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DEVELOPMENT OF AN AUTOMATIC TRANSMISSION AND MEASUREMENTS OF DATA IN NIGERIA OIL SECTOR WITH A TELEMETER USING WIRELESS TECHNOLOGY.

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Abstract

The high level of corruptions, lack of trust, insincerity and the pervert mode of operation in the oil sector over a long period of time in the country has become worrisome that needs the high level of technology to alleviate this problem to a barest minimum. This paper presents an automatic transmission development and measures of the amount of petrol and other fractions of crude oil generated in a refinery each day to transmit the result to separate users using wireless technology. The machine combines a telemeter with a hall-effect flux sensor, which helps produce the output pulses in proportion to the fluid flow rates, in which fluids are transferred via sensor and rotor blades that are rotated in the generation of pulses. The sensor is then combined with the fluid line and pinwheel, the Hall Effect Sensor for output signals. The Peripheral Interface Controller (PIC) microcontroller is sent a signal from the flow sensor to a Global System for Mobile Communication (GSM) module that links the UART port to the mobile telephone. The data analyzed, converted were sent to Liquid Crystal Display (LCD) to show the flow rate and volume. The site technician or personnel at the base station could easily calculate the product entering the calibrated reservoir and receiving it as SMS. The report will allow the country's people who have access to GSM to know how much oil is generated in Nigeria in each day. After getting the value of fluid generated via SMS from the GSM module, the personnel at the base station then manually upload the data to the firm website; thus, everyone in the country can get access to the information. The website is built such that the different stations can upload their data if the admin gives them a password and user name. This will alleviate the levels of corruption, indecency, and crime in the oil sector. The device is approximately 98 percent reliable and cost-effective.

Keywords: PIC. microcontroller, LCD, GSM, SMS, Crude Oil

1. INTRODUCTION

Telemetry is the automated recording and data transfer from remote or unavailable sources to an IT system for monitoring and analysis at a differential venue. Depending on the application, telemetry data can be relayed using radio infrared, ultrasonic, GSM satellite, or cable. It works via remote source sensors that measure physical or electrical data. It would be converted to electrical voltages, combined with timing data, a data stream transmitted via wireless, wired, or combined wireless medium, wikipedia.org (2017).

In 1894, fascinated by Hertz's discovery Guglielmo Marconi realized that wireless telegraphy could be developed if radio waves could be transmitted and detected over long distances. He experimented with rough aircraft on the other side of the family garden and received signals for 100 meters and had reached over one mile by the end of 1895 with demonstrations in England increasing to eight miles in 1896. He also developed tuned wireless transmission circuits, tuned at a specific frequency, to remove all other transmissions other than interest. . Marconi and his associates succeeded in sending a signal across the Atlantic Ocean in December 1901. Telemetry (from the Greek roots telephone, remote and matron, measurement) was not used unless a medium for transmission had been invented. Following the invention of the telegraph and then the telephone, the earliest telemetric system was based on electric wires. In Chicago in 1912, the first system was installed and used telephone lines to transfer data from electric power plants to a central office and was named a monitoring system. Telemetry usually means wireless communications but can refer to data transmission through any medium. A basic telemetry system is a measuring instrument or detector, a transmission medium, a recipient, and a data-based output device Van & Pauer, (2018). Today, many telemetry systems are built from commercial off-shelf (COTS) products with many familiar elements but are unique to specific application requirements. A transducer gets the monitoring signal and converts the value to ready-to-transmit electrical impulses. But telemetry applications supporting a large number of measuring devices are too expensive and impossible to use individual transmission channels (e.g., pressure, speed, and temperature) for each quantity measured. Individual measurements are either formatted or multiplexed by multiplexing the time division or the frequency division and transmitted as a single data stream. The data stream at the receiver is divided into the original research components Bates, (2011). Simple modes of telemetry use wired communications, while the radio is the chosen means for long distances use for advanced applications with light or sonic signals. Telemetry has been expanded to provide astronomical information or biological information from inside a person's body from the most distant planet through a micro-miniature transmitter. Flow measurements include the measurement of solid, liquid, and gas flow rates. Two primary methods of measuring the flow rate exist, one by weight and one by volumetric means Floyd, (2014). Concrete materials are measured by weight per unit time or mass per unit time. Quite rarely, substantial amounts are determined by volume. Liquids are either classified in volume or weight. Usually, gasses are measured at a volume rate. The usage of resources like crude oil, water, and even electricity is usually calculated by specifying either the instantaneous flow rate or cumulative overtime amount. The cumulative volume calculation makes it easy to determine overall consumption over time and is exact in full use.

1.1 **Telemetry Applications**

Telemetry was and remained applied in many conventional and new disciplines, including defense systems, where vital device data are inaccessible without telemetry; space exploration; geological exploration systems such as oil plants and chemical plants; motorsports, which can interpret data obtained during a test or race; physiological measurement medicine, or biology. Instruments cover places and other information ranging from basic RFID tags and G.P.S. transceivers. In medical devices, animal science, and power generation, telemetry research is applied. Telemetry-related medical applications are predominantly prosthetic implants and endoscopic devices Seria *et al.,* (2007), with

some biological data, Puers & Catrysse (2010), collected by incubators Shin *et al.*, (2013) and neural signal Neihart &Harrison, (2015).
In the majority of cases, sensors are used as part of the Telemetry Systems, which was used and remained used in many traditional, and new disciplines, including defense systems where vital device data is inaccessible without telemetry; spatial exploration; geological exploration systems like petroleum plants and chemical plants; motorsports that can interpret data collected during testing or races; Instruments cover locations and additional information from simple RFID tags and G.P.S. transceivers. A lot of telemetry research is applied in medical devices, animal science, and power generation. The medical applications related to telemetry are mainly prosthesis implants and endoscopic devices, Puers & Catrysse, (2010), with biological data from incubators Shin *et al* (2013 and neural signal. In most cases, the device uses sensors, but some telemetry boards have digital conversions or microcontrollers with S.P.I. Bellis, (2007).

1.2 Statement of the Problem

The high level of corruptions, lack of trust , insincerity and the pervert mode of operation the oil sector over a long period of time in the country has become worrisome that needs the high level of technology to alleviate this problem to a barest minimum, which has critically reduced the profit margin of crude oil production in the country. Thus, there is need to develop an automatic system that will measures and transmit the amount of petrol and other fractions of crude oil generated in a refinery each day to separate users or whoever request of it, to reduce corruptions when measure the volume and amount of crude oil extracted. This system employed GMS application as a wireless technology.

2. LITERATURE REVIEW

2.1 Flow Measurement

There are two bases of measuring flow; these are either volumetric or weight basis. Liquids are measured either in volume rate or in weight rate. Kagohashi, (2018).
The basic relationship for determining the liquid's flow rate is given in equation 2.1:

$$Q = VA \qquad (2.1)$$

Where Q = Liquid flow through the pipe

V = average velocity of the flow

A = Cross-sectional area of the pipe

Viscosity, density, and the friction of the liquid in contact with the tube are other variables that influence fluid flow. Direct liquid flow measurements can be conducted using positive flow meters. The cumulative flow is an aggregation of the measured increments, counted by electronic or mechanical methods. The flow meter efficiency is also affected by a measureless unit called Reynold's number Kagohashi, (2018). The ratio of inertial force to drag force is defined in equation 2.2.:

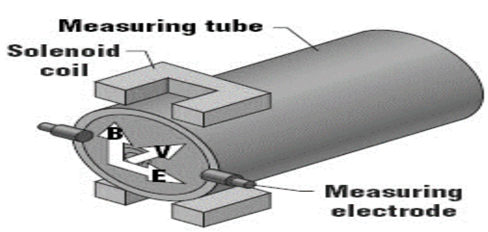
$$R = \frac{3160\,QG_t}{Dh} \tag{2.2}$$

R is Reynold's number; Q is the flow rate; Gt is specific gravity; D is the inside pipe diameter, and h is the viscosity. There are many types of flow meters, of which turbine flow meters, variable area flow meters, and target flow meters are the most common. Below are examples of the flow meter, Floyd, (2014).

2.2 Types of Flow Meters

2.2.1 Magnetic flow meters:

Often called “mag meter” or “electromag," the magnetic flow meter uses a magnetic field applied to the metering tube, which results in a potential difference proportional to the flow velocity perpendicular to the flux lines. The potential difference is sensed by electrodes aligned perpendicular to the flow and the applied magnetic field. The physical principle at work is Faraday's law of electromagnetic Induction, Kagohashi, (2018). The magnetic flow meter requires



a conducting fluid and a non-conducting pipe liner.

Figure 2.1 *Magnetic flow meter*

2.2.2 Differential flow rate meters using R.F. signals

This flow meter works on the principle of change in the volume of liquid in a container over a given space of time. It flows from a container with a higher potential to another container with a lower potential. This flow meter calculates the differential volume per unit time and transmits the values using R.F. signals whose farthest distance of travel is 500m, Kagohashi, (2018). The limitations of this flow meter are in its distance of transmission. It uses an R.F. signal, which constrains the distance of visible transmission to only a few hundred meters, after which the signal fades off and virtually loses transmission. Telemetry flow meter, because of its telemetric capabilities, uses the GSM short messaging system (SMS) to transmit data values over its network, giving room for transmission over infinite distances as long as the GSM network coverage gets there.

2.2.3 Turbine Flow Meter

The turbine flow meter translates the turbine rotating's mechanical action in the liquid flow around an axis into a user-readable flow rate (dm^3/s, L/m, etc.). The flowing fluid impinges on the turbine blades, imparting a force to the blade surface and setting the rotor in motion. When a steady rotation speed has been reached, the speed is proportional to fluid velocity. The speed of rotation is monitored most meters by a magnetic pick-up coil, fitted to the outside of the meter housing, Van & Puers, (2018). The magnetic pick-up coil consists of a permanent magnet with coil windings, which is mounted near the rotor but external to the fluid channel. As each rotor blade passes the magnetic pick-up coil, it generates a voltage pulse, which is a measure of the flow rate, and the total number of pulses gives a measure of the total flow. The electrical voltage pulses can be processed so that a zero-error characteristic of digital handling is provided from the electrical pulse generator to the fluid readout. The number of pulses generated is given as:

$$n_p = \frac{T_p f}{Q} \quad \textbf{(2.3)}$$

Where n_p is the pulses per volume unit, T_p is the time constant, Q is the volumetric flow rate, and f is the frequency in Hz. Turbine flow meters are used for the measurement of natural gas and liquid flow. Turbine meters are less accurate than displacement and jet meters at low flow rates, but the measuring element does not occupy or severely restrict the entire flow path, Chi *et al.*, (2017). The flow direction is generally straight through the meter, allowing for higher flow rates and less pressure loss than displacement-type meters. They are the meter of choice for large commercial users, fire protection, and master meters for the water distribution system. Turbine meters are generally available for 4 to 30 cm (1 1⁄2–12 in) or larger pipe sizes. Turbine meter bodies are commonly made of bronze, cast iron, or ductile iron. Internal turbine elements can be plastic or non-corrosive metal alloys. They are accurate in normal working conditions but are greatly affected by the flow profile and fluid conditions, Nelson, (2014).

2.2.4 Flow Sensor

A flow sensor detects and measures water flowing through pipes. A Hall Effect sensor is attached to the G1/2 water flow sensor to calculate the flow rate in this system. The rotor blades rotate as the water flows through the flow sensor. A magnetic field is produced. Therefore, an alternating current pulse is generated, converted into the digital output with a Hall Effect sensor placed just after the turbine. The number of pulses generated per liter can be determined by software programming. The pulses produce an output frequency that is directly proportional to the volumetric flow rate. Nelson, (2014).

2.5 Review of the Related Work

Shin (2013), developed a local real-time river flood monitoring and warning system for the selected communities near Mandulog river. This study focused only on the detection and early warning alert system via website and cell phone text messages that alert local subscribers of the potential flood event. The hardware used in the design is split into an overall part, namely, the water level detector, GSM module, and microcontroller.

Lee (2007), Explained that temperature measurements are required when investigating the thermal problems induced in modern automobile engines, and a piston telemetry system is developed using a Bluetooth wireless network. The system comprises a piston part and a data acquisition part measuring temperatures in an engine environment of 6000 rpm, exceeding 2000g and piston temperatures over 300°C. The telemetry system is installed at the big end of the connecting rod to avoid the high thermal loads encountered in the piston.

Mike (2018), developed a remote telemetry unit for continuous water quality monitoring, the system record measurements of the ph and conductivity at both the inlet and outlet of a stormwater settlement pond. The data obtained from the two RTU is stored in the onboard memory until it is uploaded via a GSM network. The data can then be viewed via SMS, M.M.S., or internet communication services. The system is also configured to send alarms to warn when predefined trigger levels are breached. This paper outlines the solution of designing a reliable remote monitoring system for a location with minimal sunlight and low data transmission coverage. The EDAC 320 used transmits data through GSM using GPRS to deliver information in the form of SMS.

Wilezynski &Varo (2010), developed a two-module telemetry system to measure temperature and strain on a spherical piston joint, withstanding high inertia and high temperature environments of up to 130°C. The transmission module contained signal conditioning, multiplexing, and F.M. radio data transmission. The Antenna was mounted on the engine oil pan and connected via cabling to an external receiver/demodulator. A linear power pan and connected via cabling to an external receiver/demodulator. A linear power generator relies on the piston's motion to convert thermal and mechanical energy into electrical energy to power the telemetry system. A coil is wound around a permanent magnet whose pole pieces extend to a modified cylinder wall of alternating ferromagnetic and non-ferromagnetic bands. As the piston and magnet travel past the bands, changes in the magnetic flux generate an E.M.F. in the coil. The coil's output is rectified and regulated to provide the required 15 mA, 9V D.C. voltage.

Automatic Water Meter Reading System Based on GSM Network by Yogandra &Tadwalka (2014). The system was created to check the excessive usage of water usage by consumers. Simultaneously, it has also generated higher revenue by using computerized billing, and customer-friendly services such as SMS alerts have improved efficiency.

3. Methodology

This section describes the methodologies used for the design of the hardware and software parts. The main hardware parts are the flow sensors and how they interfere with the microcontroller and the GSM interface. The model and methodology, considerations/ specifications of the automation of transmission, and data measurements in Nigeria's oil sector with wireless technology and its functional components are reported. The development stages and modes of operation of the software application developed for the hardware was also reported here.

3.1 System Design

The design steps involved in the system's development will be such that the system will be aimed to operate off a 24volts power supply system. The system is an automatic transmission and measurements of data with at least one programmable integrated circuit; in this case, a PIC microcontroller will be used, which is programmed using MicroC Pro and EasyPIC6. The microcontroller is programmed to receive a signal from the flow sensor through a telemeter and sends the analyzed and converted information to LCD for the site engineer and corporation's production unit to observed counted and volumetric or flow rate of products per day. The GSM module also receives the microcontroller's signal to send the information to the individual's registered mobile phone and website of the firm for easy access of the information at any time.

3.2 Hardware design

The circuit is physically implemented, as showed in the circuit diagram below. The flow sensor has three cables differentiated by their colors red, black, and yellow. The black cable of the sensor is connected to the ground; the red is connected to the Vcc, which has a voltage range of 5volts to 24volts while the yellow cable of the flow sensor is connected to the micro-controller pin 11. A crystal oscillator with two pins is then connected to the ground and the micro-controller, respectively. Two pins of the crystal oscillator are connected to the pin 9 (OSC1) and pin 10 (OSC2) of the micro-controller, and the other pin is connected to the ground and pin 8 (Vss) of the micro-controller concurrently. The pin 1 (M.C.R./Vpp/RE3) of the micro-controller is connected to the resistor within the range of 4.7k Ω to 10kΩ the resistor is then connected to GND. The pin 2 of the LCD is connected in series with a limiting resistor of 330Ω to Vcc (5 volts). Pin 7 to pin 14, the LCD's data pins, is connected to pin 24 to pin 21 of the micro-controller (RB4-RB1). Pin 28 is connected to the L.E.D. and a resistor of 330Ω in series and then connected to the ground. The enable pin of the LCD is connected to the pin 26 (RB5) of the micro-controller, while the read/write pin of the LCD is connected to the ground. The register select of the LCD is connected to the pin 24 (RB3). The GSM module has four pins. One is connected to the Vcc, and the other is connected to the ground; the other two pins are the transfer and receive pins (TX & R.X.) are connected to pin 18 and pin 17 (RC7 & RC6) of the microcontroller.

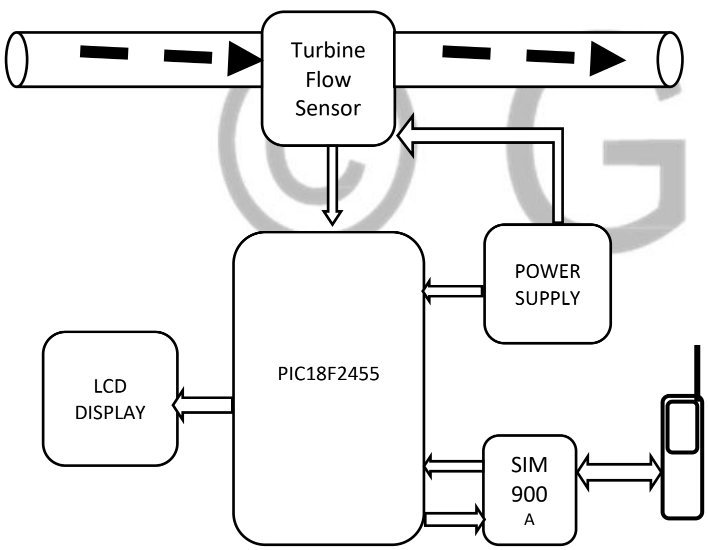


Figure 3.1: Block diagram of the designed system

The design is achieved with the use of the following components:

- Power Supply
- Microcontroller (PIC18F2455)
- Sensing unit - Turbine sensor with hall effect (YF-S201 Turbine Hall-Effect Flow Sensor)
- 16 x 2 LCD display
- GSM Modem (SIM900A)

Below is a detailed description of the functionality of each of the computer

3.2 Power Supply Section:

The power supply section is significant for all electronic circuits. The 230V, 50Hz A.C. mains is stepped down by transformer to deliver a secondary output of 12V, 1 A. The transformer output is rectified by a full-wave rectifier comprising diodes D1 through D4, filtered by capacitor C1 and C2 regulated by IC7805 (I.C.) Capacitor C3 bypasses the ripples present in the regulated supply. The power supply schematic is shown in figure 3.2.

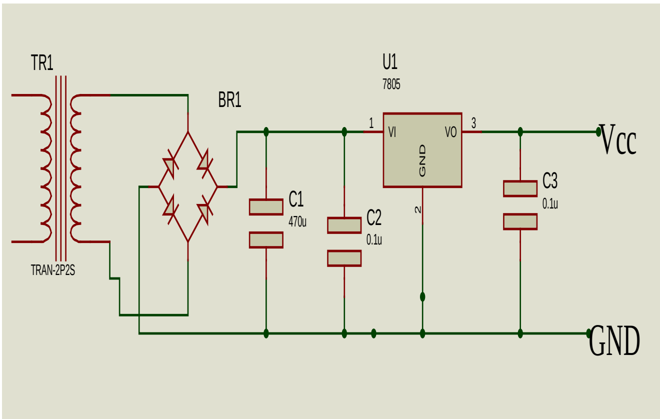


Figure 3.2: 5 Volts Power Supply Unit

3.3 Flow Sensor

The flow sensor consists of a plastic valve body, a rotor, and a Hall Effect sensor. The Hall Effect is an ideal sensing technology. When subjected to a magnetic field, it responds with an output voltage proportional to the magnetic field strength. When liquid flows through the sensor, its rotor rolls. The speed changes with different rates of flow. The hall-effect sensor gives a corresponding pulse signal. The pulse signal is then sent to the PIC. 18F2455 microcontroller. The pin configuration of the sensor is shown in figure 3.3 and has different pins as follows.

i) Pin 1 Yellow-*Signal*

ii) Pin 2 Black- Ground

iii) Pin 3 Red – Vc

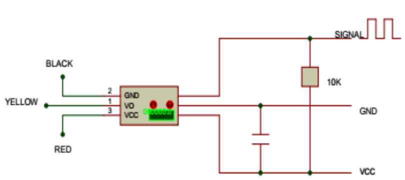


Figure 3.3: Pin configuration of the flow sensor

The yellow wire is connected to Pin 33 of the microcontroller to introduce the signal to the PIC18F2455 microcontroller. Figure 3.3 shows the interface between the flow sensor and the PIC18F2455.

3.4 Liquid Crystal Display to Pic 18f2455 Microcontroller Interface

The 2 x16 character LCD has two rows of 16 characters each. It has 16 pins with register select, read/write, and enable control lines. Also, it has a display contrast voltage line. The 4-bit interface was employed because it saves on port pins, which could otherwise be used for other additional functions. Pins 15 and 16 were employed to enable visibility in the dark and for characters to be viewed with ease from a distance. The R/W (Read/Write) pin is connected to the ground, indicating that the LCD is receiving data only. The display receives ASCII codes for each character at D4 to D7, connected directly to the 4 P.O.R.T.B. pins of the PIC18F2455 microcontroller. To initialize the LCD, the register select line R.S. must be set to logic 0. The 8-bit code for each ASCII character is sent in two halves; high nibble first, low nibble second. Although this makes the software only slightly more complicated, it saves on I/O pins and allows the LCD to be driven using only six lines, as shown in figure 3.4.

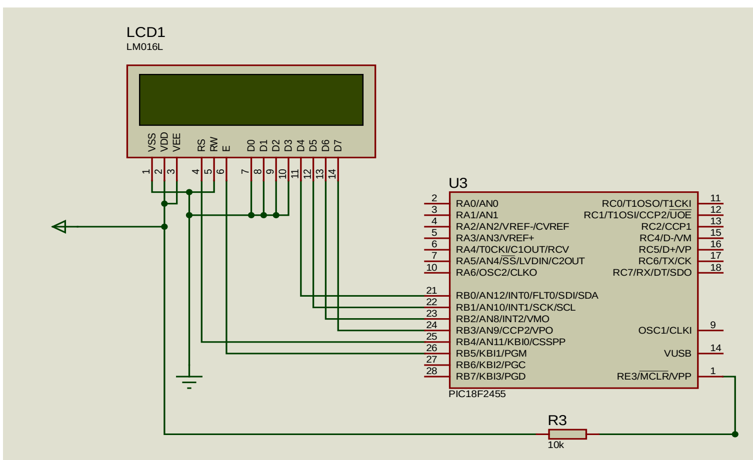


Figure 3.4: Liquid Crystal Display to PIC 18F2455 microcontroller interface

3.5 GSM Interface to PIC18F2455 Microcontroller

A GSM modem accepts a subscriber identity module (SIM) card. It is based on commands that always start with AT (Attention) and finish with a character (C.R.). The GSM module communicates with the microcontroller and mobile phone through the UART port. The GSM module SIM900A has been employed in the proposed system. The GSM Module SIM900A can be directly interfaced with PIC Microcontrollers through the three lines; TX, R.X., GND. The transmit signal of the microcontroller's serial port is connected with the transmit signal (T.X.D.) of the GSM Modem's serial interface. In contrast, the microcontroller serial port's received signal is connected with the received signal (RDX) of the GSM modem's serial interface. Figure 3.5 shows how the GSM is interfaced with the PIC18F2455 microcontroller.

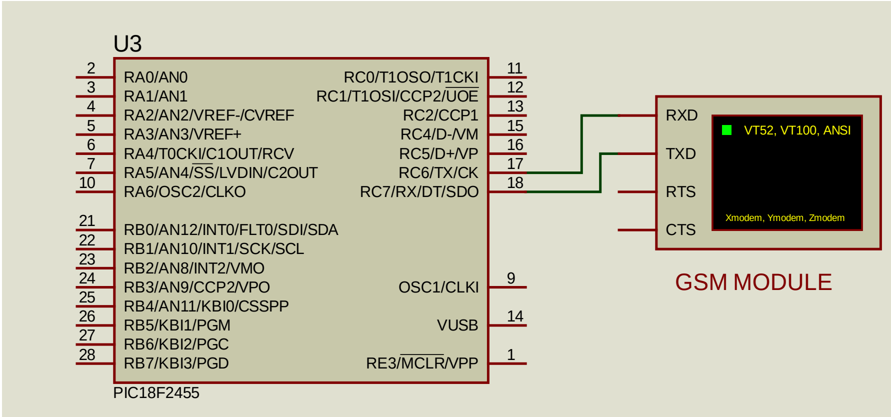
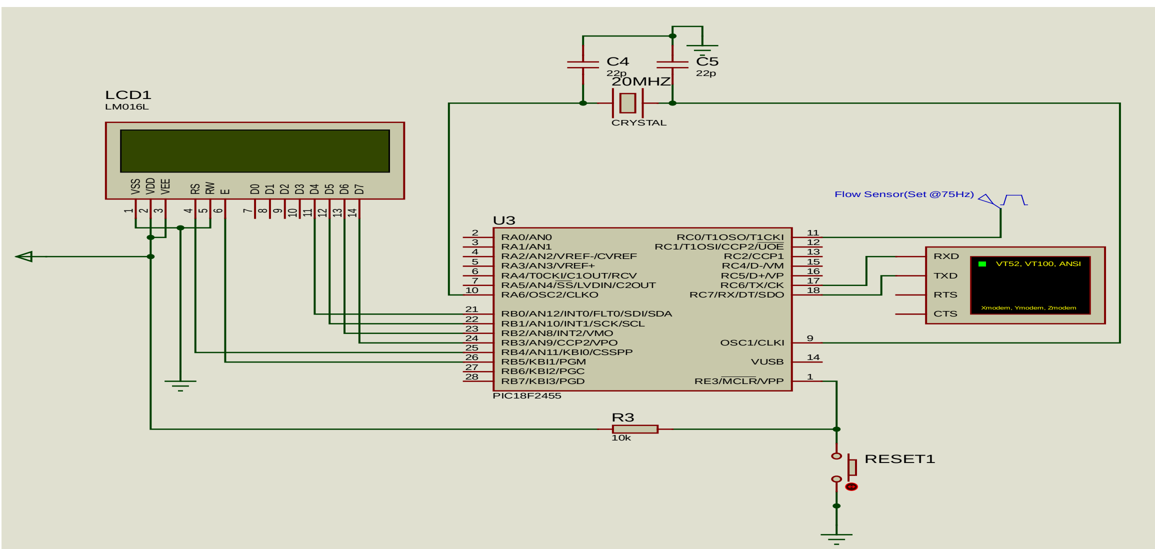


Figure 3.5: GSM interface to PIC18F2455 microcontroller



Complete Circuit Diagram of the design

Figure 3.6: Complete Circuit Diagram

3.5 System Design Approach

The software design for this work was implemented using a C compiler for PIC. microchip. This compiler consists of an optimized C compiler program as well as improved functions for many microcontroller operations. Coding instructions into the microcontroller enables the microcontroller to verify the turbine flow sensor's outputs to interface with peripheral devices.

3.6 Principle of Operation

The flow sensor will be set in the path of a fluid stream. As the fluid flow through the flow sensor, the flowing fluid impinges on the turbine blades, imparting a force to the blade surface and setting the rotor in motion, the velocity of the rotor is equivalent to the flow rate of the fluid, which when multiplied by the area of the flow sensor give the quantity flowing through per unit time. The sensor converts the quantity flow per unit time to an electrical square via the Hall Effect. This signal is then fed into the microcontroller, which analysis and does the necessary computation to convert the signal first to a binary number and later to decimal numbers. While this is being done, a timer is also set by the microcontroller. When the timer counts are completed, the measured value is then sent to the GSM Modem for transmission, and the SMS command is also triggered. Also, as the flow is also being measured, it is displayed on the LCD for the site engineer to see and compare the quantity entering the calibrated tank and the one being received as SMS.

4. Testing, Results, And Discussion

After integrating various sub-units of the complete prototype of the developed automation transmission and measurements of fluid with a telemeter, the implementation of the circuit was tested with Proteus software's help to ensure the proper connection of the circuit. The simulation was performed on Proteus software, which has helped to know the circuit performance and find & rectify the program's errors.

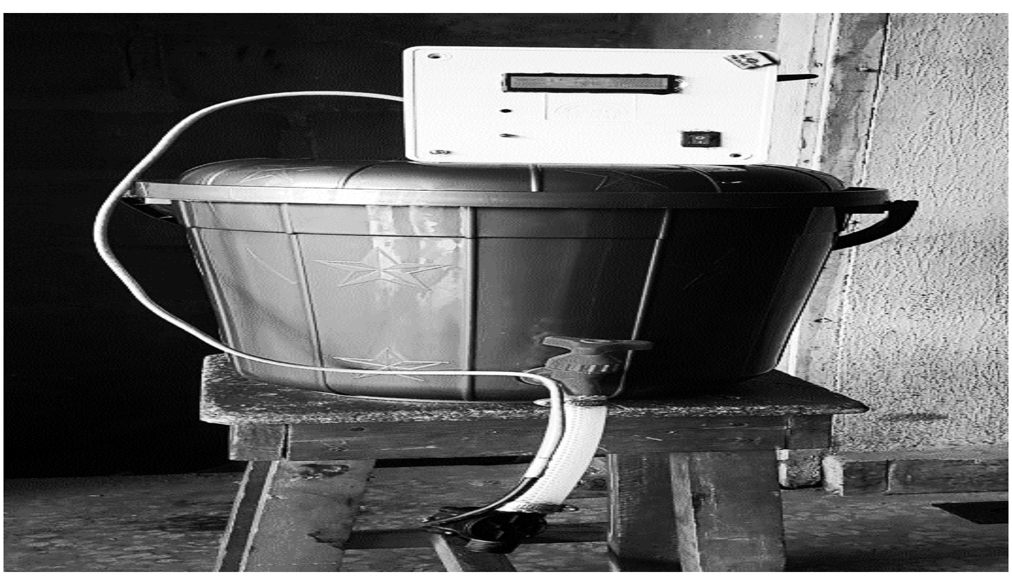
4.1. Continuity Testing

Initial testing of the board was carried out using a continuity meter to ensure all short circuit faults were cleared correctly. The sensory circuitry was tested to ascertain the level of fluid sensitivity as expected. In the connection, each component on the PCB. was then tested. The implemented design was initially tested on an open tank filled with water after construction, and the system performed as expected.

4.2 Results

The result of the simulation ensures that the circuit worked properly. The practical implementation of the simulated circuit has been presented in Figure 4.1. In this circuit diagram, PIC microcontrollers were the main components used for controlling other devices (turbine flow Sensor, GSM Module, LCD Display, and microcontroller). Among the controlling devices, a flow sensor was used as a sensor for determining the system's present status.

Figure 4.1: A picture of the design system



4.3 Working Mechanism

When the tap is filled with water, it is opened. Water flows from the tap through the pipe and then passes through the sensor's hollow space, where the sensor takes the flow rate measurement by sensing the flow of liquid. The measured flow rate is then outputted through an LCD screen on top of the casing containing the Vero board, GSM module, and other internal components, as shown in the figure below.

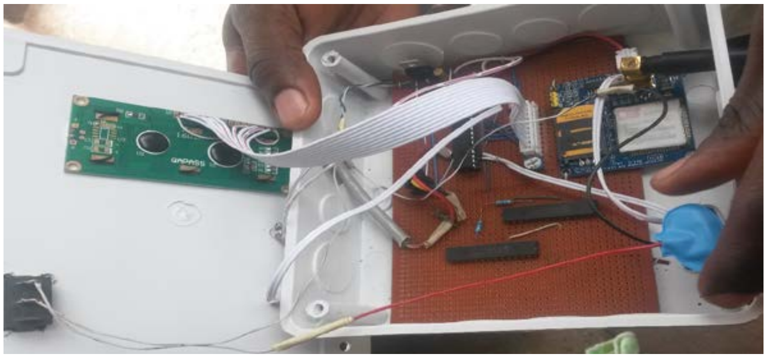


Figure 4.2: A picture of Vero Board Containing the component

The casing's external view contains a green LED. and red LED., the LCD, and the Antenna, as shown below.

Figure 4.3: A picture of an external view of the research

The microcontroller is programmed to measure or take a reading of the liquid flow after every thirty seconds. The flow rate is calibrated in volume per minute. When the circuit is switched on, the green LED. Lit on, after every thirty seconds, the red LED. Lit, indicating that the sensor has taken a reading. The reading change on the LCD after every thirty seconds.

4.5 Discussion of Results

It was observed that when the system is working after every thirty seconds, the reading on the LCD changes, and the red L.E.D. Blinks. The frequency of flow and hence the volume of fluid can be adjusted by turning the tap. Hence, the measured value depends on the frequency of flow of the fluid and its time to make a measurement and physical properties of the fluid's liquid, chemical properties.

4.6 Mechanism of Transmission

There are two mechanisms of transmission in this research;

First is the GSM module, the primary transmission mechanism, and the second is a customized website.

GSM module, as the primary means of transmission, gets the data from the microcontroller and transmits it to a few micro-SIM CARD. But it cannot get to a huge no of people, as the GSM module can only send to a few SIM cards, so the second medium of transmission is used.

WEBSITE, after getting the value of fluid generated via SMS from the GSM module, the personnel at the base station then manually upload the data to the firm website; thus, everyone in the country can get access to the information. The website is built such that the different stations can upload their data if the admin gives them a password and user name. Hence measured flow rate from all stations in the country will be on the website. The website also displays the type of fluid, the date of measurement, and the measured volume.

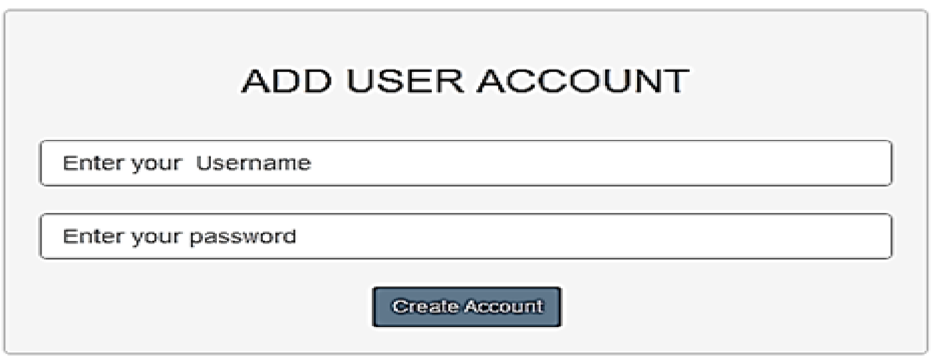


Figure 4.7: interface where the admin gets access to the website, uploading the data.

Figure 4.8: Interface where the admin access right is first created.

4.7 Calculation and Analysis

The crystal oscillator is of the frequency of twenty megahertz. The high frequency is chosen so that the transmission will be useful.

When the BRGH is high the baud rate $= \frac{\textbf{freqency of crystal oscillator}}{\mathbf{16(x+1)}}$ **4.1**

If the oscillator's frequency is 20 MHz and S.P.R.G. is 255 (0-255), then X's value is the average of the S.P.R.G.

That is; $x = \frac{0+255}{2} \approx 129$ **4.2**

Substituting the values in the equation, the value of the baud rate is approximately 9600 Hz.

Computing the volume

It should be first noted that the flow rate sensor has a tolerance of ±10% (percentage error). The micro-controller give the data output by making this calculation flowrate $=\frac{c}{7}$ where c is the pulse the micro-controller receives from the Hall Effect sensor; the microcontroller has two-byte (high &low) pulses first fill up the bits of the low byte if there is any over from there it will enter the bit of the high byte.

$$\mathbf{c = a + b} \qquad \mathbf{4.3}$$

Where a = Low Byte b = High Byte × 256;
c = the summation of these two values gives the total pulses generated.
Therefore, the flow rate in ${}^{liter}/_{hour}$ is ${}^{c}/_{7}$.
To get it in liter per minute, divide the equation by 60 that is $\frac{c}{7\times60}$; this value is displayed on the LCD screen.
To get the value outputted in liters, we multiply the flow rate by the total measurement time, that is
No of Liters = Flow rate ×Time (duration of measurement). Table 4.1 shows the outcome of the evaluated prototyped of the designed measured fluid (water) as to test the reliability of the system. Equation 4.4 was used to calculate the volume in liter of the water.

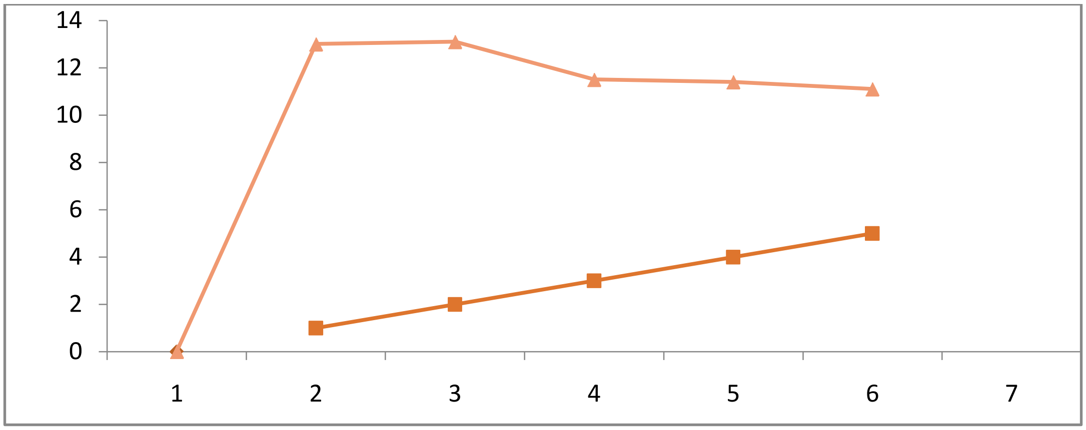
$$\frac{\mathbf{c}}{\mathbf{7\times60}}\,\mathbf{x\ T} \qquad \mathbf{4.4}$$

Error Calculation

Table 4.1: Measured volume of the design versus the calculated volume

S/N	Measured Volume (litre)	Converted valued=	Expected Value	Error	Percentage (%) Error
1	0.87	0.87	1	0.13	13.0
2	1.76	0.88	2	0.24	13.1

3	2.69	0.89	3	0.31	11.5
4	3.59	0.91	4	0.41	11.4
5	4.50	0.93	5	0.50	11.0031



The graph of the percentage error versus the expected value

The graph shows that this flow meter's designed can measure and transmit the quantity of fluid such as petroleum, water, and other fluids with minimum error.

Table 4.1 shows that the average error was computed and found to be 12.03 %, within the limit of the sensor tolerance of ± 13%.

5. CONCLUSION

The development of this was tested and it gave good responses to the flow sensor through a telemeter and sends the analyzed and volumetric or flow rate of the products per day. The GSM module also receives the microcontroller's signal to send the information to individual's registered mobile phone.

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