Overcoming the Challenges in Liver Tumor Imaging and Classification

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Abstract — **Liver disease is one of the leading causes of death today. In particular, liver tumor is increasingly affecting a larger percentage of the population every day. Hence it is imperative to quickly and effectively deal with the disease. A primary step is the identification and classification of the liver tumors. Existing techniques lack the accuracy and efficiency that the treatment demands. A combination of the PHOG and SGLDM algorithms are used in tandem with the SVM classifier to arrive at a more accurate system of detection and classification. The SVM classifier helps automate the entire process. Contemporary literature in the field also supports the efficiency of the SVM technique used in this research.**

Index Terms — **Segmentation, Ultrasound, SVM classifier, PHOG and SGLDM algorithms.**

I. Introduction

It is now well-established that liver disease is one of the leading causes of mortality across populations. In fact, according to some estimates, it is soon slated to become the leading cause of unnatural death. One of the primary technical challenges in the treatment of liver disease and liver tumor in particular is the fact that even an affected person arrives at the hospital, current scanning techniques are not always accurate. In many cases, it is only when the patient experiences the symptoms of the cancer that doctors start treatment but by then it is too late. This problem is not restricted to the detection of liver tumors alone and is prevalent across the medical field in the identification of various diseases. A number of scanning and imaging techniques are available such as the MRI, CT and ultrasound coupled with a greater number of image processing algorithms and techniques. Hence, in the following paper, an attempt is made to arrive at the most accurate method of liver tumor identification and classification. Existing literature in the field in examined along with the combinations available for imaging and its various processing methods.

Literature Survey

A. Paper [1]

In article [1], the author focuses on the Ultrasound imaging technique among various others to detect and classify liver cancers. The other techniques being: Magnetic Resonance Imaging (MRI), Computed Tomography (CT) and Positron Emission Tomography (PET). In particular, the author examines the use of Support Vector Machine (SVM) methodology which has been known to provide a high degree of accuracy of up to 90%, in the classification of proteins. It has been found that in the classification of liver tumors as benign and malignant, apart from improving the accuracy, this methodology has also resulted in mitigating speckle noise in the liver images apart from retaining spatial information. The various processes contained in the methodology such as pre-processing, segmentation and the determination of classifiers in explained in a simple manner. Thus, it is possible to classify liver images as normal, containing a benign tumor or a malignant one with increased accuracy.

B. Article [2]

The authors in the article [2] similar to that of the first article make use of SVM methodology; however, it is employed in the sphere of the CT imaging technique. The aim of the paper is to enhance the quality of images obtained through CT imaging with the use of the algorithms: Contrast Limited Adaptive Histogram Equalization (CLAHE) and Constrained Variable Histogram Equalization (CVHE). While the CLAHE algorithm is used to distinguish between the normal and abnormal regions of the liver through box plots, the CVHE algorithm is most effective in detecting Hepatocellular carcinoma (HCC), the primary form of liver cancer. In addition, when the SVM technique is used for classification along with the algorithms, the accuracy of detection of abnormal liver images does not fall below 97% in any scenario. Hence, the SVM technique is effective in scanning liver tumor images with scope for further improvement available.

C. Article [3]

As proclaimed by the authors themselves in article [3], they attempt to arrive at a method of detecting tumors automatically in order to improve upon the present method of manual analysis of liver images by doctors. The authors highlight the importance of tackling liver tumors and the immense advantages of detecting them early. It is against this backdrop that they propose an algorithm founded on the bases of neural networks and fuzzy logic. Although the familiar techniques of pre-processing, processing and detection are used in the method proposed by the authors, the difference lies in the segmentation phase thereafter. Apart from the concepts mentioned above, the windowing technique is also used to automatically segment the images obtained through CT and MRI scanning. The resulting data demonstrates an improvement over the existing manual methodology.

D. Article [4]

The author establishes the importance and challenges of the identification of liver tumors in article [4]. Apart from speckle noise as pointed out by other authors, Divya mentions the inherent structure of the tumor cells which originate in the liver causing initially benign and then malignant tumors. Another feature that is similar to some earlier papers examined in this report is the fact that the author has attempted to arrive at an automated method of scanning liver images rather than manually analyzing them which is not only time consuming but also prone to error as mentioned by the author. Spatial Fuzzy C-mean algorithm is used for this process. This algorithm is used in the segmentation stage of the image processing and the input to the suggested method will be CT images of the liver. With regard to the classification of stages of the liver tumor, the author has used the probabilistic neural network (PNN) function. Both the Fuzzy logic and the PNN have resulted in an increase in accuracy and reliability when compared to other methods.

E. Article [5]

In Article [5] author describes a new 2D liver segmentation method for purpose of transplantation surgery as a treatment for liver tumors. Liver segmentation is not only the key process for volume computation but also fundamental for further processing to get more anatomy information for individual patient. Due to the low contrast, blurred edges, large variability in shape and complex context with cluster features surrounding the liver that characterize the CT liver images. The author approach is that, the CT images are taken, and then the 2D segmentation process which is based on the hybrid method which is the combination of modified k-Mean (which depend on the distance and color), the statistical structure which are the first order statistical feature and the geometrical features are applied to the liver image to extract the CT liver boundary and further classify liver diseases.

F. Article [6]

In Article [6] author describes an Image Segmentation is an important procedure in many applications of image processing. The proposed system by author comprises a Detect before Extract (DBE) technique which automatically finds the liver boundary. By using the property of local entropy method that can extracts the edge of the liver CT image. Then used the morphological method to detect the object regions using the contour modification algorithm to find the cancer location of the liver.

II. Present System

The present method of determining information about the status of tumor cells in a liver has evolved rapidly and has had relative success. Firstly, a region of interest in selected within a raw ultrasound image of the liver. Thereafter, this region is bifurcated into smaller dependent areas called cells. Thereafter dense features of the pixels within cells are extracted using the HOG (Histogram of Gradients) algorithm. Subsequently, the pixels within each cell are compiled into a histogram of intensity gradients. The descriptor that is ultimately used for classification of the liver image as a whole is a combination of various histograms of the numerous patches present in the image. Once a directory of information is present for all the patches, the sparse coding mechanism is used for building training images. Finally the raw image is represented and classified based on the processed information.

III. Problems in the Existing System

One of the advantages of the existing system is that the HOG algorithm allows normalization of images based on the data extracted from a larger part of the image than a cell called a block resulting in greater accuracy of data. What this means is that the pixels can be corrected for errors which result in better contrast with respect to the entire image rather than just the surrounding pixels in the cell. However, this approach is a strictly iteration based method in which repeated iterations are essential, leading to an increase in the time taken as well as the complexity involved for the detection process. In addition, and more importantly, the present system relies on manual effort. Although the processing and segmentation processes use the HOG algorithm, the ultimate classification needs manual expertise which causes many disadvantages such as an increase in the time required to process each image in addition to exposing the process of image analysis to mistakes that the technician or doctor may make.

IV. Research Aim

The primary aim of the research is to identify tumor in liver images and classify them based on their severity. The researcher has hypothesized to use the PHOG and SGLDM algorithms to improve accuracy and reliability of the entire process.

V. Proposed System

A. Description

The architecture of the proposed system is based on two primary phases: namely the training and subsequently the testing phases. In the training phase, a healthy liver image undergoes image enhancement and segmentation in addition to RGB to grey color conversion. Post the pre-processing stage feature extraction through the PHOG and SGLDM algorithms is carried out. The algorithms extract statistical textural features which are in turn used to train the system with descriptive information. Such information is what is used to ultimately classify the images as benign or malignant. In the testing phase, the defective liver image also called a query image is fed into the system. Similar to the above phase, this image also undergoes the pre-processing and segmentation processes to extract features. At this point, the SVM classifier plays its part. The SVM classifier is the main component of the recognition system and that is why they are referred to as classifiers. They perform binary classification based on images that are input into it also referred to as supervised learning. It is this system that also allows for automated recognition of tumor in the liver images.

B. Architecture

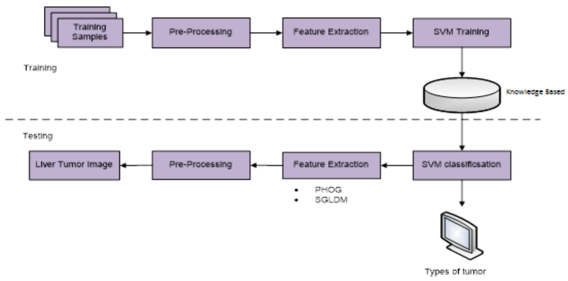

Fig. 1. The different stages involved in the proposed system.

VI. Conclusion

As mentioned in the sections above, a number of options are available in order to identify and classify liver tumor images each with their advantages and shortcomings. Existing literature in the field has pointed to the various advantages of the SVM classification method regardless of the imaging technique employed including the MRI, CT and Ultrasound. The existing system for scanning liver images has been developed over the years and is a sophisticated one but it has certain shortcomings such as increased complexity and time required. In addition, manual intervention is required to classify the images. Hence, the improved PHOG/SGLDM algorithms are used in conjunction with the SVM classification method to arrive at a more accurate and automated method. The identified method has the potential to significantly increase accuracy and saving time. This method can also be used in other medical applications such as biopsy and brain tumor.

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VIII. References

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