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Analysis of fuel adulteration by using VLSI technique

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Abstract

Our country has a lot of problems to deal with. One of them is the adulteration of fuel. When fuel is adulterated, its original properties are essentially changed. Many issues, including tail pipe emissions, air pollution, and respiratory disorders, are caused by adulteration or mixing by suppliers in order to illicitly increase their revenues. As a result of physical contamination, the fuels no longer function as intended. In this work, a VLSI implementation is proposed to replace the current approaches for detecting adulteration.

Introduction

There has been a rise in air pollution as a result of the abandonment of fossil fuels and organic chemicals during the rise of the industrial revolution. It is a well-established fact that the automotive industry is responsible for the largest share of air pollution due to its use of fuel oil. In emerging economies like China, India, and Brazil, the vehicle industry is projected to grow at a rapid pace in the future years, leading to a growth in air pollution at a comparable rate [1]. Since the vehicle industry releases such large quantities of greenhouse gases and harmful pollutants into the air, global warming has arisen as a serious threat. Increased tailpipe emissions and their impacts on public health are a direct result of the adulteration of automotive fuels like gasoline and diesel [2].

The avarice that is encouraged by the current tax structure is the main factor in the prevalence of adulteration. For instance, in South Asia, the highest taxes are placed on gasoline, followed by diesel, kerosene, industrial solvents, and recycled lubricants. The fact that it is difficult to detect gasoline adulterated with diesel and diesel adulterated with kerosene, as well as the

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differential tax structure, makes such adulteration financially enticing while being unlawful [3]. While it does not directly raise tailpipe emissions, South Asian air pollution is exacerbated when diesel is mixed with kerosene. Low-income families have less access to kerosene as a result of its diversion for adulteration, thus they switch to using bio-mass as an alternative cooking fuel. It causes a rise in indoor air pollution, which has negative health impacts. Keeping an eye on fuel quality at the pump might help stop any adulteration from happening.

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Literature Review

Jersha Felix et al, described System for automatically identifying and reporting fuel adulteration. As part of this method for detecting fuel adulteration, a sample of the fuel is heated to a temperature at which both kerosene and gasoline would boil. If it's gasoline, it's heated to its boiling point; if it's diesel, it's heated to a temperature at which kerosene boils. This may be done to ensure that if one fuel evaporates, another fuel remains in the sample. As an illustration, if kerosene were removed from diesel, the remaining fuel would be diesel. In the same way, if kerosene were added to gasoline, the resulting fuel would be identical to that of kerosene. The level of fuel adulteration can be estimated from these results. After heating the contaminated fuel, two methods are used to determine how much sample was discarded. The first method uses Infrared (IR) sensors to measure sample level, whereas the second uses a camera-based Imaging system. Finally, the outcomes of the two methods were compared, and the image processing method was shown to be superior than the IR detection method.

Prasad et al, described a Microcontroller-based method for measuring the level of adulteration in a sample. With this method, fuel adulteration is studied through the lens of different parameters, such as viscosity and density, that are determined through experimental setup, and others, like temperature and humidity, that are determined through the use of sensors. Using the ARM micro-controller, which outputs data to an LCD screen, we compared our findings to industry norms and standards.

Vaishali R et.al developed a device that operates at 2.47GHz and is based on the principle of the electric Meta material known as a complementary split-ring resonator (CSSR) (The industrial, scientific, and medical radio band – ISM band). Kerosene adulteration in gasoline may be detected with this instrument. High sensitivity and Q-factor are displayed by the sensor, which is a CSRR circuit exhibiting sub-wavelength resonance. More specifically, the device's precision, sensitivity, and selectivity are enhanced by the use of a Poly dimethyl siloxane (PDMS)-based sample cavity for micro-quantity sensing. Accordingly, a 2.47 GHz device is suggested for kerosene adulteration in gasoline, with concentrations ranging from 0 to 30%. Accurate calibration required both authentic samples (Standard samples) and adulterated samples (manufactured in the lab), both of which were sourced from the company-operated, company-owned gas station. The resonant frequency and strength were measured over a wide range of tainted fuels to look for systematic shifts. Vector Network Analyzer was used for the sensing measurements (VNA). Fast sensing and nearly immediate recovery guaranteed a very sensitive and reliable system for detecting gasoline adulteration.

Tiwari, and P. N. Patel to estimate the Porous silicon microcavity fabricated via electrochemical anodization method for detecting amount of adulteration in fuel sample. As the most common additive to diesel and fuel, kerosene can be estimated from its reflectance quantities. The sensing principle relies on the fact that introducing fuel into the micropores of silicon causes a change in the effective refractive index of the structure, which in turn alters the structure's reflectance spectrum.

Proposed Method

Acquiring images is the starting point for every image-based vision system. After collecting samples of gasoline tainted with a varying volume of kerosene, we separated the samples into groups of five. In order to make the experiment portable, images were taken from a tall tower against a white background. Each image undergoes image processing in order to differentiate between visual samples.

A camera captures the original sample image, which is then transformed to a bit file and stored in a Field Programmable Gate Array (FPGA). The next step is to use a camera to capture a

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sample of gasoline with varying concentrations of kerosene as an impurity, and then transform that sample into a bit file format to feed into an FPGA. This process culminates in an algorithmic comparison between the impurity sample and the original.

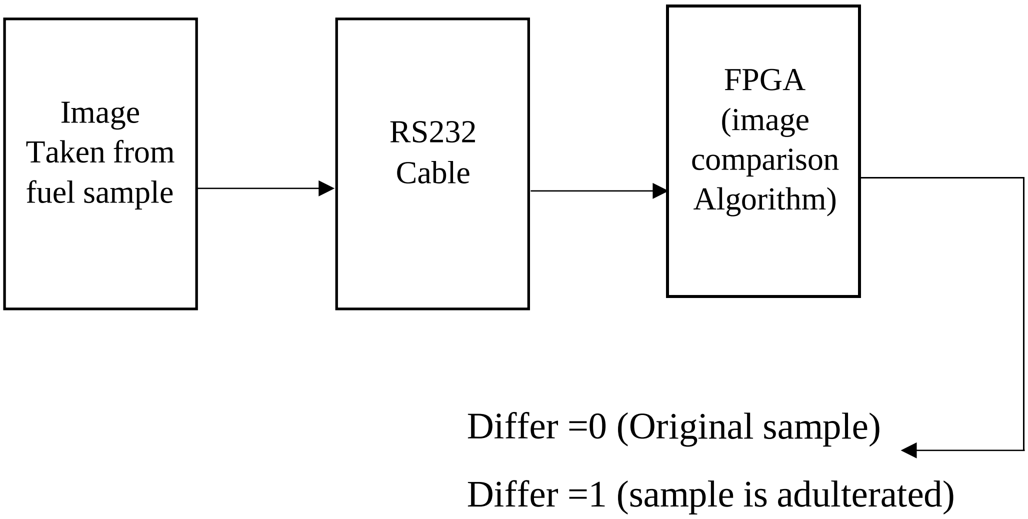

Figure 1. Proposed Block Diagram

SVM Algorithm Steps

Set

matrix x=[Test sample];

matrix X=[Training samples];

matrix Y=[Class identity];

matrix B=Y';

for i=1 to n,

for j=1 to n,

multiply matrix X(i,:) by matrix X(j,:)'

set matrix A(i,j)=X(i,:)*X(j,:)';

end

end

for k=1 to n,

for l=1 to n,

do multiply matrix A(k,l) by matrix Y(l) set matrix A(k,l)=A(k,l)*Y(l);

end

end

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divide matrix A by matrix B

set matrix C=A\B;

for m=1 to n,

multiply matrix C(m) by matrix Y(m) and matrix X(m,:)

set matrix Z(m,:)=C(m)*Y(m)*X(m,:);

end

set matrix W=[sum of the first column of matrix Z, sum of the second column of matrix Z];

calculate parameter b=Y(1)-W*X(1,:)';

build the classification function G=W*x'+b

classification result G = Ans

The SVM classifier was developed with the goal of making optimal use of the high memory bandwidth and parallel processing power made available by the FPGA's on-board memories.

Result and Discussion

Simulation and Device Environment:

Device Family:	Vertex2P
Device:	XC2VP30
Package:	ff1152
Synthesis Tool:	XST [VHDL/Verilog]
Simulator:	Modelsim Simulator [VHDL/Verilog]
Preferred Language:	VHDL
Software	Cadence Electronic Design Automation (EDA) Tool, Matlab, Xilinx ISE 8.2i

Figure 2. Image of petrol

Figure 3. Image of kerosene adulterant

The presence of colour fluctuation reveals the presence of adulteration at each stage. At last, it builds a database that can be used for education. During the FPGA training phase, every image of tainted gas is compared to the gold standard. In order to do a thorough comparison, the SVM algorithm examines each every pixel in the image.

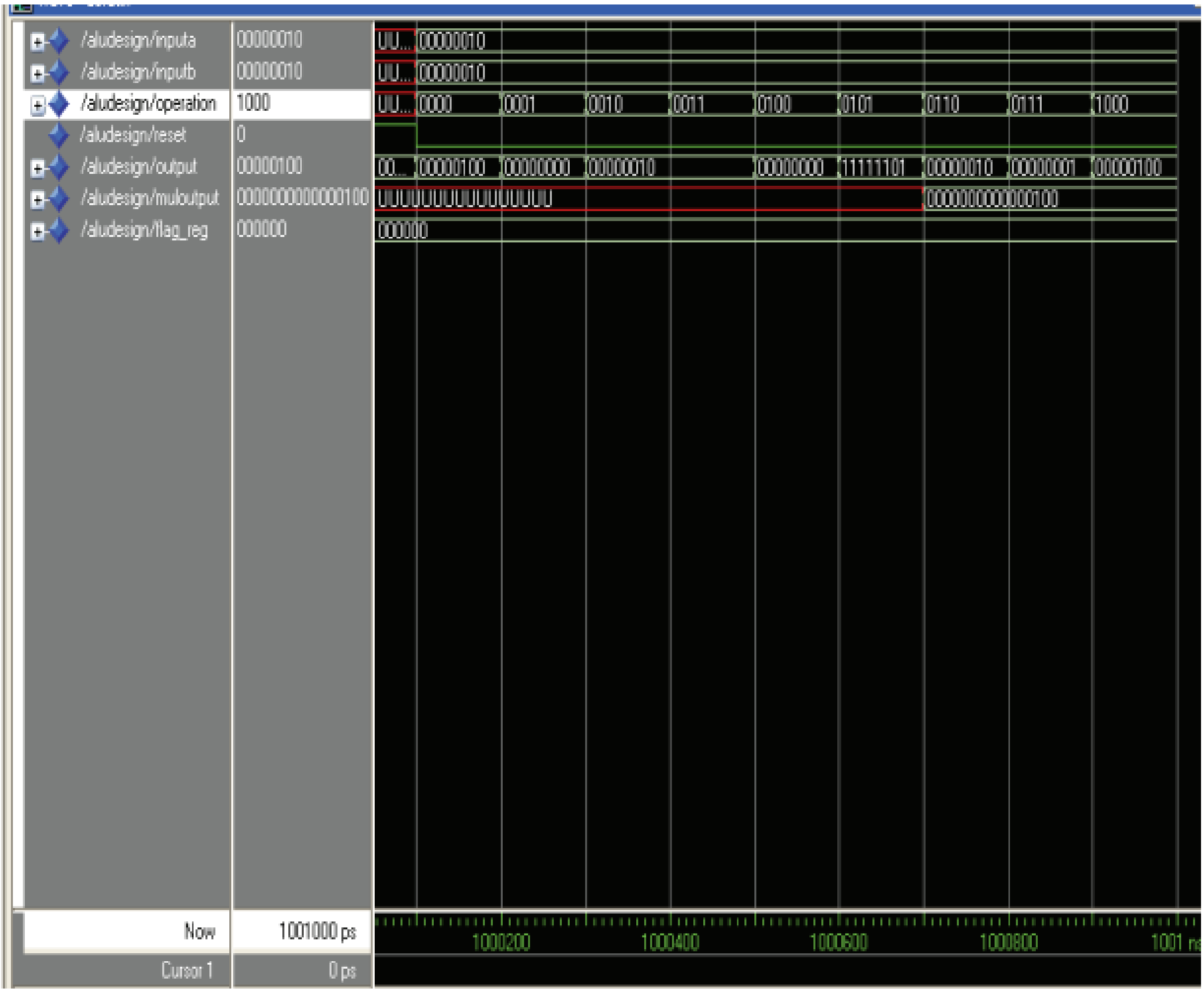

Figure 4. Proposed System Output

The results of a simulated SVM algorithm run are depicted in Figure 4 below. Specifically, the algorithm is the execution of ALU operations. The simulation result demonstrates the computational and deductive capabilities of SVM. Verifying the logical simulation is required prior to moving on to the hardware implementation of any system. Applying simulation software to model the operation of digital circuits and HW description languages is known as logical simulation. The physical abstraction level of a simulation can range from the transistor level to the gate level to the RTL level to the behavioural level. The simulation results validate SVM's rational behavior.

Conclusion

In order to produce an eco-friendly atmosphere it is vital to concentrate on autos. Air pollution and public health problems are caused by the smoke released by burning adulterated fuels. To put it simply, adulteration-grade oil that has been tampered with is extremely dangerous. A reliable, straightforward technique, designed with the user in mind, is required to prevent this

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from happening. It's possible that you'll find useful options among the already available procedures. However, they need a substantial amount of time. The suggested system introduces a fresh approach to the development of high-speed image comparison FPGA systems. The image comparison based on threshold value in MATLAB and other approaches require more time, but the suggested methodology ensures to minimise the time for comparing the images.

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