data collation techniques and sensor networks can be applied to provide information relating to fuel pump status in distributed fuel stations reliably. Thus the proposed system relies upon a microcontroller, keypad and pump to demonstrate the traditional fuel dispenser. A web-enabled PC with an accompanying graphic user interface (GUI) designed using virtual basic which is connected to the microcontroller via the serial port which is to provide the web implementation.

KEYWORDS: Fuel Pump, Microcontroller, GUI, Web

I. INTRODUCTION

The oil and gas industry is experiencing a major boom around the world thanks to the seemingly insatiable demand for fossil fuels in both developed and developing countries. Refinery end products including gasoline, petrochemicals, and lubricants all of which are used daily require efficient and adequate supply to meet ever increasing demand. A filling station/ fuel station is a facility which sells fuels and lubricants via fuel dispensers or otherwise called bowsers which themselves are used to pump gasoline, diesel, kerosene etc into vehicles and to calculate the financial cost of the product thus dispensed. Nigeria as a country has about 4700 petrol stations owned/ operated by government institutions or members of the private sector and it is not uncommon to see a single operator owning one or more fuel stations covering the entire 36 states of the federation. It has to be said that over the years fuel station operators have come and gone out of business due to bankruptcy issues and mismanagement which can all be attributed to bad management practices resulting from unaccountability issues as lots of approximations are made with the manual system of approach employed. Remote monitoring technology can thus be applied to this process to provide timely information relating to diverse parameters such as pump output volume, cost of delivered volume, total sales in a particular period etc to enable timely decision making based on accurate data.

II. ORGANIZATION OF MANUSCRIPT

The Research paper is divided into seven headings and associated sub-headings. In the introductory Heading an overview of the study has been presented drawing on the background to the study, research aim and objectives with clear definition of the problem statement.

The context and review of related literature heading enables the research to be based on a sound theoretical foundation with detailed review of relevant literature to enable the research problem, philosophy and methodology to be embedded in theory and refined to highlight the revealed gap in knowledge which this research has aimed to fill.

The method heading discusses the methodology considered to achieve the envisaged system by discussing the top-down approach and developing the individual modules that constitutes the overall system.

The results and discussion heading discusses the input, output and behavior of the complete system after development.

The conclusion and future work heading and associated sub-heading is a summary of the achievements, problems encountered, solution proffered, recommendation and suggestions for further improvements

III. REVIEW OF RELATED WORKS

Fuel station automation products has been developed and implemented in different countries by various vendors such as Technograde limited, a company with its headquarters in the Ukraine that offers a wide range of automation products like reservoir monitoring systems and remote supervision systems to fuel stations all around the globe for providing ready information regarding fuel level, fuel temperature, fuel pressure etc (Technograde,2002) .

Point of service (POS) systems for fuel stations also offer automation features as it enables retail sales of petroleum products while performing the role of a specialized electronic control cash register (Adita et al., 2001).

The fuel web (TFW) organization (National Instruments, 2007) has developed and integrated a fuel delivery management software which runs as a web browser software application that requires only high speed internet access for use in fuel delivery systems. The TFW also develops tank monitoring systems which may be solar powered for implementation in lost stations that exist in hard to reach locales.

ANDI and NEXGEN forecourt controllers manufactured by allied manufacturers enable PC based POS systems to control dispensers, card readers, cash acceptors, tank gauges, car washes, price sign and credit networks (Flanker, 2004).

NOVOSOFT Corporation developed a system that unites all gas stations belonging to the organization into one network so as to simplify internal business processes such as accounting reports consolidation and employee communication

RFID technology has been applied to fuel dispensers at fuel stations to improve accuracy of data, record keeping of dispensed product value etc

IV. METHOD

A structured approach to system analysis as summarized below was used in developing the system

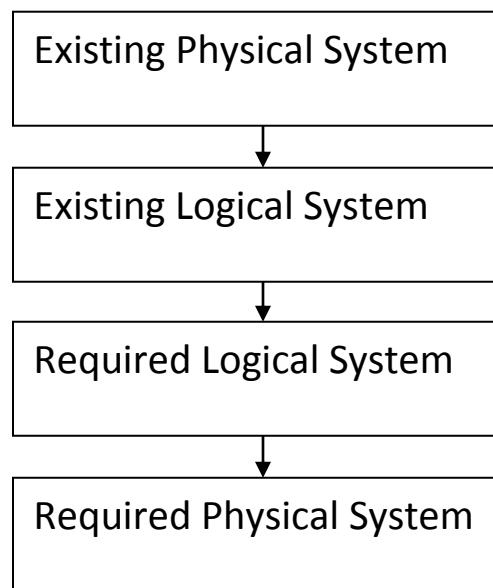


Figure 1: A Structured Approach to System Analysis (Rajaraman, 1991)

To provide answers to the following questions relating to the problem statement such as

- 1). How can the fuel pump output be captured and relayed so as to keep operators of the distributed stations informed in a timely and cost effective manner.
- 2). what is the best mode of implementing the monitoring action in a cheap, reliable and available way.
- 3). What is the best device or tool to be used to receive as well as send commands/information both relating to the state of what is being monitored.
- 4). Can there be a means of establishing a common database/ interface that can enable multi-usability amongst several stations where the system is existent.

A top-down design approach (Hawsyszkiiewyez, 1999) was used where the overall system is broken down into smaller modules to handle different areas of the study. A keypad, an Atmel 89C52 microcontroller, a MAX 232 IC chip and a pump was used to create a prototype of a fuel dispenser where for a standard fuel dispenser its mode of operation involves keying in data representing customer request at the keypad such that the dispenser only dispenses products corresponding to the value keyed in. The AT 89C52 microcontroller in the proposed system performs the role of receiving data representing customer request from the keypad, triggering the pump to dispense the petroleum product to the value demanded in liters and to send this value through its serial port to a web enabled PC located at the station.

Module one: Installing keypad and bowser pump using appropriate wiring and circuits to the microcontroller

Module two: configuration of the microcontroller and its control program along with interfacing the MAX 232 IC with the microcontroller.

Module three: design of the windows based interface using virtual basic for the PC's located at each individual station and connecting them to a hosting server and database from where operators can view related information

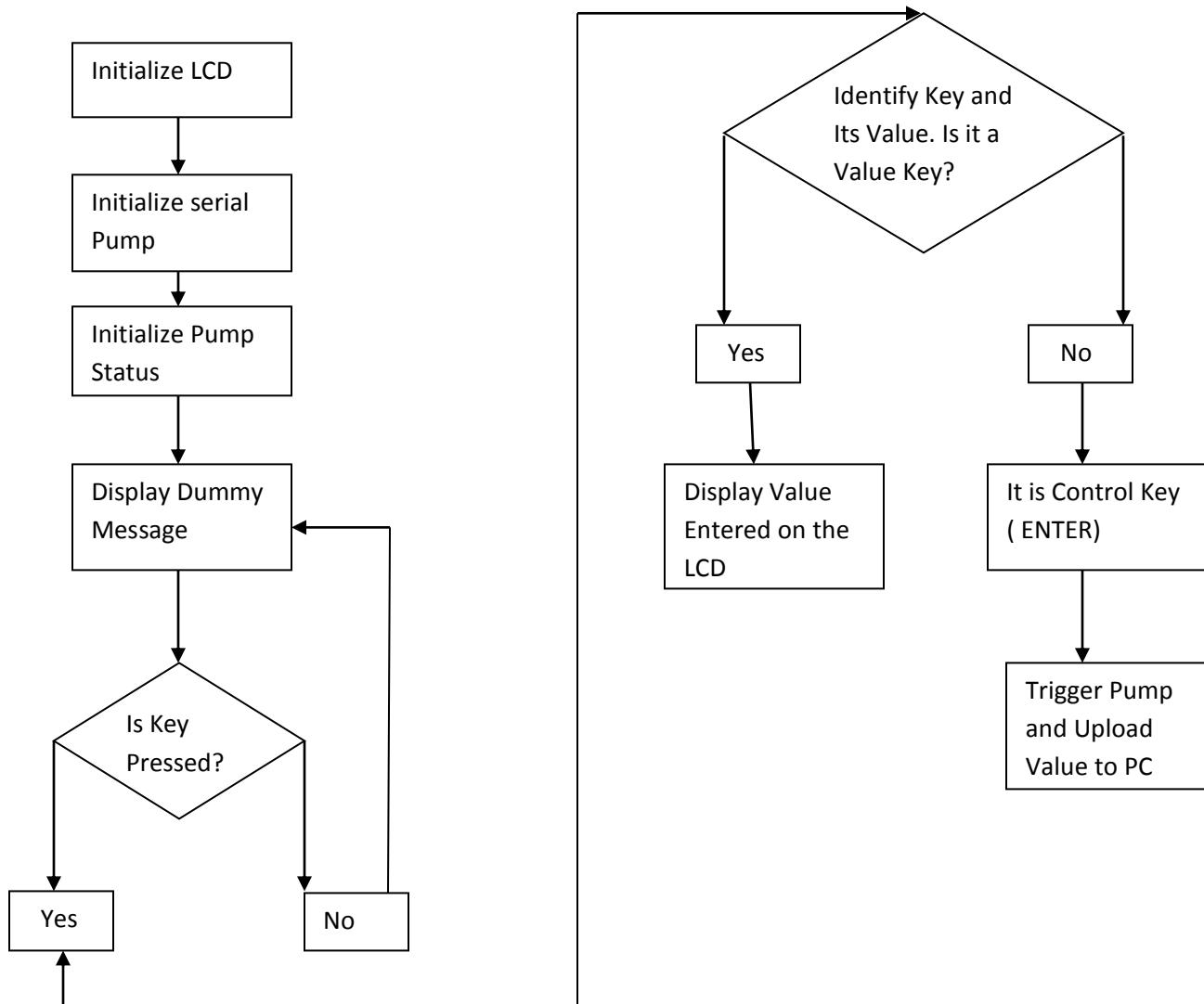


Figure 2: Flow Diagram Showing the Operation of the Microcontroller.

A combination of the three modules whose mode of operation is based on the system flow diagram is shown clearly below.

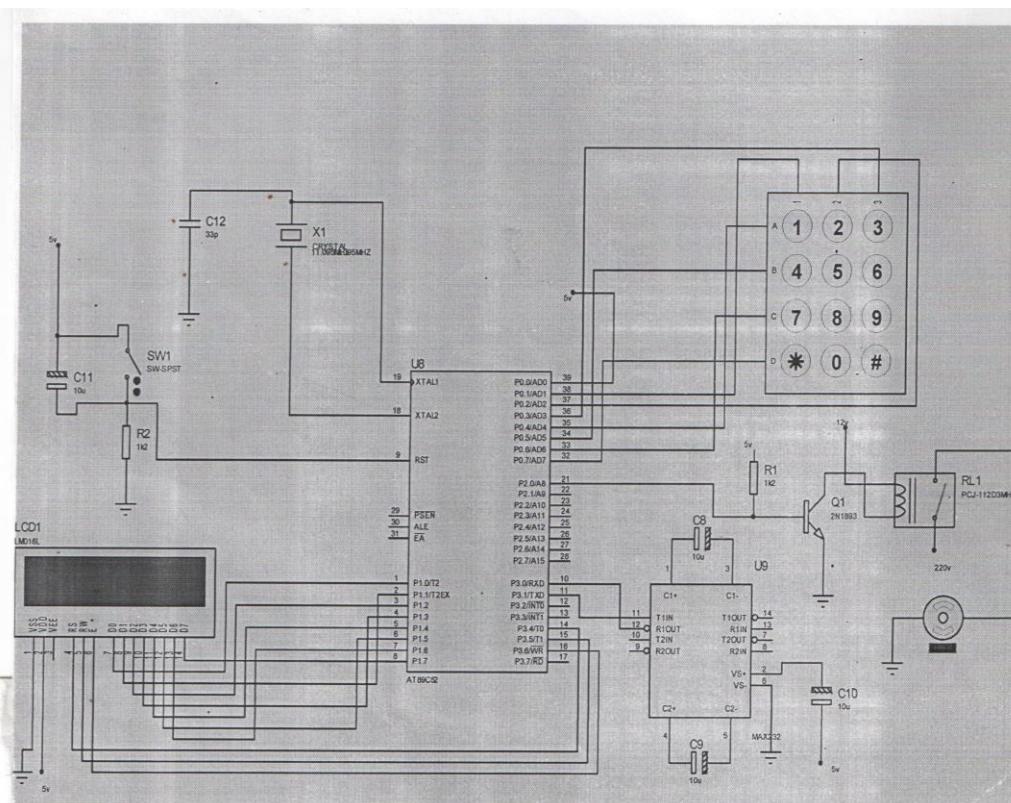


Figure 3: Overall System Circuitual Diagram



Figure 4: VB.net Based Interface for the Entire Stations Operated.

Figure 5: VB.net Interface Showing the Pump Level and Price of Dispensed Product.

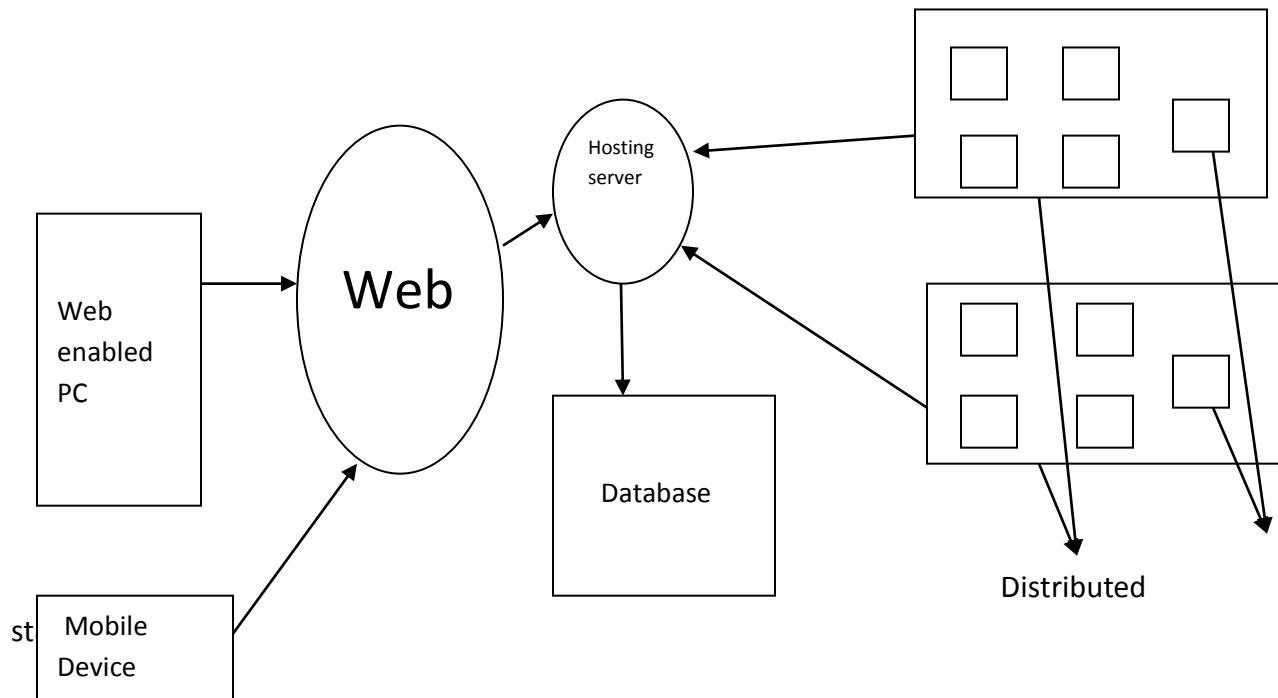


Figure 6: Overall System Architecture

V. RESULTS AND DISCUSSIONS

The system operates by the microcontroller receiving value from the keypad which represents customer request and this value is sent to a web enabled personal computer with an interactive graphic user interface designed using virtual basic as shown above has two web pages where the first depicts the total number of stations owned by the operator with information relating to their different locations while the second page shows clearly direct information on a pump-by-pump basis the

current output value and the revenue accrued at query time from the individual stations. Each station in the distributed network has a web enabled PC which performs the duty of receiving data from each pump in the station and uploads this information periodically to a hosting server who updates this value in a database. Users/operators of this system can via the internet using any web enabled device access the database to view updated information relating to pump output and sales volume.

VI. CONCLUSION

The research paper proposed a remote monitoring system for pump output monitoring in distributed fuel stations in Nigeria by recreating a fuel dispenser with an Atmel 89C52 microcontroller based system which has an added feature of being able to send collated data via its serial port to a web enabled PC to enable access of this data from anywhere in the world using a web enabled device. The proposed system finds application in distributed fuel stations in Nigeria which are currently un-automated to provide any information regarding fuel stations operation and this is unacceptable as there exists different/ appropriate technology to enable remote monitoring. The system when implemented would enhance the decision making ability of operators as it provides accurate and timely information relating to pump/station status and can go a long way to improving the decision making abilities of operators based on reliable, timely and accurate data. The use of the web/internet as a communication medium was chosen because it's a universal mode but it should be noted that cyber security challenges still exists.

VII. FUTURE WORK

The researcher intends to carry out further research on the subject topic by designing an implementation model based on the fused cooperative outputs of the developed system and the outputs of smart objects and internet of things incorporated for full real time monitoring and control of distributed fuel stations.

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