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Detection and Qualification of Fuel Adulteration by VLSI Technique

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Abstract: Given the ubiquity of fuel, fuel adulteration has persisted as a problem for quite some energy. Using fuel that has been tampered with may significantly degrade an engine's lifespan, decrease its performance, and increase pollutant levels. Examples include the release of sulphur oxide derivatives when diesel is tainted with kerosene that has too high levels of sulphur. Due of the problem's persistence over decades, sustainable fuel management is crucial. Having access to simple and dependable tests for fuel adulteration is crucial for raising awareness. In this study, a VLSI technique is suggested for the detection and validation of fuel adulteration.

1. INTRODUCTION

To claim that petrochemicals (petrol/diesel) play a significant role in the global economy would not be an exaggeration. The highly developed vehicle industry uses a single consumable: petrochemicals. The quality of the fuel used greatly impacts the longevity of any vehicle. Substandard or adulterated fuel is not only terrible for the machine's performance, but also poses serious risks to human health and the environment. The massive release of carbon dioxide has two negative effects: first, it pollutes the environment, and second, it raises the world average temperature, which contributes to global warming. The price of gasoline, diesel, and kerosene can vary widely throughout south Asian nations. Since it is used primarily as a home heating fuel, kerosene is substantially more affordable than gasoline or diesel. Kerosene's versatility in being blended with gasoline and diesel is its most useful attribute. Many persons, in their pursuit of illicit financial gain, have been observed to blend kerosene with gasoline or diesel. A large number of electric generators needed for agricultural operations are also provided with this combination.

Using this tainted fuel results in massive emissions of carbon dioxide (CO_2) and other hazardous/toxic gases, which dissolve slowly into our environment, contaminating our air, water, and soil and increasing the risk of a number of illnesses. This is damage at the human/environment level. However, the appliance's performance also declines as a result, as it was originally tuned for regular gasoline or diesel.

The urgent necessity is to create a scientific technique that can quantify the quantity of kerosene adulteration in gasoline and diesel. Not only are we the first to sound the alarm, but many others have also done extensive study and offered suggestions on how to develop gadgets that would aid the sensor in functioning more effectively. Sukhdev Roy has designed a fibre optic probe for adulteration detection in petrochemicals, and his experimental assessment of its efficacy is good. This concept relied heavily on the spectroscopic technique of evanescent waves. Yadav et al. conducted a separate investigation investigating whether or not viscosity measures couldbe used to identify adulteration.

Mishra et al. have also presented a study utilising nano porous silicon for the purpose of adulteration detection. There are a variety of other techniques that can be used to determine how much kerosene has been added to gasoline or diesel, such as the filter test, the flash point and viscosity test, the optical technique, the Ultrasonic technique, the American Standards for Testing Materials (ASTM) distillation, the testing through specific gravity, the microprocessor based electronic method using the principle of cooling on evaporation, the titration technique, the odour based method, etc. Specific gravity measurements may be somewhat inaccurate, and viscosity readings can be faked off with a few drops of high-viscosity lubricating oils, thus none of these techniques are particularly promising in terms of efficiency. There has been a lot of excitement about sensors based on surface plasmon resonance (SPR) in the field of chemical and biological detection recently.
Using the interaction between the evanescent wave of a guided mode of an optical fibre and a surface plasma wave supported by a thin metal film, R C Jorgenson reported the first experimental demonstration of surface plasmon resonance based fibre optic sensors. These sensors can function in either an angular or spectral mode. Chemical sensors based on surface plasmon resonance technology also play a significant role in observing our planet's health. Researchers favour SPR-based fibre optic chemical sensors over traditional chemical sensors due to their many advantageous properties, including their resistance to electromagnetic interference, portability, small size, and the possibility of distributed sensing over long lengths of fiber.

Adulteration Definition

Adulteration is defined as the illegal or unauthorised introduction of a foreign substance into motor spirit / high speed diesel, with the result that the product does not conform to the requirements and specifications of the product, according to the Motor Spirit and High Speed Diesel (Regulation of Supply and Distribution and Prevention of Malpractices) Order, 1998 (India). Alkanes (straight and branched chain from around C1 to C4) (low boiling fraction), cyclo alkanes or napthenes, and aromatic hydrocarbons should be present in the crude oil, albeit the exact proportions may vary from one location to another. Gases (C2 to C5) make up the bulk of petroleum. Light naphtha (C579 °C), Medium naphtha (79°-121°C), Heavy naphtha (121°- 191°C), Kerosene (191°-277°C), Distillate fuel oil (277°-343°C), Gas oil or lube stock (343°-566°C), Residuum (566°C +).

Extent of Adulteration

Research shows that 8.3 percent of samples undergo adulteration testing. It's no secret that this adulteration is enticing businessmen to opt for the "intelligent mix permitted" option. They're making more than $25,000 a day in profit.

General Fuel Adulterants

The characteristics for which adulterants are added to the base transport fuels—their profitability, availability, and blendability—vary from one location to the next.

- Adding lubricants and other solvents from the industrial waste stream to fuels like gasoline and diesel. The cost of properly disposing of these industrial solvents is high.
- Blending small amount of distillate fuels (Diesel/kerosene) into gasoline.
- Blending small amount of heavier fuel oils into diesel.

Consequences of Fuel Adulteration

Fuel adulteration causes damage to engine components, increases pollutants, and lowers an

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engine's claimed efficiency, all of which cost consumers money. Hydrocarbons (HC), carbon monoxide (CO), oxides of nitrogen (NOx), and particulate matter (PM) emitted by tailpipes may contribute to air pollution. Air toxins including benzene and polyaromatic hydrocarbons (PAHs) are known to be carcinogenic and contribute to a variety of health issues. Using biomass for home fuel might contribute to unhealthy levels of carbon monoxide in the home.

Gasoline Adulteration: Toluene, xylene, and other aromatic solvents share the same boiling point range as gasoline, so adding them won't make much of a difference. Additional addition of these solvents results in increased HC, CO, and NOx emissions, air pollutants.

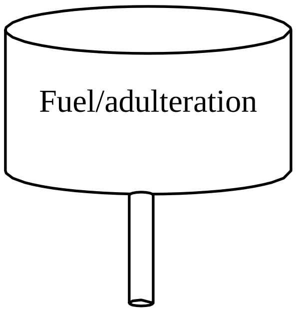
Diesel Adulteration: Kerosene is often mixed with diesel to increase the fuel's low-temperature operability (particularly in terms of viscosity and cetane number). More mixing might result in

more sulphur being released into the atmosphere. There will be a noticeable hue shift if diesel is blended with heavy oil.

2. PROPOSED METHOD

Through the use of a camera-based Imaging system for level detection, we can determine how much of the sample was discarded after the contaminated fuel was heated.

First, a certain quantity of pure petrol is heated until it entirely evaporates, and the time it takes to do so is recorded in the experimental setup. The adulterated fuel is then heated for the same duration, allowing all of the gasoline to evaporate and leaving behind only the adulterant. Then, this adulterant is poured into a 50-milliliter glass tube. Taking pictures of the tube at 320 x 240 pixels, the camera then transmits the data to the FPGA for analysis. The picture is processed by an FPGA, which calculates the height of the liquid from the data. To do this, we employ edge detection. It has been determined that the adulteration in the fuel may be found thanks to an edge detection procedure.



Glass tube Collection of Fuel

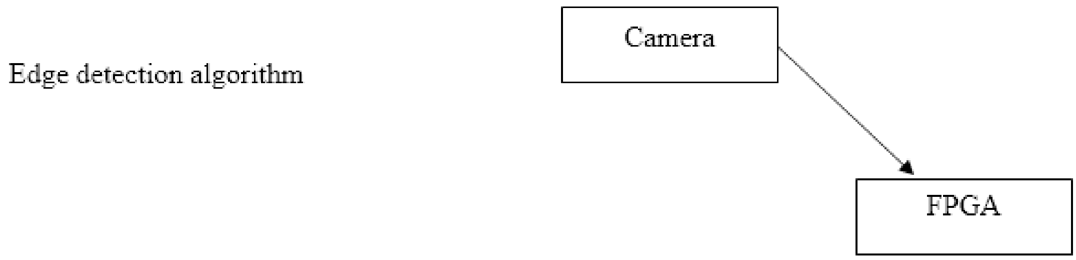


Figure 1. Proposed System

3. RESULT AND DISCUSSION

Device: XC3S400 SynthesisTool: XST (Verilog/VHDL)Package: TQ144
Simulator: Modelsim SE-VHDLImage Size: 256*256
RAM size: 2 GB Processor: Core2Duo
Software: Cadence Electronic Design Automation (EDA) Tool, Matlab 6.1, Xilinx ISE 8.2i
Programming Language: VHDL, Verilog Hardware Description Language (HDL)

Figure 2. Sample image

You can see the suggested system's VHDL output in Figure 3. The design can include basic timing data, such as the time it takes for a signal to move from one point to another, thanks to event simulation. In the context of simulation, signal variations are monitored through the use of events. When a condition is met, an event occurs at some later time. When all events for a given time have been processed, the simulation time is advanced to the time of the next planned event. Events are ordered according to the time at which they will occur. The time it takes for an event simulation to complete depends on how many events need to be handled (the amount of activity in the model). Although event simulation can offer insight into signal timing, it should not be used in place of static timing analysis. Delays cannot be set in a cycle simulation. Every gate is checked at each cycle in a model that is cycle accurate. Therefore, the cycle simulation always proceeds at the same rate, independent of the model's state. It is possible that optimised implementations will omit evaluating gates whose inputs have not changed during periods of low model activity, so speeding up simulation. Cycle simulation is typically more efficient, scalable, and amenable to hardware acceleration/emulation than event simulation.

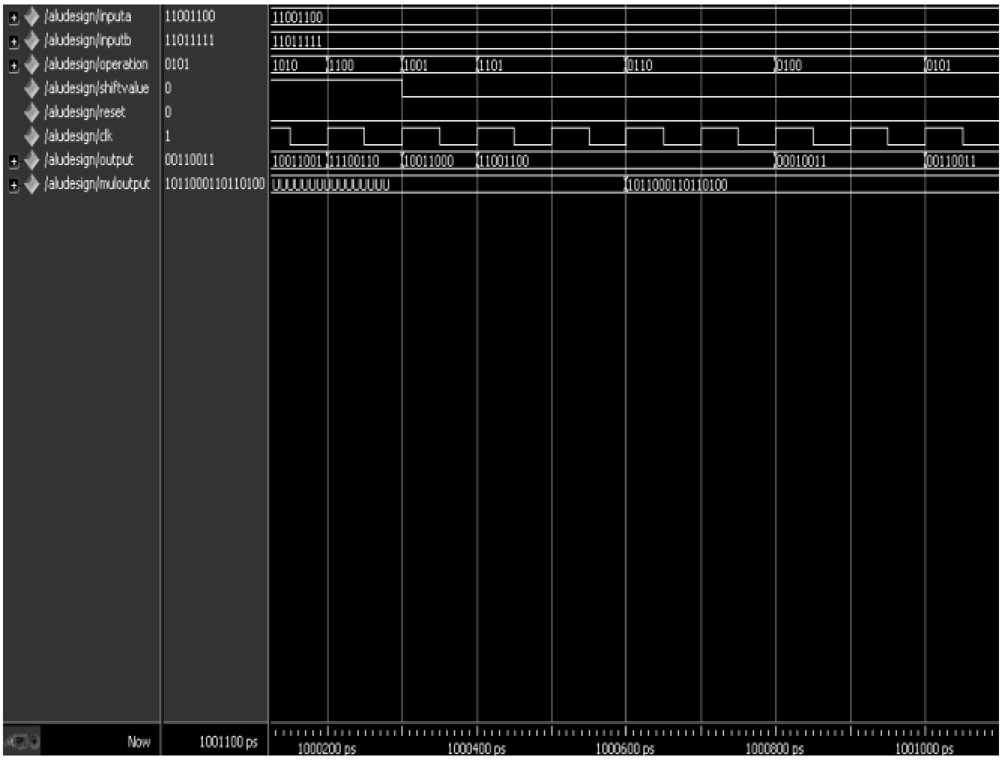


Figure 3. Output of Proposed System

4. CONCLUSION

This research introduces an affordable vehicle-mounted adulteration detection device. Engine failures are commonly attributable to adulteration. As a result, this strategy aids in lowering the prevalence of adulteration, which in turn lengthens the useful life of engines while improving their performance and ultimately leads to a cleaner, safer environment.

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