DAYANANDA SAGAR UNIVERSITY

KUDLU GATE, BANGALORE – 560068

Bachelor of Technology
in
COMPUTER SCIENCE AND ENGINEERING

Major Project Phase-II Report

DENTAL ASSISTANCE TOOL

By
ANIRUDHA NARAYAN SHASTRI- ENG18CS0039
ELWIN THOMAS- ENG18CS0098
ALLWYN A.K- ENG18CS0030
JYOTHSNA T-ENG18CS00119
ANANYA SANJEEV SAWANT-ENG18CS0036

Under the supervision of

Prof. Arjun Krishnamurthy

Assistant professor

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING,
SCHOOL OF ENGINEERING
DAYANANDA SAGAR UNIVERSITY,
BANGALORE

(2021-2022)

DAYANANDA SAGAR UNIVERSITY

School of Engineering
Department of Computer Science & Engineering
Kudlu Gate, Bangalore – 560068
Karnataka, India

CERTIFICATE

This is to certify that the Phase-II project work titled **"DENTAL ASSISTANCE TOOL"** is carried out by **ANIRUDHA NARAYAN SHASTRI (ENG18CS0039), ALLWYN A.K (ENG18CS0030), ELWIN THOMAS (ENG18CS0098), JYOTHSNA T (ENG18CS0119), ANANYA SANJEEV SAWANT (ENG18CS0030),** bonafide students of Bachelor of Technology in Computer Science and Engineering at the School of Engineering, Dayananda Sagar University, Bangalore in partial fulfillment for the award of degree in Bachelor of Technology in Computer Science and Engineering, during the year **2021-2022**.

Prof Arjun Krishnamurthy Assistant Professor Dept. of CS&E, School of Engineering Dayananda Sagar University Date:	**Dr Girisha G S** Chairman CSE School of Engineering Dayananda Sagar University Date:	**Dr. A Srinivas** Dean School of Engineering Dayananda Sagar University Date:

Name of the Examiner **Signature of Examiner**

1.

2.

DECLARATION

We, **ANIRUDHA NARAYAN SHASTRI (ENG18CS0039), ALLWYN A.K (ENG18CS0030), ELWIN THOMAS (ENG18CS0098), JYOTHSNA T (ENG18CS0119), ANANYA SANJEEV SAWANT (ENG18CS0036),** are students of the eighth semester B.Tech in **Computer Science and Engineering**, at School of Engineering, **Dayananda Sagar University**, hereby declare that the phase-II project titled **"DENTAL ASSISTANCE TOOL"** has been carried out by us and submitted in partial fulfillment for the award of degree in **Bachelor of Technology in Computer Science and Engineering** during the academic year **2021-2022**.

Student **Signature**

Name1: Anirudha Narayan shastri
USN: ENG18CS0039
Name2: Allwyn A.K
USN: ENG18CS0030
Name3: Elwin Thomas
USN: ENG18CS0098
Name4: Jyothsna T
USN: ENG18CS0119
Name5: Ananya Snajeev Sawant
USN: ENG18CS0036

Place : Bangalore
Date :

ACKNOWLEDGEMENT

It is a great pleasure for us to acknowledge the assistance and support of many individuals who have been responsible for the successful completion of this project work.

First, we take this opportunity to express our sincere gratitude to School of Engineering & Technology, Dayananda Sagar University for providing us with a great opportunity to pursue our Bachelor's degree in this institution.

We would like to thank **Dr. A Srinivas. Dean**, **School of Engineering & Technology**, **Dayananda Sagar University** for his constant encouragement and expert advice. It is a matter of immense pleasure to express our sincere thanks to **Dr. Girisha G S, Department Chairman**, **Computer Science, and Engineering**, **Dayananda Sagar University,** for providing the right academic guidance that made our task possible.

We would like to thank our guide **ARJUN KRISHNAMURTHY, Assistant Professor**, **Dept. of Computer Science and Engineering**, **Dayananda Sagar University**, for sparing his valuable time to extend help in every step of our project work, which paved the way for smooth progress and the fruitful culmination of the project.

We would like to thank our Project Coordinator **Dr. Meenakshi Malhotra**, **Dr. Bharanidharan N** and all the staff members of Computer Science and Engineering for their support.

We are also grateful to our family and friends who provided us with every requirement throughout the course. We would like to thank one and all who directly or indirectly helped us in the Project work.

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ABSTRACT

With rapid development in field of AI for healthcare, it is crucial that the gap between AI technological advancement and usability for the healthcare professionals must be bridged. The goal of our tool is the bridge this gap in the field of healthcare starting with Dentistry.

In dentistry, the field which we are working closely on development of multifarious AI powered solutions, lacks the basic infrastructure, for us engineers to develop and deploy it to them, which brought into light two major issues:

1)Generation and collection of data for a specific diagnostic task

2)Deployment of the developed AI Algorithm with ease of usage for the dental professionals.

As a solution we built a web-based portal. To address the issue of data collection, custom annotation tools were built for the different projects/departments, which provided the dentist a simple platform to annotate the images with less efforts and providing us the data needed in the desired formats. This platform also provided us the opportunity to give the dentist access to the AI tools at the click of a button for different diagnostic analysis and research.

List Of Abbreviations

CVS	Cervical Vertebrae Staging
ML	Machine Learning
AI	Artificial Intelligence
IOPA	Intraoral Periapical Radiographs

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

CHAPTER 1

INTRODUCTION

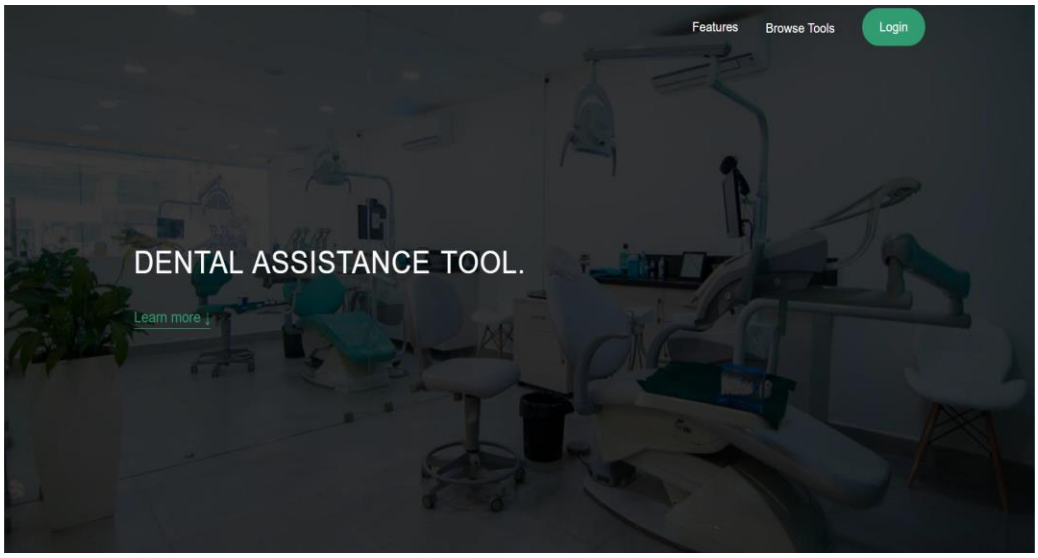
The world of AI revolves around executing the basic tasks through machines which make the human work simpler and time effective. It makes the human life simpler through the use of various technology. The actual use of AI now is beyond ones wildest dream. But the discussion of AI also brings up the topic of its impact on the society, economy, healthcare and politics as well. One of the best example in the healthcare is the dentistry.AI in dentistry is used to detect many tooth related issues such as detecting the bone fractures, detecting the bone loss, it is also used to detect the bone cyst, implants and even gum related issues and many more diseases.AI can perform these tasks more precisely and with more safety. It also reduces the chances of error under the manual human tasks.

1.1. INTENDED AUDIENCE

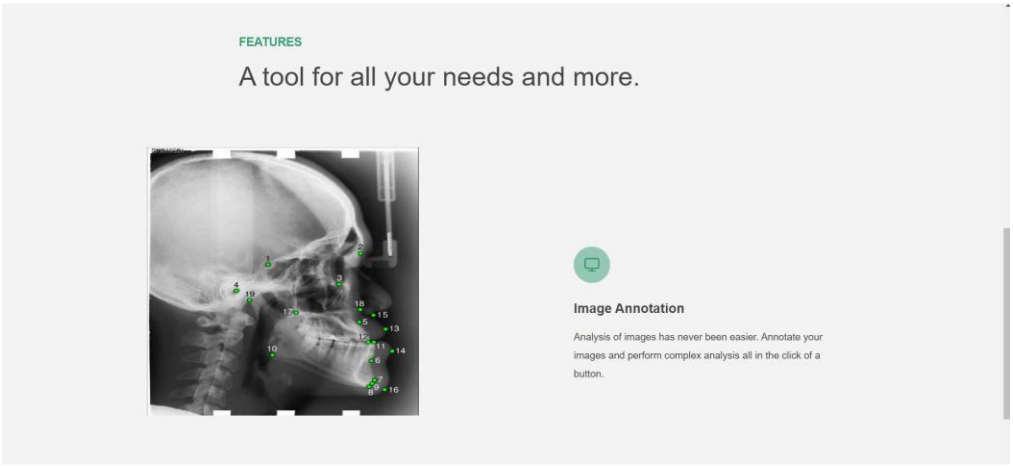
This project is designed to help ease the workload and diagnostics for the field of Dental Sciences. It is designed to cover requirements of all the different departments under dental Sciences. This tool is not only for professional use but can be used for teaching and research purposes.

- Dental Doctors
- Research Professionals
- Teachers

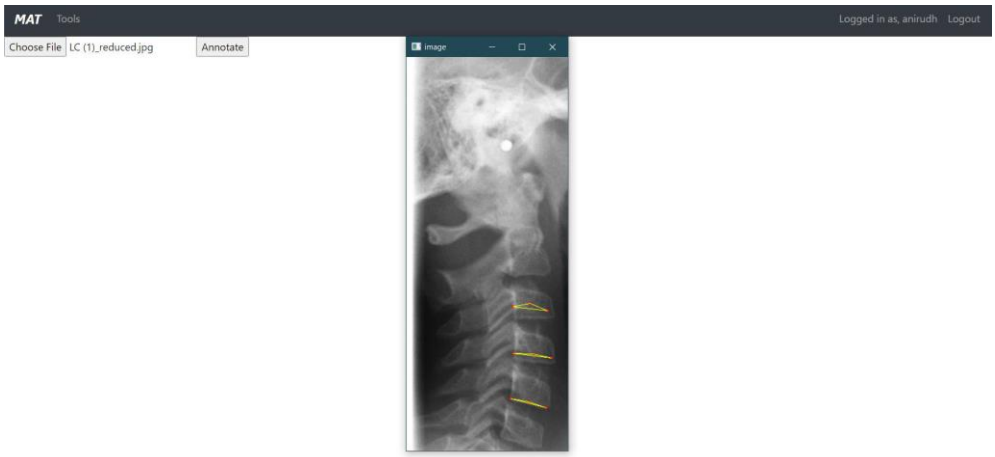
1.2. FIGURES AND TABLES



(Fig:1.2-a)



(Fig:1.2-b)



(Fig:1.2-c)

1.3. SCOPE

The annotation tools currently in use are really time consuming and hard to understand the usage. With our tool users will be able to do the annotations easily, as it guides the users in each step. And since the design is very simple and user friendly there won't be any problem to get used to using the tool. So, this can be a very good tool for annotation in future after it is developed to business level.

AI can be used to detect dental decay and periodontal disease.

AI can improve quality in the dental field using image detection, classification, and segmentation. For example, CNNs can detect dental decay based on learning the location and morphology of carious lesions on radiographs; thus they're effective for diagnosing decay.[2]

CNN techniques can provide image classification and segmentation that can be used as an additional tool to detect periodontal disease on radiographs. CNNs can capture

patterns from periodontally compromised teeth (PCT) images and perform edge detection.

AI can detect oral cancer .It can be used to analyze images of oral cancer lesions for early detection and diagnosis. Oral cancer survival rates depend on early diagnosis, and it is imperative that the clinician perform an oral cancer screening at each recall visit.

1.3.1 Future work:

- This is an initial version of the tool that is based on a survey with dental professionals. Once the tool has been deployed, based on further feedback we can improve it further.

- The tool will be deployed on a web page accessible to all.
- More features in terms of usability and ease in user interface will be developed
- A patent will be filed before global deployment of the tool

CHAPTER 2

PROBLEM DEFINITION

CHAPTER 2

PROBLEM DEFINITION

The Goal is to develop and deploy a web-based software that is designed keeping in mind the needs of dental professionals and students. It will be intended to help dental professionals to have easy access to AI enabled Landmark Detection, NLP based electronic healthcare Records, Image annotation Tools and other image processing techniques easily without any difficulty and extra software. It will also be collecting data in a database for use by us for any machine learning problems in the future. This data collected will be very large and really helpful for the university in the future.

- LANDMARK DETECTION FOR BONE AGE PREDICTIONS
- LANDMARK DETECTION FOR EARLY BONE LOSS DETECTION
- LANDMARK DETECTION FOR CEPHALOMERTIC ANALYSIS
- CUSTOM ANNOTATION TOOLS
- CARIES DETECTION

CHAPTER 3

LITRATURE REVIEW

CHAPTER 3
LITRATURE REVIEW

3.1 CLASSIFICATION

The use of AI in different dental specializations include applications in Orthodontics, Conservative dentistry and prosthodontics, Periodontology, Temporomandibular joint disorders, Endodontics, Maxillofacial surgery.

There was also a study to retrospectively assess radiographic data and to prospectively classify radiographs, comparison was made between three deep learning architectures for their classification performance. convolutional neural networks , a residual network, and a capsule network for classification. . Results: All three models showed high accuracy (>98%). ResNet achieved the best performance at small variance and fastest convergence.

3.2 ANNOTATION TOOL

PLAINSIGHT is an AI powered annotation tool that has been developed with the idea of selecting and annotating with ease. It is capable of auto annotation, label tracking , label classification, customization options for the labels and it also lets one to export the annotated image and it also supports a vast format of images for Computer Vision.

DL in dental An example

The paper Deep learning for early dental caries detection in bitewing radiographs Shinae Lee1 talk about how DL can be effectively used on images for detection of a dental decay. By usen U-NET CNN model it was made possible to help dentist to locate cavities using Bitewing radiographs. Training was done on 340 radiographs and performance evaluation was done using 50 radio graphs.

3.3 IMAGE PROCESSING

Image classification is the process of segmenting images into different categories based on their features. A feature could be the edges in an image, the pixel intensity, the change in pixel values, and many more.

Some techniques which are used in digital image processing include:

Anisotropic diffusion, Hidden Markov models, Image editing, Image restoration, Independent component analysis, Linear filtering, Neural networks, Partial differential equations.

Using keras: Keras is an open-source software library that provides a Python interface for artificial neural networks. Keras acts as an interface for the TensorFlow library.

Using openCV: It can process images and videos to identify objects, faces, or even the handwriting of a human. When it is integrated with various libraries, such as Numpy which is a highly optimized library for numerical operations.

3.4 TYPE OF MEDICAL SCANS IN DENTISTRY-:

- MRI
- CT scan
- CBCT scan
- X-rays
- PET scan

3.4.1 MRI(Magnetic Resonance Imaging):-

It is a well established imaging technique in various areas of medicine that has become fundamental for non-invasion diseases of soft tissue diseases since it has a great advantage of not using ionizing radiation, it also avoids the biological damage that's related to other three dimensional imaging techniques such as CT. MRI is almost comparable to the latter in terms of spatial resolution and data visualization ability in the visions of the traverse and panoramic planes which are mostly familiar to the dentists.

MRI techniques are currently being used in dentistry for diagnosis of temporomandibular joint diseases which may lead to a degeneration of the discs, inflammatory conditions of the facial skeleton, and in examination of the salivary glands, maxillary sinuses, masseter muscles, in the detection of early bone changes such as tumors, fractures, inflammatory conditions and hematoma.

3.4.2 Ct- Scans:-

CT or computer Tomography scans offer medical professionals a detailed and clear picture of your teeth and bones. Unlike the CT scanning machine used for a full body imaging, dental CT scanning machines work much like a dental x-ray machine. The patients sit upright as an X-ray device rotates around the skull to capture a 3D image. The process is faster as compared

to the other CT scans and emits a relatively low amount of radiation. It creates images that are similar to the X-rays but which are of superior quality.

3.4.3 CBCT Scans:-

The major difference between CT and CBCT is that, CT is usually done at the hospital where the patient lays down, but in the CBCT the scan is done by making the patient stand. You simply stand in a marked area in front of the scanner, you hold onto the bars in front of you and then guides will be put in place to hold your head stationary.

3.4.4 X-Rays:-

X-rays are a form of energy that can travel through or be absorbed by solid objects. This energy is absorbed by dense objects, such as teeth and bones, and show up in X-rays as light-colored areas. X-rays pass through less dense objects, such as gums and cheeks, and appear as dark areas on X-ray film. X-rays can help find problems that cannot be seen with an oral exam.

X-rays help your dentist diagnose problems in your teeth and jaws.

In adults, X-rays show:

- Decay, especially small areas of decay between teeth.
- Decay beneath existing fillings.
- Bone loss in the jaw.
- Changes in the bone or root canal due to infection.
- Condition and position of teeth to help prepare for tooth implants, braces, dentures or other dental procedures.
- Abscesses (an infection at the root of a tooth or between the gum and a tooth).
- Cysts and some types of tumors.

3.4.5 PET Scans:-

Positron emission tomography (PET) uses small amounts of radioactive materials called radiotracers or radiopharmaceuticals, a special camera and a computer to evaluate organ and tissue functions. By identifying changes at the cellular level, PET may detect the early onset of disease before other imaging tests can.

3.5 TYPES OF ANNOTATIONS :

- Key Points
- Polylines
- Semantic Segmentation
- 2D Bounding Box
- Polygon

3.5.1 Key Point Annotation:-

The objects in an image are labelled using points to determine the shape of it. Key points annotations are used to label facial/skeletal features.

3.5.2 2d Bounding Box :-

It outlines the objects using bounding boxes for in depth recognition either its humans, cards or order object. We use the 2D bounding box annotation tool depending upon on the quantity and the quality of the data

3.5.3 Polylines Annotation:-

Polylines annotation is suitable in lane detection for autonomous vehicles defining bicycle, directions, divergence and opposite direction traffic to perceive the surroundings for safe and trouble-free driving of such vehicles backed with successful AI-models.

3.5.4 Semantic Annotation:-

The image is segmented semantically at its pixel level. Based on the pixel labeling, semantic segmentation is of 2 types:

- Full pixel/Standard segmentation
- Instance segmentation

3.5.5 Polygon/Contour Annotation:-

Objects in an image are labeled by drawing an accurate contour around it. Used in creating datasets for training precise application models.

CHAPTER 4

PROJECT DESCRIPTION

CHAPTER 4

PROJECT DESCRIPTION

The AI enabled dental assistance tool is integrated as a web-application. Our tool aims at helping dental professionals/ practitioners by using AI technology to make their everyday tasks easier. Meticulous care has been taken to provide a smooth and user-friendly UI which makes it easy even for someone without technical expertise to use the various features of our tool.

Functionalities:

Image annotation is the process of labelling images of a dataset to train a machine learning model. Therefore, image annotation is used to label the features you need your system to recognize. Our tool uses cv2 to automatically annotate cervical vertebrae on cephalograms. This annotation feature can be extended to work on other images as per requirements.

Landmark detection using a stacked hourglass architecture On IOPA and Lateral Cephalogram with Region of interest classifiers are integrated. This architecture is used due to its high special awareness and good functionality of landmark localization.

Among deep neural networks, the convolutional neural network has demonstrated excellent results in computer vision tasks, especially in image classification. We use image classification to detect various dental diseases.

Modules:

Login - The user will be required to login to access the various tools in the application. Each dental department will have their own unique features on the site. The registration, login authentication and session management is achieved using the Flask web framework which is a micro-framework written in Python.

The database - We have used SQLite for our database. User table stores all user information. We also store the original and annotated images as a way of collecting data.

Annotation tool - This is a CV2 based tool designed with the dentist's requirements in mind and the idea of data collection for us engineers. This tool provides the dentist a user-friendly software for annotation and for us engineers the coordinates and other data which can be used for training our AI/ML models.

Landmark detection - The concept of landmark localization is one with vast application in the field of dentistry. Currently our tool has deployed three AI powered landmark localization tool for Cephalometric analysis, Bone Age perdition using CVS classification and Early prediction of Bone Loss in IOPA images.

CHAPTER 5

REQUIREMENTS

CHAPTER 5

REQUIREMENTS

5.1 FUNCTIONAL REQUIREMENTS

The Tool should provide the following functions:

- The user shall be able to input images of desired format
- perform tasks as desired for segmentation, edge detection and Annotation, etc.
- The system shall generate reports with the help of machine learning or just geometric calculations about required measurements, coordinates and basic classification.
- Landmark detection for bone age prediction
- Landmark detection for bone loss detection
- Landmark detection for Cephalometric analysis
- Annotation tool for data generation and collection

User interfaces

- Front-end software: Flask, TensorFlow, jupyter notebook, Dicom image software, Web browser
- Back-end software: Python, Database systems

5.2 NON-FUNCTIONAL REQUIREMENTS

5.2.1. Product requirement

The user program shall be implemented on an open-source software on Python programming language.

Usability

The system should be easy to use. One of the software's features is timesaving. The system also should be user friendly for admins. The desktop user interface shall be Windows 7 (or above) compliant.

Reliability

This software will be developed with Machine Learning, feature extraction classification and regression. It will be trained on well processed datasets and well-trained parameters and hyperparameters for the learning algorithm. This way we will be able to get accurate results every time.

Performance

The system should be able to support multiple users at any given point of time. Prediction time and response time should be as little as possible, because one of the software's features is timesaving.

Supportability

The system should require Python and Deep learning knowledge for its maintenance. If any problem occurs in system, it requires code knowledge and ML knowledge to solve. Client-side problems should be fixed with an update.

1. SOFTWARE REQUIREMENTS

- Windows 8 and above
- Jupyter Notebook
- Web browser

2. HARDWARE REQUIREMENTS

- Processor: Any Processor above 2 Giga Hz
- Ram: minimum of 4GB
- Hard Disk: 1 TB
- Input Device: Keyboard and Mouse.
- Output Device: Monitor.
- Internet connection.
- RTX 3080 /GPU COMPUTATION POWER
- SERVER SYSTEM

CHAPTER 6

METHODOLOGY

CHAPTER 6

METHODOLOGY

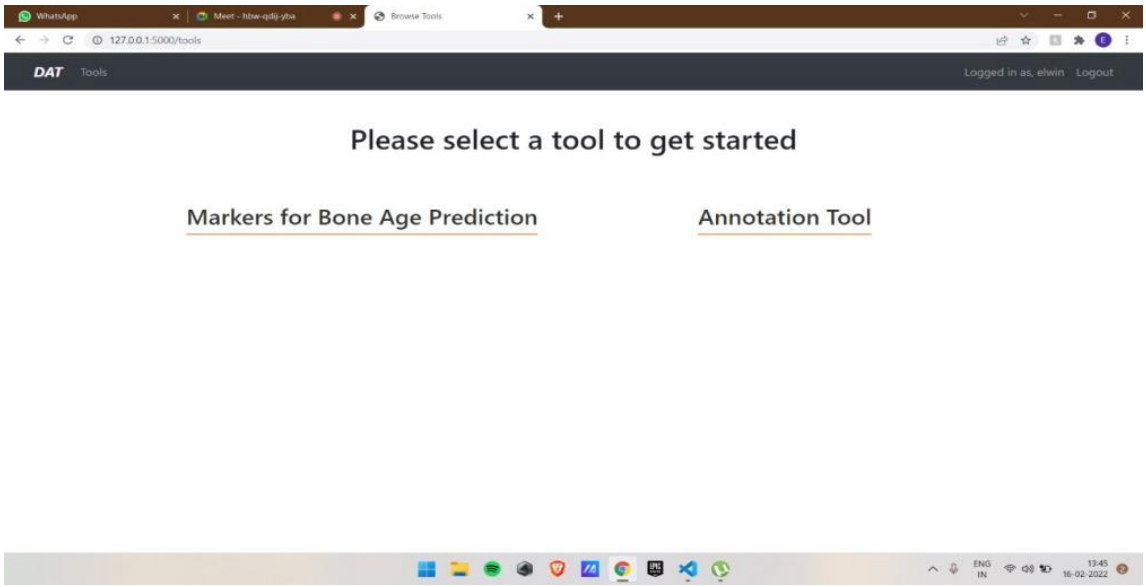
Methodology: Our project is developed and focused based on multiple surveys with dental professionals and studying about what is currently being used in terms of software technology for diagnostics. Currently in the field of Dental diagnostic there has not been any commercial incorporation of AI enabled Diagnostic. Our project aims to achieve a platform for Ai enabled diagnostics that can be commercially by the dental industry.

Method: We have developed a platform that surves two purposes for AI enables dentistry.

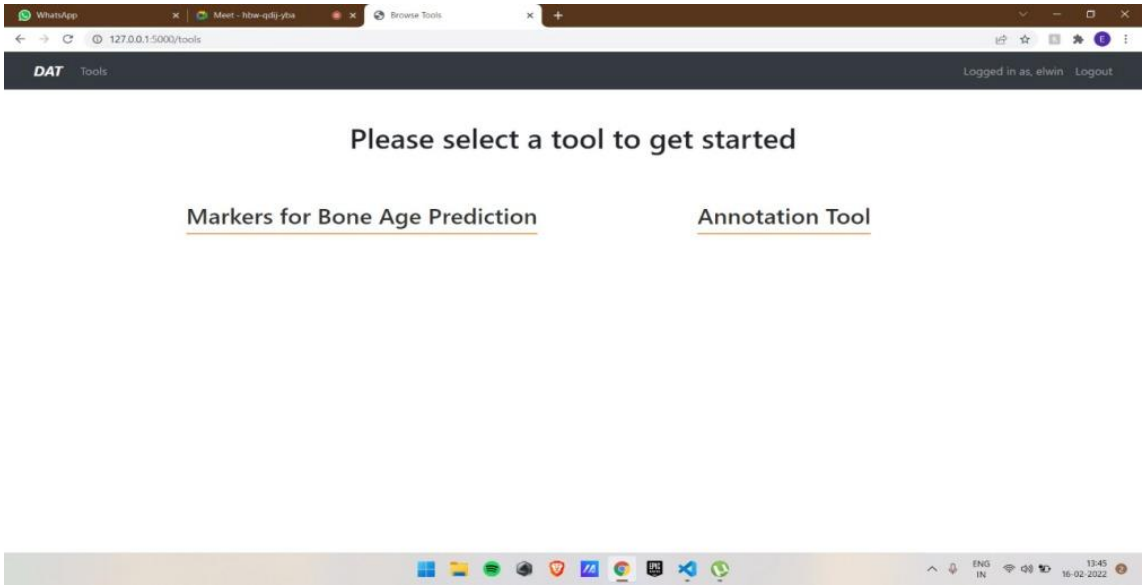
1) We have a inhouse annotation tool developed and deployed for the sole purpose of collection of data based on our and the dentists custom requirements.
2) The data generated from this platform can be used for training and development of AI models which will be deployed on the same platform as a diagnostic tool.

The tool developed is focused and customized based on the project in consideration. The main focus of the tool if to provide us with annotated images as ground Truth and a CSV file that contains the data required for the training of models with the original images.

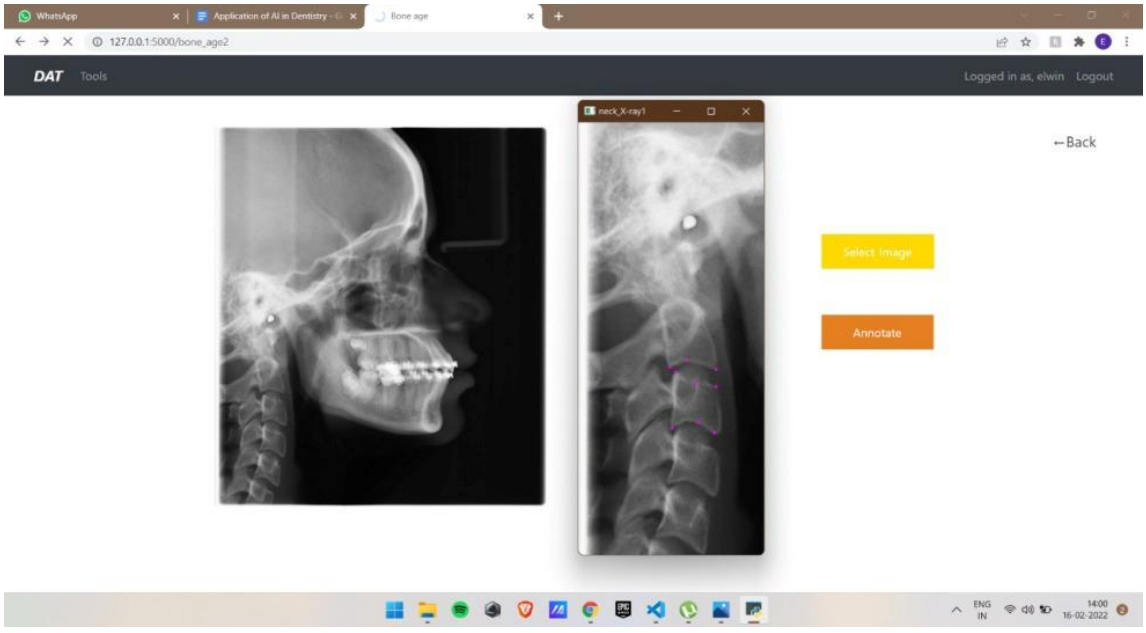
The AI tool on the same platform focuses on removing human error and saving time for the diagnosis. The tool is again custom designed based on the requirements of the particular diagnostic focus.



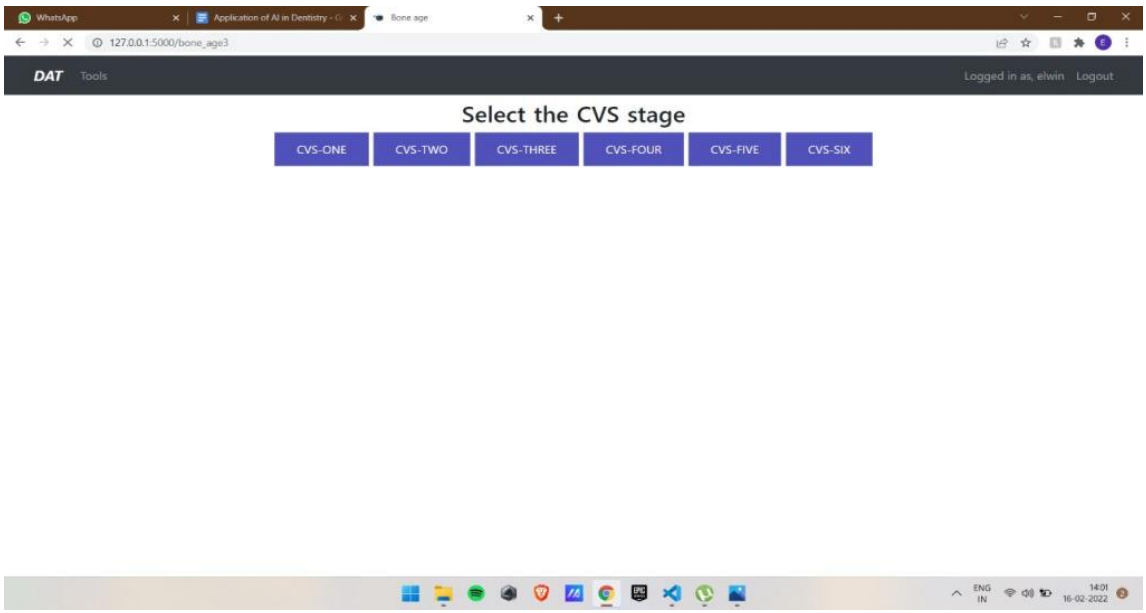
(Fig:6-a)


DAT
Tools
Logged in as, elwin
Logout
Please select a tool to get started
Markers for Bone Age Prediction
Annotation Tool

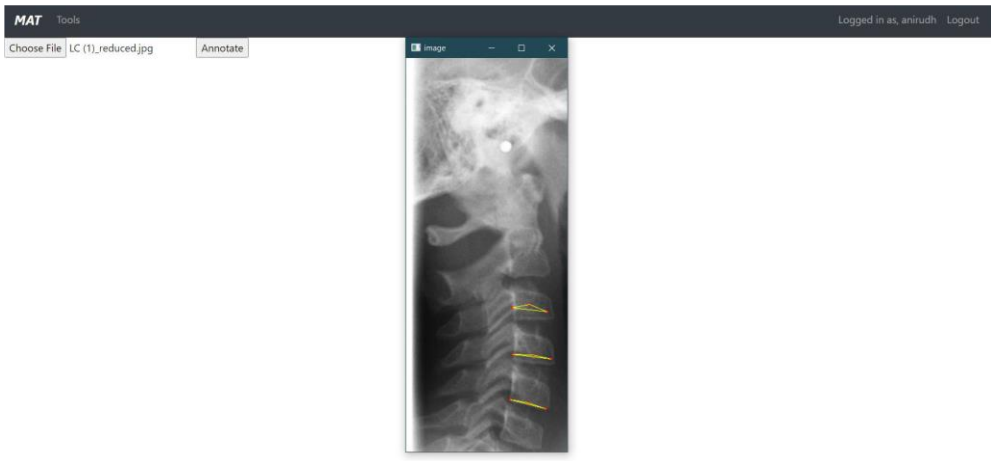
(Fig:6-b)


DAT
Tools
Logged in as, elwin
Logout
←Back
Select Image
Annotate

(Fig:6-c)



(Fig:6-d)



(Fig:6-e)

Existing data

All data used for this project is real time. It has been collected by our own inhouse tools which are custom designed based on the use case. Since we are working with dentists the main data type we are working are X-Ray images of the following types.

1)IOPA

2)Lateral Cephalograms

3)OPG

Following data Collection all the required preprocessing image enhancement and augmentation techniques have been used to make the dataset more versatile for training robust models.

CHAPTER 7

EXPERIMENTATION

CHAPTER 7

EXPERIMENTATION

Code Snippet (Markers for bone age prediction):

```
            y_vals1.append(y)

# This is the main function for the annotation of points and drawing all the lines and adding the whole
    #second image copy with depth identification
def auto_full_anno(image_final,x_vals,y_vals,annotation_vals, image, filename):


        x_vals1=[]
        y_vals1=[]
        temp_lst=[]
        # Close()


        cv2.namedWindow('neck_X-ray1')
        param = [x_vals, y_vals, annotation_vals, image_final]
        cv2.setMouseCallback('neck_X-ray1', draw_dots, param)
        exit_imgdisp(image_final)
        cv2.destroyAllWindows()

        temp_lst=['1','2','3','4','5','6','7','8','9','10','11','12','13','14','15','16','17','18','19']
        for i in range(len(temp_lst)):
            annotation_vals[i]=temp_lst[i]


        data = {'X':x_vals,'Y':y_vals,'Annotation':annotation_vals}
        df = pd.DataFrame(data)
        print_txt_img(df, image_final)


        data = {'X':x_vals,'Y':y_vals,'Annotation':annotation_vals}
```

(Fig:7-a)

```
    cv2.line(image_final1,(df.iloc[0][0],df.iloc[0][1]),(df.iloc[2][0],df.iloc[2][1]),colors['yellow'],1)

    cv2.line(image_final1,(df.iloc[0][0],df.iloc[0][1]),(df.iloc[1][0],df.iloc[1][1]),colors['yellow'],1)
    cv2.line(image_final1,(df.iloc[1][0],df.iloc[1][1]),(df.iloc[2][0],df.iloc[2][1]),colors['yellow'],1)


    #findind the line equation between point 9 and 11
    cv2.line(image_final1,(df.iloc[8][0],df.iloc[8][1]),(df.iloc[10][0],df.iloc[10][1]),colors['yellow'],1)

    cv2.line(image_final1,(df.iloc[8][0],df.iloc[8][1]),(df.iloc[9][0],df.iloc[9][1]),colors['yellow'],1)
    cv2.line(image_final1,(df.iloc[9][0],df.iloc[9][1]),(df.iloc[10][0],df.iloc[10][1]),colors['yellow'],1)


    #findind the line equation between point 9 and 11
    cv2.line(image_final1,(df.iloc[16][0],df.iloc[16][1]),(df.iloc[18][0],df.iloc[18][1]),colors['yellow'],1)

    cv2.line(image_final1,(df.iloc[16][0],df.iloc[16][1]),(df.iloc[17][0],df.iloc[17][1]),colors['yellow'],1)
    cv2.line(image_final1,(df.iloc[17][0],df.iloc[17][1]),(df.iloc[18][0],df.iloc[18][1]),colors['yellow'],1)


    cv2.namedWindow('neck_X-ray1')
    param = [x_vals1, y_vals1, image_final1]
    cv2.setMouseCallback('neck_X-ray1',single_dot1, param)
    while True:
        cv2.imshow('neck_X-ray1', image_final1)
        # Continue until 'q' is pressed:
        if cv2.waitKey(20) & 0xFF == ord('q'):
            break

    cv2.destroyAllWindows()
```

(Fig:7-b)

Code Snippet (Annotation tool):

```
from dat import db
from dat.hourglass104 import StackedHourglassNetwork

model = StackedHourglassNetwork(
        input_shape=(256, 256, 3), num_stack=2, num_residual=1,
        num_heatmap=19)
model.load_weights('dat/models/automatic_bone_age/model-v0.0.1-epoch-4158-loss-0.8258.h5')

plt.rcParams["figure.figsize"] = (10,10)

def find_max_coordinates(heatmaps):
        flatten_heatmaps = tf.reshape(heatmaps, (4096, 19))
        indices = tf.math.argmax(flatten_heatmaps, axis=0)
        # after flatten, each 64 values represent one row in original heatmap
        y = tf.cast(indices / 64, dtype=tf.int64)
        x = indices - 64 * y
        return tf.stack([x, y], axis=1).numpy()

def extract_keypoints_from_heatmap(heatmaps):
        max_keypoints = find_max_coordinates(heatmaps)
        # pad the heatmap so that we don't need to deal with borders
        padded_heatmap = np.pad(heatmaps, [[1,1],[1,1],[0,0]])
        adjusted_keypoints = []
        for i, keypoint in enumerate(max_keypoints):
            # since we've padded the heatmap, the max keypoint should increment by 1
            max_y = keypoint[1]+1
            max_x = keypoint[0]+1
            # the patch is the 3x3 grid around the max keypoint location
            patch = padded_heatmap[max_y-1:max_y+2, max_x-1:max_x+2, i]
```

(Fig:7-c)

```
        return normalized_keypoints

def draw_keypoints_on_image(image, keypoints,filename, index=None):
        fig,ax = plt.subplots(1)
        ax.imshow(image)
        joints = []
        for i, joint in enumerate(keypoints):
            joint_x = joint[0] * image.shape[1]
            joint_y = joint[1] * image.shape[0]
            if index is not None and index != i:
                continue
            plt.scatter(joint_x, joint_y, s=10, c='blue', marker='o')
        # plt.show()
        buf = io.BytesIO()
        plt.savefig(buf, format='jpg')
        buf.seek(0)
        imgf = im.open(buf)
        imgf.show()
        img_arr = np.array(imgf)
        converted_img = cv2.imencode('.jpg',img_arr)[1].tostring()
        img_name = filename.replace('.jpg','')+"_auto_annotated.jpg"
        img_auto = Img_Auto_Ann(img = converted_img,name=img_name)
        db.session.add(img_auto)
        db.session.commit()
        buf.close()

def predict(img):
        # encoded = tf.io.read_file(image_path)
        image = tf.io.decode_jpeg(img)
        inputs = tf.image.resize(image, (256, 256))
```

(Fig:7-d)

```
                continue
            plt.scatter(joint_x, joint_y, s=10, c='blue', marker='o')
        # plt.show()
        buf = io.BytesIO()
        plt.savefig(buf, format='jpg')
        buf.seek(0)
        imgf = im.open(buf)
        imgf.show()
        img_arr = np.array(imgf)
        converted_img = cv2.imencode('.jpg',img_arr)[1].tostring()
        img_name = filename.replace('.jpg','')+"_auto_annotated.jpg"
        img_auto = Img_Auto_Ann(img = converted_img,name=img_name)
        db.session.add(img_auto)
        db.session.commit()
        buf.close()

def predict(img):
        # encoded = tf.io.read_file(image_path)
        image = tf.io.decode_jpeg(img)
        inputs = tf.image.resize(image, (256, 256))
        inputs = tf.cast(inputs, tf.float32) / 127.5 - 1
        inputs = tf.expand_dims(inputs, 0)
        outputs = model(inputs, training=False)
        heatmap = tf.squeeze(outputs[-1], axis=0).numpy()
        kp = extract_keypoints_from_heatmap(heatmap)
        return image, kp
```

(Fig:7-e)

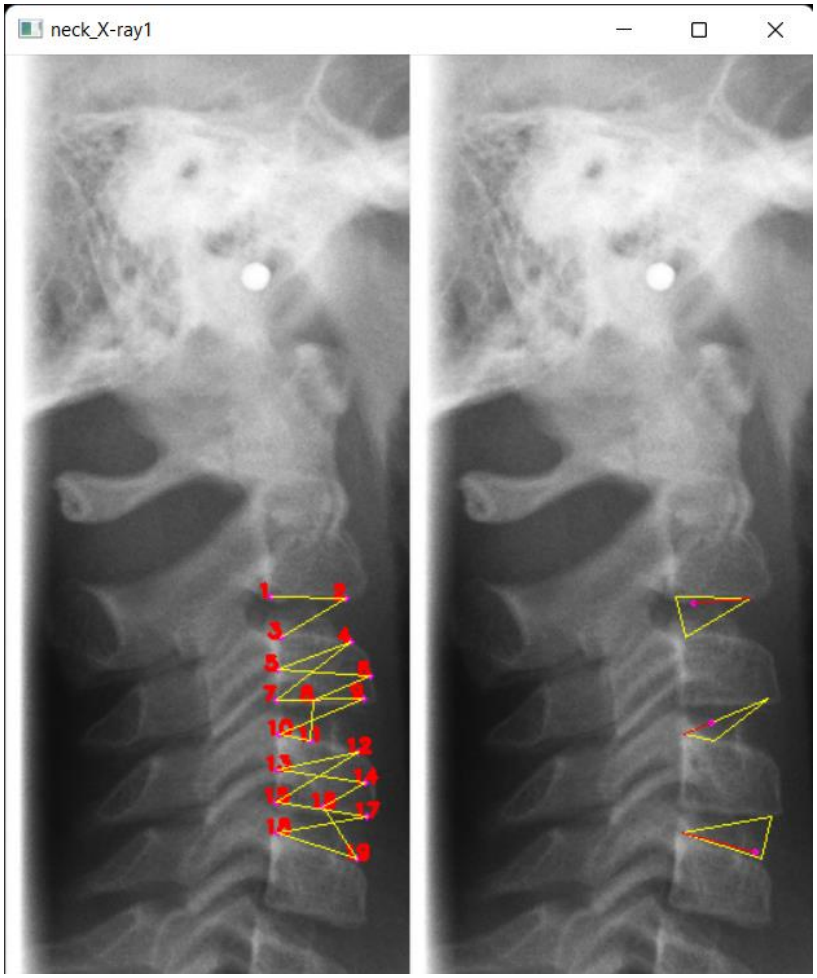
CHAPTER 8

TESTING AND RESULTS

CHAPTER 8

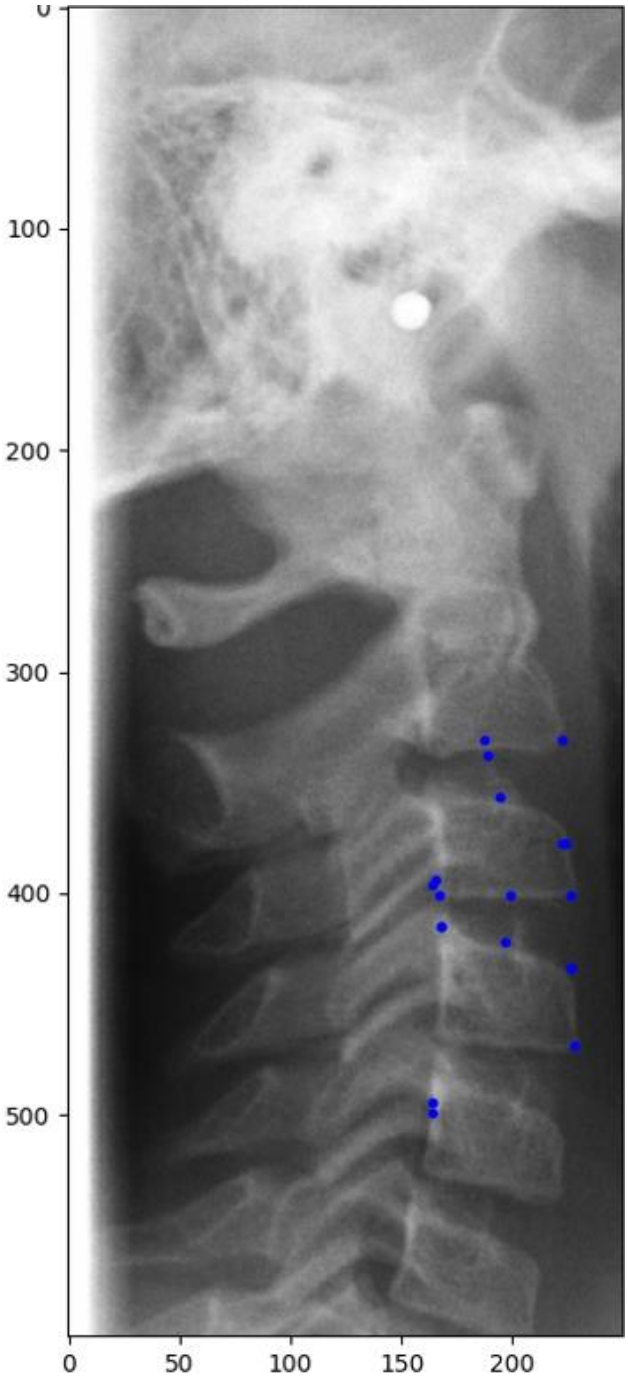
TESTING AND RESULTS

Annotation tool:



	X	Y	annotations---LC_1.jpg-----CVS-FOUR
1			
2			
3	164	335	1
4			
5	210	336	2
6			
7	170	360	3
8			
9	213	363	4
10			
11	168	380	5
12			
13	225	384	6
14			
15	167	399	7
16			
17	190	399	8
18			
19	221	398	9
20			
21	169	420	10
22			
23	188	424	11
24			
25	218	431	12
26			
27	168	442	13
28			
29	222	450	14
30			
31	167	462	15
32			
33	196	465	16
34			
35	223	471	17
36			
37	168	481	18
38			
39	217	497	19
40			

AI annotation tool:


0
100
200
300
400
500
0
50
100
150
200

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- AL Powered Labelling
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RESEARCH PAPER

Multifarious Techniques For AI Enabled Dentistry

Abstract:-

This research paper is focused on the explanatory dissemination of the indegenous Dental Assistance Tool developed in collaboration with dentists aimed at solving challenges faced during diagnosis and treatment. This tool signifies the narrowing gap between dentistry and AI techniques. The field of dentistry, specifically in India lacks the technical assistance and any form of AI infrastructure for which brought into light two major issues, firstly, the generation and collection of data for diagnosing a particular disease and secondly, deployment of the developed AI Algorithm which proved utilitarian for dental professionals.

So as a solution to these problems we have designed and developed an AI based software tool . To address the issue of data collection, custom annotation tools are built for the different projects and the departments, which provided the dentists with a simple platform to annotate the images with comparatively lesser effort and provided us with the data in desired formats for training AI models. This platform also provides us with an opportunity to deploy these models to the dental professionals at the click of the button for different diagnostic analyses and research.

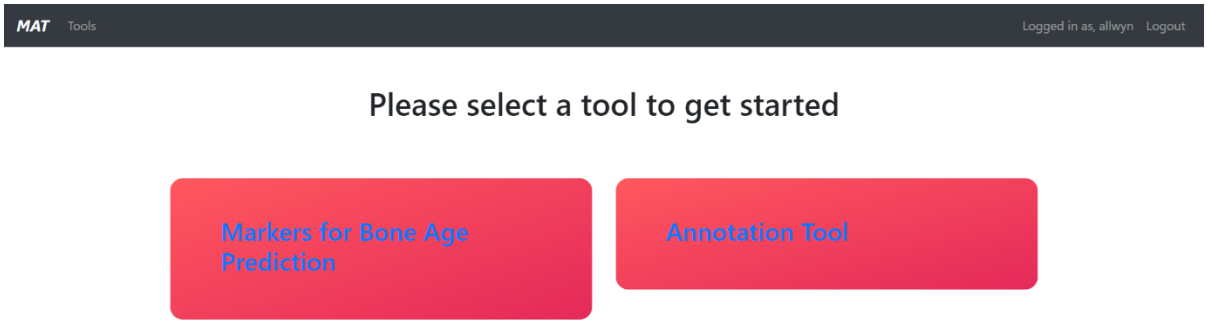
Introduction: -

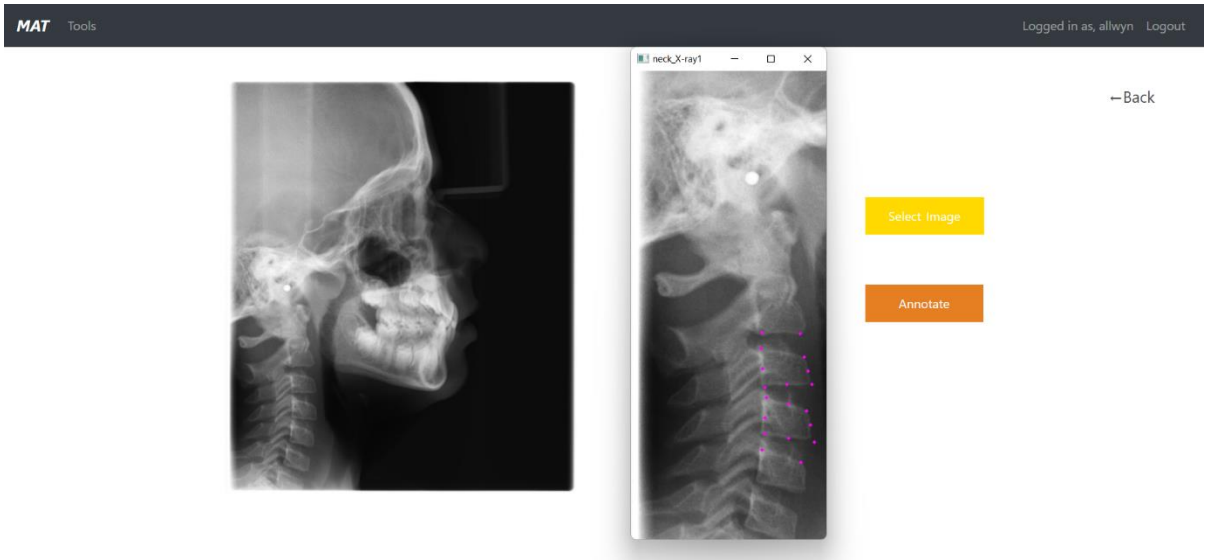
The world of AI revolves around executing the basic tasks through machines which make human work simpler and more time-effective by using various technologies. The actual use of AI now is beyond one's wildest dream. But the discussion of AI also brings up the topic of its impact on society, economy, healthcare and politics as well. One of the upcoming fields for implementations of AI in healthcare is Dentistry. AI in dentistry is used to detect many teeth related issues such as jaw fractures, bone loss, bone cysts, gum related issues and many more diseases. By using AI the speed of diagnosis can be improved without compromising on accuracy.

At the moment we have collected around two thousand training images. These include four hundred lateral cephalograms for CVS staging and four hundred IOPA images. These will be used to train our AI model for predictions. The feedback from the dentists has been very positive. They expressed that the tool helped them save a lot of time compared to previously used annotation tools such as Autocad and ImageJ.

METHODOLOGY

The AI-enabled dental assistance tool is integrated as a web application. Our tool aims at helping dental professionals/ practitioners by using AI technology to make their everyday tasks easier. Meticulous care has been taken to provide a smooth and user-friendly UI which makes it easy even for someone without technical expertise to use the various features of our tool.





Functionalities:

Image annotation is the process of labeling images of a dataset to train a machine learning model. Therefore, image annotation is used to label the features you need your system to recognize. Our tool uses cv2 to automatically annotate cervical vertebrae on cephalograms. This annotation feature can be extended to work on other images as per requirements.

Landmark detection using a stacked hourglass architecture On IOPA and Lateral Cephalogram with Region of interest classifiers are integrated. This architecture is used due to its high special awareness and good functionality of landmark localization.

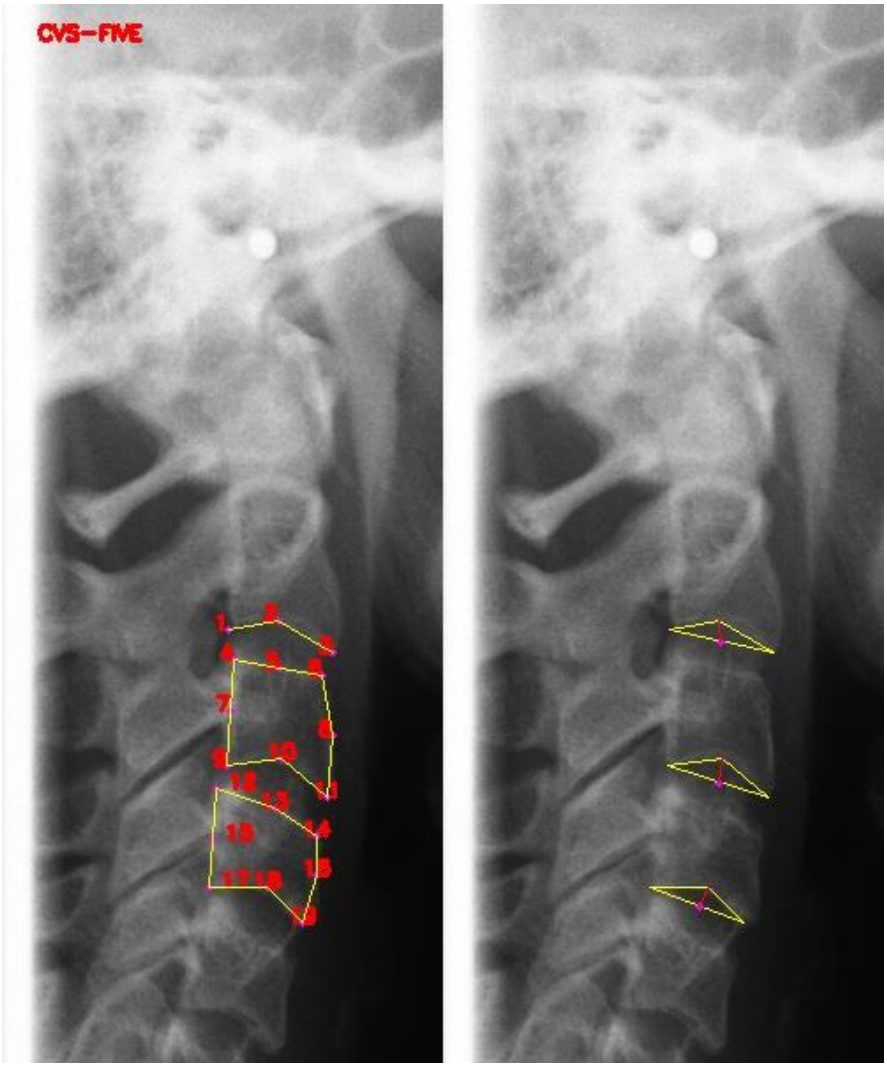
Among deep neural networks, the convolutional neural network has demonstrated excellent results in computer vision tasks, especially in image classification. We use image classification to detect various dental diseases.

Modules and Features:

Login – The user will be required to login to access the various tools in the application. Each dental department will have its own unique features on the site. The registration, login authentication and session management are achieved using the Flask web framework which is a micro-framework written in Python.

The Database – We have used SQLite for our database. User table stores all user information. We also store the original, annotated images and CSV(Comma separated Values) file as a way of collecting data.

Annotation Tool: - This is a CV2 based tool designed with the dentist's requirements in mind and the idea of data collection for us engineers. This tool provides the dentist with user-friendly software for annotation and for us engineers the coordinates and other data which can be used for training our AI/ML models.



Landmark detection – The concept of landmark localization is one with vast application in the field of dentistry. Currently, our tool has deployed three AI-powered landmark localization tools for Cephalometric analysis, Bone Age prediction(CVS-Cervical Vertebrae Staging) and Early prediction of Bone Loss in IOPA images.

Results and Discussion:

In this study, we developed a web-based tool that performs image annotation on IOPA and Lateral Cephalogram. These dental Radiographs are subsequently used with CSV files as inputs to the Stacked Hourglass Network for landmark detection, which provides a satisfactory detection performance which will certainly ease the work of Dental professionals.

Stacked Hourglass Network has a stack of multiple hourglass modules instead of forming a giant encoder and decoder network. The Hourglass module produces a full heat map for landmark prediction. Thus, the following Hourglass module learns from the landmark predictions of the previous Hourglass module.

On interaction with the Dental Professionals, the IOPA radiographs which are used to detect periodontal bone loss are very likely to be missed in the early stages through the naked eye. To accomplish the goal of early detection, we developed a tool that can annotate the image which gives a region of interest and as it is an annotated image, it gives a clear look at the radiograph which will help in our next stage. The next stage is, the radiographs are fitted into a model where automatic landmark detection takes place.

The results of automatic landmark detection on an IOPA gives us four,eight or twelve points on an IOPA of two teeth, three teeth or four teeth respectively. The points are marked on bone levels(Bone level left and bone level right) and cementoenamel junction(CEJ left and CEJ right) between two teeth. Once the landmark is confirmed, the distance between bone level points and CEJ points is calculated to reach a conclusion on the analysis.

The second type of radiograph we worked on is Lateral Cephalogram where approximately thirty two points are automatically detected as each point is marked under its unique name to have a better understanding of what and where the points are. These points are later used to do the necessary calculations which can help the dental professionals to sort the results into eleven possible analyses.

After an image is annotated, the original image and the annotated image is saved in the same file along with a CSV file which gives all X and Y coordinates of each point. The study comes with a number of strengths and limitations. Our limitations can be categorized into two parts. First, the generation and collection of data is labor intensive and time-consuming. Second, Deployment of the developed AI algorithm with ease of usage for dental professionals.

For which a web-based portal is created using Flask for different departments to annotate and store the images in a database. In future research, the ongoing addition of training data will be added, which will improve the accuracy of automatic landmark detection of the CNN model using Stacked Hourglass Network. As the accuracy increases, more clinicians can count on our dental assistance tool to give a specific diagnostic task, or at the minimum, have a second opinion on their analysis.

References

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