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A Survey on Early Detection of Liver Cancer for Preventive Health Care using Image Processing

Meenu Sharma[1], Rafat Parveen[2]

[1]*Department of Computer Science, Jamia Millia Islamia, mshwetab@gmail.com*
[2] *Department of Computer Science, Jamia Millia Islamia, rparveen@jmi.ac.in*

Abstract

Liver cancer is becoming a major reason of death globally in most of the cases diagnoses of the liver cancer are take place only at its late stage, it becomes late to cure, that leads to increase the number of people who dies due to liver cancer. If it is diagnosed in its early stage then the possibility will increase for curing the suffered peoples. It becomes necessary to treat liver cancer in its early stage. Digital image processing technique is a non-invasive widely used way which play most important role in early detection and prediction of liver cancer and applied when the input data is in the form of images. For detecting liver tumors or nodules numerous tests of patients are required, automated diagnosis system utilizing digital image techniques employed for the prediction and detection of Liver cancer at early stage, plays a vital role in decreasing the mortality rate because of early detection of Liver cancer. In this paper, a comparative table has been presented by analyzing various existing image processing techniques used for early detection and prediction of Liver cancer with their accuracy. This comparative table, shows that for CT scan images higher accuracy is obtained by k means segmentation, active contour segmentation and GLCM with SVM classifier.

Keywords: early detection, prediction, data mining, image processing, Liver cancer

1. Introduction

The Human are composed by uncountable number of living cell. Normal body cell grows, divide and then die with a predefined sequential fashion. Each cell has the ability to transform into a cancerous cell, it happens only when a cell loses control over their growth and division. When cells grow abnormally without any control results in the formation of a Cancer. There are various kinds of cancer, all having the same reason of uncontrolled growth and division. Liver is the largest internal organ of our body and it play role in many vital functions like food digestion, generation of blood clotting factors, detoxification of toxic waste found in blood, processing of some nutrients before they get utilized for energy, building and repairing of tissues, maintenance of proper blood sugar level, it releases bile into intestine which help in the nutrients absorption, etc.

Liver cancer is the fifth most commonly death causing cancer among men (https://doi.org/10.15680/IJIRCCE.2016) (Gowsalya, Divya, Radha, and Sudha, 2016) and eighth among women. Liver cancer can be of two types such as benign or primary liver cancer and cancerous. Benign liver cancer able to grow but not able to spread while cancerous is malignant means it has both the ability such as growth and spreading. Metastasis cancer is more common in liver cancer as compared to primary liver cancer. There are various risk factors which can make susceptible the person to the liver cancer. A risk factor can be anything which has the ability to increase the person's chance to get affected by liver cancer. Risk factors mostly has impact on the cancer development, they mostly not directly cause liver cancer. Some persons who have risk factors are never affected by cancer, rather others who do not have any risk factor do. There are various risk factors for liver cancer like age, gender, cirrhosis, chronic hepatitis B virus and hepatitis C virus,

alcohol abuse, non-alcoholic fatty liver disease, obesity, diabetes etc. (Tsukuma, 2005; Balogh et al., 2016). Symptoms are also shown by liver cancer like any other disease. It usually shows in later stages but sometime they may show in early stage. Some most common symptoms are vomiting, nausea, swelling in the abdomen, jaundice, weight loss, pain at the top right of the abdomen, hard lump present at the right side of body under ribs, weakness and fatigue. There are numerous treatment options kinds of diagnosis tests are developed like computerized tomography (CT), Magnetic Resonance Imaging, ultrasound, biopsy, laparoscopy etc. used to identify or to know that particular patient is affected by liver cancer or not (Balogh et al., 2016). There are numerous treatment options are there after confirming liver cancer like Hepatectomy, Liver transplantation, Radiation therapy, Percutaneous ethanol injection, Chemoembolization and radioembolization, Targeted therapy, etc.

Digital image processing is a method of employing the computational algorithms on digital images to infer useful information or knowledge. Image processing field is a fast-growing field with respect to medical applications (Upadhyay and Wasson, 2014). Image processing technique is a non-invasive method utilized for detection of tumors. Recent developments in this field made it possible to utilized CT image datasets with high resolution, and enable physician to detect small tumors with large tumors. Due to a large number of images are present in a dataset, so it is not possible for a physician to read each and every image and predict some useful information. However, a Computer Aided Detection (CAD) system is made by utilizing digital image processing (Paper, 2016).

All the medical treatments which are given above are useful only when our diagnosis system will detect them, mostly in later stages, in which it is very critical to cure patient from that disease. None of the diagnosis are able to detect liver cancer at early stage of disease development, so for make it possible digital image processing is being utilized.

The main difficulties found during the detection of liver cancer using Digital Image processing technique is that this technique is not able to detect tumors in its initial stage. In liver segmentation problem arises during segmenting the liver tumors because of the very small observable changes are found between the tumors and healthy tissues and unclearness between the boundaries of tumors and the liver tissue because of little difference is found with respect to density in liver parenchyma, vessels and tumors. As a result of these multiple problems, new developed methods or algorithms depicts a valuable job and sometimes looks like insufficient. In order to be clinically accepted these methods needs to work with high accuracy and fast speed.

This paper has been organized in four sections. In Section 2, covered literature related to Digital Image processing and classification algorithms, and their applications in liver cancer diagnosis. In Section 3, summary of tumor detection and classification work of liver has been presented in the form of a table. Finally, conclusion presented in Section 4.

2. Review of Literature

All researchers work with the aim to develop a system which has the ability to detect and predict the liver cancer in its initial stage of development. They also work to improve the accuracy of Early Prediction and Detection system. In this section, we provide a review of major contributions of research in the field of Early Detection and Prediction of liver cancer.

Yu Masuda et al. – They proposed a method to identify the nodules of tumors in Liver CT images, based on adaptive contrast enhancement and the expectation maximization / maximization of the posterior marginal (EM/MPM) algorithm. While using this methodology, user interaction is not needed and both the tumors such as large and small are accurately detected. This method is also works with the images of poor contrast. They used histogram transformation algorithm to enhance the contrast of image and by applying EM/MPM algorithm, tumors can be detected more accurately (By, n.d.).

Gowsalya N, Divya A, Radha K, Sudha K – In this paper they worked on Ultrasound images of different stages of Liver cancer development. They proposed a method which is intelligent and having CDS framework, will automate the image enhancement, segmentation, disease classification and progression, allow the efficient detection of tumors of Liver cancer in its initial stages. Proposed framework is composed of numerous stages begins with the preparation of image dataset, preprocessing of images does before applying any segmentation algorithm. The second stage comprises of the cancer detection and its segmentation, in this stage various segmentation techniques are applied for breaking an image into small parts and then to extract features.

Segmentated objects have been classified in third stage, in which they used to find the similarity between the identified segments and the dictionary of disease prepared by physicians and radiologists. A dataset of ultrasound images is prepared to check and evaluate the successive stages of Liver cancer disease, in final stage. They used 200 patients dataset for performing testing of this proposed framework. Their class distribution are 80 malignant and 120 benign. LESH features were used for testing the performance of classifiers, performance of classifiers is measured by using WEKA Explorer, in which more than one classifiers are used like SVM, J48graft, KNN, Multi-Layer Perception and Bayesian Logistic regression. SVM performs best among all the tested machine learning algorithms which gives results with the accuracy of 95.29% (https://doi.org/10.15680/IJIRCCE.2016) (Gowsalya, Divya, Radha, and Sudha, 2016).

M V Sudhamani, G T Raju – A semi-automated system has been presented in this paper, by which surgeons and radiologists are able to visualize and do organ measurements in a simple and efficient manner. They also presented that, the segmented results which they get after segmentation of liver CT scan images are much more helpful for analyzing the presence of liver tumor and for classifying the liver tumor found in the CT images of cancer patients. A region growing technique is utilized for analyzing the neighboring pixels found around initial points, to know that particular neighboring pixels should be further added to the image or not. This step is continual and interactive for selecting the initial point within the suspected region. By this region growing technique, the contour is generated which gets further segmented with the help of watershed method. Grey Level Co-occurrence Matrix (GLCM) is applied for extracting the features. These extracted features are further utilized by employing Support Vector Machine (SVM) for classifying the tumor as benign or malignant. Experimental results present that the error in liver segmentation reduces considerably, and all the liver tumors are segmented, and then they are further segregated as benign or malignant type. This methodology is tested over 100 CT images of 63 patient cases. The results show the performance of this methodology is greater than 96% accuracy in classifying the tumors as benign or malignant (Sudhamani and Raju, 2014).

L. Ali et al. - Everything is same as written in one step ahead except using only one classifier i.e. SVM rather using more than one classifier, but in both cases they got the same results with accuracy of 95.29% (Ali et al., n.d.).

Yu Masuda, Amir Hossein Foruzan, Tomoko Tateyama – They developed a method which employs EM/MPM algorithm and shape information to detect large and small sizes tumors accurately. They include two stages in their methodology. EM/MPM algorithm is applied for identifying the tumor region in first stage of methodology, then these tumor regions are further utilized for making a cluster of liver tissue. For making cluster a dataset algorithm is employed which utilizes both the pixel intensity and nearby pixel labels. This leads to increase the detection accuracy, as compared to another probabilistic algorithm. Shape related information is utilized for removing the false positive in second stage, like they used shape information of tumor. As tumor are of circular shape, they firstly check circular property of each region to reduce the rate of false positive. They also do not take into consider those tumor candidates which have their centroid at the liver boundary. This method evaluated quantitatively and results presented that it can reduce efficiently the rate of false positive without doing any compromise with the rate of true positive (Paper, 2016) and it classified liver tumors into hepatoma and haemangioma with 83% of accuracy (Deore, 2014).

Pedro Rodrigues et al. – In this paper, for segmentation of liver tumor an effective and efficient algorithm is developed which enable customers to interactively paint the region of interest with the help of a brilliant paint brush. This proposed approach is based on segmenting image in identical fundamental areas, by applying a pseudowatershed algorithm to a digital image stored in gradient form. Results produced, after applying segmentation algorithm at initial stage, becomes the input for a smart region growing method, for analyzing and selecting the perfect image partitioning, and this selection is done on the basis of minimum description length principle.

For experiment purpose, this proposed algorithm was applied on image data of Computed Tomography (CT) and Magnetic Resonance (MR). This experiment is done by employing the dice similarity coefficient (DSC) like a statistical confirmation matrix. Results produced in the form of DSC mean score, like 87% DSC score for CT and 84% DSC score for MR.

One approach which is not fully automated was developed for both Computed Tomography (CT) scan and Magnetic Resonance imaging (MRI) images. By taking all the fundamental areas, which belongs to the

anatomical target into consideration, rather considering all pixels, results in the shortening of segmentation procedure. Which results in the reduction of the number of total decisions, user dependency and duration of time required and maximize the segmentation potency and strength. It is also highly sensitive towards detecting the tumor boundaries which are present nearby to other anatomical structures, predicting the edges which are not strong, has high strength towards the noise found in image, and has the ability to distinguish between the high and less dense metastasis stages of distinct sizes or shapes (Rodrigues, 2011).

Abdalla Zidan, N. Ghalli, H. Hefny – Evaluated a novel combined approach made for authentic segmentation of CT liver image, which separate the liver from other organs and partition the liver into a set of regions of interest (ROIs). In this approach, the level set is combined with watershed approach applied as a post segmentation step for producing an authentic segmentation result. Segmenting a liver image is a complicated process consists of many steps like preprocessing, segmentation and classification. The preprocessing step keep in mind about the similar intensities of other organs like spleen, flesh and muscles. For solving this problem, ribs connecting algorithm utilized with contrast stretching filter. The output of first order statistics and grey grey-level co-occurrence matrix is in the form of features passed to train an ANN and classify ROIs. Before segmentation approach filtering is utilized to enhance the contrast, remove noise and stress on certain features and connecting ribs around the liver. They perform tests on different CT liver images for evaluating the performance of this presented approach. Obtained experimental results, represents that this approach gave the overall accuracy of 0.921% with MSE = 0.0009, and in segmenting the liver CT images into a set of regions with noise, and average accuracy of 0.889% using SI by neural network classification (Mostafa, 2012).

Walaa H. El-Masry – In this paper, they developed an automated CT liver image clustering approach, by using evolutionary metaheuristic algorithm called invasive weed optimization as base, not having any previous knowledge related to the quantity of genuinely present cluster in the image.

Table 1: Summary of tumor detection of liver

Sr. No.	Author Name	Year	Images	Accuracy	Segmentation algorithm	Classifier	Advantages	Limitations
1.	Gowsalya N, Divya A, Radha K, Sudha K	2016	US	95.29%	K-means algorithm	SVM	Robust and intelligent CDS framework	Numerous classifiers are used
2.	M V Sudhamani, G T Raju	2014	CT	96%	GLCM	SVM	Robust, simple and efficient way visualize and do organ measurement	Intervention by human expert is required
3.	L. Ali et al.	2014	US	95.29%	Active Contour model	SVM	Robust CDS framework	Highly complex and Numerous classifiers are used
4.	Yu Masuda, Amir Hossein Foruzan, Tomoko Tateyama	2014	CT	83%	GLCM	EM/MPM	Decreases the rate of false positive without compromising with the rate of true positive, able to detect tumors of very small size	Cost function has to be minimized to reduce the total number of misclassified voxels, only works with the sphere like tumor/structure

5.	Yu Masuda et al.	2012	CT	50% (when image includes numerous minute tumors)	Adaptive Contrast Enhancement	EM/MPM	Reduces false positive rate without decreasing true positive rates, Can detect very 172mall tumors	It is not fully automated, intervention by human expert is required
6.	Abdalla Zidan, N. Ghalli, H. Hefny	2012	CT	88.9%	Watershed	ANN	Take into consideration similar intensities organs	NA
7.	Pedro Rodrigues et al.	2011	CT and MR	NA	Pseudo Watershed algorithm	NA	Less number of decisions required to segment an image, highly robust, less time consumption and reduced user dependence	Not fully automated algorithm, having low accuracy

Smoothed compact cluster is identified by using fitness function of genetic algorithm referred as k-means objective function. By experimental results it has been suggested that invasive weed optimization has tremendous power seems as an efficient metaheuristic for multi-objective optimization in the applications of computer aided diagnosis. It was observed, from the reported results that by extending the repetitive numbers, better results can be obtained (http://www.egyptscience.net) (El-Masry, Emary, and Hassanien, n.d.).

3. Summary of Tumor Detection and Classification Work of Liver

Significant improvement has taken place in medical industry with respect to prediction and decision making of liver cancer, by applying Digital Image Processing and Data mining techniques together. After analyzing all the research papers, a comparative Table 1 is prepared, which gives the summary of applied Digital Image Processing and the classification work, their accuracy with limitations and advantages of various used techniques.

4. Conclusion

In this paper, a comparative study has been done after analyzing various types of Digital Image processing and Data mining techniques, which can be utilized in automated liver cancer prediction system. In recent years, many existing techniques have been utilized for Early Detection and Prediction of liver cancer. An overview of different applied algorithm for classification and Digital Image processing employed in liver cancer prediction is also presented in this paper. The main focus of this paper is on using the combination of different classifiers with different segmentation algorithms for the detection of tumor in liver by using image processing. The comparative summary of various segmentation and classification techniques with their limitation, advantages, classification, accuracy has been presented in the form of a table. By this comparative study, we can also see that the detection of tumor heavily depends on the choice of segmentation and classifier algorithm. We can also see that the performance of the methods is affected by the applied segmentation and classifier algorithms. Therefore, to obtain the reliable and accurate testing results for detecting liver tumor, we first need to explore the characteristic of segmentation and classifier and then apply in the form of combination to the CT scan images. From this study, it is inferred that for CT scan images gives the most accurate result 95.29%, which is attained in both k means segmentation and active contour algorithm with SVM and higher accuracy of 96% is attained by the use of GLCM segmentation and SVM classifier.

5. Future Work

Future work is to develop a robust and intelligent Clinical Decision Support (CDS) framework that offer an approach to detect liver tumor at initial stage of development with the help of digital image processing. It is clearly known that digital image processing is useful in solving medical diagnosis.

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A Brief Author Biography

1st Meenu Sharma – Received the MSc and M.Phil degrees in Bioinformatics from Jamia Millia Islamia, New Delhi, India in 2013 and 2016, respectively. She is currently pursuing PhD from the same University. Her Research interests include Bioinformatics, data mining, Computational Biology, gene expression and Systems Biology.

2nd Rafat Parveen – Received the PhD degree in Computer Science in 2007 from Jamia Millia Islamia, New Delhi, where she currently serves as a professor. Her research interests include Computer Networks, Modelling and Simulation, Computational Biology, Bioinformatics and Systems Biology.

