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A Review on Various Computer Aided Diagnosis Methods for Detection of Liver Tumor from CTA Images

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Abstract: Liver tumors are one of the most familiar categories of tumor occurring nowadays. These can be either malignant or benign. The major reason for this is due to alcohol based cirrhosis and hepatitis. There is also another category of liver cancer termed metastatic liver cancer which begins in some other organs and then spreads to liver. The early detection of liver tumors are essential as it can avoid loss of life.Tumor status should be analyzed during different stages of treatment. The segmentation and detection of tumors manually are really time consuming. Also different types of tumors have different appearance and these appearances change when contrast is being injected. Here comes the role of various computer -aided diagnosis methods for the accurate detection of liver tumors. This paper describes various techniques which were used for the detection of liver tumors from Computed Tomography Angiography (CTA) images which can assist the radiologists

Keywords-Computed Tomography Angiography (CTA) images, liver tumor segmentation, liver tumor detection, computer Aided Diagnosis (CAD).

I. INTRODUCTION

The most common cause of liver cancers is Hepatocellular Carcinoma (HCC).Globally it constitutes about ninety percent of liver cancers. Although lungs, breast and large intestine cancers are found to be the most occurring cancers, three dominant reason of annual death because of cancers comprise of lungs, stomach and liver. Around 7.5 lakhs of recent HCC cases per year occurs globally lead HCC to be the fifth common reason for cancers which affects the human. The rate of mortality of HCC is incredibly high. Approximately seven lakhs death because of HCC happen annually and has predicted to be the third frequent cause

of death which affects the mankind due to cancers. According to the data published by the International Agency for Research on Cancer(WHO),HCC's incidence rate which is age adjusted in India, for men varies between 0.7 and 7.5 and 0.2 to 2.2 for women per one lakh population each year. In India, the ratio of male to female for HCC is 4:1[19].

The early detection of liver tumors is very much necessary. There can be a series of CTA images per patient. The first pre-request task is to segment liver region. Next is to detect the tumor in segmented region of liver. Classification of tumor is followed by these steps. For this there are several computerized techniques for segmentation and classification of liver tumor. Once the tumor growth is being properly detected at early stage, adequate treatment could be provided to patients improving life expectancy. The figure 1 below lists the distinct methods for diagnosis of tumors in liver.

S.No	Year	Methods for Detection of Liver Tumor
1	2009	Watershed Algorithm
2	2010	Curvelet Transform
3	2014	Genetic Algorithm
4	2015	Support Vector Machine Classifier and Clustering Model
5	2016	Probabilistic Neural Network Classifier and Clustering Model
6	2016	Adaptive Neuro-Fuzzy Inference System
7	2016	Markov Random Field
8	2018	Deep Learning

Figure 1.Various Methods Used for Detection of Liver Tumor from CTA images

II. Various Segmentation and Classification Techniques for Detection of Liver Tumors

Watershed Algorithm

Jianhua Liu, Zhongyi Wang, et al.[1] describes a technique to realize a effective segmentation for liver tumor CT image. The planned system utilizes comprehensive edge detection, the watershed algorithmic rule and region merging approach, propose a segmentation technique of liver cancer CT image supported the watershed algorithmic rule, gain a much better result within the course of liver cancer CT image segmentation, and solve effectively the over-segmentation development of the standard technique, get closed, continuous, additional correct lesion region contour. This methodology proposes a liver cancer CT image segmentation methodology supported the watershed formula. Specific strategies area unit as follows: initially, tend to pre-process image, and convert the liver CT pictures into gray-scale image; then, use Sobel operator to calculate the gradient image, and use OTSU methodology to calculate a threshold and thresholding, and eliminate some little meaningless areas; once more, use Vincents formula to phase the processed image; nally, according to the common gray-scale and boundary average gray-scale criteria of adjacent regions, merge over-segmentation regions.

The advantages of watershed algorithm method involves isolating the watershed pixels from the background, an optimum number of pixels is needed to retained for achieving an acceptable segmented image, improving accuracy of results by using various remedial measures. The disadvantages include over segmentation of image and effect of noise on quality of output image.

2.2. Curvelet Transform

S. S.Kumar, Dr. R.S.MONI, et al.[2] describes multiscale transform known as curvelet transform[10] to show curve discontinuities likewise . Curvelet remodel includes an extremely redundant lexicon which can offer distributed illustration of signals that have edges on regular curve. Curvelet remodel partitions the curves into a group of ridge fragments so uses ridgelet remodel to represent every fragment. Implementation of the curvelet transform involves following steps: 1) Sub-band Decomposition: The image is initially disintegrated into log2M (M is that the size of the image) rippling sub-bands and then Curvelet Sub-bands are shaped by partial reconstruction from these wavelet sub-bands at numerous levels. 2) Smooth Partitioning: Each sub band is simply windowed in to squares of associate degree applicable scale. 3) Renormalization: Each resulting square is renormalized to unit scale. 4. Ridgelet Analysis: Ridgelet transform is performed on each square eventing from the earlier stage [3].

The advantage of this method involves offer exact reconstruction, stability against perturbation, ease of implementation, low computational complexity. Disadvantages include risk in curvelet shrinkage.

2.3. Genetic Algorithm

Yamini,Vikas,et al.[6]describes Genetic formula (GA) may be a computing model that may result as biological heredity, mutation of method biological process within the nature and manifests thoughts through choice, crossover and mutation operators. Its main characteristics are the looking out strategy, exchanging of data between people during a cluster. its notably applicable for

advanced and nonlinear issues that were tough to be resolved managing ancient strategies, demonstrates its distinctive charm in combinatorial optimisation, adaptive control, artificial life and different application areas. It's one amongst the intelligent computing technologies.

The advantages of this method involves it can find fit solutions in a very less time, (t solutions are solutions which are good according to the defined heuristic) the random mutation guarantees to some extent that we see a wide range of solutions, coding them is really easy compared to other algorithms which does the same job. Limitations are Its really hard for people to come up with a good heuristic which actually reflects what we want the algorithm to do, it might not find the most optimal solution to the defined problem in all cases, it's also hard to choose parameters like number of generations, population size etc. When we are working even though our heuristic was right we were not realizing it because we were running for a fewer generations.

2.4. Support Vector Machine and Clustering Model

S.Kumaravel, N.S.Vijayalaksmi,et al.[7] describes A coarse-to- fine approach is employed for the segmentation of the total liver from CT pictures. To make the method automatic, the liver 1st must be localized within the image. This task is difficult because of inter-patient and inter-phase form variability, liver cause and placement variability within the abdomen, variation in reconstructed field-of-view (the reconstructed image might target the liver or might cowl the total chest and abdomen).Once triple-crown liver initialization victimization model adaptation methodology, liver form may be custom-made to the coarse boundary. Because of the quality of liver anatomy, influenced by adjacent organs and insufficiency of form previous, it makes correct segmentation difficult. Deciding was performed in 2 stages: options extraction victimization the four level moving ridge decomposition followed by Haralic options and therefore the classification victimization support vector machine(SVM).The performance of the SVM classifier was evaluated in terms of coaching performance and classification accuracies.

The advantages include: Better texture and edge representation, better clustering efficiency. Disadvantages of SVM Classifier and Clustering Model are slow in test phase and choice of the kernel.

2.5. Probabilistic Neural Network and Clustering Model

Divya.v[8] describes Performance of the PNN classifier was evaluated in terms of coaching performance and classification accuracies. Probabilistic Neural Network provides quick and correct classification and may be a promising tool for classification of the tumors. Existing weights can never be alternated however solely new vectors are inserted into weight matrices once coaching. So it may be utilized in time period. Since the coaching and running procedure may be enforced by matrix manipulation, the speed of PNN is extremely quick. The network classifies input vector into a particular category as a result of that category has the maximum chance to be corrected. The PNN has 3 layers: the Input Layer, Radial Basis Layer and also the Competitive layer. Radial Basis Layer evaluates vector distances between input vector and row weight vectors in weight matrix. These distances square measure scaled by Radial Basis Function nonlinearly. Competitive Layer finds the shortest distance among them, and so finds the coaching pattern closest to the input pattern supported their distance [5].

The advantages of this method are PNNs are much faster than Multilayer Perceptron Networks (MNNs), PNN can be more accurate than MNN, PNN networks are relatively insensitive to outliers, PNN networks generate accurate predicted target probability scores and PNNs approach Bayes optimal classification. Limitations include PNN are slower than MNNs at classifying new cases and PNN require more memory space to store the model.

2.6. Adaptive Neuro-Fuzzy Inference System

Marwa, Nihal, et al.[4] describes An ANFIS may be a form of artificial neural network that maps first order TakagiSugeno fuzzy logical thinking system. This method was originated by Jyh-Shing and Roger Jang in 1993. The two main fuzzy if-then rules to explain the ANFIS design will be expressed as follow: Rule 1: if x is A1 and y is B1, then f1=p1x + q1y+r1 Rule 2: if x is A2 and y is B2, then f2=p1x + q2y+r2 Where, x and y: are the crisp inputs; Ai and Bi: are linguistic variables; fi: are the outputs; p1, q1 and r1: are the adaptive consequent parameters that are updated in the forward pass in the learning algorithm.

Advantages include Combines advantages of both fuzzy systems and neural networks, when new data or rules are added to the system, there is no need to re-train the system, in fuzzy systems and Artificial Neural Networks (ANNs) have the ability to learn and model non-linear and complex relationships. Disadvantages include Artificial Neural Networks (ANNs) are complex to train.

2.7. Markov Random Field

Amitha Raj, Jayasree M,et al.[9] describes Markov Random Field Segmentation is that the method of assignment labels to every of the pixels in a picture in order that pixels with same label have some common properties. It helps to represent the image in order that it's simple to analyse it. It is the help to many tasks like seeing and image understanding particularly in medical image. Level set methods implicitly model the planar closed curve C by the zero level set of the level set function f(x, y, t) i.e. C(t) = (x, y)-f(x, y, t) = 0.The proposed model builds an energy function framework as E = Einternal + Eexternal + EMRF. It consists of 3 terms which corresponds to internal energy operate, external energy operate and MRF energy function, severally. The inner energy operate is denoted by characteristics of the evolving contour itself, such as its curvature, length and space. The external energy operate issues the evolution force determined by image information that has no association with the evolving contour. The MRF energy operates finds the simplest segmentation label for every pixel by considering the neighbor pixels mistreatment the mathematician theorem.

The advantages include They can be applied to a wider range of problems in which there is no natural directionality associated with variable dependencies and undirected graphs can succinctly express certain dependencies that Bayesian nets cannot easily describe. Disadvantages include computing the normalization constant Z requires summing over a potentially exponential number of assignments, undirected models may be di cult to interpret and it is much easier to generate data from a Bayesian network, which is important in some applications.

2.8. Deep Learning

Yoshihiro, Xian-Hua,et al.[10] describes Deep learning is one amongst machine learning strategies, that uses multilayered convolutional neural networks, and it exhibits high performance against numerous applications like image recognition and language process. The projected growth detection technique consists of 2 steps. The primary step is to segment liver from the CT image exploitation our developed liver division algorithms. The second step is to calculate the likelihood of every pixel within the divided liver happiness to tumors by the utilization of a deep convolutional neural network [11][12][13] (DCNN). The DCNN we tend to used may be a network consisting of 2 convolution layers, 2 pooling layers and one full connected layer[14][15]. The convolution layers are wont to extract helpful features. The pooling layers are wont to minimize the spatial variations of the options[16][17].And the last full connected layer is employed for classification (calculation of the growth probability)[18].

The advantages are system is trained with large dataset to get accurate results. Disadvantage includes non availability of data.

III. Conclusion

Various techniques for segmentation and classification of liver tumors were discussed in the paper which actually helps the radiologists for fast and accurate diagnosis of the disease. Each method was discussed with its advantages and limitations. The recent method of diagnosis of liver tumor was done with deep learning approach which outperformed conventional methods. In this method large dataset is used to train the neural network which resulted in accurate detection of the disease.

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II. TYPES OF E-LEARNING RECOMMENDER SYSTEMS

There are different approaches used to build a recommender system in e-learning context, some of them are:

A. Collaborative recommendation approach

This is one of the widely implemented recommendation techniques in data mining. It is based on the assumption that "similar users have same preferences" [2]. This technique aggregate rating of objects to recognize commonalities between learners and generate new recommendations based on inter-learner comparisons. A learner profile consists of a vector of learning objects and their ratings. Ratings indicate the degree of preference. It may be binary (likes/dislikes) or real-valued. Two classes of collaborative recommendation are:

i. Memory-based: Memory based technique can be classified into user based and item based. The user-based model is based on the fact that each learner reside on a group of similarly behaving learners and find a set of learners with similar preferences. Finally, it generates a list of recommendation for the target learner. The item-based model identifies the set of learning object that are similar or related to the target learner liked objects. After that, it computes the similarity of learning objects and finds the most similar objects to the target objects within the set of learning objects that the learner has rated.

ii. Model-based: Model based techniques provide recommendations by estimating statistical models for learner ratings. A probabilistic method can be used to compute the probability that the learner will give a particular rating to a new learning object based on previously rated objects.

Advantage: Does not need a representation of items in terms of features.

Limitations: Challenges like cold start, Sparsity problem and scalability issues.

B. Content -based recommendation

This technique is based on a comparison of the content of a learning objects and a learner profile. The content information can bridge the gap between the existing and new learner as well as the learning objects. The two classes of content based recommendation are:

i. Case based reasoning techniques: A case based reasoning technique recommends learning objects that are in highest correlation to objects the learner liked in the past. This technique does not desire a content analysis. The quality of the recommendation rises over when the learners have rated more learning objects. The new learner problem also stated to case based reasoning techniques. The limitation of this technique is overspecialization, because it recommends only the learning objects that are in higher correlation with the learner profile or interest.

ii. Attribute-based techniques: In attribute-based techniques, learning objects are recommended based on mapping of their attributes to the learner profile. Attributes could be weighted for their relevance to the learner [3]. This technique is sensitive to changes in the learner profile. Adding new learners or learner attributes will not cause any problem. The limitation of this type of recommendation is that it is static in nature and is not able to understand from the behavior of the network. Attribute-based technique can handle the cold-start problem because it directly maps characteristics of learners to learning attribute and the behavior data about the learners is not needed.

Advantage: Doesn't require data of other users.

Limitation: Over specialization.

C. Utility-Model based recommendation

This system does not attempt to build a long term generalization about their learners but rather base their advice on an evaluation of the match between a learner's need and the set of available options [4]. It makes suggestion based on computation function of the utility of each learning objects for the learner. The learner profile is considered as the utility function and the system employs constraint satisfaction methods to determine the finest match.

Advantage: Can factor non-object attributes.

Limitation: Learner must input utility function.

D. Demographic recommendation

This technique classifies the learners based on their personal attributes and the recommendations are based on the demographic classes. This approach is based on the assumption that all learners belonging to a certain demographic class have alike interest or preference. It uses demographic data about the learner and their point of view for the recommended learning objects. It forms people to people correlations like collaborative ones. But they use different data [4]. In systems like machine learning, it is used to reach at a classifier based on demographic data [5].The benefit of this approach is that it is independent of learner rating history.

Advantage: It does not require history of learner ratings.

Limitation: Security and privacy issue.

E. Context-aware systems

Traditional recommender systems compromise with two types of entities, users and items. The recommender system includes additional information about learners context such data can be used to change recommendations based on individual learner characteristics and additional contextual information such as available time, location, people nearby, etc. Context is information that can be used to classify the situation of an entity [6]. An entity is an object, person or place that can be considered relevant with the interaction between an application and a user [6]. The context data consists of different attributes, like physical location, date, season, emotional state, physiological state, personal history etc. This system automatically uses context data to run the system that are suitable for a specific time, places or events. It was integrated to improve the existing learner request response pattern that requires the learners to raise the wish for recommendation. The traditional recommender system focused on suggesting the most essential learning objects to learner without considering any additional contextual information, like location, emotional state and physiological state. It is necessary to combine the context data into the recommender systems so as to recommend learning objects to the learners under some circumstances. It covers the understanding of learner's objective with objects that learners might find interesting by knowing the wide area of contextual attributes.

Advantage: Based on changing contexts the recommendations can be adjusted.

Limitation: Need to integrate contextual data.

F. Hybrid recommender system

Hybrid filtering is a collaboration of two or more different recommendation approaches. Depending on domain and characteristics of data, several hybridization methods are possible to combine collaborative recommendation and content based recommendation techniques which may produce different outputs. Some of them are [7] mixed, weighted, feature augmentation, switching, feature combination, cascade etc. The widely known hybrid approach is provided by collaborative recommendation and content based recommendation. The collaborative recommendation is based on a similarity between the learner navigation path and the access patterns of similar learners. Content based recommendation is based on the correlation between the content of the learning objects and the learner taste. Hybrid recommendation tries to overcome the limitations in each approach, by making the collaborative recommendation deal with any type of content and explore new area to find something that is interesting to the learner.

Advantage: No cold start problem.

Limitation: Issue on Time complexity.

G. Knowledge-based recommendation

This recommender systems attempts to propose objects based on a learner needs and preferences. It contains knowledge about how a specific learning object meets a specific learner need. Therefore it can be a reason about the relation between a need and an achievable recommendation. The learner profile can be any knowledge structure that supports this conclusion. This technique collects knowledge about the learners and learning objects to apply them in to the recommendation activity. It is independent on learner ratings. It does not collect data about a specific learner because its intuition is independent of individual preferences. Knowledge-based techniques are suitable for hybridization with other recommendation techniques in the case of e-learning recommenders [8].

Advantage: Independent of learner ratings.

Limitation: Requirement of knowledge acquisition.

H. Ontology-based model recommendation

Ontology is an explicit specification of a conceptualization [9]. It consists of entities, attributes and relationship [9]. Ontology is used to model knowledge about the user background, item, and the domain [6]. The use of ontology can effectively improve the quality of personalized recommendation. Ontology is used to model the domain knowledge about the learner as well as the learning objects. The learner model ontology contains the personal information, learning style and knowledge level of the learner. The learning object ontology contains resource types, resource format. Personalization through ontology provides a more customized recommendation to the target learner preference. Ontology based recommendation do not experience most of the problems associated with traditional recommender systems.

Advantages: It depends on domain knowledge rather than ratings and improves the quality of personalized recommendation.

Limitation: Construction of ontology is a difficult, expensive and time consuming process.

III. GENERAL CHALLENGES AND ISSUES OF E-LEARNING RECOMMENDER SYSTEMS

Recommendation techniques have been very successful in past years but their wide use has exposed some challenges. Some of them are:

I. Cold-start problem

It is mainly based on new user or new item. This problem occurs due to an initial lack of ratings for new users who have not rated any item or new items which have not been rated by any user. Hence it becomes unattainable to make good recommendations.

New User: It occurs when there is a new learner to the system has no prior rating found in the rating table. So it is difficult to give prediction of a learning object for the new learner because it requires the learner's historic rating to calculate the similarity for determining the neighbors. Here the recommendations follows a comparison between the target learner and other learners based on their ratings, a learner with few ratings are difficult to classify.

New item: Cold start problem for a new learning object occurs when there is no enough previous rating related to that learning object exists [10].

II. Sparsity problem

Sparsity problem occurs where the number of learners who have rated learning object is too small compared to the number of available learning objects. If there is no such overlap in ratings with the target learner occurs, it is difficult to generate appropriate recommendation [9]. The main cause for data sparsity problem is that most of the learners do not rate most of the available learning objects. It has a major negative impact on collaborative recommendation approach because it is highly probable that the similarity between two given learners is zero, lay down collaborative recommendation useless.

III. Over Specialization

This is the major problem faced by the content-based recommender system. It lacks in suggesting diverse learning objects. The learners are recommended with learning objects that are already familiar with. It prevents learners from finding new learning objects and other alternatives. Additional techniques have to be added to the system to make suggestion outside the scope of learner interest. By integrating additional methods the learner will be provided with a set of different and a wide range of options [11].

IV. Scalability

As the numbers of learners and learning objects grow, traditional collaborative recommendation will suffer serious scalability issues [12]. In collaborative recommendation calculation grows linearly with the number of learners and learning objects, sometimes lead to inaccurate results.

5. Privacy

In the context of a demographic recommender, privacy is considered to be a major issue [10]. In order to provide more accurate recommendation to the learner, the most sensitive data of a learner must be acquired. It includes demographic information and information about the location of a specific learner, which may rupture the privacy of the learner.

IV. CONCLUSION AND FUTURE SCOPE

This paper surveys on various traditional recommendation techniques used in an e learning platform and also considered their advantages and limitations. A recommender system tries to intelligently recommend actions that are beneficial to the user. The development of sophisticated e-learning environments provides a path to education in life for long term. In an e-learning platform, the recommender system tries to intelligently recommend learning objects to a learner based on the task already done by the learner and their success. With the development of e-learning platforms, personalization is becoming a consequential feature in e-learning context. It is due to the dissimilarities in goals, backgrounds and capabilities of the learners. The future work will focus on incorporating intelligent technologies from field deep learning to enhance the recommendation performance and accuracy of the recommendation approach.

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