

A New Automation Approach for Fuel Station Management System

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Abstract

Day by day the number of vehicles and machines are increasing in the modern world. In the present day's scenario, the demand of fuel is increasing because of vehicles and machines are depending on fuel. The long line in front of fuel stations, especially in front of gas pumps is a common scenario in the daily life that waste the valuable time. In Bangladesh, the fuel stations are operated manually that causes the delay. In this paper, we have developed an automated fuel management system that can maintain the account of the fuel stations. The results of this experiment print a receipt automatically after every transaction and can monitor the transactions from remote place via Internet. This management system also helps the fuel stations to become faster and can reduce corruptions in transactions of fuel stations.

Keywords: Automation, Compressed Natural Gas (CNG), Fuel Station, CNG Pump Automation

Benzin İstasyonu Yönetim Sistemleri için Yeni bir Otomasyon Yaklaşımı

Öz

Makine ve araç sayısı modern dünyada günden güne artmaktadır. Araçlar ve makineler benzinle çalıştıkları için yakıtta olan bağımlılık gün geçtikçe artmaktadır. Benzin istasyonlarındaki pompaların önündeki uzun kuyruklar günümüzde çok karşılaşılan değerli zamanın israfıdır. Bangladeş'te benzin istasyonları manuel olarak işletilmekte bu da gecikmelere sebep olmaktadır. Bu çalışmada benzin istasyonlarının hesaplarını koruyabilmek için otomatik yakıt yönetim sistemi geliştirilmiştir. Bu deney sonucu olarak bütün işlemlerden sonra fatura otomatik olarak yazdırabilmekte ve işlemler internet yolu ile uzaktan da kontrol edilebilmektedir. Bu sistem benzin istasyonlarındaki işlemleri hızlandıracağı gibi olası aksaklıklar da giderebilir.

Anahtar Kelimeler: Otomasyon, Sıkıştırılmış Doğal Gaz (SDG), Benzin İstasyonu, SDG pompa otomasyonu

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1. Introduction

Energy is a vital issue in the modern world. At present, the machine is part of parcel of the daily life. Moreover, most of the machines are depending on energy or fuel in order to operate. The modern life depends on energy and most of the energy is coming from Petroleum or natural resources. Most of the countries in the world have not available petroleum or other natural resources. They have some small amount of natural Gas mine which is not good enough for a long time. Maximum developing country's government imports a large amount of petroleum in every year and sells them at fewer prices than the international market.

The government of Bangladesh gives a large amount of subsidy in petroleum sector every year. The government of Bangladesh spends a major share of its budget providing direct subsidies for fossil fuels and electricity, the costs of which have been escalating rapidly in recent years. In 2012, the government reports it spent BDT 81.4 billion (US\$ 944 million) in direct expenditure on energy subsidies [1]. In 2014 the finance ministry has sanctioned BDT 1,253 core in favor of the Bangladesh Petroleum Corporation as subsidy payments for selling petroleum products in the domestic market at prices lower than its procurement costs [2]. A well monitoring is necessary in this sector. The idea is to develop such a system that can monitor every transaction of every fuel station (e.g. Petrol or CNG pump).

The central goal of this research is to automate the fuel station so that the transactions can be maintained without difficulty. Generally, the fuel dispensaries calculate the amount of fuel and the corresponding costs of a transaction. The data is collected of every transaction from the fuel dispensary by using computer interfacing. We have developed a management system which can maintain the account of the fuel station and print a receipt automatically after every transaction. As a result, the employees of the fuel stations cannot hide any transaction to the owner of the fuel station. This also helps to reduce the time of the customers.

In this study implements a system that can monitor all the fuel stations transactions connected via Internet. The government can monitor all the fuel stations transactions efficiently. The owners of fuel stations cannot make any corruptions in the price of the fuels.

The remainder structure of this paper is as follows. Section 2 presents the Related Work of this paper. Section 3, provides a Research Methods of this paper. In section 4, the design and implementation part is discussed. Section 5, presents the results of the experiment. Finally, section 6, provides a set of conclusions and concludes with a future work.

2. Related Work

The main part of this research is to communicate with the fuel dispenser by computer interfacing. Computer interfacing is the most difficult thing. Previously, a serveral number studies has been done on the automatic refueling system and automated fuel management system [3-9]. This study shows an improved fuel control system that required no operation action. The most of those researches was focused on fuel tank management. Computer based fuel dispenser management is still an unexplored research area. There is a company named "TECHNOTRADE LTD" who provide hardware and software support for automation of fuel station [10].

There is a research work on an Electronic meter reader and data base management system whose objective is to develop a system which can transmit the meter reading of local area electric meter to the nearest electric meter billing and controlling station [11]. The designs and implements the gas station automation management system based on neural network [12]. The another research presents an automation experiment setup of fuel cell test station and a grid-connected circuit design of PAFC power plant [13].

This paper focuses on a new approach to design and implement an automated fuel management system that can maintain the account of the fuel stations and also print a receipt automatically after every transaction.

3. Research Method

The literature review is performed to find out the details about the fuel station. According to literature review results, this research method is divided into three parts. Firstly, we have studied about the fuel dispenser [8], especially the display of the fuel dispenser. Secondly, we have to collect the reading from the fuel dispenser with computer interfacing. Then we try to connect the display of the fuel dispenser with the computer via parallel port and get the reading with parallel port interfacing in C programming language. Then we have developed the management system with the Java programming language, including a database (MySQL) [14]. We also take help of Java Native Interface (JNI) [15] to get the reading of fuel dispenser from C program to the Java program. The fuel station management system prints a receipt after every transaction and also stores the information in the database. Finally, a careful analysis of the graph provides a quantitative measure of the results.

4. Design and Implementation

The proposed automated fuel management system is shown in figure 1. In our system the reading is taken from fuel dispenser then the data is processed and generate a bill. Simultaneously, the billing information is stored in database.

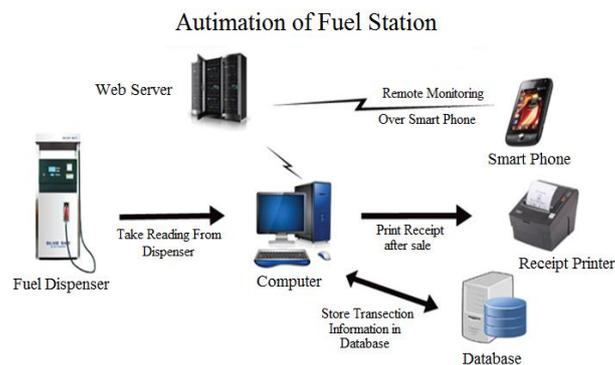


Figure 1. Proposed Automation of Fuel Station Management System

4.1 Creating the environment

There is no real life fuel dispenser in the laboratory. To do the experiment in the laboratory at the initial stage is to create an environment of fuel dispenser. We require the reading of the fuel dispenser. The study required only the display of the fuel dispenser and a supporting circuit that can increase the

value on the display. The display of the fuel dispenser is 7-segment displays. Similarly, in this experiment we also build a display module using 7-segment display. The 7-segment displays are operated by 7-segment decoder ICs. Again, a counter circuit is used to increase the range of the display.

There are two types of 7-segment display, common anode and common cathode. In this research, we have used common cathode segment display. There are several 7-segment decoder ICs and several counter ICs [16]. We have used 74LS48 7-segment decoder IC and 74LS193 four bits BCD up down counter and also some AND gate 74LS08 IC, NOT gate 74LS04 IC.

First, we connect six, 7-segment displays with six, 7-segment decoder ICs (74LS48) and six counter ICs (74LS193) with decoder ICs shown in figure 2.

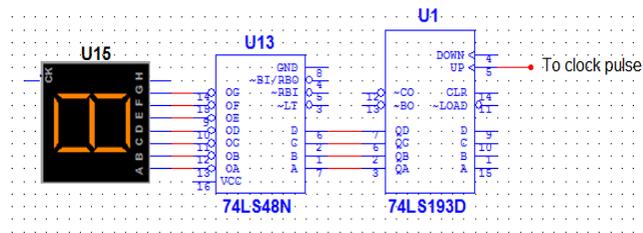


Figure 2. Connection diagram of 7-segment display, decoder IC and counter IC

The connected data (A, B, C, D) pins and the clear pin of IC 74LS193 (74LS193 IC pin 15, 1, 10, 9 and 14) to the ground and connect QB and QD (74LS193 IC pin 2 and 7) to load (74LS193 IC pin 11) via a NAND gate to make it mod 10 counter. Connect the output of the NAND gate to the next segments up clock counter (74LS193 IC pin 5) to make a multi digit counter shown in figure 3.

4.2 Interfacing with the circuit

The goal is to take input the value displayed in the display. It should be a float number. For taking input the value on the display and interface to display.

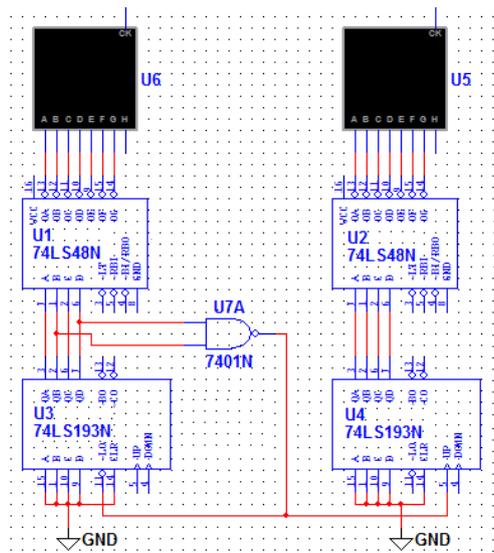


Figure 3. Connection diagram of two display digits

Computer interfacing is the more difficult thing. There are three types of computer ports, like as parallel port, serial port and USB port. Though in modern computers the parallel port is absent, we have used the parallel port interfacing with the system, because parallel interfacing is easier than other ports.

The Parallel Port is the most commonly used port for interfacing homemade projects. This port allows the input of up to 9 bits or the output of 12 bits at any one given time, thus requiring minimal external circuitry to implement many simpler tasks. The port is composed of 4 control lines, 5 status lines and 8 data lines. It's found commonly on the back of the PC as a D-Type 25 Pin female connector. There may also be a D-Type 25 pin male connector. This is a serial RS-232 port and thus, is a totally incompatible port [17].

4.3 Activate the parallel port

Before start working with parallel port we have to activate it. To activate the parallel port we have to copy a ".sys" file called "UserPort.sys" in directory "C:\Windows\System32\drivers". The "UserPort.sys" helps to activate the parallel port that is available in the Internet. Then we have to run software "User Port" and click on start. After starting the parallel port we can test the parallel port with a simple C program.

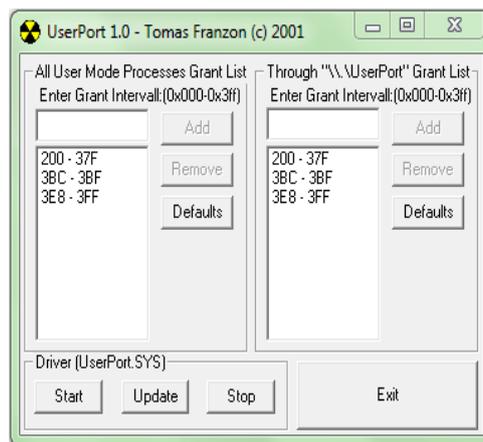


Figure 4. Activation of user port

4.4 Simple Output and Input test with C program

In Turbo C, there are some functions used for accessing the port: `outportb (PORTID, data)`; `data = inportb (PORTID)`; `outport (PORTID, ata)`; `data = inport (PORTID)`; `outpor()` function sends a word to port, `inport()` reads a word from the port. `outportb()` sends a byte to port and `inportb()` reads a byte from the port. The DOS.H header, these functions is considered as a macro, otherwise as functions. Function `inport ()` is returning a word having lower byte as data at `PORTID` and higher byte as data at `PORTID+2`. We have used this function to read status and control registers together. The `inportb()` function returns byte at `PORTID`. The `outporta()` writes the lower byte to `PORTID` and higher byte to `PORTID+1`. This can be used to write data and control together. The `outportb()` function writes the data to `PORTID`. The `outporta()` and `outportb()` return nothing. Let us start with a simple C program that can test the data in the status register and send output to the output pins. Then we should see data available in status register and

pin numbers 10, 11, 12, 13 and 15 of the parallel port. Pin 11 (active low) is 0 and all other pins are 1 means it is "OK".

4.5 Interfacing with Java

Java does not support interfacing code like `inportb()` or `outportb()`. We need to take help of C language for interfacing. There is a feature of Java called Java Native Interface (JNI) which is an interface that allows Java to interact with code written in another language. For JNI first we have to create a Dynamic Link Library (.dll) file which implements the methods `inportbs()` and `outportb()`. We have created the file `Jnput32.DLL`. Then we have to copy `Jnput32.DLL` in `Windows\System32` folder. Then we can create a Java class with native methods.

4.6 Taking input a single digit of the display

Using the parallel port interfacing we can take input 8 bit at a time, pin configuration shown in figure 5. The display of the fuel dispenser is 7-segment displays, which is operated by seven segment decoder ICs. We can take input from the seven segment decoder IC. The input of seven segment decoder IC is a four bit binary number. We need to take input a four bits binary number. Now we can write a class to get the digit on the display. First, take 8 bits input on the status register with native function of `inputa ()` and store in an integer variable. Then ignore first 4 bits by dividing the integer by 16.

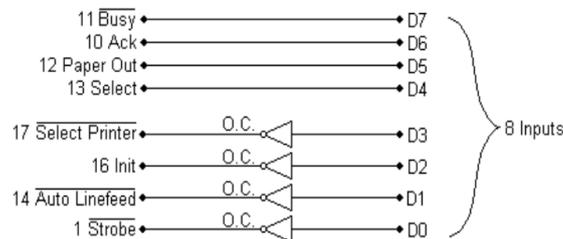


Figure 5. Eight input pins of standard parallel port

4.7 Taking input all the digits of the display as a float

We are able to take one digital input. We have to take input six digits. One digit contains four bits. Six digits contain 24 bits. We cannot take 24 bits input at a time. To take input 24 bits we need to design 24 to 4 bits multiplexer shown in figure 6.

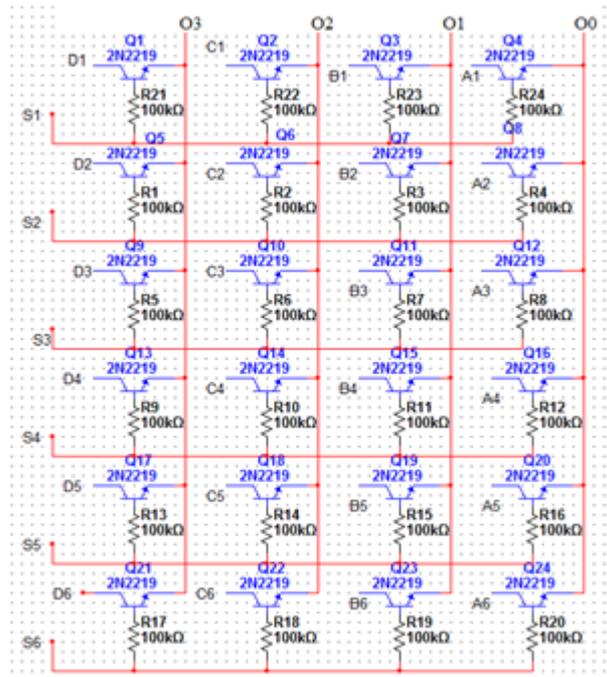


Figure 6. 24 to 4 line multiplexer with transistor

Connect the six, 7-segment displays ICs to the multiplexer and connect parallel port pins according to the table 1. Then we can get the float value displayed on the display with a Java class. First give output 10000000 with the native function of `outportb ()` to select the last digit and get the value using previous methods. Multiply the value by 10 and store it in a float variable. Then output 01000000 to select the second last digit and repeat the method and finally we can get the float value that's displayed on the display.

Table 1. Connection of multiplexer with parallel port

Symbol	Connected to
S1	Parallel port pin number 2
S2	Parallel port pin number 3
S3	Parallel port pin number 4
S4	Parallel port pin number 5
S5	Parallel port pin number 6
S6	Parallel port pin number 7
O0	Parallel port pin number 13
O1	Parallel port pin number 12
O2	Parallel port pin number 10
O3	Parallel port pin number 11 via a NOT gate
A1-A6	Decoder ICs pin number 7
B1-B6	Decoder ICs pin number 1
C1-C6	Decoder ICs pin number 2
D1-D6	Decoder ICs pin number 6

4.8 Controlling multiple fuel dispenser at a time

We can control multiple fuel dispenser at a time by designing higher multiplexer. There are eight data pins in parallel port. We can set 28 selectors and design a big multiplexer that can control a large number of fuel dispensers at a time.

4.9 Developing the management system

After getting the value from the dispenser it is easy to design and develop a system. We have implemented a fuel management system which can print a receipt after every transaction and generate business report.

5. Experiment Results

This section gives a detailed description about the analysis of the obtained experiment results. These results are based on the data obtained from an experiment in the laboratory. To test the fuel station management system first time is given some clock pulse in the counter IC and generates a value in the display circuit. At the same time it also shows the value in the main window of the fuel management system.

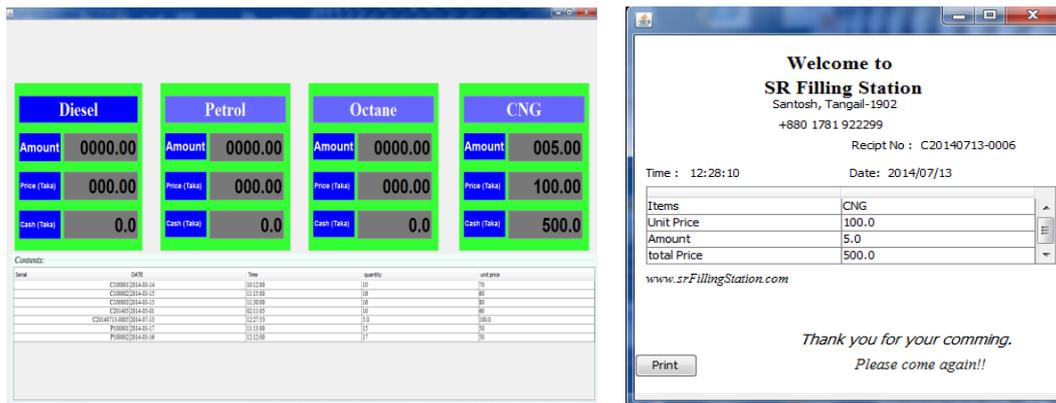


Figure 7. User Interface of fuel station management system

After finishing the transaction press the print button in the circuit. After pressing the print button a receipt is shown on the monitor. After pressing press the print button in the receipt window, then the receipt is printed from the printer connected to the computer. There is an admin panel in the fuel management system, which is password protected for security issue. When an admin logged in with his password can set the unit price of fuel and can select a date to view the business report of that day.

6. Conclusion

This paper developed a fuel management system that can take input from the fuel dispenser by parallel port interfacing and print a receipt automatically after each transaction. At the same time this management system can store the transaction information in the database that can generate daily, weekly, monthly and yearly business report in iReport. This system is more efficient, realible and cheap compare to existing system. Another features of this system is to store all previous transaction record, that can be print using iReport when users needed.

Nowadays, the USB ports are available in the modern computers. The future works could be addressed as to develop the system using USB port interfacing with cloud based system. It would be interesting to develop the system with USB interfacing that will be flexible for any Operating System (e.g. Windows 8, Linux etc).

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