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Electronic ACPM meter in gallons, for the electric generator tank of the ESUFA radar

Medidor electrónico de ACPM en galones, para el tanque del generador eléctrico del radar de ESUFA

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Abstract

Since measurements such as meters (m), kilometers (km) or gallons (gal) of any object, substance or matter; man has sought systems that guarantee the accuracy of what he sells, buys, uses or consumes in his activities. The Colombian Air Force (FAC) is no exception; at the Colombian Air Force Non-Commissioned Officers School (ESUFA) there is a storage tank for Motor Fuel Oil (ACPM) that is used for the operation of the electric generator that supplies electric power to the ANTPS-70 radar. The measurement of ACPM consumption in gallons is done by hand. The operators use a gauging rod, which is inserted into the tank and, depending on how long it is wetted, allows them to estimate the number of gallons of fuel in the tank and

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use this data to estimate the number of gallons used. This procedure is carried out in each of the AN/TPS-70 type radars of the FAC military units. In the present investigation, a digital system for measuring the gallons of ACPM in the tanks was developed. The volume of the tank is established with the tank manufacturer's data. With an ultrasound sensor HC-SR04, which works by emitting an ultrasonic sound by one of its transducers, and waiting for the sound to bounce off the surface of the ACPM, the echo is captured by the second transducer. Thus, the height of the fuel (ACPM) inside the tank is obtained and a comparison table of height & volume is made, the Arduino UNO board is programmed and with this relationship the amount of gallons of ACPM contained in the tank is measured, which are transmitted wirelessly by a NRF24L01 module to the receiver where the amount of gallons is displayed on an LCD.

Keywords: Radar, Generator, Fuel, Gallons, Volume, Tank.

Resumen

Desde que las mediciones como son los metros (m), kilómetros (Km) o galones (gal). de cualquier objeto, sustancia o materia; el hombre ha buscado sistemas que le garanticen su exactitud de lo que vende, compra, utiliza o consume en sus actividades. En la Fuerza Aérea Colombiana (FAC) no es la excepción; en la Escuela de Suboficiales de la Fuerza Aérea Colombiana (ESUFA) se encuentra un tanque de almacenamiento del Aceite Combustible para Motores (ACPM) que sirve para el funcionamiento del generador eléctrico el cual suministra energía eléctrica al radar ANTPS-70. La medición del consumo de ACPM en galones se realiza de manera artesanal. Los operarios utilizan una varilla de aforo, la cual es introducida al tanque y según la longitud que se humedece permite estimar la cantidad de galones de combustible en el tanque y con este dato hacen un estimado de los galones utilizados. Este procedimiento se efectúa en cada uno de los radares tipo AN/TPS-70 de las unidades militares de la FAC. En la presente investigación se realizó un sistema digital de medición de los galones de ACPM de los tanques. Se establece el volumen del tanque con los datos del fabricante de este. Con un sensor de ultrasonido HC-SR04 que su funcionamiento consiste en emitir un sonido ultrasónico por uno de sus transductores, y esperar que el sonido rebote en la superficie del ACPM, el eco es captado por el segundo transductor. Así se logra obtener la altura del combustible (ACPM) dentro del tanque y se realizó una tabla de comparación de altura & volumen, se programa la placa Arduino UNO y con esta relación se mide la cantidad de galones de ACPM contenidos en el tanque, los cuales son transmitidos inalámbricamente por un módulo NRF24L01 al receptor donde se visualiza la cantidad de galones en un LCD.

Palabras clave: Radar, Generador, Combustible, Galones, Volumen, Tanque.

1. Introduction

It is of great importance for the Colombian Air Force to acquire new innovative technologies that improve the operational processes that are carried out daily for the performance, compliance and technological growth of the institution. The problem that has been latently experienced within the radar subspecialty of the Colombian Air Force for some time is due to the inaccuracy in the current methods of measurement performed by the operators of the fuel level in the tanks that store the ACPM for the electric generator, Cummins Generator Power model DSGAC-997035 and through this electric power is supplied to the radar AN/TPS-70, which is located in the School of Non-Commissioned Officers of the Colombian Air Force (ESUFA).

To perform this measurement, the operators use a gauging rod, which is introduced into the tank and according to the length that is wetted allows estimating the amount of gallons of fuel present in the tank. For this reason, this measurement is not accurate, leading to an unreliable daily statistic of the radar's consumption of gallons of ACPM. With the data of the gallons, an estimate of the amount of gallons that would be needed for the operation of the generator in the year is established and thus to have an average of consumption and to be able to make a plan of annual expenses of the ESUFA.

Analyzing the problem, we propose to design a digital fuel gallon measurement system for the fuel tank of the electric generator of the AN/TPS-70 radar and thus be able to establish with greater precision the consumption in gallons of ACPM consumed by the ESUFA radar.

This research is based on the theory of electronic communications systems, dimensional metrology and Arduino programming as fundamental knowledge for the understanding of technical processes with reliability and quality.

In the different research on the measurement of the level of ACPM in the different hydrocarbon storage tanks, we found the research work done by Haider Amaranto Sanjuán and Marvin Ahumada Pinedo "*Analysis of level measurement technologies for tanks of products used in the oil industry",* where they name different methods of measurement of hydrocarbons.

They are based on different operating principles and can be classified into the following groups: Hydrostatic Measurement System (HTG), Radar or Ultrasonic Measurement System and Radio Frequency - Admittance Measurement System (also called Capacitive Measurement System). All these systems measure level either directly or indirectly (by deducing it from other physical parameters such as density, volume, pressure, temperature) of the storage tank. [1]

Also in another degree work was found a communication system capable of visualizing the levels of gasoline contained in emergency tanks for maintenance, filling and distribution at different points in the city of Santiago de Cali using the non-touch ultrasonic sensor type, Digital 485/232 ultrasonic and communication by wireless network gps/gprs. [2]

Reviewing other projects, Andersson Arbeláez Naranjo conducted a research called "Design of level control by means of a continuous measurement in the storage tanks of ACPM in the company Colcafe S.A.", using the simatic program, which performs the simulation of the system proposed in his research. [3]

In the analysis it can be established that different methods can be found in the part of technologies as established by Haider Amaranto and Marvin Ahumada, in their research.

The main thing is to address the issue of power generators and then hydrocarbons, theories on the different systems for measuring hydrocarbons are also reviewed. In wireless communications we find different devices for this purpose, then the analysis of data processing as is the measurement of distance in centimeters, as in the case of this project, to establish measures of distance, volume or gallons, as needed and in programming connectivity between different devices that will help to obtain the distance and transmission of the same with the Arduino board is established.

1.1. Diesel Electric Power Generator

This is an installation consisting of a set of alternators coupled in parallel to an electrical system and driven by a set of diesel engines powered by a
liquid or gaseous fossil fuel. [4]

Figure 1. Diesel Generator. [4]

1.1.1. Diesel Engine

Cummins engine company, Inc. (1976). Defines: The diesel engine is an internal combustion engine that uses compression for ignition. No artificial ignition, such as spark plugs, is required for combustion. When air is compressed within the cylinder by the compression stroke of the piston, the temperature of the air rises sufficiently to immediately ignite the injected fuel. [5]

1.2. Motor Fuel Oil (ACPM)

In the field of hydrocarbons, the diesel oil extracted from petroleum is known as ACPM. The ACPM, acronym used to name Motor Fuel Oil, is nothing more than the so-called Petrodiesel, a name that is popularly known in most Latin American countries, being called ACPM especially in Colombia. [6]

Being a less refined compound than gasoline, ACPM is also much more efficient, with up to 18% more energy than gasoline, in terms of its volume units. In fact, some sources have even pointed out that in addition to being much more efficient than gasoline, diesel is a fuel that can even last up to twice as long as gasoline. [6]

ACPM is a liquid hydrocarbon with a density of approximately 850 kg/m^3 and is composed mainly of 75% saturated hydrocarbons or kerosenes and 25% aromatic hydrocarbons. The most common chemical formula is $C_{12}H_{26}$ (12 carbon atoms for 26 hydrogen atoms). [7]

1.3. Hydrocarbon Measurement Systems

The verification of tanks is an important and very recurrent process in the routine of every service station that has a supply of ACPM; those, however, who invest in automatic solutions, reap important rewards such as cessation of waste, reduction of the risk of miscalculations at the time of refueling, rapid detection of fraud, product contamination and leaks, resulting in significant savings of money. There are two commonly marketed technologies for measuring fuel tank levels at service stations: automatic metering and the ruler or dipstick. The latter was the most commonly used for years, mainly in past decades, when automatic systems did not possess the level of sophistication we see today. [8]

In Colombia, fuel consumption measurement standards are based on CFR 40 of the United States and UNECE Regulation number 83. [9]. Within CFR 40 there are two regulations, 1065 and 1066 that govern fuel consumption measurement methods. [10] [11]. With the previous regulations helped to define the following measurement methods.

1.3.1. Gravimetric Method

Gravimetry is a quantitative analytical method, i.e., it determines the amount of substance by measuring the weight of the substance (by the action of gravity) using an analytical balance. [12], Figure 2

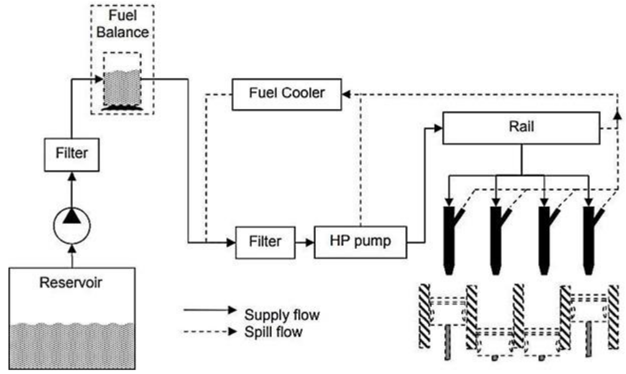

Figure 2. Diagram of fuel supply circuit with gravimetric fuel balance. [13]

This method consists of measuring the tank mass variation to determine the volume of fuel consumed during a test. The weight of fuel in a supply tank is measured. Fuel flows from the supply tank, through a gasoline filter, pump and pressure regulator, to the engine and the resulting change in tank weight is the measured fuel consumption. [13]

In this gravimetric process two methods are used, the precipitation method, which consists of the classical analytical technique based on the precipitation of a compound of known chemical composition such that its weight allows the original amount of analyte in a sample to be calculated by means of ratios, generally stoichiometries. And the volatilization method, this method measures the components of the sample that are or may be volatile. The method will be direct if we evaporate the analyte and make it pass through an absorbent substance that has been previously weighed so the weight gain will correspond to the analyte sought; the method will be indirect if we volatilize the analyte and weigh the residue after volatilization so the weight loss suffered corresponds to the analyte that has been volatilized. [12]

1.3.2. Volumetric Method

There are two types of volumetric measurement for fuel consumption. The first is a direct measurement of fuel flow thanks to a flowmeter. This device records the average fuel flow every second or more depending on the need for measurement accuracy. It requires an estimation of fuel density, which is often based on data from fuel suppliers and measurement of fuel temperature to compensate for the effect of environmental parameters. [13]

The second is with OBDII connected to the vehicle's ECU. The fuel demand signal from the ECU can be used as a fuel consumption estimate. Depending on the engine strategy, subsequent density estimates may be necessary. This signal is not a measurement but a demand signal and requires calibration for each particular engine to produce accurate results. However, ECU data is good for assessing repeatability and is available on a cyclic basis, allowing in-depth analysis, especially during transient events. [13]

1.3.3. Carbon Balance Method

This method is the most widely used because it allows the measurement of fuel consumption and exhaust gas emissions [13]. But a 3-gas analysis kit is needed for hydrocarbons (HC), carbon monoxide (CO) and carbon dioxide (CO_2). There are also versions that analyze nitrogen oxides (NOx) and oxygen (O_2). The measurement of consumption is not direct, but is deduced by analyzing the

composition of the vehicle's exhaust gases. The analysis is dynamic, i.e. the gases are collected throughout the duration of the test. [14]

1.4. Wireless Communications

The great challenge of wireless communication systems is to provide a high transmission speed and offer a guaranteed quality service. In recent years there has been an increase in the demand for broadband wireless services, in this sense, technologies have been developed to meet these requirements as shown in Figure 3 [15].

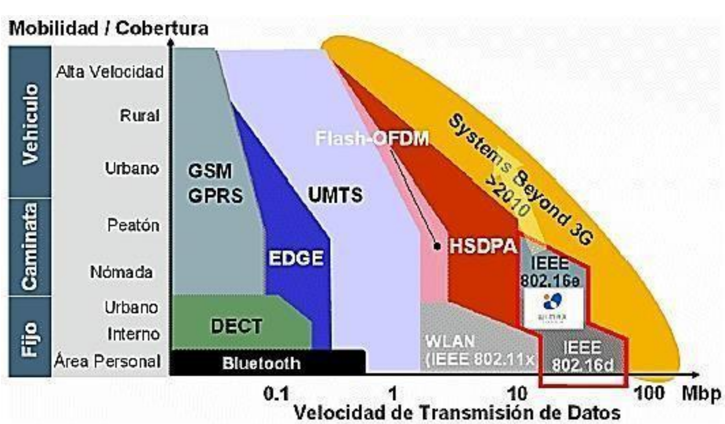

Figure 3. Transmission capacity and mobility of wireless technologies. [15]

The various wireless technologies allow us to transmit data and each of them has a number of advantages or disadvantages that gives them greater or lesser validity when used. Therefore, depending on the compromise of the requirements, cost, bandwidth, among others, the wireless technology to be used is selected. [16]

Wireless communications include RF, Wi-Fi and Bluetooth, which are used for data transmission over short distances of 10 to 100 meters.

1.4.1. Bluetooth

This wireless technology network is probably the most widely used for data transmission between nearby devices. Initially used by most people to transfer photos and music between cell phones, today there are many everyday possibilities for regular use. Any vehicle today has a Bluetooth system for such things as taking hands-free phone calls while driving safely. In home equipment it is common to use peripherals that use bluetooth as a wireless technology to avoid cables, such as wireless mice or bluetooth headphones, among others. [17]

1.4.2. Wi-fi

WiFi is a wireless transmission technology for connecting and communicating microcomputer equipment with each other within a local area network (LAN). WiFi is a trademark of the WiFi Alliance, the trade organization that adopts, tests and certifies that equipment meets the 802.11 standards required for such communications. [18]

Wi-Fi stands for "wireless fidelity", which is an acceptance of "high fidelity" or "Hi-Fi". A Wi-Fi connection uses radio signals, just like cell phones and other similar devices. A Wi-Fi connection is bidirectional, which means that the process just described also works in reverse. In the reverse process, the wired Ethernet device providing Internet connectivity sends the information to a wireless router. [19]

1.5. Programming

It is the process of taking an algorithm and encoding it into a notation, a programming language, so that it can be executed by a computer. Although there are many programming languages and many different types of computers, the first step is the need to have a solution. Without an algorithm there can be no program. [20]

1.5.1. Arduino programming.

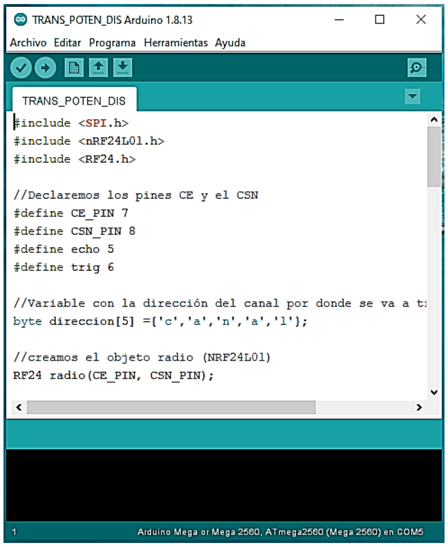

Figure 4. Arduino software. Source: own.

Arduino programming, Figure 4, is the programming of a microcontroller. This used to be more of an electronics engineer's thing, but Arduino has extended it to the public at large. Arduino has socialized the technology. Programming Arduino consists of translating the automated tasks you want to do into lines of code, reading from sensors and depending on the conditions of the environment program the interaction with the outside world through actuators. [21]

To start programming the Arduino board it is necessary to download an IDE (Integrated Development Environment). The IDE is a set of software tools that allow programmers to develop and save all the code needed to make our Arduino work the way we want it to. The Arduino IDE allows us to write, debug, edit and save our program (called "sketches" in the Arduino world) in an extremely simple way, in large part to this is due to the success of Arduino, to its accessibility. [22]

2. Materials and Methods

2.1. Materials and Equipment

In the development of the system design, different materials and equipment were used to develop the system, among which are listed below.

2.1.1. Arduino Uno, Figure 5.

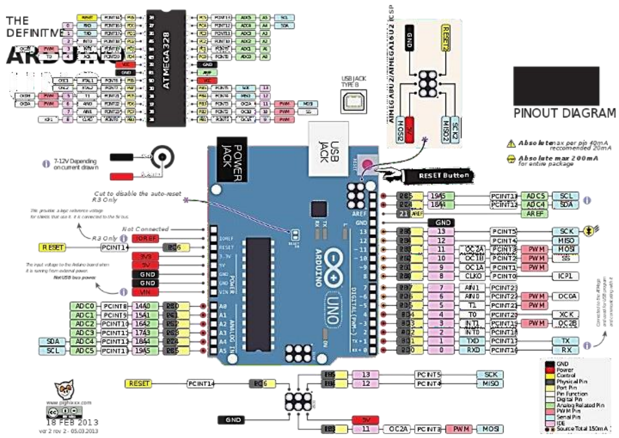

Figure 5. Diagram of the ARDUINO board and the ATMega328PU. [23]

Arduino UNO is a board based on the ATmega328P microcontroller. It has 14 digital input/output pins (of which 6 can be used with PWM), 6 analog inputs, a 16Mhz crystal, USB connection, power jack connector, terminals for ICSP connection and a reset button. It has all the necessary electronics for the microcontroller to operate, simply connect it to power through the USB port and with an AC-DC transformer. [23]

2.1.2. HC-SR04 sensor, Figure 6.

Figure 6. Ultrasonic Sensor Hc-Sr04. [24]

The HC-SR04 sensor is a low-cost distance sensor that uses ultrasound to determine the distance of an object in a range of 2 to 450 cm. The sensor includes a piezoelectric emitter and receiver, as well as the electronics necessary for its operation. The operation of the sensor is, the piezoelectric emitter emits 8 pulses of ultrasound (40KHz) after receiving the command on the TRIG pin, the sound waves travel in the air and bounce when they find an object, the bouncing sound is detected by the piezoelectric receiver, then the ECHO pin switches to High (5V) for a time equal to the time the wave took from the time it was emitted until it was detected, the ECO pulse time is measured by the microcontroller and thus the distance to the object can be calculated. [25]

The sensor is simply based on measuring the time between sending and receiving a sound pulse. We know that the speed of sound is 343 m/s in conditions of temperature 20ºC, 50% humidity, atmospheric pressure at sea level. [24], figure 7.

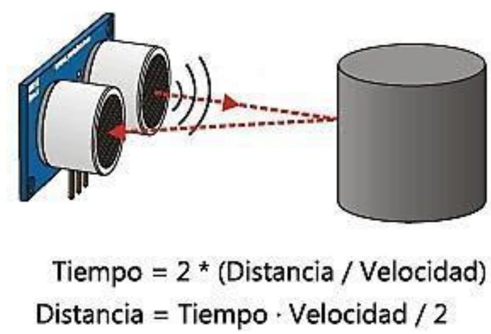

Figure 7. Schematic diagram of sensor operation. [24]

2.1.3. Transceiver NRF24L01, Figure 8

The NRF24L01 integrates an RF transceiver (transmitter + receiver) at a frequency between 2.4GHz to 2.5GHz, a free band for free use. The transmission rate is configurable between 250 Kbps, 1Mbps, and 2 Mbps and allows simultaneous connection with up to 6 devices. [26]

Figure 8. NRF24L01 pin configuration. [27]

Connecting a 2.4 GHz RF module NRF24L01 is simple, we just power the integrated from Arduino via GND and 5V and connect the data pins as we saw in the entry about the SPI bus. [26]

2.2. Digital System Construction

Obtaining and defining the materials and software to be used, the different stages in the development of the system assembly were carried out.

2.2.1. Information Gathering.

In the development of the project, research was conducted on the fuel tanks used in the supply for the power plants used by the radars and the different fuel measurement systems used.

Having the characteristics of the tank used in ESUFA for the storage and supply of ACPM to the electric generator, information is gathered from the manufacturer and the tank measurements are taken to establish its volume, Figure 9.

Figure 9. ACPM storage tank measurements. [16]

Having the external measurements of the tank such as length 1.83 m, height 1.1 m and width 1.03 m, with these measurements the volume calculation was made. The technical manual of the tank states that the maximum capacity is 500 gallons. [28]

Recall that the volume of a rectangular prism is calculated as the product of its dimensions (edges a, b and h). [29], figure 10.

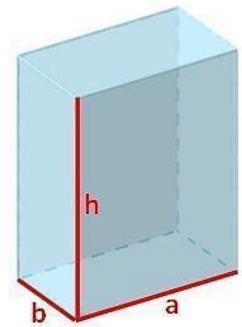

Figure 10. Volume of a right prism. [29]

A rectangular prism (or orthohedron) is a polyhedron whose surface is formed by two equal and parallel rectangles called bases and by four lateral faces that are also parallel and equal rectangles two by two. [29]

$$V = abh \qquad \textbf{(1)}$$

Being V the volume to find, a and b the different sides of the bases and h the height. In our case it would be like this:

$$V = 1,03m * 1,83m * 1,1m$$

$$V = 2,07\ ^{m3}$$

In order to establish the gallons that can be contained in the volume found, the corresponding conversion was made, the International System of Units (SI) establishes that ^{1m3} is equivalent to 264.172 gal [30], therefore:

$$1\ m^3 \longrightarrow 264{,}172\ gal$$

$$2{,}07\ m^3 \longrightarrow X$$

$$X = \frac{2{,}07\ m^3 * 264{,}172\ gal}{1 m^3}$$

$$X = 546{,}836\ gal$$

A volume of 546,836 gallons was obtained, taking into account that the maximum capacity of the tank is 500 gallons, the internal observation of the tank is made, and there is a small reduction due to the fact that it has a double layer of sheeting. Then the internal measurements vary a little with respect to those taken externally.

When calculating the volume with the external measurements taken and verifying that the capacity in gallons is greater than that established by the manufacturer, it is considered that the external measurements are greater than the internal measurements of the tank. Therefore, the volume of the tank is reconsidered with the capacity in gallons indicated by the tank manufacturer.

Then its internal volume will be:

$$1\ gal \longrightarrow 0{,}00378541\ m^3$$

$$500\ gal \longrightarrow X$$

The rule of three is performed and we obtain:

$$X = \frac{500\ \text{gal} * 0{,}00378541\ m^3}{1gal}$$

$$X = 1{,}892\ m^3$$

Establishing that the internal volume of the tank is V = 1.892 m^3, the internal measurement of the tank height was performed again and a measurement of 0.95 m was obtained.

2.2.2. Volume to Height Ratio

Considering that the capacity of the fuel in gallons is 500 gallons and its volume is 1,892 m^3, it was established by measuring the distance of height that the tank has internally. As the ACPM is consumed, its internal height changes and therefore its volume will be different. Due to this change in height and with a rule of three, the different volumes of the tank were calculated, knowing the ratio of gallons with respect to the volume it occupies, it was possible to establish the capacity of gallons that is in the tank, therefore, for each volume obtained there is a quantity of gallons. Thus the following relation was obtained.

Height (m)	Width (m)	Length (m)	Volume in (m^3)	Volume (gal)
1,08 m	0,968 m	1,81 m	1,892 m^3	500 gal
1 m	0,968 m	1,81 m	1,752 m^3	463 gal
0,90 m	0,968 m	1,81 m	1,577 m^3	417 gal
0,80 m	0,968 m	1,81 m	1,402 m^3	370 gal
0,70 m	0,968 m	1,81 m	1,226 m^3	324 gal

0,60 m	0,968 m	1,81 m	1,051 m^3	278 gal
0,50 m	0,968 m	1,81 m	0,876 m^3	231 gal
0,40 m	0,968 m	1,81 m	0,701 m^3	185 gal
0,30 m	0,968 m	1,81 m	0,526 m^3	139 gal
0,20 m	0,968 m	1,81 m	0,350 m^3	92 gal
0,10 m	0,968 m	1,81 m	0,175 m^3	46 gal
0 m	0,968 m	1,81 m	0 m^3	0 gal

Table 1. Volume to gallon ratio. Source: own.

Table 1 establishes the amount of gallons according to its volume obtained depending on the height of the ACPM. Therefore, with a minimum height the tank would be full (FULL) and as the fuel goes down the height increases and with the help of table 1 the amount of gallons was related according to its height. With this data we proceed to make the related table height & gallons, as shown in table 2.

Height (m)	Gallons (gal)
0 m	500 gal
0,10 m	463 gal
0,20 m	417 gal
0,30 m	370 gal
0,40 m	324 gal

0,50 m	278 gal
0,60 m	231 gal
0,70 m	185 gal
0,80 m	139 gal
0,90 m	92 gal
1 m	46 gal
1,08 m	0 gal

Table 2. Height & Gallons Relationship. Source: own.

Table 2 shows that at a minimum height (0 m) the tank is Full (full) and as it is unoccupied, the height detected by the HC-SR04 ultrasonic sensor increases, and if the sensor measures a height of 1.08 m, it is determined that it is Empty (empty).

3. Methodology

During the execution of this project, several sources of information were used to help in the design of the fuel level measurement system. Among them, technical information for the use and operation of the power supply system of this radar was taken into account in the first instance. [16]

In addition, a consultation of different research on the different ways used to measure the ACPM and the methods applied was carried out. This research was carried out based on the fact that it is an electric generator, in addition to scientific articles published on the internet, where the properties and composition of ACPM are specified. Another research topic was the consultation of the properties of materials required and applied in the industrial field, which have optimal and ideal characteristics to be applied in this project. [16]

Taking into account that the objective is the design of a digital fuel level measurement system, which allows a digital indication, multiple consultations were made to technical personnel, which has an arduous experience in digital indication issues, each of these interviews or information consultations, was vital to carry out the execution and development of this project, it is considered as the main source of information each of the interviews conducted with technical personnel involved in the practice of having a control of the consumption of the ACPM of the electric generator. [16]

4. Results

The digital fuel level measuring system was developed with the purpose of simplifying the measurement of fuel in the tank that stores ACPM, which is used for the operation of the ANTPS-70 Radar generator located at the NCO school of the Colombian Air Force.

This project is an equipment that measures the height (cm) of the fuel in the storage tank (Figure 11); depending on the height that will be measured by the HC-SR04 ultrasound installed in a tank nozzle located in the upper part of the tank and by making a comparison between height and volume, it will determine the amount of gallons of ACPM in the tank.

Figure 11. Radar AN / TPS-70 fuel tank located at the Escuela de Suboficiales "CT. Andrés M Díaz". Source: own.

4.1.1. Programming

After obtaining the volume & gallons data (table 2), the programming is developed starting with the transmission of the distance in cm; processing the data from the HS04 sensor, as shown in figure 12.

```
void loop()
{

  digitalWrite(trig, LOW);
  delayMicroseconds(2);
  digitalWrite(trig, HIGH);   // genera el pulso de triger por 10ms
  delayMicroseconds(10);
  digitalWrite(trig, LOW);

tiem= pulseIn(echo, HIGH);
dist= (tiem/2)*0.0343;
datos[0]= dist;
```

Figure 12. HS04 sensor programming. Source: own.

After programming that "data [0]" is equal to the variable "dist", which are the variables in the program that indicate the data from the HS04 sensor, the transmission of "data [0]" is performed by means of the NRF24L01 module, where the distance obtained from the HS04 sensor is sent, in cm. When the receiver receives the variable "data [0]", the program performs a comparison of the transmitted measurement, with respect to the gallons, as established in Table 2 and the programming is observed in Figure 13.

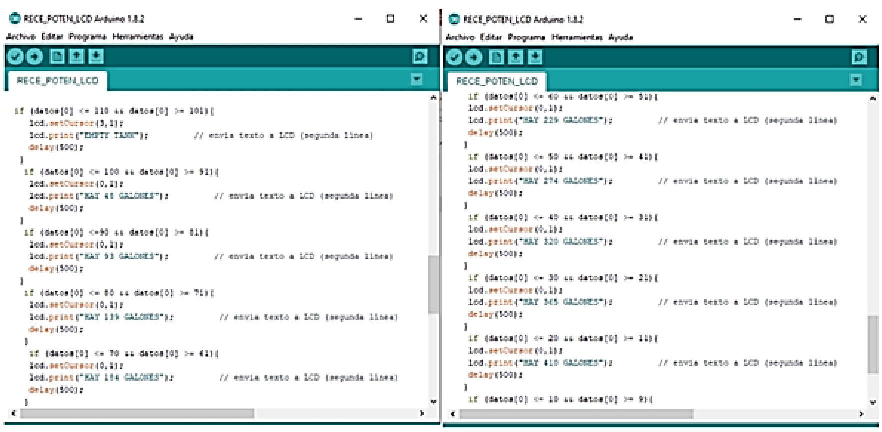

Figure 13. Programming of the transmission and reception of the distance variable. Source: own.

Likewise, the receiver module displays the height measurement and the number of gallons in the tank on an LCD, as shown in Figure 14.

Figure 14. Gallons visualization on the LCD screen. Source: own.

With the transmission and reception modules programmed and working, the coupling to their respective boxes was performed, and then the tests were carried out in the radar of the NCO school "CT. Andrés M. Díaz". We proceeded to place the transmitter module that has the HRS04 sensor in one of the filling ports, figure 15.

Figure 15. Transmitter Module. Source: own.

The receiver was located in the inner part of the hangar where the radar control cabin is located and it is observed that the transmission was successful with a distance of 10 meters without point of view and obtaining the data of the gallons in real time.

5. Conclusions

In conclusion, at the end of this project, the question of how to implement a digital fuel level measurement system, which was the guiding question of the work, is answered, fulfilling the objectives set out in this research through the design, construction and evaluation of a digital fuel level measuring equipment.

Likewise, through the consultation of different sources, it is possible to obtain information that supports the realization of the digital system for data collection in real time about the gallons of fuel inside the tank, from this information it is possible to perform measurements digitally reaffirming the taking of quality measures.

Within the research it is concluded that to create electronic communications is necessary the application of different programming software such as: Arduino that allows programming Arduino boards, Fritzing digital logic circuit design, PCB Artist electronic circuit design being found more complete for this project the Arduino given its advantages such as easy operation, data visualization in real time, data capture and a free hardware platform, programming any micro controller. It is achieved by converting liters to gallons the transformation of the traditional method of obtaining measurement of fuel volume inside the tank to a digital technological innovation achieving greater accessibility, improved mobility, convenience, scalability and cost. When performing the functional tests of the system we verified the correct operation of each module that composes the system, the reading provided by the system is visualized giving to know the volume of fuel reducing the time in 95 % demonstrating to be an efficient, optimal and of great quality system in coherence with the study cost benefit where its investment is presented in its coefficient.

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