Design and Development of a Smart Reservoir Monitoring System

IHEKWEABA CHUKWUGOZIEM, AMADI CHRISTOPHER C. And OKEREKE EZE ARU.

Corresponding Author: Amadi.christopher@mouau.edu.ng

Abstract - Recently Liquid dispensing systems are controlled and managed manually which consumes time and also requires manpower to operate. This gives room for irregularities in the management and a resultant flow in business expectation. The management and proper organization of the operations in the liquid dispensing systems has become a rising issue which led to this decision to come up with a proper and more efficient way to handle effectively the management system of the liquid dispensing systems and other typical systems. The result of this development is that owners of several dispensing systems will find it easier to monitor and manage the operations in their several outlets remotely. It also enhances proper documentation and inventory of the stock in liquid dispensing systems. It will also help to curb corruption and also help operations in liquid dispensing systems become faster and less time consuming. Since Machine to Machine has its origin in the supervisory control and data acquisition systems, where sensors and other devices are connected through wired or radio frequency networks are used and with attendant computers to monitor and control industrial processes. This system is to be implemented using IP-connected devices such as sensors, monitors, and actuators. Also, the web application will be developed using PHP on Laravel. This system is an improved automated liquid dispensing management system because of it's incorporated real time features and advantages. It can be applied in several areas that need proper monitoring and management especially our gas stations(Premium Motor Spirit(PMS), Automotive Gas Oil(A.G.O), Dual Purpose Kerosene(D.P.K) liquefied petroleum gas (LPG)).

Index Terms - Microcontroller, Sensors, laravel ,GSM, GPRS, WIFI, Tanks,

1.0 INTRODUCTION

Storage reservoirs are artificial containers that hold liquids, compressed gases (gas reservoir) or mediums used for the short- or long-term storage of hot or cold liquids. Large above ground storage reservoirs filled with hydrocarbon and hazardous liquids such as oil, oil derived products, chemicals and process plant liquids are in widespread use in Nigeria and the rest of the world including UK,USA and Europe. The reservoirs are generally spread across a large area and use manual detection and measurement methods which are still under developed. This makes it more laborious and time consuming to monitor the reservoir levels. Remote monitoring and data collection systems are necessary to collect information from the reservoirs and monitor same. So it is necessary to build a system which can be accurate, fast in measurement and simple to install and handle, but has an intelligence which takes decisions in real-time and alerts and communicates when necessary(Deepiga 2015). The data acquisition is done by the sensors used to sense the changes in the liquid level of the reservoir and is stored in the system's memory. A server collects the information sent from the onboard microcontroller through a GSM modem in the reservoir; saves it to a database and displays it on a website graphically. Such intelligent monitoring systems help in effective management of reservoirs, by assessing the status of the reservoirs periodically allowing optimized logistical supply of product and minimized inventory holding (Islam, 2009).

A filling station, gas station or petrol station is an establishment that sells fuel and lubricants usually gasoline (petrol) or diesel fuel. Some stations carry fuels like liquefied petroleum gas (LPG), natural gas, or kerosene.As GSM(Global System for Global Communication) technology is used, it helps the system to be installed in industries, liquid storage fields, oil-reservoir and trucks. These measurements are sent to a server via a GSM module through GPRS(General Packet Radio Services). The GPRS is activated and the TCP/IP(Transmission Control Protocol/Internet Protocol) sockets are used to communicate to and from the server. The server stores the values in memory and ensures that fluid inventory levels are maintained, and helps in identifying problems such as reservoir leaks and fluid theft. The various components of the system includes an ultrasonic sensor, a microcontroller which contains the processor and the analogue to digital converter to measure the temperature and the WIFI module used to connect to the server. The processing of the sensor data is done by the microcontroller and communicates to the server periodically as defined during installation.

Research was done to communicate with the fuel dispenser by computer interfacing. Previously, a several number stud-

ies has been done on the automatic re-fuelling system and automated fuel management system [Felix, 2000]. This study shows an improved fuel control system that required no operation action. The most of those researches was focused on fuel reservoir management. Computer based fuel dispenser management is still an Unexplored research area.
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 [Mehmood, 2011]. The designs and implements the gas station automation management system based on neural network [Meihong, 2009].
Several review papers discussed D2D communications in the context of wireless technologies by focusing on various D2D applications such as e-healthcare,smart metering, smart grids, IoT paradigm,and radio resource management. For instance, authors in (EKartsakli,2014) addressed the D2D e-healthcare application, i.e,m-Health, by highlighting the benefits of using D2D technology for both patients and service providers due to reliable autonomous communication.
The another research presents an automation experiment setup of fuel cell test station and a grid-connected circuit design of PAFC power plant (Cheng, 1995).
Brown et al. 1987 developed a computerized assisted dispatch system for Mobil Oil Corporation in the United States. The dispatching procedure used by the system was an extension of the one presented by Brown and Graves in 1981
Ng et al.(2008) studied two small petrol distribution networks in Hong Kong: the Hong Kong Island network and the network for the Kowloon Peninsula and the New Territories. They proposed a model for simultaneously assigning trips to trucks and stations. For this case, station' inventories were managed by the vendor who decided when to replenish each station and what quantities to deliver.

2.0 SYSTEM DESCRIPTION

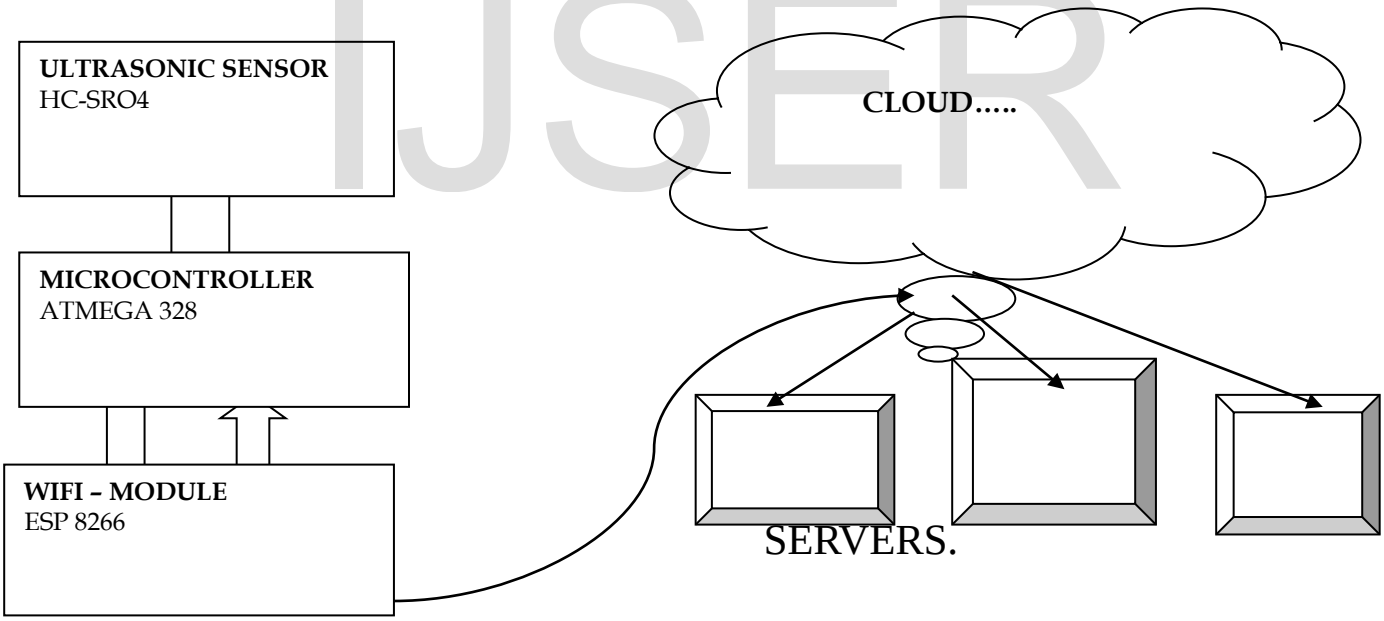


Fig 1: Simple Block Diagram Of The System Flow.

The hardware module consists of the sensors, monitors, actuators and other devices that makes up the machine. These various devices are placed at strategic positions. The M2M devices of the gas station automation are designed to measure and transmit signals to a flexible and scalable M2M network. M2M nodes connected to reservoir sensors are placed in the reservoir and are mainly responsible for collecting and transmitting signals. All M2M nodes come with their own unique IP addresses that is connected to the M2M gateway. Each of these nodes consists of a very-low power microcontroller, external memory and a transceiver unit packed in a small board. These devices are connected

to the reservoir and also the dispensing pump to monitor both discharge of product into the reservoir and also the dispensing of products from the various pumps and subsequently communicates with the minicomputer to upload real time values. The authors in (ZmFadlullah et al 2011), surveyed a number of existing communication technologies which can be used for D2D communication in smart grids.

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 (Mehmood, 2011). The designs and implements the gas station automation management system based on neural network (Meihyoung, 2009).

2.1 SYSTEM SOFTWARE MODULE

The software which interfaces the hardware devices with the computer system to enable the devices communicate with the minicomputer efficiently with the help of a microcontroller. The software module is an essential part of the entire system. The software module enables communication between the hardware and the application module. The software source code is embedded into the microcontroller which enables the microcontroller get reading gotten by the ultrasonic sensor and sent to the cloud via the wifi module. Since the automation is in real time, there would be need to interface the whole system with the internet for real time monitoring and management. So a web application will be developed linking the sensors, actuators and devices. A brief illustration of the system flow is as stated below.

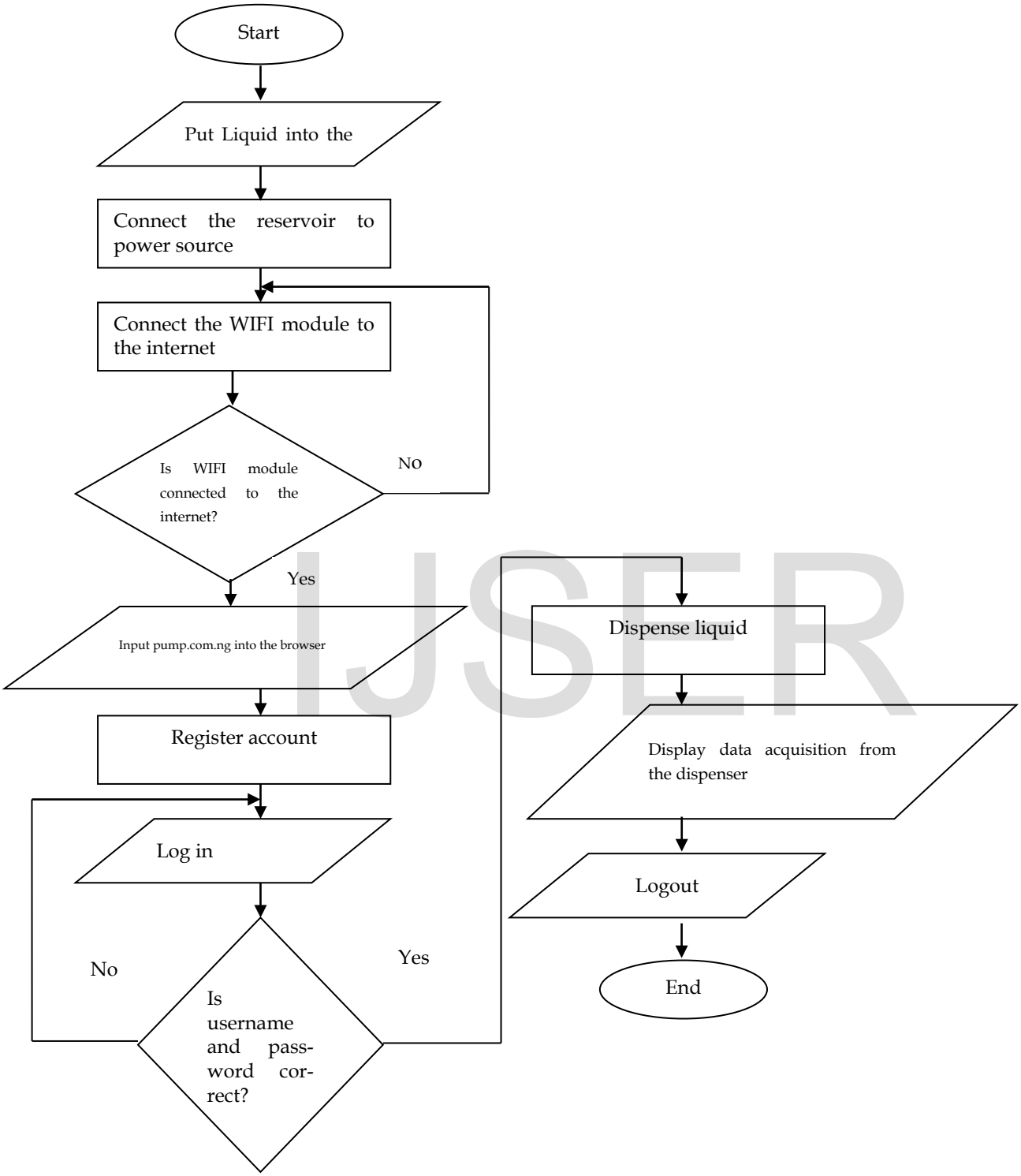


Fig 2: System flow diagram.

2.2 SYSTEM INTEGRATION.

The proposed system which includes a windows application as user interface, a cloud database to store and retrieve data. A software requirement is like the brain for these mechanical devices which are hardware components.These would be controlled through the instructions given by the software from the programmers. Their use inthis scope takes control of login data, sensors data, and some commands for the effective control of the system. The product has been designed based on the user requirements. Here, the productmust have to get the sensors data from the sensor by Arduino and sends data collected. Then the Software developed for data processing. The python programming language code was deployed in the software developed.

3.0 MATERIALS AND METHODS

3.1 Materials

The sensors, communication and processing units act as endpoints of M2M applications and together constitute the capillary network. The devices shall interconnect amongst themselves over various PAN and LAN technologies in both Wireless and Wireline domain. Their primary components are sensors, processors, and radio transceivers. The

Ultrasonic sensors.: As the name indicates, ultrasonic sensors measure distance by using ultrasonic waves. The sensor head emits an ultrasonic wave and receives the wave reflected back from the target. Ultrasonic Sensors measure the distance to the target by measuring the time between the emission and reception.

The following list shows typical characteristics enabled by the detection system.

- *Transparent object detectable*

Since ultrasonic waves can reflect off a glass or liquid surface and return to the sensor head, even transparent targets can be detected.

- *Resistance to mist and dirt*

Detection is not affected by accumulation of dust or dirt.

- *Complex shaped objects detectable*

Presence detection is stable even for targets such as mesh trays or springs.

HC-SR04 UltrasonicSensor - Working

HC-SR04 Ultrasonic (US) sensor is a 4 pin module, whose pin names are Vcc, Trigger, Echo and Ground respectively. This sensor is a very popular sensor used in many applications where measuring distance or sensing objects are required. The module has two eyes like projects in the front which forms the Ultrasonic transmitter and Receiver. The sensor works with the simple high school formula that

Distance = Speed × Time

The Ultrasonic transmitter transmits an ultrasonic wave, this wave travels in air and when it gets objected by any material it gets reflected back toward the sensor this reflected wave is observed by the Ultrasonic receiver module as shown in the picture below

Now, to calculate the distance using the above formulae, we should know the Speed and time. Since we are using the Ultrasonic wave we know the universal speed of US wave at room conditions which is 330m/s. The circuitry inbuilt on the module will calculate the time taken for the US wave to come back and turns on the echo pin high for that same

particular amount of time, this way we can also know the time taken. Now simply calculate the distance using a microcontroller.

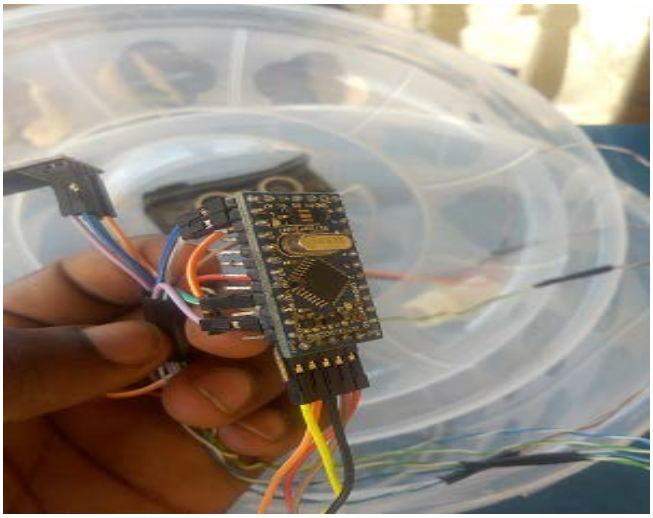
The amount of time during which the Echo pin stays high is measured by the MCU/MPU as it gives the information about the time taken for the wave to return back to the Sensor.

Applications

- Used to avoid and detect obstacles with robots like biped robot, obstacle avoider robot, path finding robot etc.
- Used to measure the distance within a wide range of 2cm to 400cm
- Can be used to map the objects surrounding the sensor by rotating it
- Depth of certain places like wells, pits etc can be measured since the waves can penetrate through water.

Microcontroller.

A microcontroller is a single chip microcomputer made through VLSI fabrication. A microcontroller also called an embedded controller because the microcontroller and its support circuits are often built into, or embedded in, the devices they control. A microcontroller is available in different word lengths like microprocessors (4bit,8bit,16bit,32bit,64bit and 128-bit microcontrollers are available today).Microcontrollers usually must have low-power requirements since many devices they control are battery-operated. Microcontrollers are used in many consumer electronics, car engines, computer peripherals and test or measurement equipment. And these are well suited for long lasting battery applications. The dominant part of microcontrollers being used recently are implanted in other apparatus.



ATmega328 Microcontroller used in the prototype

A microcontroller basically contains one or more following components:

- Central processing unit(CPU)

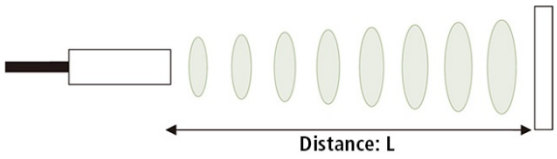
- Random Access Memory)(RAM)
- Read Only Memory(ROM)
- Input/output ports
- Timers and Counters
- Interrupt Controls
- Analog to digital converters
- Digital analog converters
- Serial interfacing ports
- Oscillatory circuits

There are many AVR family microcontrollers, such as ATmega8, ATmega16 and so on. The ATmega328 and ATmega8 are pin compatible ICs but functionally they are different. The ATmega328 has flash memory of 32kB, where the ATmega8 has 8kB. Other differences are extra SRAM and EEPROM, addition of pin change interrupts and timers. Some of the features of ATmega328 are:

Features of ATmega328:

- 28-pin AVR microcontroller
- Flash program memory of 32kbytes
- EEPROM data memory of 1kbytes
- SRAM data memory of 2kbytes
- I/O pins are 23
- Two 8-bit timers
- A/D converter
- Six channel PWM
- In built USART
- External Oscillator: up to 20MHz

The ultrasonic sensors are used to measure distance and also can be used to measure the depth of objects. The ultrasonic sensor sends an ultrasonic wave which once it hits an obstruction it sends back an echo.



An optical sensor has a transmitter and receiver, whereas an ultrasonic sensor uses a single ultrasonic element for both emission and reception. In a reflective model ultrasonic sensor, a single oscillator emits and receives ultrasonic waves alternately. This enables miniaturization of the sensor head. The distance can be calculated with the following formula:

Distance L = 1/2 × T × C

where L is the distance, T is the time between the emission and reception, and C is the sonic speed. (The value is multiplied by 1/2 because T is the time for go-and-return distance.)We know that sound vibrations cannot penetrate through solids. So what happens is, when a source of sound generates vibrations they travel through air at a speed of 220 meters per second. These vibrations when they meet our ear we describe them as sound.. As said earlier these vibrations cannot go through solid, so when they strike

with a surface like wall, they are reflected back at the same speed to the source, which is called echo.

Interfacing HC-SR04 Ultrasonic Sensor with the Microcontroller

The ultrasonic distance sensor has 4 Pins: Vcc, GND, Trigger and Echo. The Vcc and GND are used to power up the sensor and are connected to power and ground rails on breadboard. Trigger is connected to PIN 14 (RX/PD0) and Echo is connected to PIN 16 (INT0/PD2) of the microcontroller. ATmega328p microcontroller needs to transmit at least 10 us trigger pulse to the HC-SR04 Trig Pin. After getting trigger pulse, HC-SR04 automatically sends eight 40 kHz sound wave and micro controller waits for rising edge output at Echo pin. When the rising edge capture occurs at Echo pin which is connected to input of ATmega328p, start Timer of ATmega328p and again wait for falling edge on Echo pin(connected to PD5(INPUT PIN))

When the micro controller is triggered by the ultrasonic sensor, it gets the data and in turn transmits the data to the wifi module which communicates with cloud. The ESP8266 modules comes with a default firmware loaded into it, hence we can program the module using AT commands. These commands have to be sent through a serial communication channel. This channel is established between the AVR and the ESP8266 module by using the USART module in the AVR microcontroller**.** We should note that the communication between the modules are serial using UART(Universal Asynchronous Receiver and Transmitter). ESP8266 wifi module is low cost standalone wireless transceiver that can be used for end-point IoT developments.ESP8266 wifi module enables internet connectivity to embedded applications. It uses TCP/UDP communication protocol to connect with server/client.To communicate with the ESP8266 WiFi module, microcontroller needs to use set of AT commands. Microcontroller communicates with ESP8266-01 WiFi module using UART having specified Baud rate (Default 115200).

Arduino UNO

Arduino UNO is a microcontroller MCU platform which has many I/O Pins for analog / digital work and it has other components such as small memory storage. ATmega328 is the core component of the Arduino UNO MCU, that it is working as the processor unit. Other components that make up this board include, 14 digital I/O pins, 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack and a reset button. The Arduino UNO is a model from the Arduino series. Arduino UNO has one USB connector which can be used to upload code or for a power connection. Battery and main power options are available for power connection. The board can work on 6V to 20V. Less than 5V supply can make the board unstable, whereas more than 12V will overheat and damage the board. The recommended range is 7 volts to 12 volts. The ATmega328 has 32 KB (with 0.5 KB used for the bootloader) of Flash memory. It also has 2 KB of SRAM and 1 KB of EEPROM

The Arduino UNO has a number of facilities to communicate with a computer. The ATmega328 provides serial communication, which is available on digital pins 0 (Receive) and 1 (Transmit). Universal Asynchronous Receiver/Transmitters (UARTs) are present in the Microcontroller to receive and transmit data serially. It transmits one bit at a time at a specified data rate (e.g. 9600bps, 19200bps, etc.). This method of serial communication is sometimes referred to as transistor-transistor logic (TTL) serial. Serial communication at a TTL level is between the limits of 0V and Vcc. Vcc is 5V or 3.3V. While I am trying to make the communication secure, a general question that would come up is: Can Arduino UNO code be read from the chip once it is uploaded? When the code is uploaded in the Arduino UNO

microprocessor, it is converted into Hexadecimal format. The pulled hexadecimal code is the converted machine code from the original code and is not as same as the original code. This protects the code primarily because the resources required to extract the original code from the machine code will be higher. Secondly, there is one ultimate way to protect the microprocessor, which is by locking boot loader bits. This allows the user to set the microprocessor bit in a way that will not allow anyone (including the authentic user) to read the data from Arduino UNO. The user can erase data from the chip and then upload data but cannot read what is already uploaded and bit locked. The boot loader lock mode can be enabled by software or serial or parallel programming but only can be erased by a chip erase command. The facility provides much needed protection for WSNs.

WIFI MODULE. – ESP8266

The ESP8266 WiFi Module is a self-contained SOC with integrated TCP/IP protocol stack that can give any microcontroller access to your WiFi network. The ESP8266 is capable of either hosting an application or offloading all Wi-Fi networking functions from another application processor. Each ESP8266 module comes pre-programmed with an AT command set firmware, meaning, you can simply hook this up to your Arduino device and get about as much WiFi-ability as a WiFi Shield offers.

WI-FI MODULE ESP8266

The ESP8266 module is an extremely cost effective board with a huge, and ever growing, community. This module has a powerful enough on-board processing and storage capability that allows it to be integrated with the sensors and other application specific devices through its GPIOs with minimal development up-front and minimal loading during runtime. Its high degree of on-chip integration allows for minimal external circuitry, including the front-end module, is designed to occupy minimal PCB area. The ESP8266 supports APSD for VoIP applications and Bluetooth co-existance interfaces, it contains a self-calibrated RF allowing it to work under all operating conditions, and requires no external RF parts.

There is an almost limitless fountain of information available for the ESP8266, all of which has been provided by amazing community support

3.2 METHODS.

The method involved the use of engineering principles and intuition to connect the various components and develop the drivers and the application software (backend-frontend) to enable the system perform the desired process. The process involved the sensor continually getting information or data from the reservoir and sending the acquired information down to the microcontroller. The microcontroller accepts the data and in turn sends the processed data to the Wi-Fi-module which then sends it out to the cloud and down to the servers. There are several sensors which can

be used to achieve this but ultrasonic sensor was used in this project.

4.0 RESULTS AND DISCUSSION

Two units will be placed at petrol station which will take care of customer's needs & also it will continuously monitor the fuel level at the petrol station. The third is the data base regarding customer's ids, passwords & will also take care of the account balance and quantity of product remaining. The Wifi module will act as a link between reservoir and the owner of the petrol station. The software part of this project will help to keep record of all the things in short we are providing total security while distributing the fuel.

The methodology that has been implied in the project development is the prototyping model. Prototyping is a software development process which allows programmers or developers to create part of the solution to demonstrate technical feasibility and functionality to the client and make needed refinements before developing the final product. This method can reduce risk and limit expenses and costs.

4.1 RESULTS

The Principle of Measurement

An ultrasonic sensor is used to sense the amount of liquid inside the reservoir. These sensors send out high frequency waves which are reflected back when it strikes an object or liquid surface. The time span between the transmitting and reflecting waves is measured by the microcontroller. This time of flight is used to determine the distance travelled by the waves, and extrapolate the depth of the liquid in the reservoir from the point where sensor is placed.

The microcontroller sends a pulse through the software code, to the ultrasonic sensors which in turn transmits a wave form. Simultaneously, a timer in the software code is activated and runs until the waveform is received back. Once the waveform is received, the sensor sends a signal to the microcontroller and the timer value is counted and the distance is determined. The microcontroller has various timers and timer 3(TIM3) is used because it consumes relatively less current (0.46mA) when compared to all the other timers present in the microcontroller. The software code used here takes three different ranges into consideration to find the distances. The ranges are 1) Short Range, 2) Medium Range and 3) Long Range. The depth of the liquid is calculated accordingly and stored in the flash memory available for transmission to the server via the GSM Module.

WEB APPLICATION RESULTS.

The automation of the whole process is being monitored from a remote server. The webpage was developed using Laravel to display the received data from the hardware system. The entire system consists of both the hardware and software module. The hardware which consists of the bucket, microcontroller , ultrasonic sensor, and wifi module is interfaced with the software using PHP to handshake the internet and computerized monitoring of the entire system process. process.

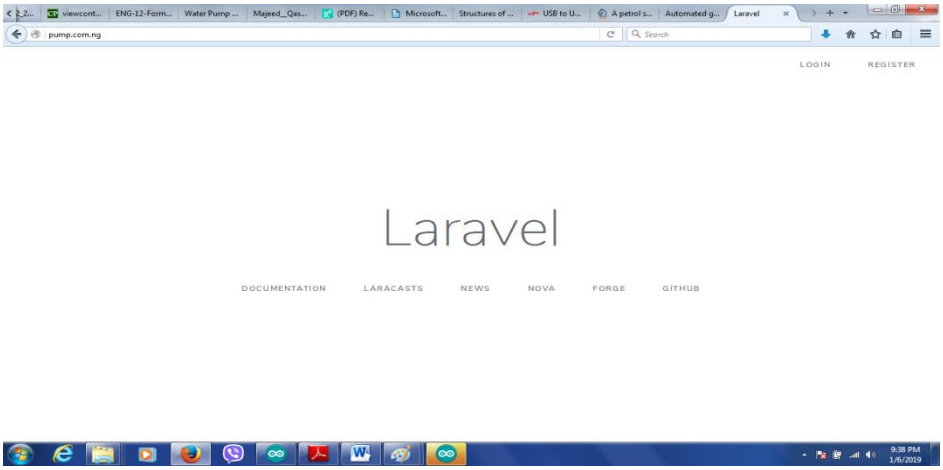


Fig 2: Initial Page of the Webpage developed

The above FIG 2 shows the initial page of the web page which has two major links "LOGIN" and "REGISTER". These two links takes the operator to two different pages. This is the first page that opens up once you get on the web address pump.com.ng .this address opens up the first page where you have the option to either register if you a new user or login if you already have a login ID.

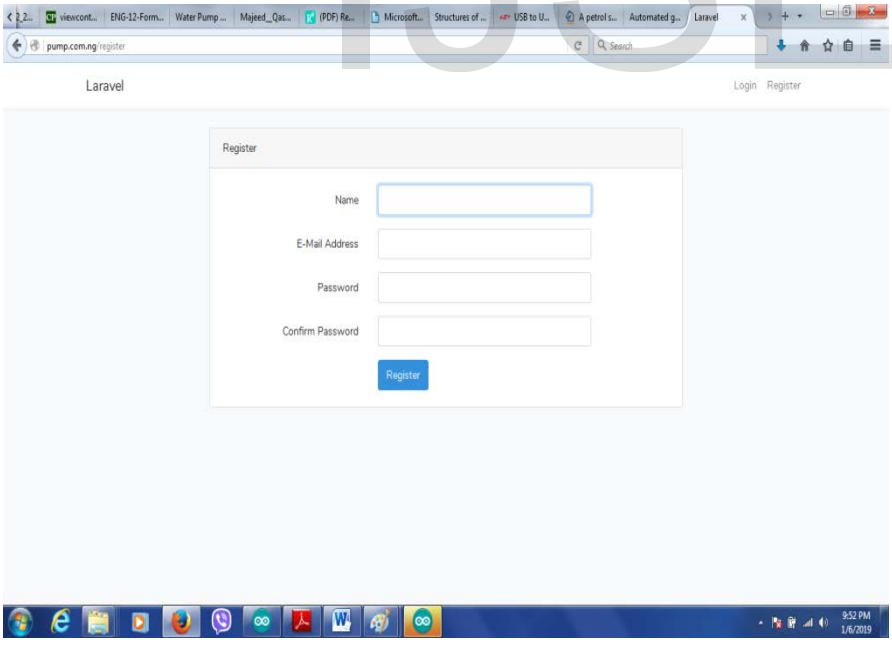


Fig 3: The Registration page

REGISTER.

The above FIG 3 shows the registration page. This page gets the information from the user and stores it in the database to enable the user log into the server when he wants to view the data received from the reservoir. From the above page, the user is required to input his "Name",Email address" and "password". Once these informations are correctly typed,the register button is clicked to register the user.With these details being successfully registered, the user is assigned to a space on the database and can be able to log in .

LOG IN PAGE.

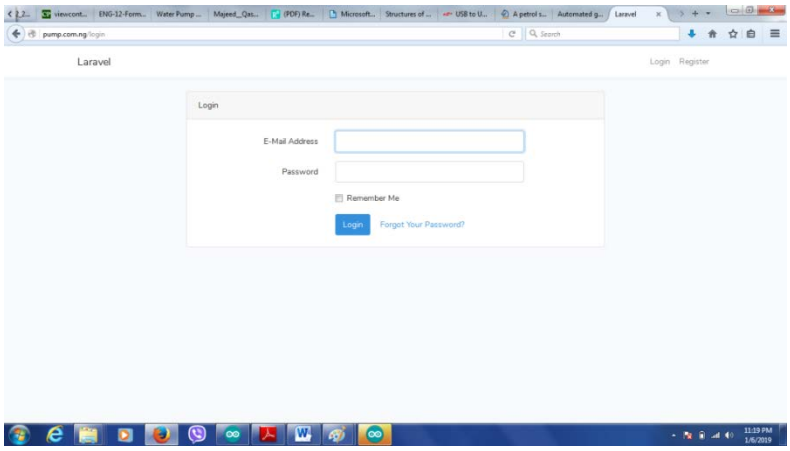


Fig 4: Log In Page.

The above FIG 4 shows the log in page on the webpage where the user will key in the log in details to be able to access the data information as received. With the correct details the user can log in successfully. If the details are incorrect, the displays shows up as the FIG 5 below.

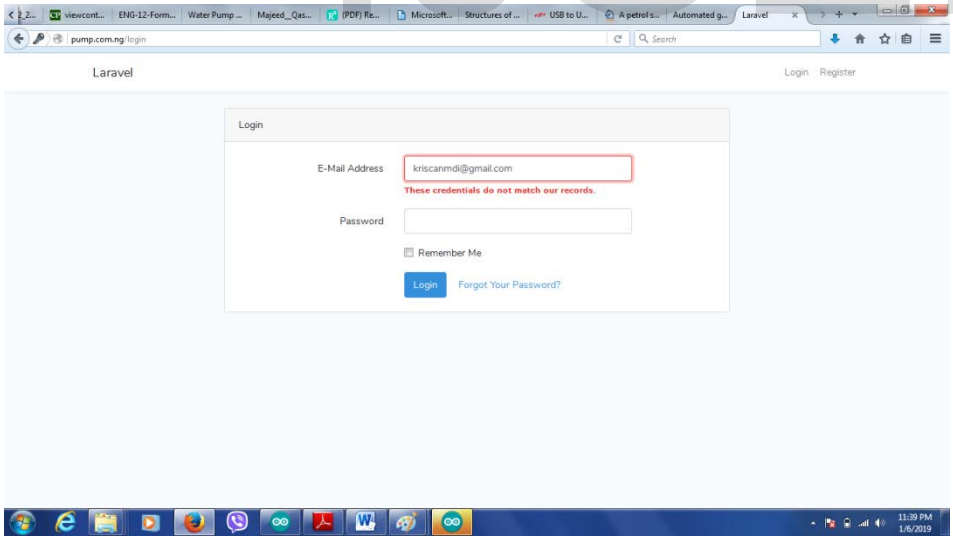


Fig 5 : Error Page.

When your input doesn't tally with the pre-registered datails, you get a feedback as seen above. This serves as an error page.

Data Page

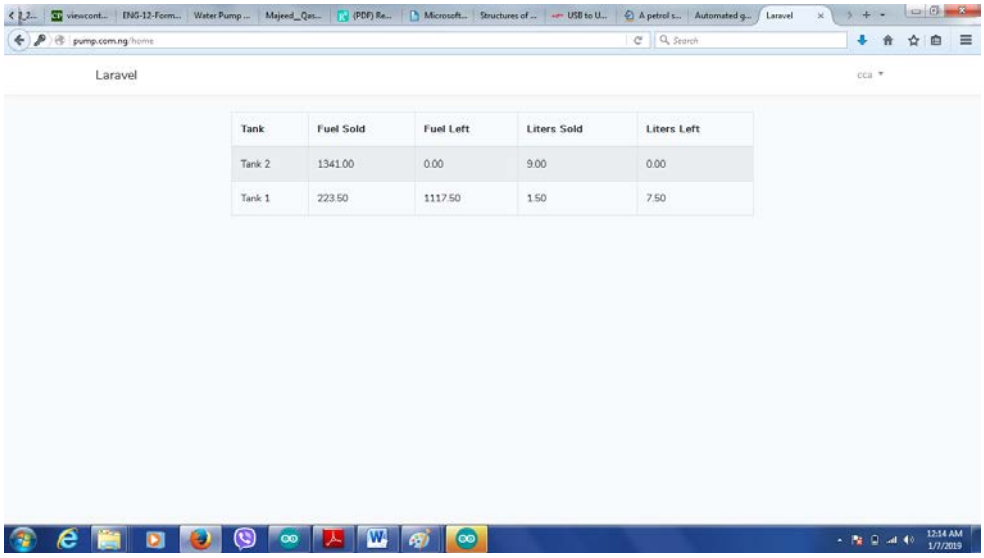


Fig 6: Data Acquisition page

The FIG.6 is the full data page which displays all the acquired data from the onsite system. Working with two reservoirs, FIG 6 shows the overall running of the system, ranging from the number of reservoirs involved, how much fuel sold, how much fuel left unsold, quantity of product left and quantity sold. This gives all the basic information of the stock during the process. With this, the operator can easily monitor and manage operations in the fuel station with ease.

CONCLUSION

The creation of a fuel station management system for tracking products and inventory of liquid in liquid dispensing systems will help the organization to enhance its performance. Moreover, a well implemented fuel station management system will provide the organization with the structure to activate continual improvement actions. This research has been carried out by a lot of people in the past to enhance and make fuel station process monitoring easier and more efficient. This thesis deals with the management, organization and monitoring of the operation in the fuel station, ranging from the reservoir dispensations down to the monetary value.

RECOMMENDATIONS FOR FUTURE WORK.

This work was done based on the prototype model. We used low budget materials to achieve the aim just to prove it is achievable and can be obtained. For further works I recommend better and more accurate level sensors be used to achieve more accurate results and also suggesting to add anthers sensors to the system such as temperature sensor and PH sensor. This system can be further improved by accompanying a SMS notification feature which will inform the owner in case of an error. On the other hand the sensors are strictly power limited; hence improving the sensor's power utilization with a better sleep-wake up mechanism would be very handy.

REFERENCES

Brown GG, Ellis CJ, Graves WG, Ronen D (1987) Real-time, wide area dispatch of mobil tank trucks. Interfaces 17(1):107–120

Brown GG, Graves WG (1981) Real-time dispatch of petroleum tank trucks. ManagSci 27(1):19–31.

Cheng, Y.C., W.H.Yuen, A. S.Lin, J.T.Tsay, 1995. "Automation and control for the PAFC fuel cell components and the power plant", In Industrial Automation and Control: Emerging Technologies, International IEEE/IAS Conference on, pp: 66-71

Deepiga, M.T. and Sivasankari, M.A., 2015. Smart Water Monitoring System Using Wireless Sensor Network at Home/Office.International Research Journal of Engineering and Technology (IRJET), 2(04), pp.1305-1314.

E Kartsakli, AS Lalos, A Antonopoulos, S Tennina, MD Renzo, L Alonso, C Verikoukis, A survey on M2M systems for mHealth: a wireless communications perspective. Sensors.**14**(10), 18009–18052 (2014)

Felix, C., M.Paul and W.Amy, 2000. "Fuel dispenser Interface", U.S. Patent D 433,035

Islam, N.S. and Wasi-ur-Rahman, M., 2009, December. An Intelligent SMS-based remote water metering system. In Computers and Information Technology, 2009.ICCIT'09. 12th International conference on (pp. 443-447).

Mehmood, N., Z.A.Ali, A.A. Sidiqui, M.Asif,S.Wasi, 2011. "Electronic meter reader database management system", In Information Technologyand Artificial I intelligence Conference (ITAIC), 2011 6th IEEE Joint International, pp: 68-71

Meihong, Z., L.Yun,2009. "Research on Gas Stations Automation Management System Based on Neural Network",In Information Engineering, 2009. ICIE'09. WASE International Conference on, pp: 573-575.

Ng WL, Leung S, Lam J, Pan S (2008) Petrol delivery tanker assignment and routing: a case study in Hong Kong. J Oper Res Soc 59:1191–1200.

Witzel, Michael Karl. *The American Gas Station*.Motorbooks International, 1992.

ZM Fadlullah, MM Fouda, N Kato, A Takeuchi, N Iwasaki, Y Nozaki, Toward intelligent machine-to-machine communications in smart grid. IEEE Commun. Mag. **49**(4), 60–65 (2011)

Ihekweaba Chukwugoziem is a Professor in the Department of Computer Engineering, Michael Okpara University of Agriculture, Umuahia, Abia State, Nigeria. His research interests include Computer Hardware design and maintenance, Security system design, Digital Communication, etc.Email: Ihekweaba.gozie@mouau.edu.ng

Amadi Christopher C. is currently pursuing masters in computer engineering, michael okpara university of agriculture, Umudike, Umuahia, Abia State, Nigeria. His research interest include Information Communication Technology. Email: **amadi.christopher@mouau.edu.ng**

Aru, Okereke Eze is a Senior lecturer in the Department of Computer Engineering, Michael Okpara University ofAgriculture, Umuahia, Abia State, Nigeria. His research Interests include Computer Hardware design andmaintenance, digital systems design using microcontrollers and other computer related subjects.Email: okezearu@yahoo.com