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Early Cavity Detection Using Image Processing Approach

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Abstract: Over 3.9 billion people worldwide get affected by dental cavities. Barriers such as dento phobia, limited dentist availability, and lack of dental insurance prevent millions from receiving dental health care. To address this, an Artificial Intelligence system will be developed that can detects cavity presence on photographs. For preventing further damage of teeth, it is necessary to detect cavity as soon as possible. This is particularly significant as it addresses issues related to accessibility, affordability, and convenience in the domain of dental healthcare. By using the widespread availability of smartphones, this innovative approach has the potential to change oral health assessments, reaching a greater number of people and promoting proactive dental care. The "Oral Cavity Detection" project aims to revolutionize dental diagnostics through the application of deep learning techniques. Using the TensorFlow API for object detection, this system will operate seamlessly on a web-based platform, providing a user-friendly interface for the detection and prediction of oral cavities within images of teeth. For training of this cavity detection model, the custom dataset will be required. Comprehensive analysis of this study reveals positive results that can be improved in the future and can be implemented on a commercial scale.

Keywords: Healthcare, Artificial Intelligence, TensorFlow, web-based platform, User friendly

I. INTRODUCTION

Detecting abnormalities or diseases in the oral cavity using image processing algorithms involves a significant application of technology in the field of healthcare. The project aims to develop an system that assists in the early detection of oral cavity [6]. Early detection of oral cavity is crucial for effective treatment and patient care.

Visual inspection and analysis are conventional methods used by dentists and healthcare professionals, but purposed systems can assist in enhancing accuracy, efficiency, and the early diagnosis of oral abnormalities.

Utilizing advanced algorithms and TensorFlow's object detection capabilities, this system uses advanced image processing techniques to identify potential cavities in dental images. By integrating state-of-the-art technology into a web-based interface, we prioritize user convenience and empowerment, allowing individuals to conduct preliminary self-assessments of their oral health from the comfort of their homes.

This system aims to revolutionize dental care by providing a user-friendly, web- based platform for early detection of cavities [3].

II. PROBLEM STATEMENT

"Early Cavity Detection using image processing approach"

According to the survey conducted by World Health Organization, the WHO estimates that globally close to 3.5 billion people (approximately 50% of population) suffer from one or the other form of oral disease. Most Commonly the Cavity in Teeth.

The project aims to tackle the high incidence of tooth cavities, a pervasive oral disease affecting a significant portion of the global population. The primary challenge is the early identification and diagnosis of tooth cavities to facilitate timely treatment and prevent further oral health deterioration.

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III. OBJECTIVES

- To study Teeth Cavity Problems
- To collect and preprocess data about teeth cavity problem
- To use image processing algorithm for detection of cavity

IV. MOTIVATION OF WORK

The motivation behind Developing a cavity detection system using TensorFlow's object detection API could have several motivation:

Accessibility: making cavity detection available on a website could increase accessibility to dental care, especially for those who might not have easy access to dentists.

Convenience: it offers a convenient way for users to perform initial self-assessments of their oral health without needing immediate dental visits.

Awareness: the system will help in spreading awareness about dental health. security: the system will ensure the security of user data.

V. SYSTEM ARCHITECTURE

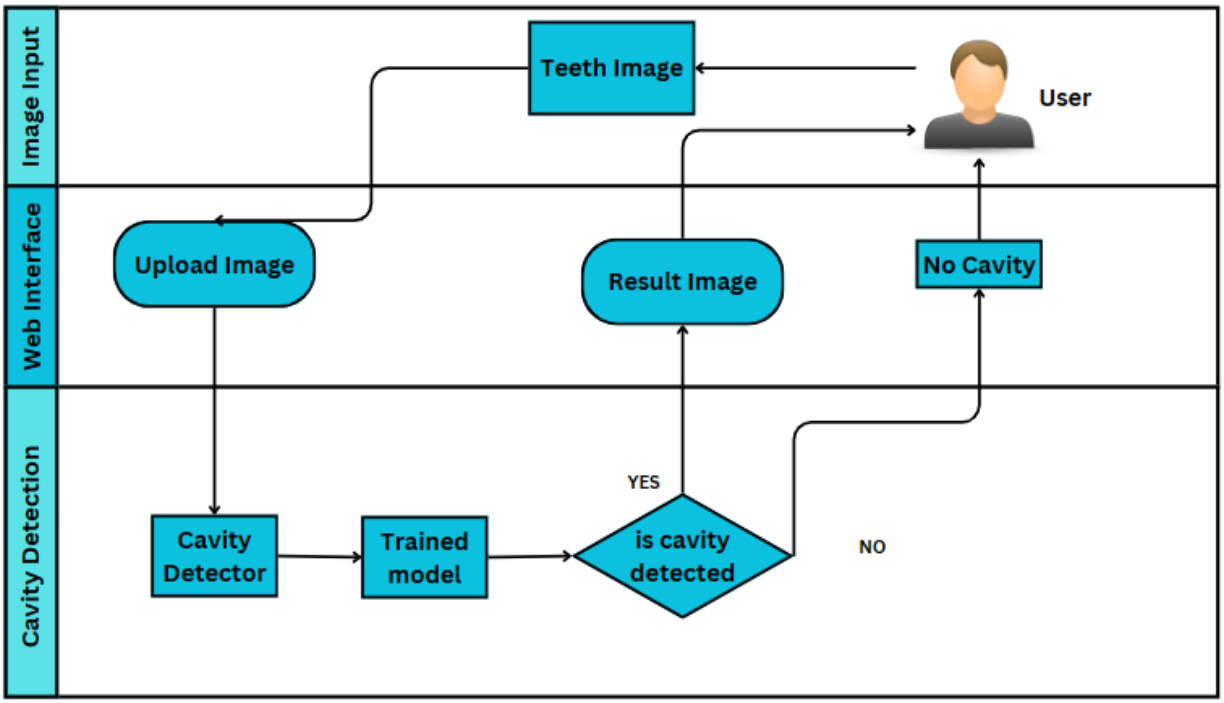

Fig. 1 System Architecture

Module 1: Image Input
Firstly, user enter URL of website into the web browser. The user should click image through their smartphone with good lighting condition.

Module 2: Web Interface
The module provides a user-friendly interface on the website to allow users, such as dentists or patients, to upload dental images for analysis. This interface may include features such as drag-and-drop functionality or a file upload button to streamline the image input process Once an image is uploaded and pre-processed, the module passes it to the TensorFlow API for inference.

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Module 3: Cavity Detection
The TensorFlow API is integrated into the system to leverage pre-trained or custom cavity detection models. This integration allows for seamless communication between the website and the deep learning model. The TensorFlow API uses the underlying cavity detection model to analyse the input image and identify potential cavities or dental issues.

VI. UML DIAGRAMS

A. Class Diagram

A class diagram is a type of UML (Unified Modelling Language) diagram that illustrates the structure and relationships of the classes within the system being developed. UML is a standardized modelling language used in software engineering to visually represent the design of a system.Class diagrams help visualize the static structure of a system, showing the classes, their attributes, and how they are related. They serve as a blueprint for the software development team, helping them understand the architecture and design of the system.Creating and analysing class diagrams can be crucial for documenting and communicating the system's design, facilitating collaboration among team members, and providing a foundation for the implementation phase of the project.

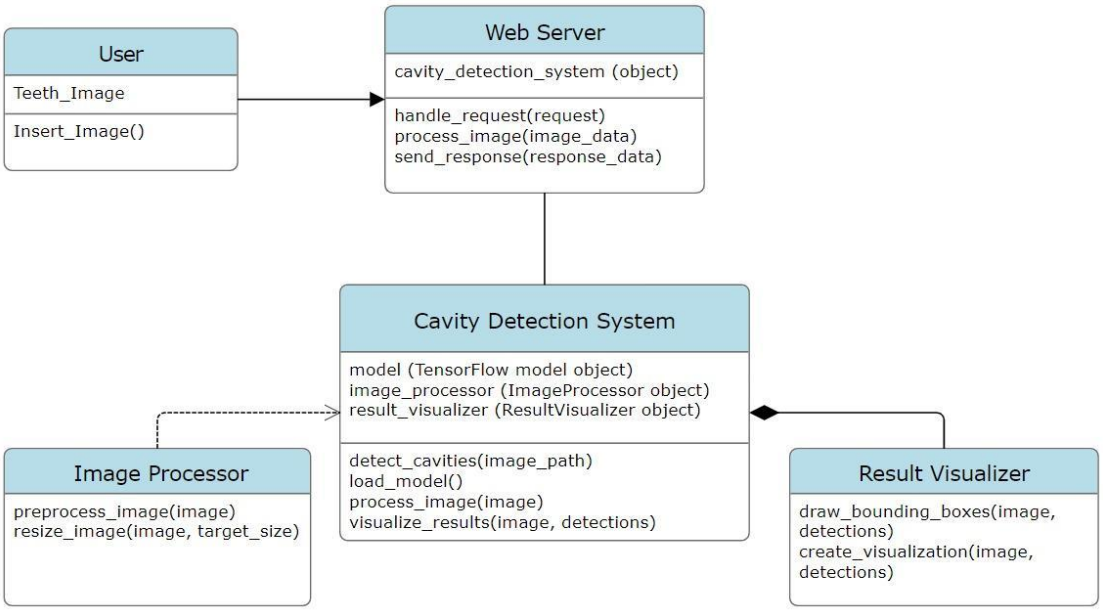

Fig. 2 Class Diagram

The class diagram for the Early Cavity Detection System is designed to encapsulate the key components and interactions. The classes in our system are :-

1.User
Attributes : Teeth_Image
Methods : Insert_Image()
The User class is inherited in the Web Server class.

2.Web Server
Attributes : cavity_detection_system(object)
Methods : handel_request(request)
process_image(image_data)
send_response(response_data)
The Web Server class and Cavity Detection System class have association with each other.

3.Cavity Detection System
Attributes : model(TensorFlow model object)
image_processor(ImageProcessor object)
result_visualizer(ResultVisualizer object)
Methods : detect_cavities(image_path)

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```
Load_model()
                process_image(image)
visualize_results(image, detections)
```

Cavity Detection System class is the core of the system.

4.Result Visualizer

Methods :- draw_bounding_boxes(image, detections)
create_visualization(image, detections)

Result visualizer class the combined with Cavity Detection System class

5.Image Processor

Methods :- preprocess_image(image)
resize_image(image, target_size)

Image Processor class is dependent on Cavity Detection System class.

B. Use Case Diagram

A use case diagram is a visual representation that depicts the interactions between different actors (users or external systems) and a system. It is a part of the Unified Modelling Language (UML), which is commonly used in software engineering to model the behaviour of a system.The use case diagram helps in identifying and illustrating the various ways users or external systems interact with the system being developed. It focuses on the functional requirements of the system and provides a high-level view of its functionality.

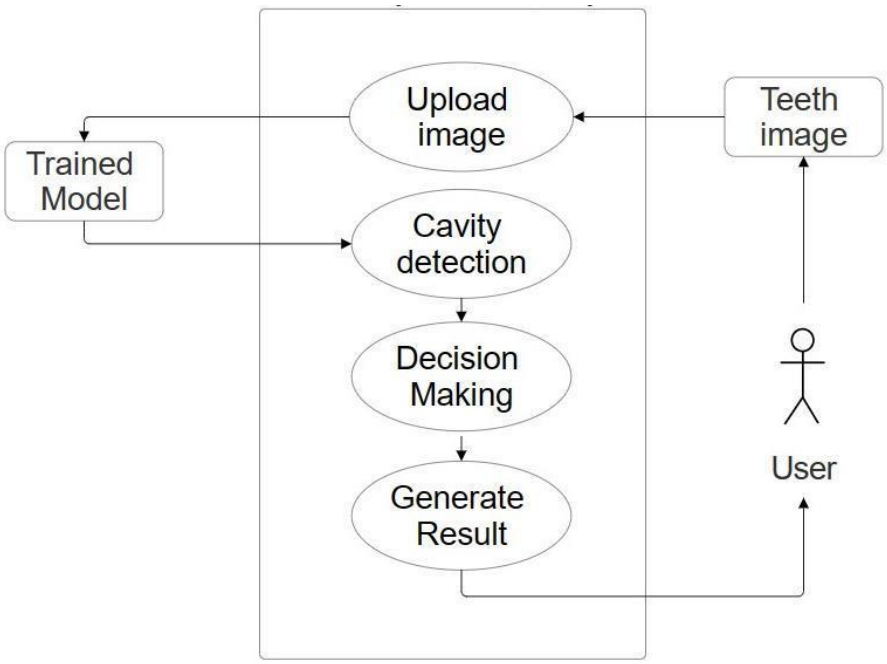

Fig. 3 Use Case Diagram

The above Use Case diagram represents the interaction between user and cavity detection system. It helps to understand how user is going to access the particular parts of system.

In above use case diagram user captures the image from their mobile camera then user access the system through website and upload the captured image into website.

Website will then passes this uploaded image to trained model. Model is optimized to detect the cavity in the uploaded image. After that all the background tasks starts executing one by one like decision making and generating result. The Generated result is passed to the user.

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VII. OVERVIEW OF SYSTEM

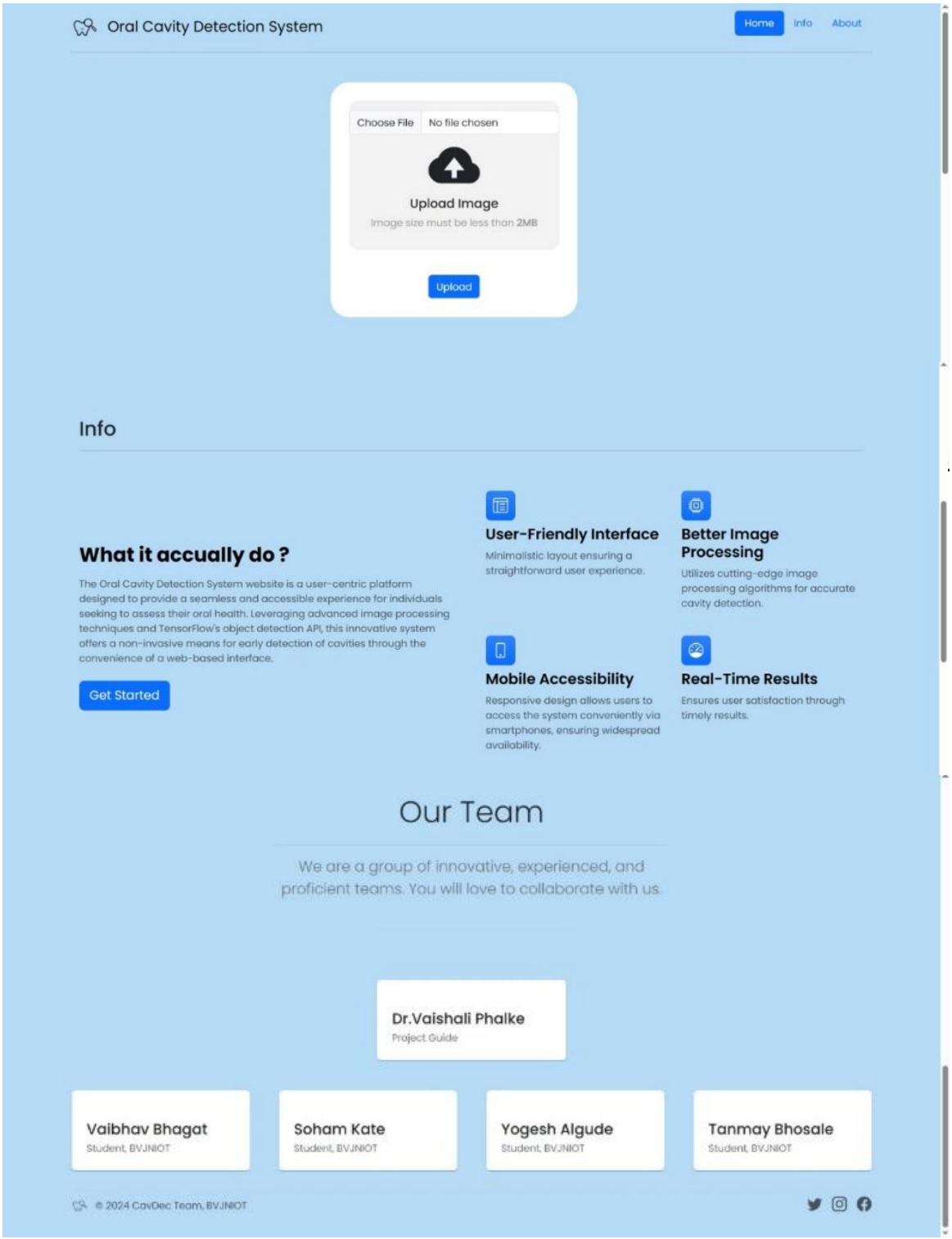

Fig. 3 Home Page

(Here User Upload the Image)

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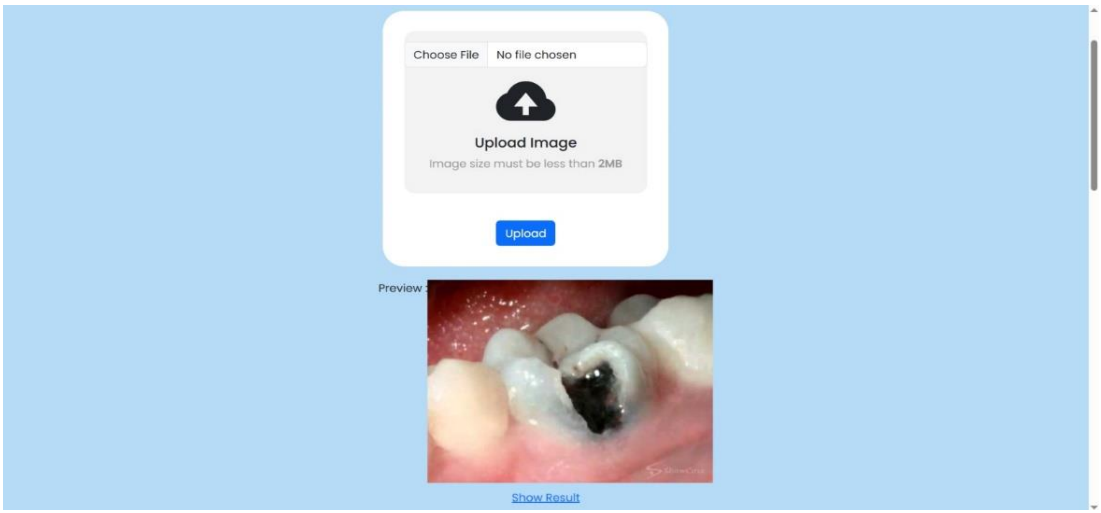

Fig. 4 Upload Image

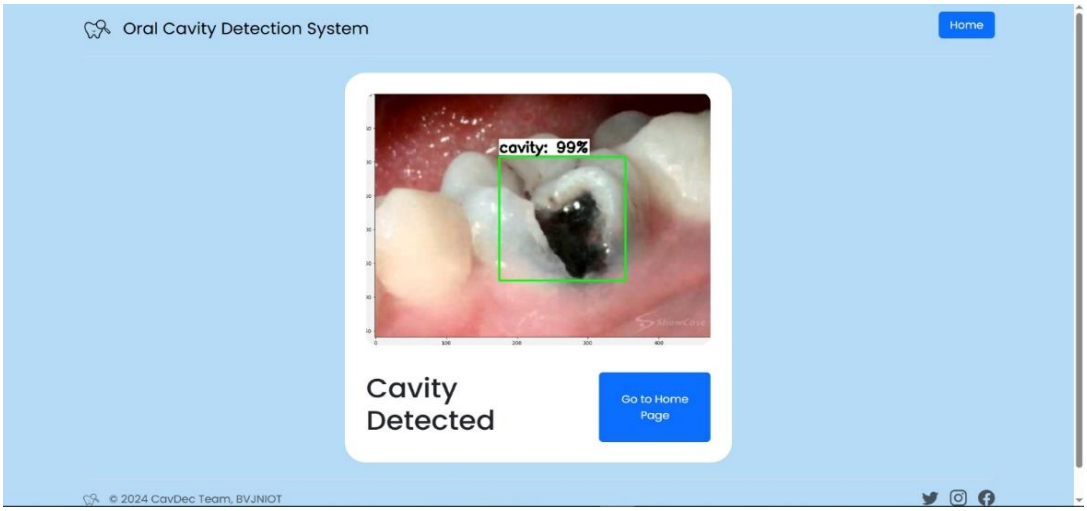

Fig. 5 Result Page

VIII. CONCLUSION

In conclusion, the integration of TensorFlow's Object Detection API into the development of online cavity detection systems marks a significant advancement in the field of computer vision and healthcare technology. The reviewed literature underscores the effectiveness and versatility of this framework in addressing the complexities associated with oral cavity detection.

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