FUEL ANTI-THEFT AND USAGE CONTROL SYSTEM

By

BSE 18-16

EMBEDDED SYSTEM

DEPARTMENT OF NETWORKS

SCHOOL OF COMPUTING AND INFORMATICS TECHNOLOGY

A Project Report Submitted to the School of Computing and Informatics Technology for the Study Leading to a Project in Partial Fulfillment of the Requirements for the Award of the Degree of Bachelor of Science in software Engineering of Makerere University.

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June, 2018
Declaration

We BSE 18-16, hereby declare that the work presented is the original and has never been submitted for an award to any university or institute of higher learning.

<table>
<thead>
<tr>
<th>NAMES</th>
<th>REGISTRATION NUMBER</th>
<th>SPECIFIC ROLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>OHEMA EMMANUEL</td>
<td>14/U/13843/EVE</td>
<td>Team coordination / Developer / designer / documenter / architectural designer / test engineer / system analyst / quality analyst</td>
</tr>
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<td>THEMBO EDDPOUL</td>
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</tr>
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<td>14/U/14252/EVE</td>
<td>Developer / designer / documenter / system analyst / test engineer / quality analyst</td>
</tr>
<tr>
<td>SSEGAWA TIMOTHY</td>
<td>12/U/14241/EVE</td>
<td>Developer / designer / documenter / system analyst / test engineer / quality analyst</td>
</tr>
</tbody>
</table>

Project blog URL: fanucsystem.wordpress.com

Supervisor: Mr. Alex Mwotil.

Signature: ........................................

Date: ........................................
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1 Introduction

1.1 Overview of System

Fuel Anti-Theft and Usage Control System is a GSM based embedded system which uses very few electronic components. It will be compact and can be mounted on any kind of vehicle, generator or fuel pump easily.

The system is able to alert the user about any imminent activity on the fuel tank, for example when the fuel tank is opened and there is a sharp decrease in the fuel level (fuel siphoning), an alarm is set and an SMS sent to the user. This will enable the user to take immediate action. The system will compute fuel levels at the start and stop of every journey and also after refueling since some fuel stations today have frauds in the pumps which display the amount as entered but the quantity of fuel filled in the customer’s tank is less than the displayed value. It will also act as a back up to the gauges as it will be able to determine real time values of fuel levels as they refuel and sends fuel details in form of GET requests with the readings to a web server running a custom Database and PHP application, the PHP application will store the values when new GET requests are received and also serve the page that displays the information. This will enable the company to perform some statistics to help them evaluate the efficiency of their engines in terms of fuel consumption.

1.2 Overview of document

This document contains documentation of the system validation activities. The tables are filled in with information about the tasks performed, methods used, criteria for acceptance, input and output required for each task, required documentation, the persons that are responsible for the validation among others.
2 Requirements and system acceptance test specification

The requirements describe and specify the system completely and are the basis for the development and validation process.

Table 1 Requirements specifications

<table>
<thead>
<tr>
<th>Topics</th>
<th>Requirements specification</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Version of requirements</strong></td>
<td></td>
</tr>
</tbody>
</table>
| **Input** | • Ultrasonic sensor value inform of Analog voltages  
• When fuel tank is opened.  
• User mobile number.  
• Server name and port number.  
• SSID and password  
• Username and password for the web application.  
• GET Requests sent from embedded system to the web server. |
| **Output** | • The LCD displays the Fuel level present, fuel used, fuel added and fuel stolen.  
• The buzzer produces sound in form of an alarm indicating fuel siphoning.  
• The LEDs Emit light depending on the system status, green indicating normal fuel usage and red indicating fuel siphoning.  
• GSM sends an SMS to transport company in case of fuel siphoning.  
• Web browser display fuel details in graphical and tabular format. |
| **Limitations** | • The Company/owners phone should always be on for him to be able to receive an alert  
• Only register phone numbers which are registered in the system will receive message.  
• The battery has to be in good working conditions or the system to run efficiently with minimal error.  
• The SIM Card used should always be recharged with enough SMS. |
<table>
<thead>
<tr>
<th>Topics</th>
<th>Requirements specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety</td>
<td>● All inputs to the server shall be verified to prevent injection attacks, or any manipulation of database.</td>
</tr>
<tr>
<td></td>
<td>● An online support to help the user on how to interface with the system. This comes in form of a blog which contains any updates regarding the system, an email</td>
</tr>
<tr>
<td></td>
<td>addressed specialized to receive complains or requests concerning the use of the system.</td>
</tr>
<tr>
<td></td>
<td>● The LCD display is clear and the font used is big enough for easy reading of fuel values</td>
</tr>
<tr>
<td></td>
<td>● The system has proper connections to avoid short circuiting which may cause the fuel tank to blast.</td>
</tr>
<tr>
<td></td>
<td>● All the system’s electrical and electricity related and heat producing parts are fully insulated to prevent sparks and excessive heat that may cause disastrous</td>
</tr>
<tr>
<td></td>
<td>and catastrophic events because the system work in a highly flammable environment.</td>
</tr>
<tr>
<td>Default settings</td>
<td>● The system uses English language for the first time it is installed though language customizations are to be considered for the future system versions.</td>
</tr>
<tr>
<td></td>
<td>● Systems comes with a default user name and password which can be changed the system admin.</td>
</tr>
<tr>
<td>Dedicated platform</td>
<td>● The system collaboratively works with the vehicle’s fuel system.</td>
</tr>
<tr>
<td></td>
<td>● Web browser to support and display information on the web component.</td>
</tr>
<tr>
<td></td>
<td>● protocols like TCP/IP protocol</td>
</tr>
<tr>
<td>Installation</td>
<td>● Online support in form of a blog and a dedicated customer care email.</td>
</tr>
<tr>
<td>Service and maintenance</td>
<td>● Any discovered failures or faults will be published on the system blog.</td>
</tr>
<tr>
<td></td>
<td>● The battery has to be replaced regularly. This has to be done every 3 months.</td>
</tr>
<tr>
<td>Topics</td>
<td>Requirements specification</td>
</tr>
<tr>
<td>------------------------</td>
<td>---------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Errors and alarms</td>
<td>• Notification of failed/failing components to the web application.</td>
</tr>
<tr>
<td></td>
<td>• Notification of error messages on the LCD screen.</td>
</tr>
<tr>
<td></td>
<td>• Robust coding. Code that will restart the system component in case of any sort of failure.</td>
</tr>
</tbody>
</table>

3. Design and implementation process

3.1 Development plan

3.1.1. Development tools

I. Arduino editor

This is the editor that was used to write the C code for the system. It was used to generate the .HEX file that can be uploaded to the Arduino component to trigger components to perform as per the instructions in the C code.

```
int Trig_pin = 13;
int Echo_pin = 13;
float length;
float distance, volume, duration;
float availableAmount = 0;
float r = 5.0;
void setup() {
  Serial.begin(115200);
  pinMode(Trig_pin, OUTPUT);
  pinMode(Echo_pin, INPUT);
}
void fuelLevel (){
  digitalWrite(Trig_pin, LOW);
  delayMicroseconds(2);
  digitalWrite(Trig_pin, HIGH);
  delayMicroseconds(10);
  digitalWrite(Trig_pin, LOW);
  duration = pulseIn(Echo_pin,HIGH);
  distance = microsecondsToCentimeters(duration);
  length = (30 - distance);
  volume = ((2 * (22 / 7) ) * (r * r) * length);
  Serial.println(length);
  availableAmount = (0.001 * volume);
  return availableAmount;
}
long microsecondsToCentimeters(long microseconds)
{
  return microseconds / 29.1 / 2;
}
void loop() {
  fuelLevel();
  delay(4000);
}
```

Figure 1 Arduino IDE
II. Proteus
This software platform was used to simulate the hardware components required to system to run. This was especially used during early stages of development were we had not acquired the physical hardware.

![Proteus simulator](image)

*Figure 2 Proteus simulator*

III. Arduino UNO Development Board
We have used Arduino UNO whose function is to decode the instructions and use them to control other components interfaced with it.

![Arduino development board](image)

*Figure 3 Arduino development board.*
3.2 Design inputs and outputs

The design output must meet the design input requirements, contain or make references to acceptance criteria, and identify those characteristics of the design that are crucial to the safe and proper functioning of the product. The design output should be validated prior to releasing the system for final inspection and testing.

*Table 2. Design output checklist*

<table>
<thead>
<tr>
<th>Topics</th>
<th>Design output</th>
</tr>
</thead>
<tbody>
<tr>
<td>Implementation (coding and compilation)</td>
<td>• Arduino IDE was used for coding.</td>
</tr>
<tr>
<td></td>
<td>• Proteus was used for simulating</td>
</tr>
<tr>
<td></td>
<td>• The jumper wires were used to connect the different components together</td>
</tr>
<tr>
<td></td>
<td>• The ultrasonic sensor calibrated to ensure correct values before use</td>
</tr>
<tr>
<td></td>
<td>• The system was tested after addition of a new component.</td>
</tr>
<tr>
<td></td>
<td>• After introduction of a new module, a load test was also carried out to</td>
</tr>
<tr>
<td></td>
<td>know how the system will perform under real-life loads.</td>
</tr>
<tr>
<td></td>
<td>• Testing components based on TCP/IP protocols.</td>
</tr>
<tr>
<td></td>
<td>• Supply of edge-case data and voltage surges for power circuits</td>
</tr>
</tbody>
</table>

| Version identification                      | Version 1.0.0                                                                |

| Good programming practice                   | Source code is...                                                            |
|                                           | □ Modulized                                                                  |
|                                           | □ Encapsulated                                                               |
|                                           | □ Functionally divided                                                       |
|                                           | □ Strictly compiled                                                          |
|                                           | □ Fail-safe (handling errors)                                                |
|                                           | Source code contains...                                                      |
|                                           | □ Revision notes                                                             |
|                                           | □ Comments                                                                   |
|                                           | □ Meaningful names                                                           |
|                                           | □ Readable source code                                                       |
|                                           | □ Printable source code                                                      |

| Dynamic testing                             | All statements have been executed at least once                               |
|                                           | All functions have been executed at least once                               |
|                                           | All case segments have been executed at least once                           |
|                                           | All loops have been executed to their boundaries                             |
|                                           | Some parts were not subject to dynamic test                                  |
|                                           | Comments:                                                                    |

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*Fuel Anti-Theft and Usage Control System Report*
### Utilities for validation and testing

- **Proteus** – this was used for simulation of the system.

### Documentation

- User manuals.
- On-line help

### 3.3 Design changes

1. Interaction via GSM channels was only made half-plex ie there is only system to the user information flow and not back. The user cannot command (interact with) the system via the GSM channel.

2. Use of an ultrasonic sensor rather than a pressure plate (sensor) which was proposed in the initial and concept stages of the project.

3. Use of Arduino UNO instead of the PIC micro-controller as the main processing module.

#### 3.3.1 Design change justification

1. Interaction via GSM channel was done away with for the following reasons;
   i. It was a compromised the security of the system as it provided a channel via which individuals can manipulate the system
   ii. Since the system is a real time system, performance requirements are high and so there was need to reduce on the load on the system in terms of inputs.
   iii. There was no need for the user to interact directly with the system.

2. The ultrasonic sensor was favored over the pressure sensor for the following reasons;
   i. The domain values that were guaranteed by the pressure sensors available at the market were very small compared to that guaranteed by the ultrasonic sensors.
   ii. The price range of the most optimum pressure sensor was beyond our budgetary range.
   iii. The pressure sensor guaranteed a large margin of error as would much more difficult to calibrate.

3. The Arduino UNO was considered for the project for the following reasons;
   i. Cross-platform - The Arduino software runs on Windows, Macintosh OSX, and Linux operating systems.
   ii. Simple, clear programming environment - The Arduino programming environment is easy-to-use for beginners, yet flexible enough for advanced users to take advantage of as well.
iii. Open source and extensible software - The language can be expanded through C++ libraries, and people wanting to understand the technical details can make the leap from Arduino to the AVR C programming language on which it's based.

iv. Open source and extensible hardware - The Arduino is based on Atmel's ATMEGA8 and ATMEGA168 microcontrollers. The plans for the modules are published under a Creative Commons license, so experienced circuit designers can make their own version of the module, extending it and improving it. Even relatively inexperienced users can build the breadboard version of the module in order to understand how it works and save money.

3.3.2 Design change evaluation
Using ultrasonic sensor rather than a pressure plate (sensor) reduced the costs of implementation since the ultrasonic sensor was relatively cheaper than the pressure sensors. And the ultrasonic sensor provides a higher level of accuracy as compared to the pressure sensor.
4 Inspection and testing

The inspection and testing of the system is planned and documented in a test plan. The extent of the testing is in compliance with the requirements, the system acceptance test specification, the approach, complexity, risks, and the intended and expected use of the system.

The test plan is created during the development or reverse engineering phase and identify all elements that are about to be tested. The test plan should explicitly describe what to test, what to expect, and how to do the testing. Subsequently it should be confirmed what was done, what was the result, and if the result was approved.

4.1 Test Objectives and types

Table 3 Test Objectives and types

<table>
<thead>
<tr>
<th>Topics</th>
<th>Test plan and performance</th>
</tr>
</thead>
</table>
| Sequence of tests  | • Model-based testing by testing the main two modules i.e. the embedded module and the web application module.  
                       • Functional testing- basing on the requirements matrix provided in the Software Design Document, the system checks out the functionality it satisfies.  
                       • Unit testing- quite similar to model testing however individual units are tested individually.  
                       • White box testing based on a components specification.  
                       • Fault testing by supplying edge case data  
| Calculation tests  | • Calibration of the ultrasonic sensor using a foot ruler, and an object at a known distance.  
| Regression tests   | • Testing of the system every after addition of a new component.  
| Action if errors   | • Restart the system if the error affects the processing module.  
                       • Send alerts inform of GET posts to the web application showing the affected module.  
                       • Alert on the LCD that an error has been observed.  

4.2 Test Results

Testing approved
5 Installation and system acceptance test

The validation of the installation process ensures that all system elements are properly installed in the host system and that the user obtains a safe and complete installation, especially when installing software products.

Table 4 Installation summary

<table>
<thead>
<tr>
<th>Topics</th>
<th>Installation summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Installation method</td>
<td>□ Automatic - installation kit located on the installation media</td>
</tr>
<tr>
<td></td>
<td>√ Manual - Copy &amp; Paste from the installation media</td>
</tr>
<tr>
<td>Comments:</td>
<td>- The installation files are uploaded onto the Arduino board using a USB cable connected to the PC where the source code is</td>
</tr>
<tr>
<td>Installation media</td>
<td>□ Diskette(s)</td>
</tr>
<tr>
<td></td>
<td>□ CD-ROM</td>
</tr>
<tr>
<td></td>
<td>√ Source disk folder (PC or network)</td>
</tr>
<tr>
<td></td>
<td>□ Download from the Internet</td>
</tr>
<tr>
<td>Comments:</td>
<td>- The installation files are uploaded onto the Arduino board using a USB cable connected to the PC where the source code is</td>
</tr>
<tr>
<td>Input files</td>
<td>□ .HEX file. This input file is the main file that is uploaded onto the Arduino board</td>
</tr>
<tr>
<td>Installed files</td>
<td>□ Arduino files</td>
</tr>
<tr>
<td></td>
<td>□ .HEX files</td>
</tr>
<tr>
<td>Supplementary files</td>
<td>□ User manual that will guide the users on how to operate the system.</td>
</tr>
<tr>
<td>Installed components</td>
<td>□ Arduino development board which hosts the microprocessor and all the other embedded parts. It is verified to see if it can send instructions to all components.</td>
</tr>
<tr>
<td></td>
<td>□ LCD screen that will show directions for use.</td>
</tr>
<tr>
<td></td>
<td>□ LED It shows the working status of the system.</td>
</tr>
</tbody>
</table>
6 Performance, servicing, maintenance, and phase out

In this phase the system is in use and subject to the requirements for service, maintenance, performance, and support. This phase is where all activities during performance reside and where decisions about changes, upgrades, revalidation, and phase out are made.

<table>
<thead>
<tr>
<th>Topics</th>
<th>Performance and maintenance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Problem / solution</td>
<td>1. Sparks and excessive heat that may cause disastrous and catastrophic events:</td>
</tr>
<tr>
<td></td>
<td>Solution - All the system’s electrical and electricity related and heat producing parts shall be fully insulated since the system is to be installed in a highly flammable environment.</td>
</tr>
<tr>
<td>Functional maintenance</td>
<td></td>
</tr>
<tr>
<td>Functional expansion and performance improvement</td>
<td>In future, we plan to enhanced the system by:</td>
</tr>
<tr>
<td></td>
<td>• The use of camera and GPS which would be more convenient for the vehicle owner to track the crime scene and the criminal.</td>
</tr>
<tr>
<td></td>
<td>• Providing voice feedback system.</td>
</tr>
<tr>
<td></td>
<td>• Detecting mileage covered.</td>
</tr>
<tr>
<td></td>
<td>• Computing fuel consumption and evaluating engine efficiency.</td>
</tr>
</tbody>
</table>

7 Conclusion

By the subsequent signatures it becomes evident that all validation activities are documented and approved.
Appendix:

Appendix A: User manual

1. Embedded System
Step by step procedure to setup the system is shown below:

I. Connecting GSM Modem
   a. Insert SIM card
   Open the SIM cardholder by sliding it as per the arrow mark and lift up. Insert the SIM card, so as to align the chamfered corner suits in card holder. After inserting the SIM card, lock the holder by sliding it to the opposite direction of arrow mark.

Figure 4 inserting the SIM card in the GSM

   b. Connect The Antenna
   c. Fix the Supplied RF antenna to the SMA Antennae connector and tighten it by Rotating the Nut (Never rotate the antennae for tightening).

Figure 5 Attaching the antenna on the GSM
d. Power the Modem
Power the modem from suitable power supply, which is having enough current capacity (>1A).

e. Check the Status of the Network LED
The Network LED indicates the various status of GSM module e.g. Power on, Network registration & GSM connectivity. When the modem is powered up, the status LED will blink every second. After the Modem registers in the network (takes between 10-60 seconds), LED will blink in step of 3 seconds. At this stage you can start using Modem for your application.

II. System notifications:
After switching on the system, the Fuel Anti-Theft and Usage Control System is installed

a) When fuel tank is open.

When the system detects that the fuel tank is open and fuel is being siphoned, the red LED and buzzer are activated. During which the message is displayed on the LCD screen and an alert message is sent to the mobile no. which is loaded in the microcontroller.

*Figure 6 Notification displayed when tank is open*
b) During fuel Theft

When the system detects that the fuel tank is open and fuel is being siphoned, the red LED and buzzer are activated. During which the message about the fuel theft is displayed on the LCD screen and an alert message is sent to the mobile no. which is loaded in the microcontroller.

![Figure 7 Notification displayed during fuel theft](image)

![Figure 8 Notification indicating amount of fuel added.](image)

c) System status after fueling

When the system detects that the fuel tank is open and fuel is being added, the green LED turned on. And the amount of fuel added is displayed on the LCD screen.
d) System status during normal fuel consumption

During normal fuel consumption, the green LED turned on. And the amount of fuel used is displayed on the LCD screen.

![Figure 9 Notification indicating amount of fuel used](image)

2. Web Application
a. The system comes with a default username and password which a user can use to access the web application.

![Figure 10 User login page](image)
b. User particularly the system admin can add, view and edit user details.
   i. Page to display User details

   ![Figure 11 User details](image)

   Figure 11 User details

   ii. Page for editing user details

   After adding user the system administrator can also edit the user details in case they were entered wrongly

   ![Figure 12 page to edit user details](image)

   Figure 12 page to edit user details
c. Fuel Details
   
i. A page to display current fuel level where red indicates fuel level is too low.

   ![Figure 13 Current fuel detail.](image1)

   ii. A page to display daily fuel details in a tabular where user can print details in pdf format or export to an excel file.

   ![Figure 14 daily fuel records.](image2)
iii. A page to display daily fuel details in a graphical format which indicates the trends.

![Daily fuel consumption trend.](image1)

**Figure 15** Daily fuel consumption trend.

iv. A page to display daily fuel details in a graphical format red indicates the amount of fuel stolen and blue indicates amount of fuel used normally.

![Fuel details.](image2)

**Figure 16** Fuel details.
EXPLORING THE NECESSITY OF EFFECTIVE FLEET FUEL USAGE TO DERIVE IMPLEMENTATION OF FATUCS

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ABSTRACT

This report focuses on fleet fuel economy and related fuel-saving measures and policies. The main objective of this survey was to understand the current on-road fuel economy performance of fleets, and the effects of fuel theft control strategies and regulations on such fleets. Also of interest in this survey were various fuel-saving methods fleet managers have employed. Fleet managers were asked to provide overall fleet characteristics and fuel economy information, including their views regarding current and future technologies, strategies, alternative fuels, and regulations. The survey yielded completed responses from 10 Transport company managers and 2 individual Vehicle owners.

KEY WORDS: FATUCS (Fuel Anti-Theft and Usage Control System), fuel siphoning, fleet, GSM, Sensor, GPS.
1.0. INTRODUCTION
1.1. BACKGROUND INFORMATION

There have been incidents of fuel siphoning in Uganda and other countries. The drivers can practice fuel siphoning collaboratively with their turn boys.

In [1] a country called Bangkok, companies started to use a device fixed in their vehicles that can tell the position of a vehicle and tell how long the driver has delayed at that stop point. The device uses a GPS. This system only aims at enabling the driver’s bosses query him over why he delayed at that stop.

In [2] The practice of fuel siphoning has increased by 50% starting January 2009. One cause to fuel siphoning has been attributed to the increase in fuel prices and thieves, therefore, see it as a reliable source of income. Companies as a result of fuel siphoning have incurred costs on replacing that stolen fuel, missed deliveries and interruption of business activity. Some damages caused while tempering with the protection mechanisms also result in repair or equipment replacement costs.

In [3], Fuel siphoning is the discharge of fuel caused by runoff, loose cap, intentional opening of lid or breakage through a siphon.

In [4], The dynamics around fuel siphoning involve physics. The thief may only need access to the vehicle’s fuel tank, where to put the fuel (container), and a tube. To exploit gravity, the thief sets the container below the fuel tank. He connects the tube between the tank and the container that is placed on the ground. The thief evacuates the tube by sucking the fuel from the tank first usually by mouth (an offensive way). Preferably that would legally be done using a siphon pump. When the thief collects the fuel he needed in the container, he can raise the tube and the container above the fuel tank. He will then remove the tube as the remnant fuel in the tube flows back to the source (tank).

In conjunction with the pressure from the newly enacted fuel economy and emissions standards, these factors have increased the focus on fuel economy in the automobile industry and are leading to the deployment of new technologies and practices to reduce fuel consumption. Consequently, a project was developed to investigate current views regarding fuel-usage among fleet managers in the heavy-duty truck industry. To accomplish this goal, a new survey was developed for this
study to better understand fleet, managers’ views about fuel usage, fuel economy, and fuel-saving technologies being used or considered for use in heavy-duty trucking fleets in the Uganda.

The integration of sensors and GSM to work together with the GPS is invented to enable real-time capturing and transfer of data. These capabilities thus, will provide an efficient mechanism to track fuel usage and theft.

**1.2. HYPOTHESES**

**H1:** the rise in fuel prices has led to an increase in fuel siphoning.

**H2:** most companies are not aware that drivers of their trucks practice fuel siphoning.

**H3:** fuel siphoning can be tracked and reduced or stopped by application of technology and using digital data.

**H4:** not every unexpected reduction in fuel is a result of fuel siphoning.

**1.3. OBJECTIVES**

This section seeks to illustrate the intended outcome and achievement for developing FATUCS.

**1.3.1. GENERAL OBJECTIVE**

To develop a system that will efficiently be used by companies to monitor the behavior of their vehicle fuel consumption and usage, by mostly combating fuel siphoning.

**1.3.2. SPECIFIC OBJECTIVES**

- To analyze the system requirements for FATUCS to remove inconsistencies and increase feasibility.
- To design and implement FATUCS.
- To test and validate FATUCS so that upon its installation it should be within the scope of required performance.
1.3.3. Assumptions and Dependencies

- The system assumes one single fuel inlet and outlet.
- It assumes that users will have access to a properly functioning vehicle with a sufficient power source (such as gasoline and/or a charged battery).
- Additionally, it is assumed, when considering the operation of the system, that all of the previously-listed constraints are met and that the system is operating in an environment in which the full functionality of the system is possible.

2.0. RELATED WORK

This section presents the various works done by other people that are related to the problem at hand, the relevance of this paper’s topic and the solution that is put in place by this system.

2.1. The phenomenon of Fuel Siphoning from Companies’ and Individuals’ insights

The rise in fuel prices has been linked to fuel siphoning according to police reports. It has become a fraudulent income source. Some businesses have gained demand for their products as a result though such businesses can’t be victimized for the practice. Police has encouraged car owners to report anyone involved in the fuel siphoning though it has not proved absolute safety. Some thieves use pumps to carry out fuel siphoning and the victims may think the cause for reduction in fuel volumes is a result of undiscovered leakages. The practice can result in damage and loss of some parts like fuel tank lids. [5]

According to [6], there are claims that increase in the fuel prices has skyrocketed the deed of illicit fuel siphoning. Fuel (diesel and petrol) siphoning can be done by It can be siphoning it out or fuel lines below the tank can be cut. More surprising is; those thieves can drill into tanks to get to the fuel. Some potential danger with the practice is when fire outbreaks if a cigarette fire can become in touch with the fuel left under your car or igniting the car itself. Apparently people have been advised to lockable fuel caps to overcome the challenge which doesn’t ensure optimum safety. Car owners are also advised to park in visible scenes so that thieves can easily be seen.
2.2. Technologies in place to deal with Fuel Siphoning

The KPA (Kenya Ports Authority) obtained two smart fuel dispensing bowsers costing Sh54 million in a move expected to eliminate fuel losses associated with siphoning. These technologies used in Kenya remotely monitor refueling and reduces human interactivity but promotes efficiency. The officials report that this will stop fuel siphoning though it has been reported again that they use “incorporated digital gauging system that uses smart product identification to measure fuel tanks. The bowsers will aid in ensuring an audit trail of fuel movement such that the date, time, and location is recorded, regardless of whether a pump or meter is used” There technology further detects the quality of the fuel from external substances like water or soil. The officials also reported the this dilemma in the transport companies has led to financial expenses due to fuel siphoning that is even done by the drivers. They stipulate that whenever illegal temperance with refueling system is detected, an alarm will be made to alert the responsible principals. [7]

Some fuel anti-siphoning technologies and devices segregate among vehicle models like the “Model NIS800001 – 80mm Neck-IT Super ASD Long – Bayonet Fitting” can only work in models DAF-CF65, CF75, CF85, XF95, XF105, 250 (Spectra), IVECO-Stralis, Trakker, EuroCargo, Eurostar, EuroTech, Renault-Premium, Magnum, Midlum (Metal Tank), Kerax Volvo-F12, F16, FH, FM, NH, FL6, MAN-All Models Mercedes - All Mercedes trucks/buses including vehicles with a plastic fuel tank ERF – ECT [8]

3.0. METHODOLOGY AND TOOLS USED TO COLLECT AND ANALYZE DATA

This part of the survey papers illustrates the effort undertaken to achieve the objectives by collecting data, designing the survey, selecting the population and data collection methods (instruments and procedures), and data analysis and presentation methods.

3.1. Survey instrument

A survey was conducted using questionnaire. A questionnaire was developed to examine a variety of issues related to fleet fuel economy and fuel consumption, including operational strategies as well as implementation of technical solutions and the overall performance of such solutions. The full text of the questionnaire is included in the appendix.
3.2. Technologies Used

The GSM has been considered for enabling mobile data transfer while the microcontroller and the LCD collaborate to capture and display data. Whereas the prior mentioned are hardware interfaces, the software interfaces used are the arduino editor for generating the .HEX file, PHP for building the web interface combined with MySQL for the database manipulation. Proteus is software that was used while simulating the hardware components before the actual integration.

3.3. Respondents

Transport Company managers, Vehicle Owners and drivers were contacted and given questionnaires to fill in.

Fully completed questionnaires were received from 12 individual heavy-duty fleet managers regarding their respective fleets. Demographic breakdowns for the included fleets are presented in Tables below.

4.0. RESULTS

**DRIVER DETAILS**

<table>
<thead>
<tr>
<th>Experience</th>
<th>driver class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 3 years</td>
<td>Greater than 3 years</td>
</tr>
<tr>
<td>8</td>
<td>4</td>
</tr>
</tbody>
</table>

**VEHICLE SPECIFICATIONS**

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Transmission</th>
<th>Age</th>
<th>Frequency of Service</th>
</tr>
</thead>
<tbody>
<tr>
<td>Isuzu</td>
<td>Manual</td>
<td>New</td>
<td>Weekly</td>
</tr>
<tr>
<td>Toyota</td>
<td>Automatic</td>
<td>Old</td>
<td>Monthly</td>
</tr>
<tr>
<td>Mahindra</td>
<td>Both</td>
<td>0</td>
<td>Quarterly</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Annual</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>6</td>
<td>2</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>4</td>
<td>6</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>5</td>
<td>7</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>8</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

**FUEL DETAILS AND THEFT AWARENESS**

<table>
<thead>
<tr>
<th>Fuel Type</th>
<th>Experienced drastic fuel decrease</th>
<th>Track fuel</th>
<th>Experience fuel theft</th>
</tr>
</thead>
<tbody>
<tr>
<td>Petrol</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Diesel</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>3</td>
<td>9</td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>4</td>
<td>11</td>
<td>11</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>
Further some of the identified Fuel Theft Methods specified by respondents are;

1. Declaring incorrect fuel consumption

This method is typical of companies who use manual logbooks to keep track of fuel purchases and consumption, or have an overestimated consumption rate that can make it even easier for staff to steal fuel. In this instance, fuel can be filled into other cars; drivers might easily take advantage of the overestimation or the approximate method of consumption and purchases recording.

2. Fuel pumped out of the tank

Probably the one that first springs to mind: not exactly like the old fashion syphoning, but fuel can actually be pumped out of the tank, with the additional problem of damaging multiple fleet vehicles if staff also break the fuel feeding system in order to extract it.

3. Odometer tampering

Staff could also reduce mileage readings with the use of external devices such as a large magnet placed close enough to the odometer to stop it while the vehicle is in operation (the vehicle can then be used privately), or even with the use of impulse generator devices that add more kilometers/miles: it will then become necessary to give the consent for an additional fuel purchase—an unneeded one—that probably won’t finish in the right vehicle…

4. Fuel not totally filled to the tank

In these cases, a big part of the fuel purchase is pumped into the vehicle tank, while the rest is pumped into a container or into another vehicle. It might seem relatively easy to spot, but if this is done in small amounts you might not realize it.

5.0. RECOMMENDATION

We recommend that this system be used in the most cost-effective manner like there should be no room for unnecessary sending of alerts and messages. Another recommendation is besides the commercial and private sector use of FATUCS, government should also put an upper hand in using this system that will enable overcome fraud on its fuel.
6.0. CONCLUSION

With respect to the findings, a conclusion has been reached to start, implement, test and deploy FATUCS. This will be vital for transport companies to economize fuel usage for better performance. Any further effort will target the commercial continuum of this product.

7.0. FUTURE WORK

We anticipate to carryout viable work in undertaking more research aimed at ensuring that FATUCS remains most cost-effective over time. More work will also be done to ensure that FATUCS can be integrated with Android based systems.
REFERENCE


Registered in England Number 391957
Appendix B.1: DATA COLLECTION TOOL

QUESTIONNAIRE ON A SURVEY FOR A PROPOSED SYSTEM TO CURB AND DETECT FUEL SIPHON AND ALSO TRACK FUEL CONSUMPTION IN AUTOMOBILE FLEETS

(PREPARED BY: OTHIENO RICHARD OKOTH
OGEMA EMMANUEL
THEMBO EDDPOUL
SEGAWA TIMOTHY)

________________________________________________________________________

DRIVER DETAILS

Company: ...........................................................................................................
Contact: ............................................................................................................
Email Address: .................................................................................................
Address: ............................................................................................................
Driving Experience: ......................................................... (Years)
Permit Class:
☐ Class A  ☐ Class B  ☐ Class C
Others Specify .............................................................

________________________________________________________________________

VEHICLE SPECIFICATIONS

Manufacturer: ....................................................................................................
Model: ..............................................................................................................
Age: ............................................................... (YEARS)
Transmission:
☐ Manual  ☐ Automatic  ☐ Both
Engine Capacity: ............................................................................................
Fuel Tank Capacity: ........................................................................................
Frequency of Service:
☐ Weekly  ☐ Monthly  ☐ Quarterly  ☐ Annual
Other Specify:

........................................................................................................................................

Cargo Transported: .............................................................................................................

Any Additional Technology (Specify If Any):

........................................................................................................................................

........................................................................................................................................

______________________________

JOURNEY/ TRIP DETAILS

Destination: ......................................................................................................................

Starting Point: ..................................................................................................................

Trips per Working Day: .....................................................................................................

Time Taken per Trip (With Least Amount Of Traffic): ................................................. (Hours)

Stops / Rests During Journey (Exclude Time Spent At Fuel Stations): .........................

Average Time Duration of Stops: ................................................................................... (Minutes)

______________________________

FUEL DETAILS

Type of Fuel Used:

☐ Petrol

☐ Diesel

Preferred Fuel Provider: ..................................................................................................

Most Convenient Branch: ............................................................................................... 

Number Of Refueling Stops Per Trip: .............................................................................

Liters per Trip: ................................................................................................................

Do you mind so much about tracking you fuel consumption?

☐ Yes

☐ No

If yes, when do you do it? Tick one or both

☐ At the start of the journey.

☐ At stop overs.

☐ During fueling.

☐ None at all.

Fuel Anti-Theft and Usage Control System Report
Have you ever experienced a drastic decrease in the fuel than expected?
☐ Yes  ☐ No

Have you ever experienced some fuel stations pumping in less fuel than the on displayed?
☐ Yes  ☐ No

If yes, what did you do about it?
................................................................................................................................................
................................................................................................................................................

________________ AWARENESS OF FUEL SIPHONING ______________

Have you ever experienced fuel theft?
☐ Yes  ☐ No

If yes, how did you detect it has happened?
................................................................................................................................................
................................................................................................................................................

What are your perceptions and attitudes towards fuel siphoning?
................................................................................................................................................
................................................................................................................................................

What could be the impact of siphoning?
................................................................................................................................................
................................................................................................................................................

What can be done to curb siphoning?
................................................................................................................................................
................................................................................................................................................

NB: ALL DATA AND INFORMATION PROVIDED WILL BE KEPT CONFIDENTIAL
AND WILL NOT BE USED IN ANY SORT OF MONEY MAKING VENTURE.