OSTEOARTHRITIS CHECKUP SYSTEM

Group ID - 3

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Submitted by:

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Introduction

1.1 Introduction to System

Essentially the whole system can be summed up as an 'Osteoarthritis Grade Prediction and Concise Report Generation System'. Primarily the main motivation behind the project was that the traditional method to observe Xray and report generation by a Radiologist takes too much time mainly due to high population, dependence on experience of Radiologist, artefacts on X-ray images, management of physical reports and Lack of proper infrastructure and services in rural regions.

A full-fledged system with 1/5th the size of industry standard model (published by University of California San Francisco in early 2019(Fine-tuned VGG19 Model) [8]) and an **increment in accuracy from 69.7% to 75.42%** (more details in Section 3.2) and a proprietary Pre-processing method which is able to resolve most of defects from images (Sample Results [10]). Alongside that, a robust web application with a proper database management system. System is designed in a way to be more scalable in future.

1.2 Details about Osteoarthritis

Osteoarthritis is one of the most common form of arthritis, affecting millions of people worldwide. It occurs when the protective cartilage that cushions the ends of your bones wears down over time. Osteoarthritis is the second most common rheumatologic problem and it is the most frequent joint disease with a prevalence of 22% to 39% in India (over 10 million cases were observed last year). OA is more common in women than men, but the prevalence increases dramatically with age. The knee is one of the joints most commonly affected by osteoarthritis. Cartilage in the knee may begin to break down after sustained stress, leaving the bones of the knee rubbing against each other and resulting in osteoarthritis. To examine that, a Radiologist observes the X-Ray Report of the Patient. X-rays of arthritic knee may show a narrowing of joint space, changes in the bone and the formation of bone spurs(osteophytes). After determination of grade of osteoarthritis, Radiologist gives corresponding comments and then reports are finalized.

However, there is a significant time involved in this process (can vary from 2 to 4 days in India) of generating the final report and especially in areas where the population is considerably high and number of medicine practitioners are comparably low. Another thing to take into consideration especially for a developing country like India is that in private hospitals, the cost of treatment is high and in government hospitals there is a lot of overhead and managing physical reports can be difficult. In rural regions, there is an unavailability of infrastructure and healthcare services and considering results are highly dependent on the experience of radiologist it would be quite effective to automate this whole process.

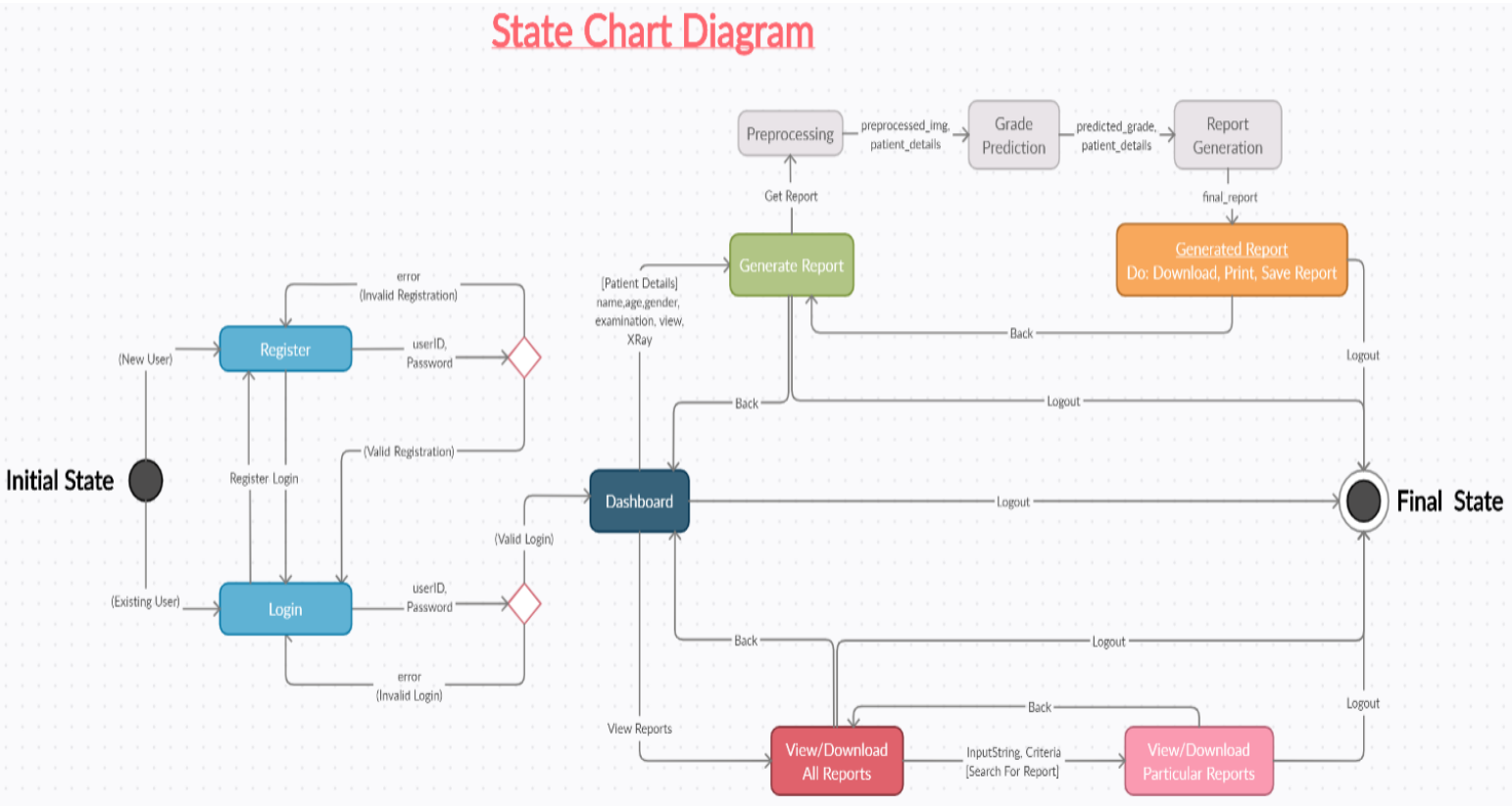
System Details

2.1 Features of the System

- Register/Login user
- Generating New Report
- Download/Print Report
- User details and Report Management
- View-Download-Search Patients Report's based on
  - Serial No.
  - Gender
  - Grade
  - Name
  - Age
- Change System's Language (108 languages including Hindi and Punjabi)

2.2 State Chart Diagram

Our team followed the Agile Development approach while constructing this system. The below diagram depicts different states the system can exist in during runtime and it can help in getting a view of the system's working as a whole (more System diagrams [9]).



2.3 Overview of System and Technologies used

System uses **Node.js with Express** framework at its Backend and **HTML, CSS(Bootstrap), JavaScript** at its Frontend.

- On opening the web application, the user is greeted by a Login/Registration Page. The login system uses the passport local strategy to authenticate users and ***MongoDB*** is used as the database to store user information as well as patient information and report data. All the passwords are encrypted and thus **made secure by *bcryptjs***.
- On successfully logging in, the user gains access to the dashboard from which the user can generate a new report or visit old reports at his/her leisure. Most of the **webpages are dynamic** which is made possible by the ***EJS* package in Node**.
- After entering the details of a new patient and uploading their X-ray scan, a Deep Learning Model predicts the Grade of Osteoarthritis using **Python** script on the basis of the given information and generates a HTML report which is converted into a PDF format using the ***puppeteer* API**. The user now has the option to print/download the report and save the information onto the database.
- Going back to the dashboard, the details of the patient added and the report can be accessed from the View Reports section. The server queries the database for information and displays the information of all the patients in a tabular form. Reports can be re-downloaded from here and the user also has the option to search for patients according to their Serial No., name, age etc.
- System also has the feature to change Language of the entire Interface using ***Google-Translate-Script***. (108 languages including Hindi and Punjabi)

  Finally, the user can Logout to end the session!

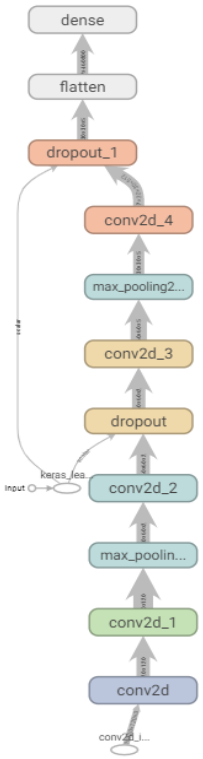
Model Details

3.1 Model Structure

The base Structure of the model is inspired by the VGG series with reoccurring 2D Convolutional layers (they apply a filter to an input to create a feature map that summarizes the presence of detected features in the input.) and Max pooling layers (Its function is to progressively reduce the spatial size of the representation to reduce the number of parameters and computation in the network.) with number of units increasing as we move towards the bottom of the model.

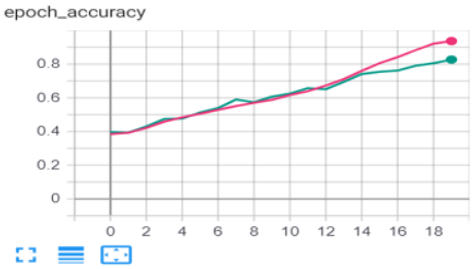
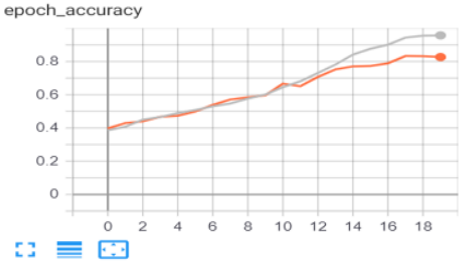
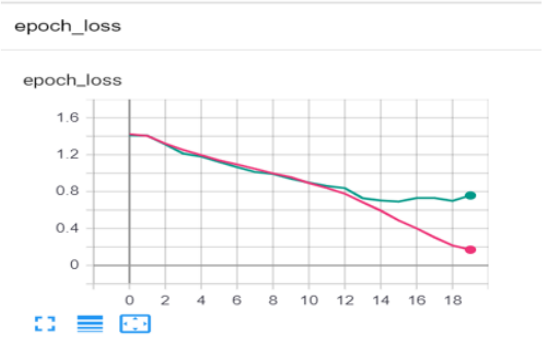
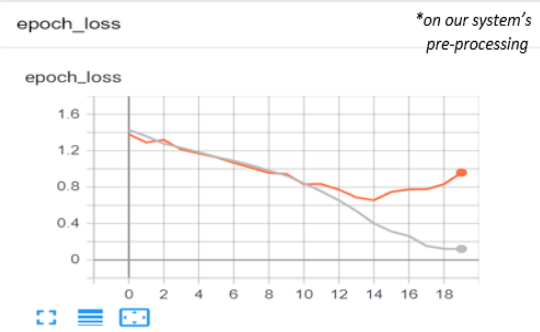
Here, Dropout is used alternatively in layers without any sort of regularization to get the most effective neurons in that layer at the end of the process and in layers without any dropout the model utilizes l2 regularization to maintain the weights of those layers to a comparably smaller amount.

```
Model: "sequential"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d (Conv2D)              (None, 120, 120, 64)      1792
_________________________________________________________________
conv2d_1 (Conv2D)            (None, 120, 120, 256)     147712
_________________________________________________________________
max_pooling2d (MaxPooling2D) (None, 60, 60, 256)       0
_________________________________________________________________
conv2d_2 (Conv2D)            (None, 60, 60, 256)       590080
_________________________________________________________________
dropout (Dropout)            (None, 60, 60, 256)       0
_________________________________________________________________
conv2d_3 (Conv2D)            (None, 60, 60, 512)       1180160
_________________________________________________________________
max_pooling2d_1 (MaxPooling2 (None, 30, 30, 512)       0
_________________________________________________________________
conv2d_4 (Conv2D)            (None, 30, 30, 512)       2359808
_________________________________________________________________
dropout_1 (Dropout)          (None, 30, 30, 512)       0
_________________________________________________________________
flatten (Flatten)            (None, 460800)            0
_________________________________________________________________
dense (Dense)                (None, 5)                 2304005
=================================================================
Total params: 6,583,557
Trainable params: 6,583,557
Non-trainable params: 0
```



3.2 Model comparison against Industry Standard Model

Industry Standard model mentioned here is Fine tuned VGG19 Model published by University of California San Francisco in early 2019(trained on Our System's Preprocessing method).

Our Model	Industry Standard Model
Size of the model is 108mb (Nearly 1/5th of Industry Standard Model)	Size of the model is more than 500mb
Accuracy of Model is 75.42%	Accuracy of Model stands at 69.7%
	
	

*on our system's pre-processing

Conclusion

A full-fledged system with **1/5th the size of industry standard model** (published by University of California San Francisco in early 2019(Fine-tuned VGG19 Model) [8]) and an **increment in accuracy from 69.7% to 75.42%** and a proprietary Pre-processing method which is able to resolve most of defects from images Alongside that, a robust web application (Currently Live at https://oa-checkup-system.herokuapp.com/) with a proper database management system. System is designed in a way to be more scalable in future since we are utilizing the tech stack which is commonly used to handle large amount of data.

GitHub Link: https://github.com/Gauravsharma-20/Minor-Project

Deployed At: https://oa-checkup-system.herokuapp.com/

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10. https://github.com/Gauravsharma-20/Minor-Project/blob/master/SystemDetails/SamplePreprocessedResults.jpg --- Sample Preprocessed Results.