

A Survey on Liver Cancer Detection: Based on Deep Learning Technology



Sunita P. Deshmukh, Dilip D. Shah, and Pravin N. Matte

Abstract Nowadays, in developing countries liver cancer has become one of the fatal and highly increasing cancers. It is very difficult to detect the tumor in the early stages of cancer mostly it is detected at an advanced stage which causes life-threatening issues. Hence, it is very necessary to develop such a system which can detect and locate tumor more accurately, precisely, and as early as possible. In this paper, a survey on different methods, techniques, and systems used for the detection of liver cancer is given. These systems are automatic, semiautomatic, manual detection systems. These systems are developed using machine learning technology with supervised, unsupervised, and deep learning techniques. Also, a table has been given in this paper, in which a comparison between different existing liver detection techniques based on accuracy is given. In recent days, in this field, deep learning is emerging out with very great results as compared to other techniques.

Keywords Liver cancer · Deep learning · CNN

1 Introduction

In 2018, as per the GLOBOCAN, about 18.1 million new cases were recorded in the world, and in that 9.6 million were death cases. Cancer is the 2nd main cause of death. Some of the major examples of cancer causes of cancer death are Lung cancer, colorectal cancer, Liver cancer, Stomach cancer, and Breast cancer, etc. The number of death cases provided by WHO [1] corresponding to different cancers in 2018 is given by the graph in Fig. 1.

Nowadays, in developing countries liver cancer has become one of the fatal and highly increasing cancers. According to AstraZeneca [2], this cancer is the 6th most common cancer and 3rd leading cause of cancer death. As per paper [3], the new cases of liver cancer recorded were 4.7% of all types of cancers in 2018. Mongolia and Egypt (Asia) have the highest liver cancer's incidence and mortality. According

S. P. Deshmukh (✉) · D. D. Shah · P. N. Matte
GHRU, Amravati, Pune, India

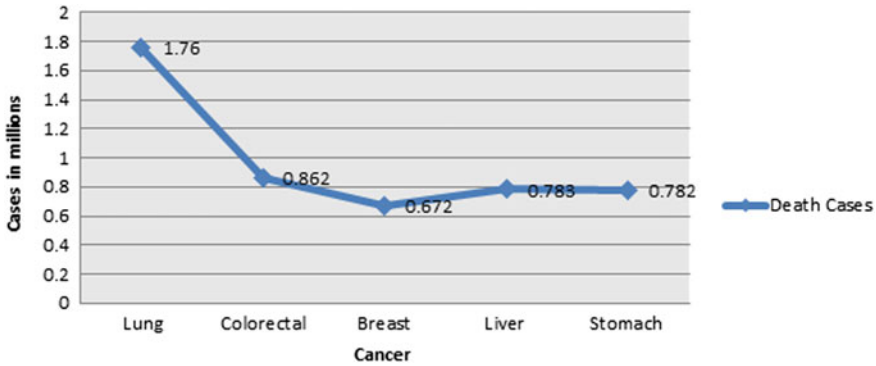


Fig. 1 Cancer death cases in 2018

to [4], Liver cancer was the 5th most common cancer in males and 9th in females also it was the 2nd cause of cancer death in males and the 6th cause in females.

The liver is an important internal organ of humans that performs many important functions such as drugs' detoxification, filtration of blood, protein generation, etc. It is the largest internal organ. In the liver, when the cell grows abnormally it causes cancer which is called hepatic cancer or liver cancer [5]. As per previous studies, it is very difficult to detect the tumor in the early stages of cancer most probably it is detected at an advanced stage which causes life-threatening issues. So it is very essential to detect it as early as possible. Due to this patients can receive the treatment immediately and it results in an improvement of survival rates. Manual detection of cancer tissue is a complicated, time-consuming, and difficult task. So, to detect the tumor accurately a computer-aided diagnosis (CAD) is used in the decision-making process.

2 Types of Liver Cancer

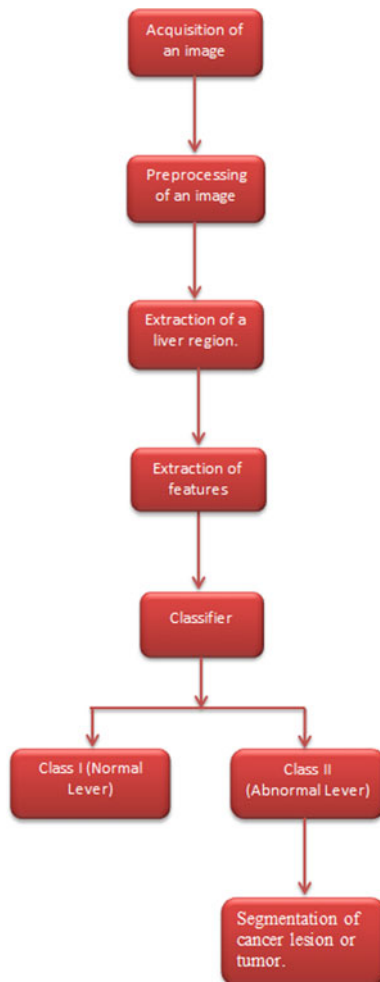
There are different types of cells present in the liver. These different cells form different types of tumors some of the tumors are cancerous call malignant and some are non-cancerous call benign. Two major types of cancer are:

1. Primary cancer
2. Secondary cancer

Primary are those which start in the liver and secondary are those which come to the liver from other parts. Hepatocellular carcinoma (HCC) is one of the common forms of liver cancer. According to [6], almost 80% of liver cancers in adults are of this type. There are some risk factors such as obesity, cirrhosis, gender, age, alcoholism, hepatitis B, and C [7]. According to WHO, the hepatitis B virus (HBV) can cause chronic infection, cirrhosis, and liver cancer.

According to previous studies, this Liver cancer is diagnosed by imaging tests, including ultrasound scans, MRI scans, and CT scans.

Nowadays, Computer-Aided-Detection (CADe) and Computer-Aided-Diagnosis (CADx) systems using machine learning techniques became indispensable in the medical field. There are various systems with different techniques that have been proposed in previous studies. Each one has some pros and cons. But the basic algorithm and steps are common in all. So, different techniques and algorithms that have been used in previous studies are discussed in this paper. The general approach used in previous studies is given in the flowchart.



Now, the different existing techniques and methods used for each process given in the above workflow are summarized as follows:

- preprocessing of image:

The image acquired by different imaging techniques is a raw image. Hence, in preprocessing quality of the image is enhanced by removing different noise and imperfections. It also involves different standardization and normalization methods of images. This process helps to improve not only the visual quality of the image but also the effectiveness of further processes. This is the basic process in Digital image processing (DIP).

Digital image processing is one of the important techniques by which an image is processed through computers with various algorithms. This image is acquired by different imaging techniques such as Magnetic Resonance Imaging (MRI), Computed tomography (CT), Positron Emission Tomography (PET), and Ultrasonography (US).

There are different methods to remove noise in the images. Major two categories of these methods are given below:

1. Spatial domain approach
2. Spectral domain approach

3 Methodologies

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2. Spectral domain approach

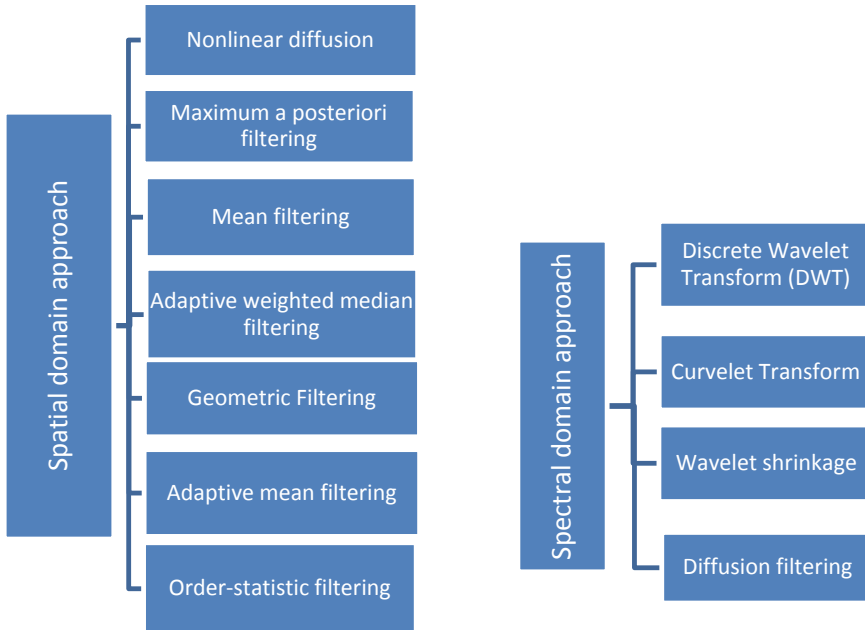


Fig. 2 Spatial and spectral domain approach

4 Classification

In the medical field, classification is used to predict diseases and medical diagnosis [8].

Two major performance factors of the classification are:

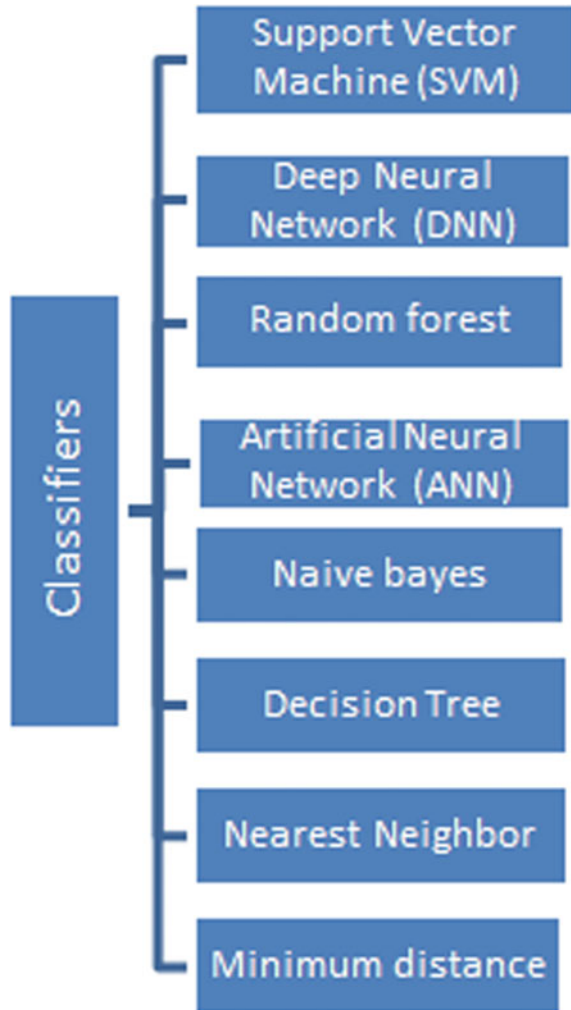
1. Accuracy: It must be as high as possible.
2. Execution time: It must be as low as possible.

In this process, the given object is classified into two, three, or multiple classes as per the requirement and for this procedure, features that were extracted or selected in the earlier steps are used. Training and testing is a fundamental process in classification. In two different ways the object can be classified as stated below:

1. Supervised: Predefined classes with labeled input data.
2. Unsupervised: Unknown classes with unlabeled data.

Some of the major examples of classifiers that are available are listed in Fig. 3.

Fig. 3 Methods of classification



5 Results

Early detection is very essential to improve the survival rate. Enhanced MR image provides enough information for the diagnosis of the tumor, but according to paper [9], this diagnosis is affected by subjective experience. So, deep learning is one most suitable technique to overcome this problem.

Zhen et al. [9] used a deep learning technique for the diagnosis of liver tumors. To develop deep learning they used Convolutional Neural Network. In the dataset, enhanced and unenhanced MR images and clinical data are used. In the proposed system they have classified the given image into seven categories. This system has a high accuracy of detection and classification.

In paper [10], a Liver tumor segmentation system using deep learning was proposed. In this system, a 3D convolution neural network (CNN) was used. In this study, 3D CNN and plain (2D) CNN are compared. For 2D CNN U-Net is used. According to the paper [10], 2D CNN gives better results than 3D CNN. 3D CNN is computationally expensive.

5.1 Expected Result

From the previous studies and their result shown in Table 1, it is clear that not only the detection of a tumor but also detecting it as early as possible is very important. This can be achieved with the system having high speed and good accuracy. Therefore, it is expected that the proposed system should require less execution time and high accuracy (greater than 98%) or it should classify images precisely. This can be achieved with deep learning technology. Figure 4 shows the accuracy obtained using different classifier.

Table 1 Comparative study of existing liver tumor detection technique

| Sr. No. | Applications | Authors and references | Year | Techniques methods/classifier/segmentation algorithms | Result/accuracy |
|---------|---|------------------------|------|---|-----------------|
| 1 | Intelligent image processing techniques for liver cancer | Shah et al. [11] | 2014 | SVM, active control model | 95.29% |
| 2 | Automatic liver and tumor segmentation | Yuan [12] | 2017 | Hierarchical convolutional/deconvolutional N.N. | 96.7% |
| 3 | A computer-aided diagnostic system to characterize CT focal liver lesions | Gletsos et al. [13] | 2003 | Neural network classifier (NN) | 97% |
| 4 | Liver tumor in CT Scans segmentation | Almotairi et al. [14] | 2020 | Modified SegNet | 98% |
| 5 | An efficient method for segmentation of images | Ghamisi et al. [15] | 2012 | CNN model | 80.06% |
| 6 | Liver and tumor segmentation from CT volumes | Sun et al. [16] | 2019 | H-DenseUNet | 96.5% |
| 7 | Classification of Liver tumor candidate | Chlebus et al. [17] | 2017 | Random forest | 90% |
| 8 | Computer aided diagnosis system for abdomen diseases in CT images | Sethi and Saini [18] | 2016 | Genetic algorithm, SVM, ANN | 95.1% |

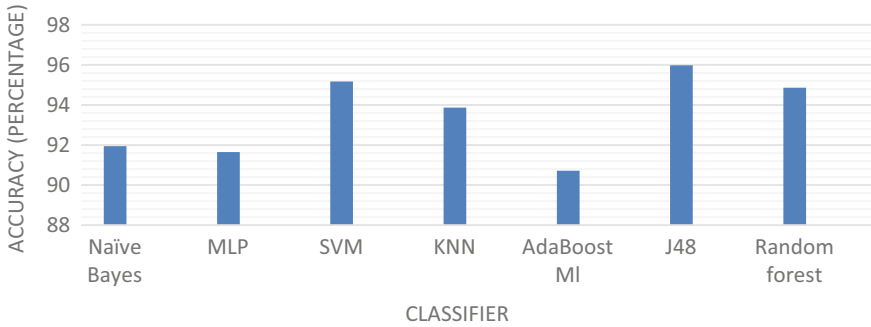


Fig. 4 Accuracy of different classifier

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