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PREDICTION OF RHABDOMYOSARCOMA USING TRANSFER LEARNING ON PATHOLOGY AND RADIOLOGY IMAGES

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Abstract: This paper presents the prediction of Rhabdomyosarcoma (RMS) using Transfer Learning model VGG19. While many machine learning techniques have been created to recognise the most common tumour types in histology images, considerably less is understood about the automatic categorization of tumour subtypes. The most prevalent soft tissue cancer in children, rhabdomyosarcoma (RMS), contains a number of subtypes, the most prevalent of which are embryonal, alveolar, and spindle cell. It is important to assign RMS to the appropriate subtype since different subtypes have been shown to react to various treatment modalities. Rhabdomyosarcoma is a common paediatric cancer of malicious soft-tissue tumour that affect 40% to 50% children more than adults. Due of the subtle differences in appearance of histopathology images, manual categorization needs a high level of knowledge and takes time. While many machine learning techniques have been created to recognise the most common tumour types in histology images, considerably less is understood about the automatic categorization of tumour subtypes. The most common sites of RMS tumor are head, neck, genitourinary tract, and extremities. The RMS prediction achieves 97.6% of accuracy for radiology images and 88.4% of pathology images byVGG19 model.

Keyword: Transfer Learning, Machine Learning, Deep Learning, VGG 19

I. INTRODUCTION

Artificial Intelligence is a capability to decode data and information into knowledge by distinguish atmosphere and instructions. Artificial Intelligence create intellectual machines that can simulate human thinking skill and behavior like "algorithm solving" and "learning". Machine Learning is a subdivision of Artificial Intelligence and enables machines to learn from past data or involvements to make prediction or classification without being programmed explicitly**.** Deep neural networks consist of multiple layers of interconnected nodes, each build upon the previous layer to refine and optimize the prediction or classification.

Data resources and computing resources has become a boundary to the development of Artificial Intelligence technology. In order to solve these problems, the transfer learning method is proposed. It is a domain of AI, which uses machine learning algorithms to improve learning capacities in one domain through previous experience to another domain with small amount of data. Transfer Learning can train deep neural networks with lesser data. It also pre-trained and fine-tuned AI models.

Soft tissue sarcomas (STS) are a rare group of tumors and are heterogeneous regarding to location, histologic type, and prognosis. STS develop in different soft tissues such as muscles, fat, connective tissues, or nerves. More than 70 histologic subtypes are recognized by the American Cancer Society. In 2016, 40% of patients suffering from STS*s* die and 25% of them develop distant metastases. However, 40% are Rhabdomyosarcoma (RMS) the most common extracranial solid malignancy found mainly in children, adolescents and, to a lesser extent, in young adults. Rhabdomyosarcoma tumors are so called because they arise from ancestor or primitive muscle cells called **"rhabdomyoblast".** Rhabdomyosarcoma can spread throughout the body. A tissue biopsy is imaging tests to determine if the cancer has spread. Imaging tests may include CT scanning, MRI, PET scanning, and bone scans to determine the risk of cancer. An autopsy report of 57 children who died from ARMS had reported the prevalence of pancreatic metastases in 67% of patients. Several distinct histologic groups have prognostic significance, including embryonal rhabdomyosarcoma (ERMS), which occurs in 55% of patients; the botryoid variant of ERMS, which occurs

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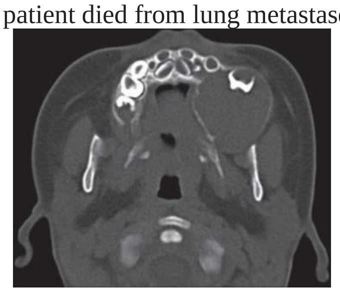
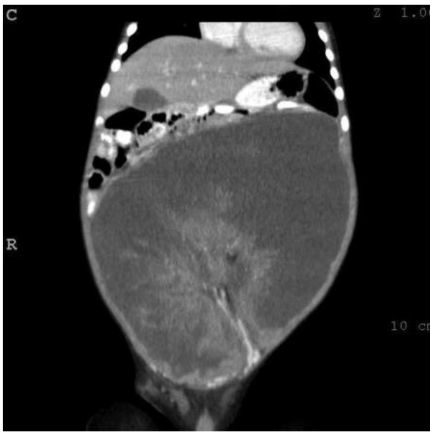
in 5% of patients; alveolar rhabdomyosarcoma (ARMS), which occurs in 20% of patients; and undifferentiated sarcoma (UDS, which occurs in 20% of patients. Early-stage prediction of Rhabdomyosarcoma is important. There is limited data on the outcome of this disease from developing countries, including India for this here the transfer learning with deep learning method is used to predict the disease with better accuracy by imaging tests of rhabdomyosarcoma.

II. CASE STUDY

1. A 1-year-old boy with painful swelling in his mouth swelling was present in size up to 5 cm × 6 cm. Computed tomography confirmed the presence of an extensive infiltrative lesion companied by severe bone destruction and displacement of adjacent structures. patient developed metastatic lesions in bone and lungs. Despite the treatment, the tumor continued to increase in size, and the patient died from lung metastases 6 months after the treatment.



2. A 2-year-old boy was brought to casualty with a 2-week history of insistent vomiting associated with an unknown duration of progressive abdominal swelling. On physical examination he was pale and dehydrated The CT scan is performed and detect the huge mass [4].



3. A 35-year-old male presented with right orbital swelling and diminution of vision for the past 1 month. Biopsy of the orbital mass revealed small round malignant cell arranged in nests, surrounded by fibrovascular stroma. Then F-18-FDG-PET/CT scan performed and it gives the highest accuracy of tumour [5].

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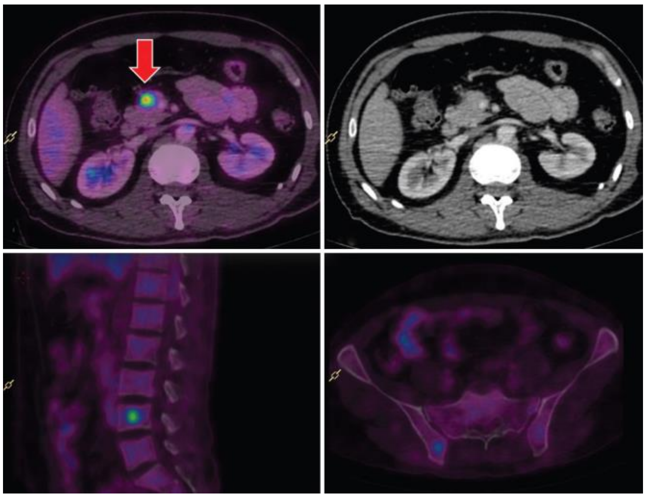
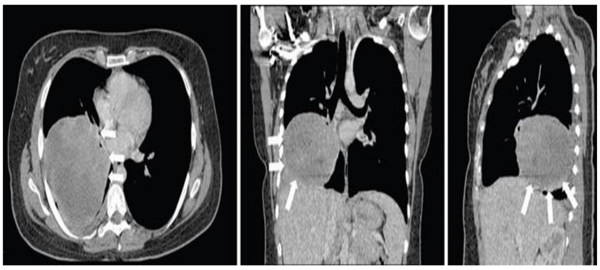


4. A 26-year-old woman presented with cough and breathlessness of 2 weeks duration. Contrast-enhanced computed tomography (CECT) of the chest revealed a well-circumscribed moderately enhancing heterogeneous mass in the right lung lower lobe [6].



III. LITERATURE REVIEW

Develop CNNs to classify and predict ARMS and ERMS using digital and genetic mutation from 144 patients from multiple institutions. Use trichrome, MyoD1 and Myogenin to classify RMS and it automatically select 0.22mm patches from digital images. Reached 90% of AUC for classify the subtypes of RMS [8].

RNA-Seq and clinical data of 125 RMS patients were retrieved from the GEO database, and the tumour samples were analysed using the ESTIMATE algorithm with scores were − 893.87–1079.43, − 1350.06–1034.71 and − 3037.15–2202.51, respectively. The correlation between the stromal and clinical staging of tumour is obtained by construct the PPI network and significant hub genes are screened. Identified genes relation between TME and immune cell infiltration, MAD2L1 and CCNB2 [9].

Evaluate the role of F-FDG PET or PET/CT in the prediction of patient outcome in children and young adults affected by rhabdomyosarcoma. PET performed better than some established risk factors by multivariate testing may be an effect of the limited sample size. A total of 46 patients were screened for inclusion into this retrospective analysis [10].

Deep neural network models Cox Proportional Hazards (CPH) models was developed to predict of 5-year overall and disease-specific survival in genitourinary rhabdomyosarcoma. CPH models identified increasing age, primary sites of the bladder, prostate, and ovary, as well as regional invasion/distant metastasis. CPHDNN model performance achieved an AUC of 0.93 for overall survival and 0.91 for disease-specific survival [11].

Compare machine learning based ensemble architectures for automatic classification of Rhabdomyosarcoma into the three major subtypes, from whole slide images (WSI). For training the class assigned to a WSI, having no manual annotations on the image. Predict the class of a new WSI by divide it into tiles and predict the class of each tile, then use thresholding with soft voting to convert tile level predictions to WSI level prediction and obtain 94.87% of accuracy on subtype classification accuracy on a large and diverse test dataset with 5X magnification [12].

Study included 3399 patients with RMS. (e 5-year cumulative incidence rates of Death Due to Rhabdomyosarcoma (DTR) and Death from Other Causes (DOC) after an RMS diagnosis were 39.9% and 8.7%. A nomogram model was constructed based on multivariate models for DTR and DOC and the performances of the two models were validated by calibration and discrimination, with C-index values of 0.758 and 0.670 [13].

Present a deep-learning-based CADx model for the disparity finding of embryonal (ERMS) and alveolar (ARMS) subtypes of rhabdomyosarcoma (RMS) by multiparametric MR images. Transfer Learning is used by pre-trained deep convolutional neural network and fine-tuned based on the fused images for performing classification of the two RMS

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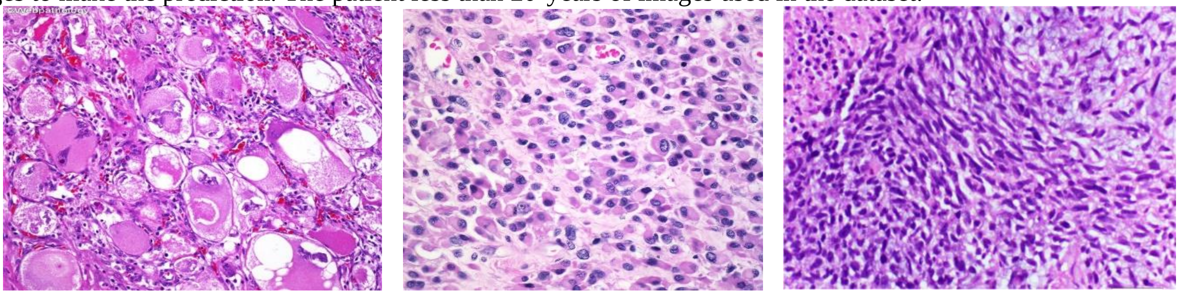
subtypes. T the framework suggests an efficient integration between advanced image processing methods and cutting-edge deep learning techniques. Achieved 85% cross validation prediction accuracy from the fine-tuned deep CNN model [14].

IV. PROPOSED WORK

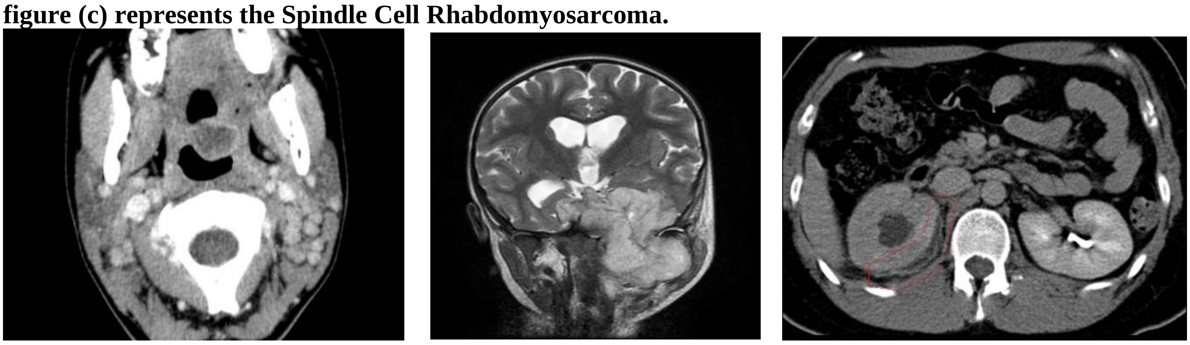
4.1 Data Sets

The data set for rhabdomyosarcoma is rare, so we download the images from the google images based on the rhabdomyosarcoma of both radiology and pathology images. The data consist of 45 pathology images and 70 radiology images to make the prediction. The patient less than 20-years of images used in the dataset.



(a) (b) (c)

Figure (a) represent the Alveolar Rhabdomyosarcoma, figure (b) represents the Embryonal Rhabdomyosarcoma, figure (c) represents the Spindle Cell Rhabdomyosarcoma.



(a) (b) (c)

Figure (a) represent the CT image of rhabdomyosarcoma, figure (b) represents the MRI image of rhabdomyosarcoma, figure (c) represents the PET/CT image of rhabdomyosarcoma.

4.2 Transfer Learning: fine-tuning the Deep Convolutional Neural Network

Using the augmented images, we apply the transfer learning approach for training the VGG19 convolutional neural network model with different model training parameter values. Due to the limited data size, our goal is to fine tune the ImageNet (contains1.2 million images with 1000 categories) pre-trained CNN model VGG19 to classify the affected and unaffected images. Our main proposition is that, on a limited sized dataset, deep models that are learned by CNN transfer learning from ImageNet to other datasets of limited scales, can achieve better performance.

CNN contain more genetic features and gives the high variation between natural images and fused medical images, but the initialization of random weights has high chance of overfitting to the training data is better compared with the use of pre-trained weights in initialization of random weights. Thus, we use transfer learning not only to replace and re-educate the classifier on top of the ImageNET with pre-trained VGG19, but to also fine-tune the weights of the pretrained network.

VGG19 is a modified of VGG model which consists of 19 layers (16 convolution layers, 3 Fully connected layer, 5 MaxPool layers and 1 SoftMax layer). A fixed size of (224 * 224) RGB image was given as input to this network which means that the matrix was of shape (224,224,3). all CNN layers except the last two are fine-tuned at a learning rate.

The prediction is done with softmax activation function with 1 layer and relu activation function with 1 layer. For pathology image processing 45 images used as training and 20 used for testing. For radiology image processing 70 images used as training and 35 used for testing. The higher mean accuracy shows that the features extracted from the pre-trained VGG-19 model.

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V. RESULTS

Following figure shows the performance of each epoch during training and validation of the CNN model for the last fold. The figure 1 shows the training error (blue) and validation error (orange) across training 50 epochs and the right pane shows the objective function value of pathology images with 50 epochs in Figure 2 shows the training accuracy is about 88.4%.

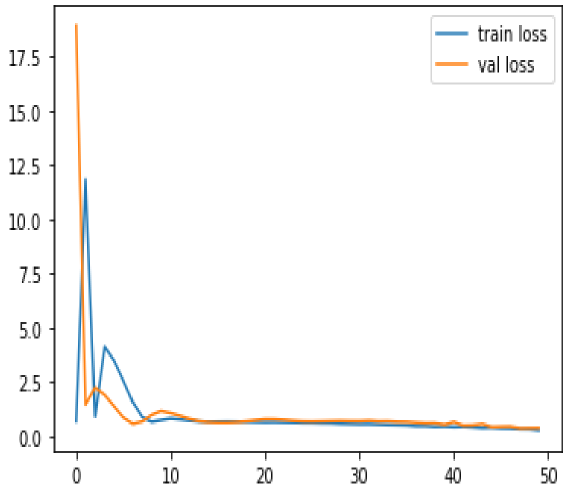

figure 1

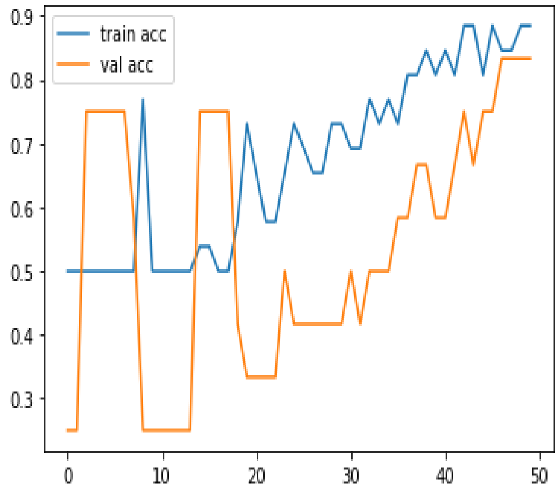

figure 2

Following figure shows the performance of training and validation of the CNN model for the last fold. The figure 3 shows the training error (blue) and validation error (orange) across training 30 epochs and the right pane shows the objective function value of radiology images with 30 epochs in Figure 4 shows the training accuracy is about 97.6%.

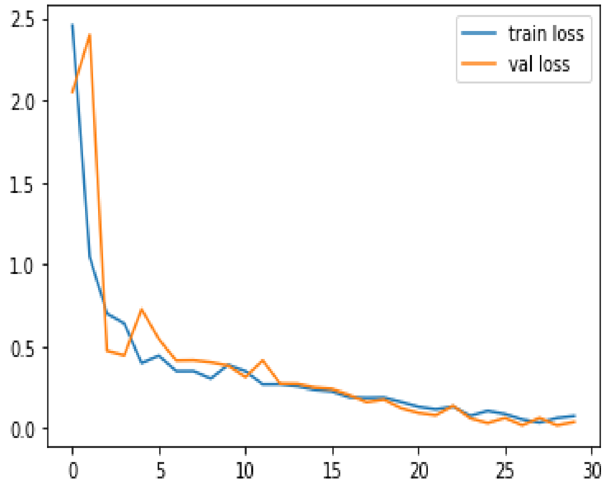

figure 3

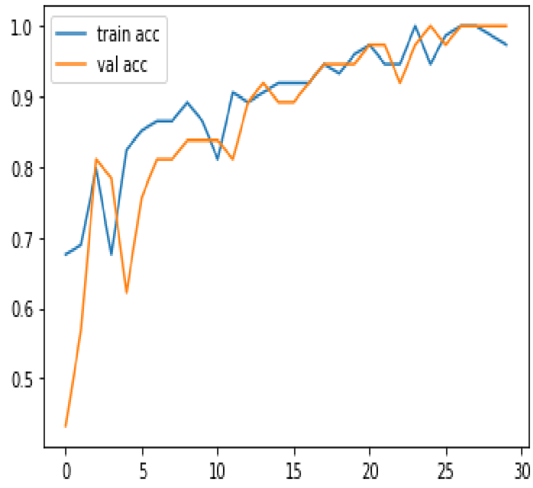

figure 4

VI. CONCLUSION

This study underlines the absolute need for prediction for children as well as the adults with RMS located at any site of human body. RMS is a small, round, blue cell tumor that is presumed to present with micro metastatic disease at diagnosis. Surgery remains an important treatment modality to achieve a disease-free status and improve the outcome. By using Transfer Learning byVGG19 model on RMS the prediction result achieve radiology images with 30 epochs with accuracy about 97.6% and pathology images with 50 epochs with accuracy about 88.4%. Radiology images shows the better prediction compared with pathology images with less amount of epochs.

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