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Capstone Project Phase-1 Report

on

Musculoskeletal Abnormality Detection using Deep Learning

Submitted by

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under the guidance of

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

PROGRAM B.TECH

Declaration

We, *Kothuru Eesha Sougandheeka,Nandana Harikumar,Niharika Gowri Raghunath,Paladi Navya Sree* , hereby declare that the report entitled "Musculoskeletal Abnormality Detection Using Deep Learning" is an original work done under the guidance of Prof. H.R. Vanamala, Assoc Professor in the Dept of ECE and is being submitted as a partial requirement for completion of Phase-1 of Project Work of the B.Tech ECE Program of study during Jan-May 2022.

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Date :24-04-2022

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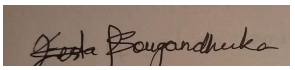
1. Kothuru Eesha Sougandheeka	
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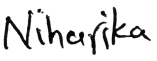
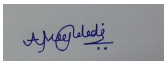
3. Niharika Gowri Raghunath	
4. Paladi Navya Sree	

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INTRODUCTION:

- Musculoskeletal disorders are conditions that affect joints, bones, muscles, and the spine.
- In the United States of America in 2009-2010, close to 105 million emergency ambulatory visits to doctors and hospitals for occurrences of musculoskeletal as well as connective tissue disorders were carried out. Of those visits to healthcare facilities, 39 million were seen by main healthcare officials, 32.4 million were seen by surgeons, and 17 million were visited by medical experts in the field . With the availability of good health service and less time to diagnose diseases, and due to limited training and abilities it might lead to inferior radiologist quality.
- Increasing radiologist workloads and increasing primary care radiology services make it relevant to explore the use of artificial intelligence (AI) and particularly deep learning to provide diagnostic assistance to radiologists.
- In this project ,we investigate new model architectures of deep learning to improve the performance in detecting abnormalities of upper extremities (specifically, shoulders) in limited data environments and allow them to serve as initial analysis tools to prioritize studies for expedited review.

LITERATURE SURVEY:

Saksham Madan et.al.[1] identified the large data as abnormal or normal using the DenseNet-169 architecture after pre-processing. On testing the proposed model, Cohen's Kappa score was about 0.680 and accuracy is around 84.028%
But, other sections of the dataset such as wrist, elbow etc. can also be included for the proposed model.

Ismail Irmarkci et. al.[2] used CNN based architectures, comparatively evaluated the knee abnormality classification performances of different neural network architectures.
In general, ResNet-18 out-performed AlexNet and GoogLeNet in all performance parameters except in specificity (0.6908).

A. F. M. Saif et.al. [3] designed a capsule network to classify normal and abnormal condition and compared the result with DenseNet architecture.The proposed CapsNet
architecture provides almost 10% better kappa score than the 169 layers of DenseNet while using 50% less training data. But since it's a very recent idea, it has been used in very limited areas like classification problems.

Wei Huang et.al. [4] proposed a key area localization mechanism (KALM) for abnormality detection .And the KALM based multi-scale abnormality
detection method is attempted for the first time. The comparative experiments on several classical CNNs are conducted on the largest dataset of MURA, and the excellent results demonstrate the effectiveness of the proposed KALM.

Tusher Chandra Mondo et.al.[5] developed a novel Computer-Aided Diagnosis(CADx) system based on Deep Convolutional Neural Network (Deep CNN). Future research can be that Contrast Limited Adaptive Histogram Equalization (CLAHE) can be used instead of Histogram Equalization (HE) to enhance the radiographs.

Obioma Pelka et.al.[6] fused automatically generated image keywords with radiographs, enabling multi-modal image representations for body part and abnormality recognition. The proposed work can be further enhanced by exploiting other word embedding methods, as well as other branding methods, and precedes the way of combining several features of different heterogeneous modalities.

Takumi Sato and Kazuhiro Hotta [7] proposed a transfer learning method which can easily transfer CNN to Capsule Network. Using images of liver cells from mice.They created a capsule random transformer to make CNN pre-trained networks and made them interact with each other.

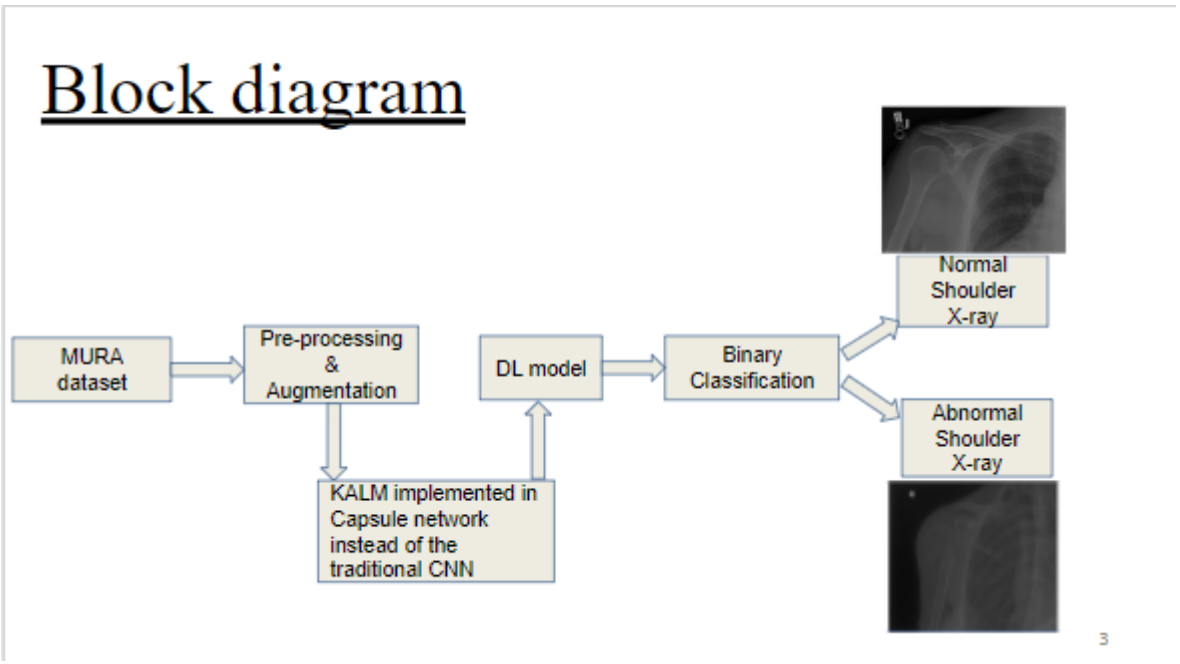
Sun Jin Park,Ho-Hyun Park[8] proposed a method to accelerate the learning of the CapsNet model, which is much slower than the existing neural network. They Confirmed that the learning time is decreased in inverse proportion to the increase of the number of nodes in learning.

Conclusion:

- We have concluded from the literature survey that CNN architectures gave better performance for lower extremities such as wrist,humerus.
- But for upper extremities specifically shoulder capsule networks gave best accuracy i.e.92.08 % to 94.06%.
- KALM is a newly proposed approach which has both local and global features that makes feature extraction easier.
- Integrating both capsule and KALM yields better results.

PROPOSED METHODOLOGY:

- CNN, which is very powerful in computer vision, is essentially a system that accumulates many neurons.
- Although CNN performs well in categorizing images close to the data set, if the image rotates slightly, tilts, changes direction, or changes lighting, it cannot be detected by simple CNN. In general, these problems have been solved by adding variations of the same image during learning. Each layer of CNN understands images at a much more detailed level. As data is propagated from the lower layer to the upper layer, the filter tries to see the entire picture. In this situation, it tries to summarize through the pooling to obtain a reasonable computation time, which in essence results in the loss of positional data
- Capsule Network has been proposed to solve the problem. Capsule Network has been implemented for some tasks such as object segmentation , classification tasks and so on. Capsule Network preserves location information of the feature map. In order to achieve this, Capsule network uses capsule structure, which is a vector representation of a feature map. In comparison, CNN uses scalar to represent feature maps. It also uses routing-by-agreement to perform pooling-like operations and preserve location information at the same time.
- For abnormality detection, it is crucial to locate the most important area in the musculoskeletal radiographs. To achieve this goal, a key area localization mechanism (KALM) can be used. The KALM explicitly defines the process of selecting the most important area from the whole image by using only image-level labels. Based on KALM, we can present a joint global and local feature representation strategy for abnormality detection which takes as input both the entire image and the selected local area.
- We can integrate the features of both Capsule networks and KALM to overcome disadvantages of CNN and feature extraction.



SOFTWARE REQUIREMENTS:

The MURA dataset

MURA (**mu**sculoskeletal **ra**diographs) is a large dataset of bone X-rays. Algorithms are tasked with determining whether an X-ray study is normal or abnormal.

It is a dataset of musculoskeletal radiographs consisting of 14,863 studies from 12,173 patients, with a total of 40,561 multi-view radiographic images. Each belongs to one of seven standard upper extremity radiographic study types: elbow, finger, forearm, hand, humerus, shoulder, and wrist. Each study was manually labeled as normal or abnormal by board-certified radiologists from the Stanford Hospital at the time of clinical radiographic interpretation in the diagnostic radiology environment between 2001 and 2012.

IMPLEMENTATION DETAILS:

Pre-Processing

- Performed a comparative study based on the different pre-processing methods used in Ensemble learning with Class Activation Map technique (CAM) [13], VGG-19, ResNet [9] and Capsule network [1].

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