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Classification and Precision Diagnosis of Endometrial Cancer - Survey

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Abstract

Diagnosis of Cancer type is as important as the right classification of benign and malignant tumor cells. It is also very critical to achieve precision diagnosis to help doctor's find better clinical outcomes. Endometrial type of a cancer that starts in the uterus and found at an early stage as it frequently produces abnormal vaginal bleeding and hence it becomes critical to not only classify the tumor but also to detect the type and grade of the cancer.

In the United States of America, endometrial cancer is a top five leading cancer with fifty-two thousand unique cases reported in the year 2014. This number raised to around sixty thousand in the year of 2016 and these numbers are further estimated to increase to around sixty-two thousand in 2019.

The dataset used is composed of radiology and pathology images from Corpus Endometrial Carcinoma (CPTAC) Patients. This paper uses the Machine learning approaches that will classify the cell as malignant or benign. Deep learning approaches are used to provide Precision diagnosis that provides better outcomes to the clinicians. Convolutional Neural Network algorithms have been successfully used in diagnosis of Brain tumor, Skin Cancer and similar approaches can be used to tackle this problem.

Keywords: *Machine Learning, Deep Learning, Endome- trial Cancer, Convolutional Neural Networks (CNN), OpenCV2, Keras, Scikit-Learn*

1. Introduction

Cancer is a disease that occurs when the old cells in a human body doesn't die and instead grows out of proportion and hence forming abnormally large cells. As seen cancer is one of the deadliest diseases and hence early and precision diagnosis of the disease is critical.

Endometrial cancer like most of the cancer types starts when cells in the endometrium grow abnormally. Endometrial cancer is a most common gynecological disorder in the western parts of the globe, however in India, the rate of occurrence is low. [1]

According to the estimates from GLOBOCAN around 12.7 million unique cancer incidents are there, which results in 7.6 million deaths that have occurred from cancer in 2008 around the globe. In India there are around 0.88 million cancer cases. Endometrial cancer cases are very low in India, based on the city split, there are more cases in Bangalore, followed by Delhi and then Mumbai with the ASR of 4.2, 4.3 and 2.8 per 100,000 respectively [2]

Risk factors for Endometrial cancer includes Obesity, Older age, Hormone Imbalance in the body. Symptoms include vaginal bleeding, Pelvic pain, Bleeding between periods etc. Diagnosis is done by getting picture of the uterus, removing a sample tissue and once diagnosed an X-Ray or a CT scan is done to determine the stage of the cancer.

Our contributions in this paper are as follows:

- Literature survey of related papers on Endometrial Cancer that use Machine and Deep learning techniques
- Proposed test data sets and scope of the future work in this area

Following are the sections included in the rest of the paper. Section 2 includes related works. Section 3 presents Materials & Methods, Section 4 presents Future scope of work, finally, Section 5 covers conclusion.

Related Works

Current work on Applying Machine and Deep Learning techniques in area of Endometric Cancer, revolves around prognosis using few of the machine learning algorithms and SVM, but there is less research that has happened on Precision Diagnosis using different Machine learning algorithms, also applying image preprocessing techniques and using Segmentation and other key Deep learning algorithms. Table below also includes research on various types of cancer that have used CNN.

TABLE I. Survey of Papers on Endometrial Cancer Using Machine and Deep Learning Techniques

REFERENCE	ABSTRACT SUMMARY	TUMOR(S)	DETAILED DESCRIPTION	ADVANTAGES	DISADVANTAGES
Fufen Yin et all [3]	This paper helps establish a predictive model that considers genes and clinical features for the prognosis of EEA. The RF classification method was used to establish the prediction model.	Tumor For Endometroid endometrial adenocar-cinoma (EEA)	Predicting prognosis of EEA on the basis of gene expression using Machine learning Random Forest algorithm. Model performance: RF Model 3 – 80.95%	The prediction accuracy of the RF model on the basis of the 11 genes were higher than that of the RF mod-els by either of the 11 genes or grade alone.	prediction RF model presented in this study could not provide a more individualized and accurate estimation of relapse and mortality for patients diagnosed with EEA
Runyu Hong et all [4]	A deep convolutional neural network models that is developed that predicts not only the histological subtypes, but also molecular subtypes and 18 common gene mutations based on digitized H&E stained pathological images.	Tumor For Endometrial subtypes	Predicting Endometrial Cancer Subtypes and Molecular Features from Histopathology Images using Multiresolution Deep Learning Models like CNN. Model Performance: AUROC ranging from 78.1 to 87.3%	Results of the paper suggests that Panoptes can help pathologists determine molecular and subtypes mutations without sequencing & is applicable to any cancer type.	did Methods not include aeffective way to integrate clinical features into the imaging prediction branches that would improve the overall performance which would be a future scope of work
Mehmet Eren Ahsen et all [5]	A novel sparse Classification algorithm is developed applied to predict risk olymph node metastasis in endometrial cancer patients.	Metastasis in endometrial cancer	Sparse feature selection for classification and prediction of metastasis in endome-trial cancer using Sparse Feature selection algorithm. Model Performance: Predicted 90% of positive cases correctly	Results indicate that the evaluation of the quantitative sparse-feature classifier in clinical trials may lead to significant improvement.	Method didn't cover a repeat of this study on a cohort of biopsies which would be a useful next step
Mario D'Acunto et all [6]	In this paper, Deep Learning approach to classification of osteosarcoma cells. Osteosarcoma is the most common bone cancer occurring prevalently in children or young adults.	Classification of osteosar-coma cells	Deep Learning Approach to Human Osteosarcoma Cell Detection and Classification using Region based Convolutional Neural Net-work (RCNN). Model Performance: The results show a classification accuracy of 0.97.	Identify And classify approximately the 100% of the investigated cells potentially will allow us to extend the it to a large population of tissues or cells.	Method didn't cover the application of DL to tissue in approach order to improve digital histopathology which would be a useful next step
QingZeng Song et all [7]	In this paper, three types of deep neural networks (e.g., CNN, DNN, and SAE) are designed for lung cancer calcification. Those networks are ap-plied to the CT image classification task with some modification for the benign and malignant lung nodules	Classification of lung nodules on CT images	Deep Learning for Classification of Lung Nodules on Computed Tomography Images using Convolution neural network (CNN), deep neural network (DNN), and stacked autoencoder (SAE)	Experimental results suggest that the CNN archived the best performance than the DNN and SAE	Layers of the neural network in this paper is small, due to the limitations of the data sets

TABLE II. Examples of Labelled Data Sets

ID	Specimen	Weight	Age
5f186bdc2fda72087a961e38	tumortissue	304	60-70
5f186bdc2fda72087a96152d	normaltissue	114	60-70

2. Materials and Methods

Image Types and Details

Pathology imaging aids in study of disease through examination of organs, tissues removed surgically and via biopsy etc.

Above figure is an example of the pathology image with tumor tissue

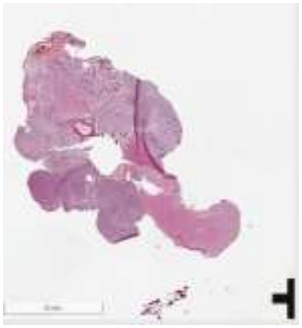

FIG. 1. Endometrial Cancer Dataset - Pathology Image

A set of around of around 676 pathology images are provided in dataset that would be used to identify the tumorous cells, their size and aid the clinicians for precision diagnosis [8-14].

Examples of labelled data sets are mentioned in the Table II.

Data Set Collection and Annotation

Data set is collected from TCIA that abbreviates to The Cancer Imaging Archive. Collection is from National Cancer Institute's Clinical Proteomic Tumor Analysis Consortium Uterine Corpus Endometrial Carcinoma cohort [8].

Dicom Images that consists of various studies and series for each study are provided. 57 and 34 Images from CT, MR scans are available.

Data set also consists of Specimen data which provides a detailed table of weight of the tissue, whether the image has a tumor cell(s) or not, radiology and pathology images and type of Endometric cancer e.g., Clear cell carcinoma, Endometroid carcinoma etc. Labelled data provided will be much useful in classifying tumor.

Each of the specimen data allows use to via either pathology or radiology or both the images that would be especially useful in diagnosing patients and giving useful insights to the clinicians, i.e., how does the weight of specimen with a tumor cell can increase risk for patient

4. Conclusion

Currently there is very less research that has happened that aims at providing Precision diagnosis to clinicians for Endometrial cancer.

Even though there are lot of models that are built most of them just provide accurate results but doesn't go to the next step of helping clinician diagnose patient faster. This is a key part of any disease especially if its life threatening one like cancer.

In this survey paper a detailed review of various survey paper both on endometrial cancer and also on Machine / Deep learning techniques used with similar cancer types is done. There is a lot of scope if these areas to do precision diagnosis by applying specific Machine and Deep Learning approaches.

Future Scope of Work

As mentioned in section 2., there is huge amount of scope for Endometric cancer to apply various Machine Learning Algorithms and Deep Learning techniques as labelled set of data for specimen images is provided, we can apply techniques like Regression, Decision Tree for classifying the tumor.
As labelled set of data for specimen images is provided, we can apply techniques like Regression, Decision Tree for classifying the tumor.
Images in data set would help us to apply preprocessing techniques to improve the image data by suppressing unwanted distortions or enhancement of few image features so that models can be trained

and validated in an iterative fashion based on this improved data which would yield very good results with test data.

Finally, we will apply Convolutional Neural Network a Deep learning algorithm that takes an image that is preprocessed, assigns weights to various aspects of an image to easily differentiate between one image to the another.

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