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VLSI Implementation of DIP Based Edible Oil Adulteration Identification

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Abstract— Authentication is of paramount importance in the food industry where incoming batches of raw materials and finished products must be tested for compliance with regulatory and health specifications. The recent dioxin crisis highlighted the importance of checking raw materials for their compliance with these specifications. In the past, other incidents such as the adulteration of olive oils with non-edible oils have shown the potentially serious consequences of such practices. With the emergence of international markets, however, the authentication of food products is receiving increased attention. **Traditionally adulteration is identified by using analog sensors and chemical reaction. This paper proposes replace the existing methods.** ***Digital color imaging can be a versatile, reliable and a low-cost tool for color-based classification of fresh produce, with the potential to replace other, more costly techniques. In this paper, select different types of edible oil samples and the images are acquired and calibrated. This is kept as a reference image. Then the sample which is to be tested whether it is adulterated or not is checked by comparing with the reference image by using suitable algorithm. The color variation in the process shows the adulteration. By using this system we can identify the adulteration. In the Very Large Scale Integration (VLSI) implementation, these images are compared with standard image stored inside the Field Programmable Gate Array (FPGA) with suitable algorithm. It is helpful for*** **high-speed comparison of image according to the pixel intensity value. The design based on using FPGA for the hardware implementation of the architecture using Very high speed IC Hardware Description Language (VHDL). FPGA Vertex4 has been used for the hardware implementation. The proposed method is an improvement over traditional software package based approaches.**

Keywords— Sensors, VHDL, FPGA, VLSI, Aduteration

I. INTRODUCTION

The economic adulteration of spices can have serious implications. In some instances, spices have been adulterated with highly toxic materials such as lead-bearing pigments and other unapproved color additives. In these instances, adulteration may have serious public health consequences. In most instances of adulteration, spices are adulterated with material that is not highly toxic or carcinogenic, and therefore does not present a significant, immediate public health risk [1]-[4]. In some instances, adulteration can simply result in inferior products with no safety risks. However, even these circumstances have significant implications for the spice industry because any reported adulteration damages the spice industry's reputation and credibility [5]. Several techniques for assessing the authenticity of food products have been proposed. The authentication methods applied to oils and fats can be classified as chemical (= separative) or physical (= non-separative). Separative techniques, such as gas chromatography, focus on the existence or absence of certain chemical compounds in the adulterated sample. Physical techniques, such as infrared or Raman spectrometry, are based on a combination of measurements (e.g., light absorbance at different frequencies or the whole spectrum). The measurements are carried out directly on the samples or after dilution in a suitable solvent. The most widely used and accepted physical technique for oil and fat authentication is ultraviolet (UV) spectrometry [6]-[8]. The proposed work is photographs (Edible oil sample images) taken through web camera (digital signal) connected to computer. The field images (just received) are compared with the Standard images already stored in the computer. Identification action is initiated when both images matches. Slowly analog transducer can come to a halt. [9]- [10]. This paper discusses the

VLSI implementation of DIP based edible oil adulteration identification. In Section II, proposed system is presented. In Section III, result and discussions are discussed. In Section IV, conclusion is drawn.

II. PROPOSED SYSTEMS

A. Errors in Reading Analog Sensors based Existing Method

A measurement cannot be made without errors in analog sensors. These errors can be only minimized but not eliminated completely. It is essential to know the different errors that can possibly enter into the measurement.

TABLE I
VARIOUS TYPES OF ADULTERANT AND THEIR HARMFUL EFFECTS

Food Particles	**Adulterant**	**Harmful effects**
Edible oils	Argemone oil	Loss of eyesight, heart diseases, tumor
	Mineral oil	Damage to liver, carcinogenic effects
	Karanja oil	Heart problems, liver damage

The error can be classified into three categories:

- Gross errors
- Systematic errors
- Random errors

1) Gross Errors

Gross errors are largely due to human factors such as misreading of instruments, incorrect adjustment and improper application of instruments. The computational errors are also grouped under these type errors. When human beings are involved in measurement, gross errors will inevitably be committed. Complete elimination of gross errors is probably impossible in analog meters. This error is almost eliminated in auto ranging digital meters. One common gross error frequently encountered in measurement work involves the improper selection of the instrument. When a voltmeter is used to measure the potential difference across two points in a circuit, the input impedance of the voltmeter chosen should be at least 10 times greater than the output impedance of the measuring circuit.

TABLE II
CHEMICAL REACTION BASED ADULTERATION DETECTION AND COST

Samples	Edible Oil
Adulterants	Castor Oil
Harmful Effects	Indigestion, dysentery, ulcer, throat irritation.
Detection By Different Methods	Take 1 ml. of oil in a clean dry test tube. Add 10 ml. Of acidified petroleum ether. Shake vigorously for 2 minutes. Add 1 drop of Ammonium Molybdate reagent. The formation of turbidity indicates presence of Castor oil in the sample.
Cost Of Detection	For 1 ml of oil, Petroleum ether: Rs. 5.42/ml Ammonium Molybdate reagent: Rs.1125/100g

As the output impedance of a circuit is normally not known before hand, the selection of the voltmeter may not be made correctly, leading to a gross error.

2) Systematic Errors

Systematic errors are due to shortcomings of the instrument and changes in external conditions affecting the measurement. These are classified into two categories.

- Instrumental errors
- Environmental errors

Instrumental errors arise out of the changes in the properties of the components used in the instrument. This can be avoided by calibrating the instrument frequently. Environmental errors are due to the changes in the environmental conditions such as temperature, humidity, pressure and electrostatic and magnetic fields. For example, the resistance of a strain gauge changes with variation in temperature. These errors can be minimized by controlling the environmental conditions in the laboratory. However, it is difficult to have a controlled environment in a industrial atmosphere. Systematic errors can also be divided into static and dynamic errors. Static errors are caused by the limitations of the measuring device or the assumption in the physical laws governing its behavior. Dynamic errors are caused by the instruments slow response in following the changes in the measured variable. Systematic errors have definite magnitude and direction. These are usually more troublesome as repeated measurements may not reveal them.

3) Random Errors

Random errors are unpredictable errors and occur even when all systematic errors are accounted for. Although the instrument is used under controlled environmental and accurately pre-calibrated before measurement, it will be found that the readings vary slightly over a period of observation. This change cannot be corrected by any method and it cannot be explained without detailed investigation. The general hardware setup of proposed system, Camera is placed 20 cm altitude from the bottom of the stand. The intensity of light source is 10 candelas and maintained the room temperature. The bottom surface color is white. The samples are placed on the white surface. First, original edible oil sample photo is taken by camera and converted in to bit file format then stored in Field Programmable Gate Array (FPGA). Next, various level of Castor Oil adulterant added to Original edible oil sample is taken by camera and converted in to bit file format provide to FPGA. Finally, Original edible oil sample is compared to Castor Oil adulterant added to Original edible oil sample by using distance vector matrix algorithm. This algorithm execution is based on pixel by pixel comparison in FPGA. While comparing two images, whether the difference is occur the sample is adulterated otherwise not adulterated.

III.RESULT & DISCUSSION

A. Existing Methods for Estimation of Fuel Adulteration

Though no test is specifically designed to measure the adulteration of petrol by mixing diesel or diesel by mixing kerosene, some tests namely Density test, Evaporation test, Distillation test, Chemical Marker test, Gas Chromatography may be used to determine the adulteration of fuel also. The petrol samples are adulterated by kerosene and crude oil. The harmful effects are air pollution, lung cancer and breathing problem. This kind of adulteration is detected by microscopic analysis methods. The total cost of this adulteration detection is $3500.

1) Evaporation Test

The evaporation techniques are capable of detecting very low concentrations (1-2%) of diesel in gasoline and fairly low concentrations (5%) of kerosene in gasoline. However this is basically a laboratory technique and is not suitable for field use.

2) Distillation Test

This technique exploits the difference in the boiling points of different liquids comprising the fuel sample. Accurate distillation data for uncontaminated fuel is essential for comparison and precise results. The technique, however, is not suitable for field use as the measurement set up is generally bulky and measurement process is time consuming.

3) Gas Chromatography (GC)

GC is powerful laboratory tool which can be used to detect hydrocarbon based adulterants. However it requires an experienced technician to operate the equipment and interpret the results. It is an effective method for detection of adulterants in gasoline and diesel but would require easily portable, robust and user friendly equipment which may be operated by an inexperienced operator also.

4) Adulteration Estimation/Detection using Optical Fiber Sensor

A technique for detection/estimation of adulteration of petrol/ diesel by kerosene using optical fiber sensor. The technique exploits the change in refractive index and therefore the evanescent absorption of monochromatic light in petrol/diesel when the same is adulterated by mixing kerosene. Optical fiber acts as a wave guide for light if the cladding has a lower refractive index than that of fiber material. When the light is reflected from the interface of the fiber and the cladding (or any other material surrounding the fiber), the field associated with the light wave extends beyond the interface into the surrounding medium. The amplitude of this field decreases exponentially with distance from the interface. If the surrounding material absorbs some part of the light propagating through the fiber, the power received at the other end of the fiber would be less by the amount absorbed by the surrounding medium.

Simulated Environment:
Family: Vertex4
Device: XC4VLX15

Synthesis Tool: XST (Verilog/VHDL)
Package: SF363
Simulator: Modelsim SE-VHDL
Image Size: 256*256
RAM size: 2 GB
Processor: Core2Duo

Figure 1 to Figure 2 is shown the pixel intensity is varying from original edible oil to Castor Oil adulterant added to Original edible oil. The adulterated edible oil sample image appearance is contrast compared to original edible oil sample image. Therefore the pixel intensity value will varying when compare the two images. The comparison takes place pixel by pixel of the image based on distance vector matrix algorithm. The speed and accuracy of comparison two images is high by using this algorithm. The process is applicable to petrol adulteration identification. FPGA based image comparison is speed compare to traditional software based approach. Figure 3 represent the processing element of proposed system using VHDL and it is useful for check the function of the proposed system. Figure 4 represent the processing element Hardware Circuits output of proposed system and its shows corresponding hardware architecture depends on the proposed system VHDL program. Figure 5 shown FPGA implementation units and Vertex4 FPGA is used for implementing the oil adulteration identification program implementation. Finally, Figure 6 is the IC Layout diagram of Oil Adulteration Identification Unit also its shows the hardware components position inside the Integrated Circuits (IC). Table I and II show the Various Types of Adulterant and Their Harmful Effects, Chemical Reaction Based Adulteration Detection and Cost. Table III displays the camera properties of sample image. Finally table IV represents the image comparison at different software package environment.

TABLE III
CAMERA PROPERTY OF PROPOSED SYSTEM

Property	**Value**
Dimension	4000 X 3000
Width	4000 pixels
Height	3000 pixels
Horizontal Resolution	300dpi
Vertical Resolution	300dpi
Bit Depth	24
Compression Resolution Unit	2
Color Representation Compressed bit/pixel	sRGB
Camera Maker	nokia
Camera Model	N8-00
F-stop	f/2.8
Exposure-time	1/8 sec
ISO-Speed	ISO-494
Exposure bias Focal length	6mm

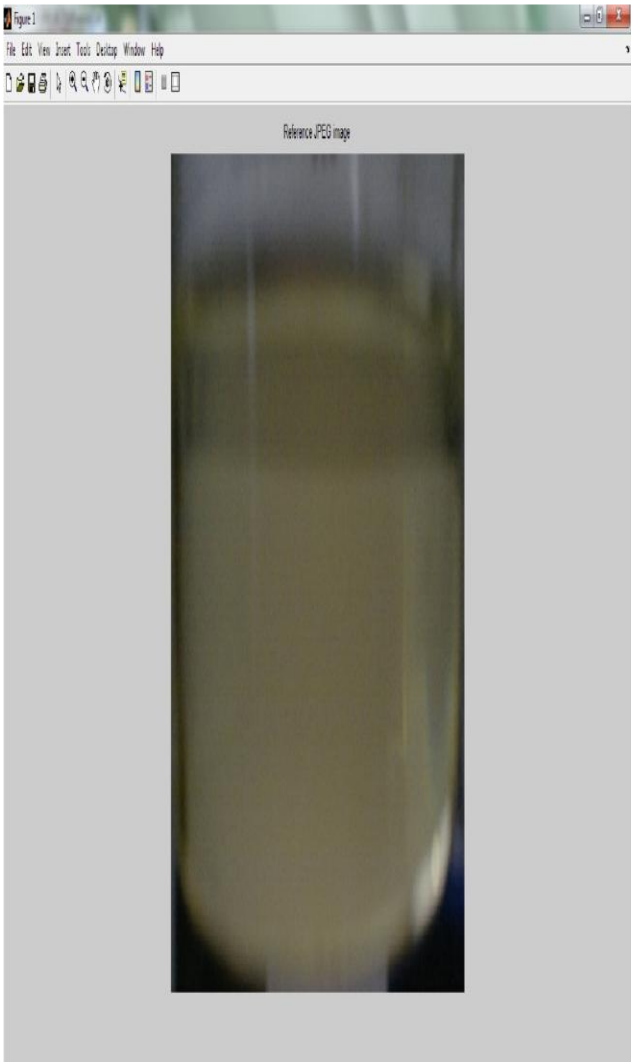

Fig. 1 Original Edible Oil

Fig. 2 Castor Oil adulterant added to original Edible Oil

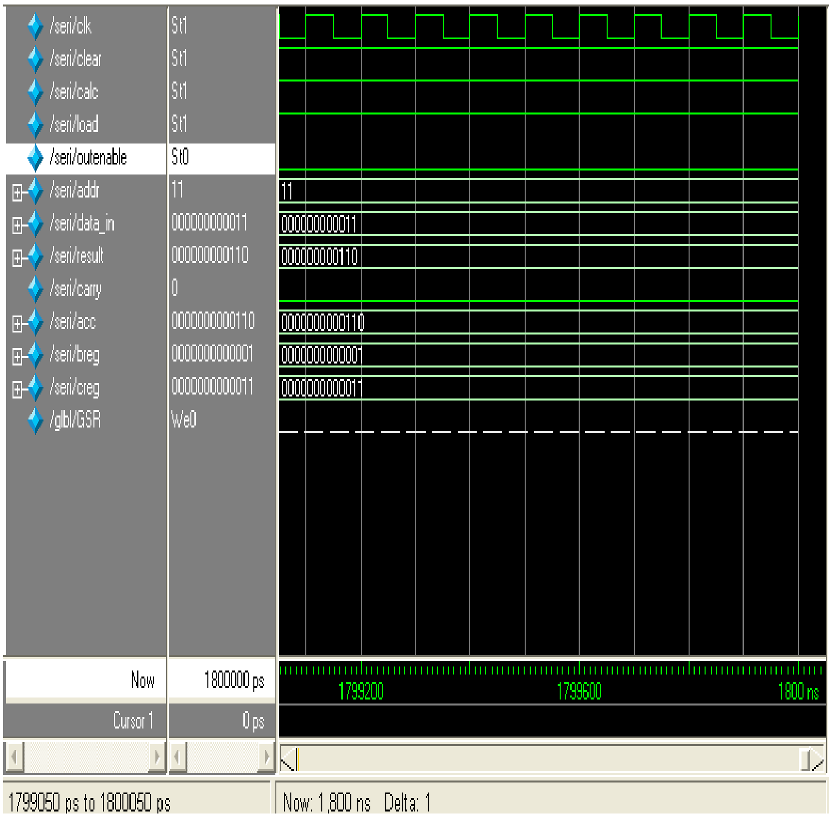

Fig. 3 VHDL Output of Proposed System

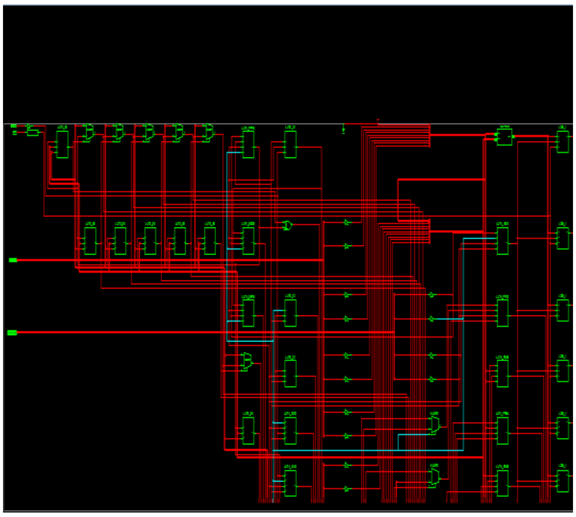

Fig.4 Processing Element Hardware Circuits

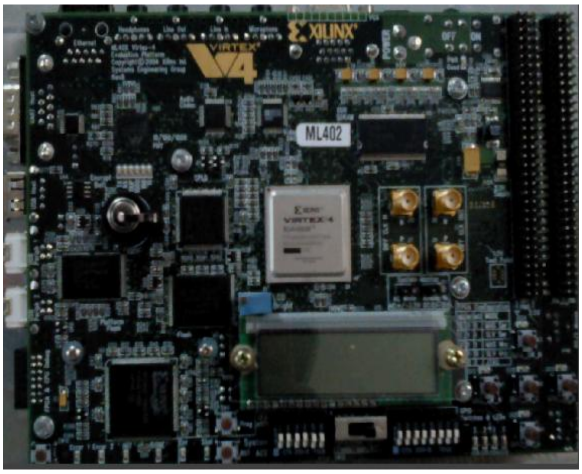

Fig.5 FPGA Implementation Unit

TABLE IV
IMAGE COMPARISON TABLE

S.No	Platform	Image Comparison Speed (ns)
1	C	13
2	Matlab	10
3	VHDL with FPGA Implementation (Proposed System)	02

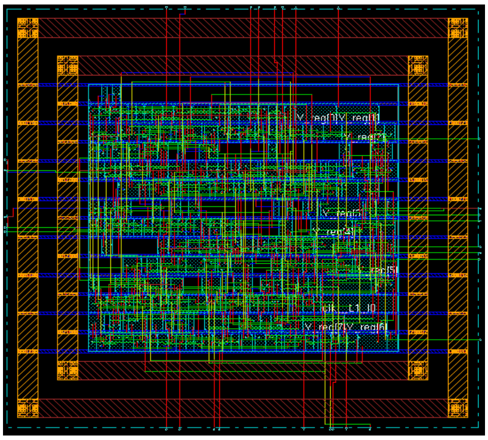

Fig. 6 IC Layout diagram of Oil Adulteration Identification Unit

IV. CONCLUSION

For the detection/estimation of the commonly used adulterants (i.e. Castor Oil adulterant added to original Edible Oil), a number of possible methods have been reviewed. As such there is no standard method/equipment for detection of adulterants. In this paper presents a new methodology for designing high speed image comparison by using FPGA and reduced the comparison time. If we comparing the image by based on threshold value in MATLAB and other technique it will take more time but our methodology guarantees to reduced the time by comparing the image. Thus we have created a system by which we can identify the adulteration. This paper will be very much useful for the government in the world wide and used by common people either in home or work stations. This system is based on digital image processing technique, so it can replace the analogue sensors and makes the process very easy for the user. VLSI implementation is helpful for faster way of identifying the adulteration; system can be the best and easier way to identify the adulteration by common people in every corner of the world. Even though, comparison algorithms are successful at software level, better results can be achieved by implementing in VLSI based hardware

References

[1] Wieldman L.S.M. et.al., "Adulteration Detection of Brazilian Gasoline Samples by Statistical Analysis", *Elsevier Fuel*-84, p. 467-473, 2005

[2] Vigli, A. Philippidis, A Spyros, P. Dais, "Classification of Edible Oils by Employing 31P and 1H NMR Spectroscopy in combination with multivariate statistical analysis. A proposal for the detection of seed oil adulteration in virgin olive oils. J. Agric", *Food Chem*. 51, 5715-5722, 2003.

[3] S. Mildner-Szkudlarz, H. H. Jelen, "The potential of different techniques for volatile compounds analysis coupled with PCA for the detection of the adulteration of olive oil with hazelnut oil" ,*Food Chem.* 110, 751–761, 2008,

[4] G. Dourtoglou, T. Dourtoglou, A. Antonopoulos, E. Stefanou, S. Lalas, C. Poulos, "Detection of olive oil adulteration using principal component analysis Applied on Total and Region FA Content", *J. Am. Oil Chem. Soc*. 80, 203-208, 2003,

[5] Stefan J. Rupitsch and Bernhard G. Zagar, "Iteration Methods to Precisely Locate Edges of Hot Objects Using Simple Infrared-Sensing Elements", *IEEE Trans. on Instrumentation and Measurement,* Vol. 60, No. 1, January 2011.

[6] Zhang Tao, Yu Feng-ping and Quan Hao-jun," An Optimized High-Speed High-Accuracy Image Matching System based on FPGA", *Proceedings of the IEEE International Conference on Information and Automation*, China June 20 - 23, 2010.

[7] Youlu Wang, Senem Velipasalar and Mauricio Casares," Cooperative Object Tracking and Composite Event Detection with Wireless Embedded Smart Cameras", *IEEE Transactions on Image Processing*, Vol. 19, No. 10, October 2010.

[8] J. Kim Y. Han H. Hahn," Embedded implementation of image-based water-level measurement system*", IET Comput. Vis.*, 2011, Vol. 5, Iss. 2, pp. 125–133

[9] A. Justin Diraviam, Dr.S.P.Victor, G.Rajakumar, Dr. K. Rajappan and Dr.D.Manimegalai "Replacing Various Analog Signal Sensors with Digital Cameras*" International Journal of Computer and Electrical Engineering*, Vol.3, PP-84-92 No.1, February, 2011.

[10] G.RajaKumar, Dr.D.Manimegalai, "Analysis and Implementation of DIP based Online Control and Monitoring System for Displacement in Control Valve"*IEEE Proce.of International Conference on Communication Control and Computing Technologies-ICCCCT 10,* PP -397-403, October 8^{th} & 9^{th} 2010.

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