Gastric Cancer Prediction: A Comparative Analysis of Methodologies and Performances in Deep Learning Perspective

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Abstract—Cancer is the second leading cause of death globally, and Globally, about 1 in 6 deaths is due to cancer. Among the various types of cancers gastric cancer which starts from epithelial cells on the gastric mucosa is one of the common malignancies cancer disease. In recent years, deep learning is widely used by medical professionals and researchers to discover the hidden patterns in complex images and data and thus serves the healthcare industry better. Deep learning in healthcare provides doctors the analysis of any disease accurately and helps them treat them better, thus resulting in better medical decisions. The goal of deep learning is to understand the structure of data, so that accurate predictions can be made based on the properties of that data. Huge complex datasets which are beyond the scope of human capability, can be processed using deep learning which can then reliably convert analysis of that data into clinical insights that aid physicians in planning and providing care, ultimately leading to better outcomes with lower costs. In this study, an analysis is performed for gastric cancer prediction with deep learning perspective.

Keywords—Deep learning, gastric cancer, prediction, neural network, medical, analysis.

I. INTRODUCTION

Cancer is the second leading cause of death globally, and according to GLOBOCAN, gastric cancer is the third leading cause of cancer deaths worldwide. Gastric cancer (GC) is one of the common malignancies that originate from epithelial cells on the gastric mucosa. The growth rate and development of Gastric Cancer are complicated and affected by multiple factors such as environment and heredity, and the influence of these factors on the occurrence of GC has not been fully explored or well defined. The survival rate for malignant gastric cancer is still lower even after the treatment such as surgery, radiotherapy and chemotherapy. This can be improved by the early diagnosis gastric cancer and hence it is important to learn, which can then reliably convert analysis of that data into clinical insights that aid physicians in planning and providing care, ultimately leading to better outcomes with lower costs. Their early detection and timely
treatment have important practical significance for the prevention and treatment of gastric cancer.

II. DEEP LEARNING

Deep learning is a class of neural network, which includes a family of machine learning algorithms that attempt to model high-level abstractions in data by employing deep architectures composed of multiple non-linear transformations [1-5]. Some of the applications of deep learning are recognizing speech, natural language processing, computer vision, social media networks, medical analysis, the design of the drug, bioinformatics, machine translations, game programs on board, inspection of materials and so on. Deep learning mimics the human brain that is organized in a deep architecture and processes information through multiple stages of transformation and representation and thus makes complex prediction [6,7].

III. ROLE OF DEEP LEARNING FOR Gastric cancer prediction

In recent years, neural network achieved extraordinary achievement for medical diagnosis and deep learning approach for Gastric prediction showed excellence performance in many of the studies. For the early diagnostic of gastric cancer medical imaging is playing a more and more important role, there are more opportunities to utilize quantitative imaging analysis in the clinical setting for diagnosis and treatment evaluation. Different types of neural network such as Artificial Neural Network, Convolutional Neural network, Recurrent Neural Network can be used for the early prediction of Gastric cancers. This study shows the deep learning perspective for the early diagnosis of gastric cancer and thus reducing the risks.

IV. COMPARATIVE STUDY OF Gastric cancer prediction USING DEEP LEARNING

Gastric cancer which is one of the leading disease in cancer and which cause too many deaths. One million new cases occur each year and early prediction of Gastric cancer may reduce the risks and. The most important measure to diagnose gastric cancer is the detection and treatment of diseases early and neural network is one the platform that can be used for early prediction of cancer. Table 4.1 presents the comparative analysis of various methodologies adopted for the GC predictions along with the dataset usage and performance evaluations.

Single point Artificial neural network is used in [8], for gastric cancer prediction which can predict the survival probability of a patient at any predetermined point of time. The authors proposed ANN model for predicting gastric cancer survivability. ANN model was developed to predict the outcome of patients starting from the first year and after each year with maximum of five years after surgery. ROC curve and the accuracy in their model are consistently high and in predicting the probabilities of death for all points of time. In their study 452 patients dataset was taken from the Research centre for Gastroenterology and Liver Disease, Iran. Various features
taken for prediction are age, gender, tumor size, pathologic stage, histological type, lymph node metastasis and so on. Even though, the accuracy their model is good, a deep learning model provides better accuracy when compared to Artificial Neural Network.

Yang et al [9], in their research used image segmentation for gastric cancer prediction. Partial annotation on images using reiterative learning algorithm is used in training dataset. Their proposed method performed well without any pre trained model or any additional annotation details. Patch based approach with fully connected neural network is combined and image segmentation is performed using this model for gastric cancer detection. In their work boundary error is eliminated in patch based model through their overlapped region based algorithm. In their work they used 1400 images as training dataset which are annotated weakly and 500 test dataset where the labels for the images are precise. The overall performance of the model may degrade when trying to detect small cancerous tissues or when over fitting occurs.

To improve the outcome of everyday endoscopy, WISENSE, a real time quality improving system to monitor blind spots with respect to time and generate photo documentation automatically during Esophagogastroduodenoscopy was presented by the authors in [10]. Deep convolutional neural network and deep reinforcement learning is used in their research to make complex and early predictions of gastric cancers in endoscopic images. In their training phase, two pretrained models were used VGG-16 and DenseNet. Three different types of datasets were used with 1.28 million images from 1000 different object classes in the training phase and three thousand images were used in the testing phase. The performance of their model was evaluated in terms of accuracy and the performance was 88.70 for still images and 90.02 for video images.

Yuanpeng Li et al[11], proposed rapid method that can be used for the early diagnosis of gastric cancer which contributes much on clinical application value. Spectral spatial classification method with deep learning is used in their study. Spatial and spectral features are used to make early diagnosis and 120 fresh tissue samples were used for diagnosis. They tested their model for nonprecancerous lesion, precancerous lesion and gastric cancer groups. A pretrainedResNet model was used in their study with spatial spectral preprocessed images with 28,000 training data set and 9600 validation data set and 9600 test dataset images. The performance of their model is measured in terms of accuracy and the model reached 96.5% accuracy indicating that deep learning combined with the spectral-spatial classification method is effective and reliable for the early diagnosis of GC.

An automatic method to detect gastric cancer on whole slide image is proposed by Yeong Won Kim et al, in [12]. Both slide level and region level labels are used for classifying tissues using deep neural network. The dataset used in their method is, each mini-batch contains 16 images with full labels and 16 images with weak labels. The initial learning rate is 0.002 with decay rate 0.5 on every 20000 iterations. In their work the tissue classification performance was improved using slide-level weak label for training the model with patches without region-level
label. Their method achieved 92.51 accuracy with the micro and macro average AUROC on the test set is .98 and .97.

Tumor invasion depth is an important factor for determining the treatment method for early gastric detection. According to the authors in [13] the flaws in endoscopic ultrasonography is measuring the exact depth in a clinical setting as endoscopists often depend on gross findings and personal experience. Hence they developed a model optimized for EGC detection and depth prediction using deep learning concepts in Artificial Intelligence. In their research work VGG-16 a pretrained model was used for classification. To activate the ECG regions a loss function is proposed to measure the performance of their model for classification and also localization errors. The number of images used in their dataset is 11,539 endoscopic images. Their model showed better accuracy in histologic differentiation and undifferentiated hostology showed lower accuracy. Thus, they in their study they proved that the lesion based model is an appropriate training method for AI in ECG.

Table 4.1: Comparative analysis of various methodologies adopted for the GC predictions

<table>
<thead>
<tr>
<th>S.No</th>
<th>Author Details</th>
<th>Model Used</th>
<th>Method for Predictor Measurement</th>
<th>Dataset Used</th>
<th>Performance Evaluation</th>
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</thead>
<tbody>
<tr>
<td>1.</td>
<td>Hamid Nilsaz-Dezfouli et al., [8]</td>
<td>Artificial Neural Network</td>
<td>Retrospective Study for censored Data</td>
<td>452 patients, Taleghani Hospital, Tehran, Iran.</td>
<td>Accuracy - 89.6%</td>
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<td>3</td>
<td>Wu L, Zhang et al.,[10]</td>
<td>Convolutional Neural Network</td>
<td>Esophagogastroduodenoscopy</td>
<td>16,760 EGD Images</td>
<td>Accuracy - 90.40%</td>
</tr>
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<td>4</td>
<td>Yuanpeng Li[11]</td>
<td>Convolutional Neural Network</td>
<td>Nonprecancerous lesion, Precancerous lesion, and gastric cancer</td>
<td>120 fresh tissues samples</td>
<td>Accuracy - 96.5%,</td>
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<td>with Both Spectral and Spatial Feature</td>
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| 5. | Yeong Won Kim, et al., [12] | Deep Learning endoscopic biopsy specimens Normal, Tubular adenoma (TA) and Cancer, tissue phenotypes | 90 cases of hematoxylin and eosin (H&E) endoscopic biopsy specimens, Korea University, Guro Hospital  
Accuracy - 92.51% |
| 6. | Hong Jin Yoon et al., [13] | Convolutional Neural Network EGC detection and depth prediction | 11,539  
endoscopic images  
Accuracy - 73% |
| 7. | Kenta Ishihara et al., [14] | Support Vector Machine- 
Machine Learning approach blood examination, focusing on H. pylori Infection | X-ray Images  
2100 samples  
Specificity - 0.866  
Sensitivity - 0.892 |
| 8. | Jing Li [15] | Convolutional Neural Network preoperative lymph node metastasis (LNM) and prognosis prediction | 204 pathologically confirmed gastric adenocarcinoma patients  
with AUCs of 0.839 (0.773-0.904) in training set and 0.821 (0.722-0.920) in test set |

Two-stage classification method was proposed in [14] for gastric cancer prediction with Computer Aided Diagnosis (CAD) for determining gastric cancer risk. Two stages are in their work. The prediction of Gastric cancer person is performed in the first stage and for the detected patients the level of cancer which is classified as low or high is performed in the second stage. Correlation analysis is perform to derive new feature based on the image features of blood examination and thus improves the performance of the classification. Actual gastric X-ray images are used for evaluating the performance of the system. For prediction they used X-ray images as input and better images such as endoscopy images can be used for the prediction.

Prognosis prediction in gastric cancer for preoperative lymph node metastasis in using spectral CT based images is build using deep learning radiomic model in [15]. Total images used
in their study are 204 images that were confirmed with gastric adenocarcinoma patients. Spectral CT scans were used as input. Radiomic features containing energy enhanced images with arterial phase and Venous phase were used in their study and the features were extracted using deep learning and hand crafted features. Harrell’s concordance index (C-index) based on patients clinical outcomes is used as performance measure. Their model AUC value is 0.711 for arterial phase and 0.755 for Venous phase. The C-indices value showed 0.637 for progression of free survival and 0.669 for overall survival. For prognosis gastric prediction their study provided a new insight for the role of a spectral CT-based radiomicnomogram.

V. CONCLUSION

Gastric cancer still poses a major clinical challenge because most cases are diagnosed in an advanced stage, with a poor prognosis and limited treatment options. The growth rate and development of Gastric Cancer are complicated and affected by multiple factors and a early prediction of gastric cancer reduces the risks. There are many approaches for the detection of gastric cancer and deep learning approach is proved to be the best with good accuracy for the early prediction of gastric cancers. Their early detection and timely treatment have important practical significance for the prevention and treatment of gastric cancer.

REFERENCES


