Implementation of Featureset Reduced Symmetric Transform in Image Retrieval Optimized for FPGA

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***Abstract*— In this paper we present an algorithm for medical image retrieval system which is optimized for use in FPGA. The algorithm proposed is based on the improvement of fast Hartley transform and can be used in conjunction with computer or with an embedded device to accelerate retrieval. Medical Image Retrieval is a complex problem due to subjective nature of human visual system which is based not only on localization and directionality but also on the pathological condition.**

Keywords-Fast Hartley transform ,CBIR, ASSERT, FPGA, Feature Extraction

I. INTRODUCTION

With the availability of large amount of digital medical images, image retrieval based on a query image is essential to effectively and efficiently use the information that is intrinsically stored in these image databases. Automated extraction of features characterizing the image plays an important role for the construction of image retrieval systems [1]. Image retrieval systems can be broadly classified into two Text Based Image Retrieval and Content Based Image Retrieval systems. Currently Content Based Image Retrieval has been a topic of intensive research. Text Based Image Retrieval is the traditional approach for image retrieval system where system features are added by adding text strings describing the content of an image. In contrast content based image retrieval just consist of pure pixel data in the form of a query image as the search input.

With rapid progress in the area of image retrieval, the challenges faced in this area are to provide fast and accurate retrieval of the desired data[2]. To achieve accurate and fast image retrieval system, two issues need to be resolved:

- Semantic gap should be addressed between low-level visual content and higher-level concepts.
- The total time of image analysis, image indexing, image searching and machine learning algorithms should be minimal.

This paper focuses on the second problem and discuss our ideas, findings, design and the system that benefit from implementing our algorithm in an FPGA. Image retrieval solutions can feature demanding and repetitive image processing tasks that overwhelm the host CPU or leave little room for additional functionality. FPGA based processing provides an alternative method to offload and even accelerate these tasks, freeing up valuable host resources. FPGA also provides the benefit of implementing custom image processing algorithms. Traditionally, the route to implementing image-processing functions is through an DSP. This is a valid route and in some cases are optimal. DSPs are costly and their corresponding software applications may not match the performance of the available hardware. The attractiveness of FPGAs derives from the combination of the virtues of the alternatives. FPGAs have become competitive with DSPs in many areas, and many design engineers look to FPGAs for their digital image processing needs.

Korn et al. proposed a system for retrieval of tumor shapes in mammogram x-rays [3]. This approach has restrictions in the feature of the image as only tumor shape was considered. The automatic search and selection engine with retrieval tools (ASSERT) is operable with only high resolution computed tomography of the lung [4] with high data entry costs.

Another popular method used in the literature is the conversion of the spatial domain data to frequency domain to extract unique features which is used in classification [5,6,7]. We propose to explore features extracted in frequency domain for faster retrieval.

In this paper, we proposed a fuzzy based method applied on the Fast Hartley Transform to reduce the dimensionality of feature space. This method comprises two phases: transformation from spatial domain to frequency domain as well as representative selection in the feature space.

This paper is organized into the following sections. Section II describes the feature set reduction technique applied on the Fast Hartley Transform, Section III describes the classification algorithm used, Section IV describes the experimental setup and Section V concludes with an discussion of the obtained result.

II. FAST HARTLEY TRANSFORM

The Hartley transform has the advantage over Fourier transform by being real valued. It provides the same phase and amplitude information even though it produces real output from real input. Like the fast Fourier transform, there is a "fast" version of the Hartley transform. A decimation in time algorithm makes use of

$$\mathcal{H}_n^{\text{left}}[a] = \mathcal{H}_{n/2}[a^{\text{even}}] + \mathcal{X}\,\mathcal{H}_{n/2}[a^{\text{odd}}]$$
$$\mathcal{H}_n^{\text{right}}[a] = \mathcal{H}_{n/2}[a^{\text{even}}] - \mathcal{X}\,\mathcal{H}_{n/2}[a^{\text{odd}}],$$

$$a_n \cos\left(\frac{\pi n}{N}\right) - \overline{a}_n \sin\left(\frac{\pi n}{N}\right).$$

where $\mathcal{X}$ denotes the sequence with elements

A decimation of the data in frequency is given by

$$A_k \equiv \mathcal{F}[a] = \sum_{n=0}^{N-1} e^{-2\pi i k n/N} a_n$$

The Hartley transform may also be computed using a 'fast' algorithm which requires O(Nlog2N) operations. The Fast Hartley transform (FHT) is roughly twice as fast as a complex valued FFT, requiring the same number of operations as the real valued FFT algorithms. Using the FHT, Discrete Cosine Transforms (DCT) and Discrete Fourier Transforms (DFT) can also be obtained.

In our work the Fast Hartley Transform was modified by considering co efficient which fall in the even portion of the matrix. This reduces dimensionality of the data which is used for classification of medical images and ultimately its retrieval.

III. CLASSIFICATION ALGORITHMS

The role of the classification process is to categorize all pixels in a digital image into one of the available classes. For analyzing the data and classification of images, the two Machine learning algorithms J48 Pruned tree and Naive Bayes classifier were adopted here. J48 Pruned tree algorithm implementation is similar to the C4.5 decision tree learner producing decision tree models. J48 algorithm uses the greedy technique to bring decision tree for classification. J48 generates decision tree, the nodes of which evaluate the existence or significance of individual features. The advantage of using J48 decision tree is the creation of threshold values for continuous data thus effectively creating a method to split the attribute above the threshold value and below it. A simple decision tree is shown in figure 1.

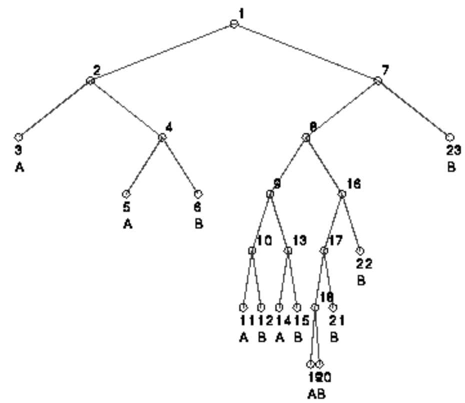

Figure 1. A decision tree example

Naive Bayes Classifier is based on Bayesian theorem and is suited well when the number of inputs is very high. Naïve Bayes classifiers works on the principle that the effect of a variable for given class is independent of the values of other variable. Based on the accurate nature of the probability model, Naive Bayes classifiers can be trained for effective classification in a supervised learning setting.

The naive Bayes classifier assigns an instance s_k with attribute values (A_1=v_1, A_2=v_2, …, A_m=v_m) to class C_i with maximum Prob(C_i|(v_1, v_2, …, v_m)) for all i.

Likelihood of s_k belonging to C_i is given by

$$= \text{Prob}\big(C_i \mid (v_1, v_2, ..., v_m)\big) = \frac{P\big((v_1, v_2, ..., v_m) \mid C_i\big)P(C_i)}{P\big((v_1, v_2, ..., v_m)\big)}$$

Likelihood of s_k belonging to C_j is given by

$$= \text{Prob}\big(C_j \mid (v_1, v_2, ..., v_m)\big) = \frac{P\big((v_1, v_2, ..., v_m) \mid C_j\big)P(C_j)}{P\big((v_1, v_2, ..., v_m)\big)}$$

Therefore, when comparing Prob(C_i| (v_1, v_2, …, v_m)) and P(C_j |(v_1, v_2, …, v_m)), we only need to compute P((v_1, v_2, …, v_m)|C_i)P(C_i) and P((v_1, v_2, …, v_m)|C_j)P(C_j)

IV. EXPERIMENTAL SETUP

A program was written in LabVIEW to implement the Fast Hartley Transform and extracting only even co efficients. For a given input image the co efficient were extracted to a text file. The co efficient so extracted become the attributes for the classifier. 44 medical images from the National Biomedical Imaging archive was used as the data for retrieval. Some of the images used are shown in figure 2. Classification by J48 pruned tree and Naïve Bayes was done using WEKA. Results obtained are displayed in figure 3 and table 2.

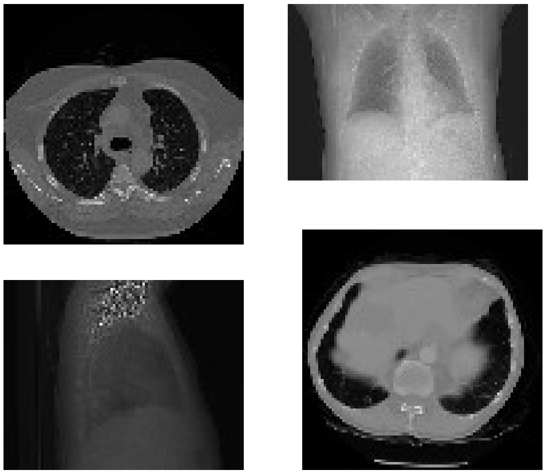

Figure 2. Images used for retrieval.

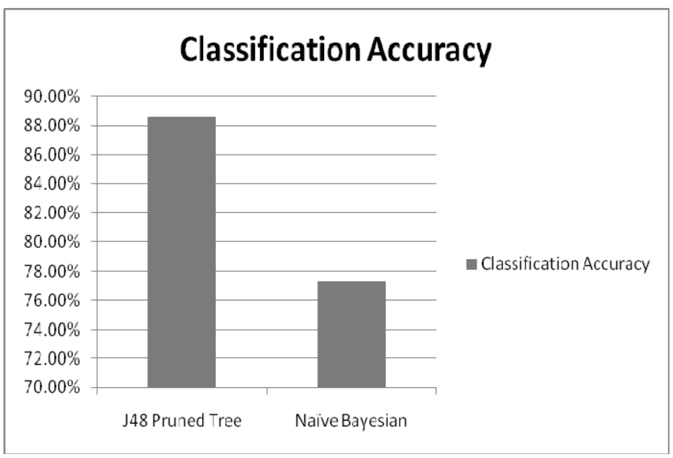

Figure 3. Classification Accuracy

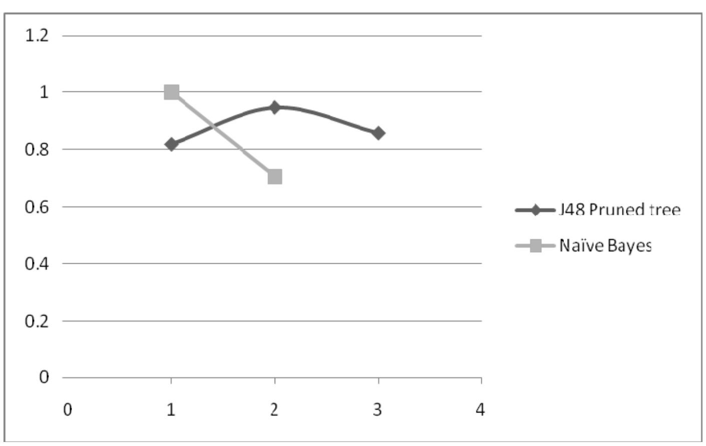

Figure 4 : Precision details for both the classification methods

V. CONCLUSIONS

In this paper we investigate an modified Fast Hartley Transform for creating the attributes in medical image retrieval. Images obtained from the database for the given query image is fairly accurate. Our ultimate goal is to increase the speed of the operation which is achieve compared to the usage of regular Fast Hartley Transform. The next step is to implement our algorithm in an FPGA and measure performance.

REFERENCES

[1] Rui Y, Huang T.S., and Chang S., “Image retrieval: Current techniques, promising directions, and open issues,” J. Vis. Commun. Image Represent., vol. 10, no. 1,pp. 39-62, Mar. 1999.

[2] A. W.M. Smeulders, M. Worring, S. Santini, A. Gupta and R. Jain “Content-Based Image Retrieval at the End of the Early Years”, IEEE Trans. Pattern Analysis and Machine Intelligence, Vol.22 No.12, 1349-1380 ec 2000.

[3] Korn P, Sidiropoulos N, Faloutsos C, Siegel E, Protopapas Z: Fast and effective retrieval of medical tumor shapes. *IEEE Trans* KDE 1998; 10(6): 889–904.

[4] Shyu CR, Brodley CE, Kak AC, Kosaka A, Aisen AM, Broderick LS: ASSERT – A physician-in-the-loop content based retrieval system for HRCT image databases. Computer Vision and Image Understanding 1999;75 (1/2):111-132.

[5] Dimauro, G.: Digital Transforms in Handwriting Recognition, In: Impedovo, S. (ed.) *Fundamentals in HWR*, NATO ASI Series "F", Vol. 124, Springer-Verlag, Berlin Heidelberg, 1994, pp.113-146.

[6] Dimov, D.: Wavelet Transform Application to Fast Search by Content in Database of Images, in: Proceedings of Intelligent Systems (IS’2002), Sept. 10-12, 2002, Varna, Vol.I, pp. 238-243.

[7] Pavlidis, T.: Algorithms of Computer Graphics and Image Processing, Comp. Sci.Press, Inc., 1982.