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# An Automated System for Measuring the Level of Fuel in Underground Tanks

Joan Munene and Benard Alaka

*Faculty of Information Technology, Strathmore University, Nairobi, Kenya*
*Corresponding author: balaka@strathmore.edu*
*+Speaker: joan.munene@strathmore.edu*
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***Abstract –*** The use of dip rods brings have over the years been in most fuel stations within most developing countries in the measurement of fuel levels in undergrounds tanks. This has been challenged by high inaccuracies resulting from the lack of experienced or honest personnel tasked with the duty of conducting these measurement. This research therefore proposes an automated fuel level measurement system in underground tanks in petrol stations. The proposed solution aims to solve the problem of inaccuracy and time wastage faced by managers at petrol stations and also attendants. This shall be achieved through the use of weight sensors which in the long run shall aid in the accountancy for every amount of fuel that is used in the petrol station. Additionally, data collected shall be used in analyzing the fuel usage trend and send forecast reports to the concern parties. The system development methodology that will be used to design the project is system prototyping due to the reason that upon the completion of the research the proposed solution will not be deployable though a working proof of concept.

*Keywords – Underground fuel tank, Weight Sensor, Arduino Uno,*

## I. INTRODUCTION

The measurement of fuel levels in underground tanks is a crucial activity performed in all fuel stations for purposes of inventory management [1]. Most fuel stations in developing countries employ the use of dip sticks in measuring the level of fuel [2]. The use of dip rods brings about inaccuracy and time wastage when measuring the level as this can be easily altered by the attendants or the people assigned to measure.

The remaining sections of this paper is structured as follows: Section II reviews pre-existing works on underground tank fuel measurement. Section III describes the Research Methodology used in this research. Section IV discusses the results obtained from tests conducted on a prototype of the build model Finally, Section V presents a discussion on the results obtained and Section VI summarizes the observations and recommendations through this research.

## II. LITERATURE REVIEW

### A. *Existing Challenges in Underground Tank Fuel Measurement*

According to [3] so many things could go wrong with using a dip stick where, the dip stick might not reach to the very end of the tank hence in accuracy also when checking where the level is on the dip stick one may check wrong or it may fail to be clear hence the results given are inaccurate.

Additionally, [1] reports that the level of fuel is measured twice in a day in most petrol stations so that they are aware of the amount fuel that has been used during the day and that has been used over the night. In such situations one needs to employ quite a number of attendants to get the work done. This increases the amount of expenses that the company has yet it can be used to improve a certain business.

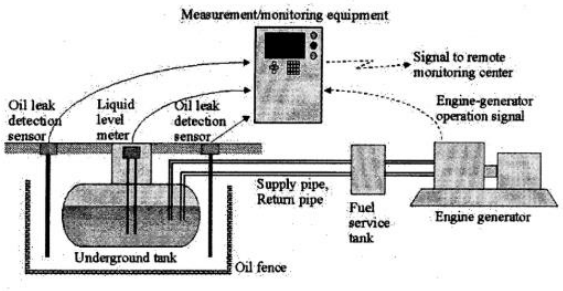
In a research conducted by [4] it was reported that the use of dipping sticks especially in steel tanks is potentially risky as it could lead to corrosion as a result of the stick continuously hitting the bottom of the tank. It was further discussed that having a corrosion resistant coating would be a temporary yet not a long term solution to the aforementioned risk. As such it was recommended that an alternative and less risky approach be employed in the measurement of fuel for underground fuel tanks.

### B. *Existing Solutions in Underground Tank Fuel Measurement*

So far attempts have been made by researchers to come up with efficient fuel measurement.

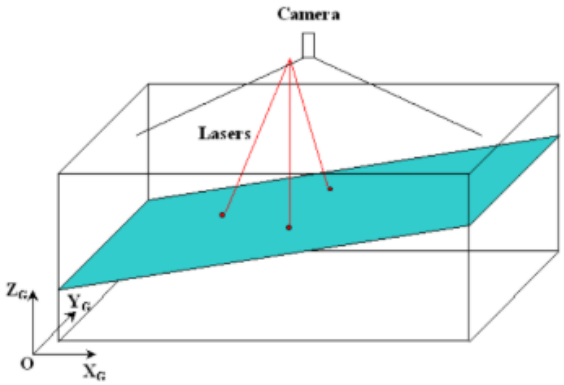
#### *1. Use of liquid level meter*

The liquid level meter is used to measure the level as it is put inside the underground tank. The results are later sent to the monitoring or measuring equipment so as to actually measure the level and then sends the signal to remote monitoring center. The system detects oil leakage when there is and also shows the level of fuel using a liquid level meter. Nonetheless the system detects the oil leakage after a couple of days during its early stages and not immediately. [5]



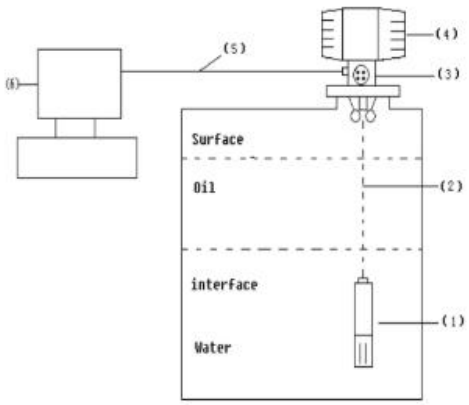
*2. Use of computer vision*

The computer vision uses the coordinates of three points located at the top of the liquid to measure the level of the fuel in the tank. It has a couple of cameras to determine the coordinates of each point by triangulation. It has a couple of challenges since it has to be done in a certain environment as in areas with a certain gas it would lead to inefficiency and also attenuate ultrasound. [6]




*3. Use of combination sensors*

It is meant to show the level for both the water and fuel. The law of density is used as the oil is closer to the surface. The combination sensor is put inside the underground tank. The data collected by the sensor is sent to the measuring agency which determines the level of water and that of fuel separately. There is an involvement of water in this system which may at times lead to inaccuracy. [7]




(1) Combination sensors (2) Cable
(3) Support (4) Agencies for measuring
the implementing

*C. The Proposed Solution*

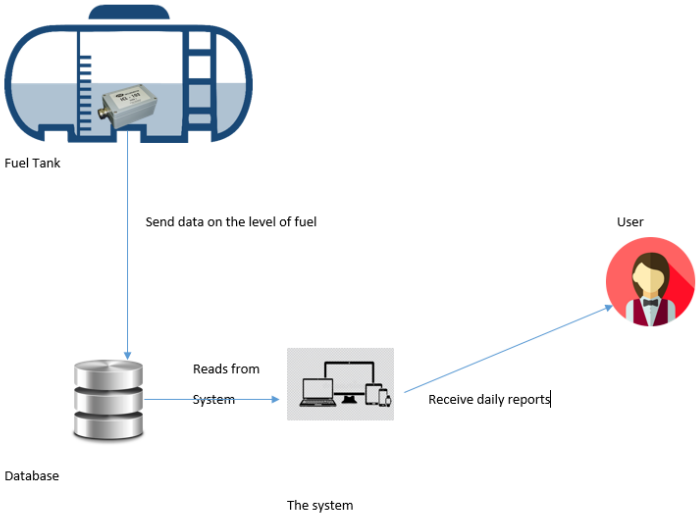



Figure 1: Conceptual Framework

The users of the system are the administrator, attendant and the manager.The admin is a user of the system the petrol station/business hence given full access to the system since they sign up other users of the system to permit them to use the system. The administrator gets to view the level of fuel as well as.The attendant checks the level of fuel. This will also help keep the records of the business on track hence reducing large amounts of files on the attendant's side.

The manager is one of the system users since he /she owns the business. Hence they need to get a record on how the business is coming along. This will help keep track of the business and know what type of fuel is mostly consumed.In cases where the level of fuel is low they get a notification on what type of fuel is low hence inform the supplier to refill the amount of fuel. It will also help keep track of the business and they are sure that fuel is not being maliciously used by the employees.

A weight sensor will be used for the project to tell the level of the fuel. The sensor will be put right below the tank so as to measure the amount of fuel. The sensor will be programmed in a way that the weight of the tank will be subtracted. Hence the only thing that will be measured is the fuel.The information will then be sent to the arduino board as it is able to read inputs that are sent by the sensor there by turning it into an output that can easily be read, as it is sent to the database.

The sensor gets information from the underground tank on the level of fuel for each and every level from all the tanks due to the different fuel types. This information is then sent it to the arduino board since it is meant for the purpose of reading both hardware and software. This is then sent to database as the arduino board has already changed it software.The database has the information on all the level of all the fuel types, having the dates and the time. The application then reads the information from the database.

## III. RESEARCH METHODOLOGY

A. *Methodology*

Object-Oriented Analysis and Design (OOAD) as an approach used for analysing and designing a system by applying object-

oriented programming hence a preferred methodology for the project since it since it uses the Object-Oriented perspective to solve the problem. With this methodology, the objects will interact with each other so as to solve the problem. It shows the attributes, the relationship between the objects and the tasks it should be performing. [8]

*1.System Development Methodology*

Shabaya [9] , defines software prototyping as a better approach as one can communicate with the customers to know expectations of the system and what they would want in the system. It helps the developer know the changes that need to be made in case the project is not up to task before they are done working on it. The steps required are**:**

a.Prototyping plan where expectations are to enquire on what the customers would require and what their needs are.

b.Outline definition where the prototype should show some of the functionalities that the system is expected to have. The function of the prototype in the fuel level measurement system is the system measuring the level of the fuel.

c.Executable prototype this is where the prototype is developed in a way that just a few changes or improvements have be made to come up with the ideal system.

d.Evaluation report where the prototype is already developed and the developers can present the system to the users to know whether they like the system and whether the system has the requirements that are need. The users are also trained on how to use the system and how fast they learn using the system.

*B. Tools*

The project uses sensors to so show the level of fuel in the tank.The weight sensor is put beneath the underground tank where it sends the information to the amplifier as to convert from analog to digital.The information is then sent to the arduino board them to the database where the information is sent to the system and hence information is conveyed to the user where they view the level of fuel.The weight sensor will be a preferable sensor to use for the project as the sensor is put under the tank. This will need coming up with an algorithm that subtracts the weight of the tank since the sensor is put under the tank.

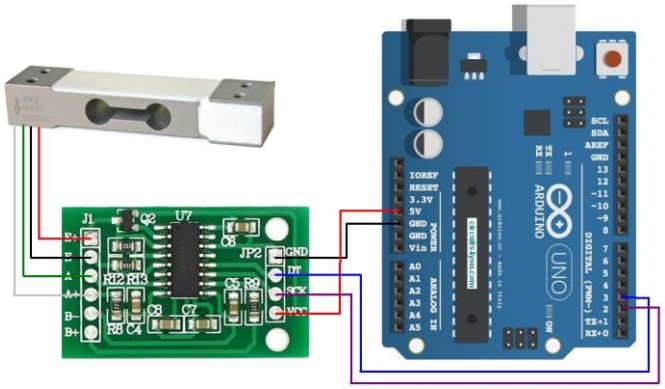
For the information to be conveyed to the database, an arduino board has to be used as a gate way so that the level of the fuel can be communicated to the database. It is preferable to use an arduino board since it can read inputs from a sensor and output that message to the software (database).The MySql database is then sent the information on the level of fuel from the arduino board. The reason behind this choice is because the database works efficiently with web-based languages such as JAVA. Hence providing reports on the level of fuel for previous weeks.

## IV. RESULTS

As stated, JAVA language and arduino are used to come up with the system. The editor tools used are netbeans and arduino. Arduino is used for the hardware part of the system while JAVA is used for the logic.

*A. Hardware Setup*

It involves HXF11 Load Cell Amplifier, a weight sensor and an Arduino UNO and Genuino UNO. HXF11 Load Cell Amplifier is a precision 24-bit analog to-digital converter. The weight sensor is connected to the HXF11 Load Cell Amplifier then to the Arduino UNO and Genuino UNO so as to convert it to digital as illustrated. [10]




Since the weight sensor can hold 20kgs the calibration is changed in accordance to the weight sensor which is a calibration factor of (-96650) while that of 40kgs is (-106600). There is also a line of code that prints a serial of what is found in the weight sensor in kilograms and one that ensures that it is print as vertically hence showing a minimum of 3 decimal places. The weight of the wood above the sensor is also subtracted to ensure that it is only the fuel weight that is measured. After the weight has been read, the scale then resets back to zero.

*B. TeraTerm port reading and reading from text file*

The readings on the level are read on a port called TeraTerm then writes it on a text file. A JAVA code is then written so as to show only the last line or rather the latest readings on the level that has been caught by the sensor. The text file (weightlog.txt) is what is used to fetch the information of the level. The JAVA code also implements on showing the exact date and time the level of fuel got to be at that. The reason for

choosing the port reader was due to the difficulty of identifying a reliable library that could aid in posting sensor readings directly into the MySQL database.

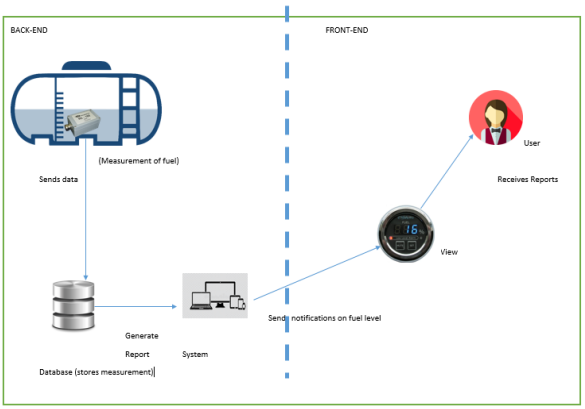
*C. Saving to database*

Once the readings have been sent to the JAVA code on netbeans, the database then fetches the readings leading to a generation of reports on the level of the fuel.

| Test ID | Expected result | Actual result | Status | Remarks |
|---|---|---|---|---|
| T1 | The system should show the fuel level, date and time | The system shows the fuel level as well as the date and time. | Pass | Successfully shows the level of fuel. |
| T2 | The system should show real-time level of fuel | The system shows the level of fuel in real-time. | Pass | Successfully shows the real-time level of fuel. |
| T3 | The system should be secure and only those verified can access. | The system only allows those verified to get access. | Pass | Successfully logging in only those that are verified. |
| T4 | The system should be friendly and easily to use. | The user can easily use the system with no challenges | Pass | Successfully developed friendly system. |
| T5 | The system's response-time should be fast | The response time for the system is fast. | Pass | Successfully fast response time. |
| T6 | The system should generate reports weekly on the level of fuel. | The system does generate reports. | Pass | Successfully generates reports. |

## V. DISCUSSION

The system is web-based. One can access a web-based system from any web browser with access to the internet with a lot of ease and from any location what so ever. Web-based system are in support of the existence of Internet of Things (IoT) devices.The use of sensors has promoted development of web-based system there is need for the use of an IOT device to communicate with the system which is the arduino board. The arduino board gives a gate way for the sensor to communicate with the system.




The sensor captures the data on the level of fuel where it is then transmitted to the arduino uno for interpretation to the database. The processing of the data where the language that is be used to code is Java. The platform where the user can log in and get reports daily. The platform is a webpage that shows the level of the fuel for each type in real-time as well as reports of previous fuel levels and receive a notifiaction on the email when the level of fuel is low to a certain level. The user gets to enquire on the level of fuel as long as he/she has logged in to the system.

The security requirements are well met since the system is only accessible to those registered to access the system hence ensure the privacy that is needed and also maintain the company's need for privacy [11]. The system is being user friendly and can be used with no difficulty.The system response-time will be fast as it gives reports.The system is only accessed by registered users hence the security level being high.The system generates the general reports weekly.

## VI. CONCLUSION

In conclusion, the system shows how much there has been a gap in the Petroleum Industry which has to be filled. The system eliminates errors experienced when measuring the level of fuel. The system is quite similar to those that have been developed before such as the use of liquid meter to measure the level of fuel.

In accordance to the System Development Methodology section, prototyping has been used for development of the system and hence used the same prototype to develop the system. Testing has also taken part in the development since some of the functional requirements have to show their functionalities. Functional requirements such as showing the level of fuel, the date and time the fuel got to that level are functionalities that have been implemented. Non-functional requirements such as security, and a user friendly system have been met.

The tools that have been used in the system such as the arduino uno, amplifier and the weight sensor are the best tools since they ensure that the requirements are well met and accurate. The calibration of the sensor has gone about by coding in arduino where the instructions of the required outpout are send from the arduino uno to the amplifier where it is converted to analog so that the weight sensor can fetch the instructions that have been sent. The user views the level of fuel of on a particular web page as it is sent to a text file then fetched to show on the webpage as an instruction has written in the JAVA code.

The system ensures that the owners of petrol stations do not endure the problems they have been having on inaccuracy of fuel level. The system also helps eliminate employment of too many employees in an institution since not so much work needs be done leading to saving of money.

## ACKNOWLEDGMENT

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