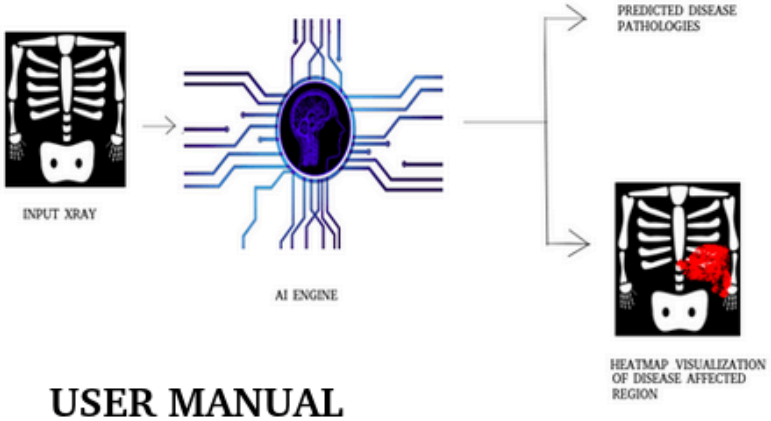
X-RAYCAD

A CHEST X-RAY COMPUTER AIDED DIAGNOSIS TOOL

AN ARTIFICIAL INTELLIGENCE ENGINE FOR COMPUTER AIDED DIAGNOSIS

An Artificial Intelligence Web Application Solution



USER MANUAL

X-RAYCAD
SUPPORTING DOCTORS

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Getting Started

The CHEST X-RAY Computer Aided Diagnosis Software Solution by Centre for Development of Advanced Computing(C-DAC), Chennai, is a Web Application Portal for assisting doctors in Chest X-Ray Diagnosis. This Solution is an Artificial Intelligence Engine that can help in Chest X-Ray Computer Aided Diagnosis. The functionality includes:

a) Chest X-Ray Disease Classification
b) Visualization of disease affected region
c) Indian Patients' Chest X-Ray Dataset Collection and Annotation

About XRAYCAD

This Section briefly describes the functionalities of XRAYCAD Artificial Intelligence Software Solution:

Chest X-Ray Disease Classification

The Software solutions identifies 7 disease pathologies associated with Chest X-Rays. The disease pathologies are following:

- Atelectasis
- Cardiomegaly
- Pneumothorax
- Lung Opacity (Infiltration, Consolidation, Pneumonia, Nodule and Mass)
- Fibrosis
- Effusion/Thickening (Pleural Thickening, Effusion)
- Cavity

In addition, the system may report an **'Others'** category for abnormalities that do not fall under the primary diagnostic groups listed above.

If the Chest X-Ray is not diagnosed with above pathologies, the Software will say the X-Ray has '**No findings**'. Multiple pathologies associated with a single X-Ray Image will also be predicted by the Artificial Intelligence Engine.

The accuracy of the proposed system is 0.9290 AUROC(Area Under Receiver Operating Characteristics). This tool is a beta version for testing and should not be used for Medical Diagnosis at this stage.

The scope of Computer Aided Diagnosis is for postero-anterior (PA) and AP Chest X-Rays and does not include Lateral Chest X-Ray.

1. Visualization of disease affected region

The tool visualizes the disease-affected region using a red heatmap generated by the AI model. In the example below, Ref. Fig. 1, the AI highlights the region associated with Cardiomegaly. The red heatmap indicates the areas the model considers relevant to the predicted pathology.

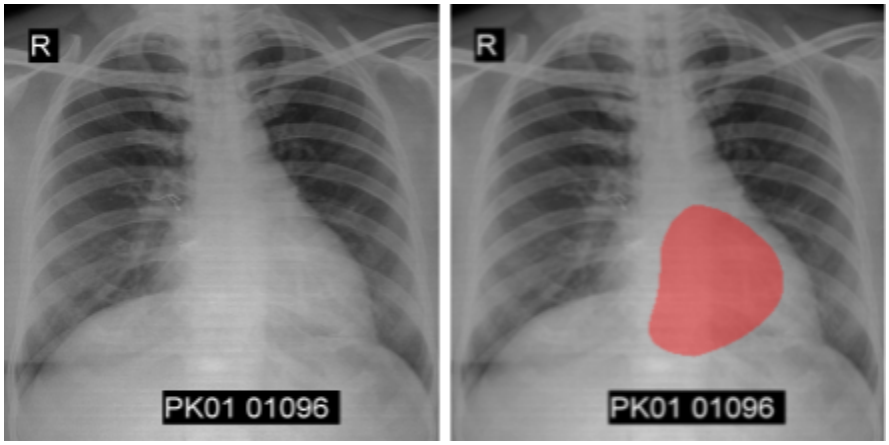

Fig. 1. Cardiomegaly Heatmap Visualization

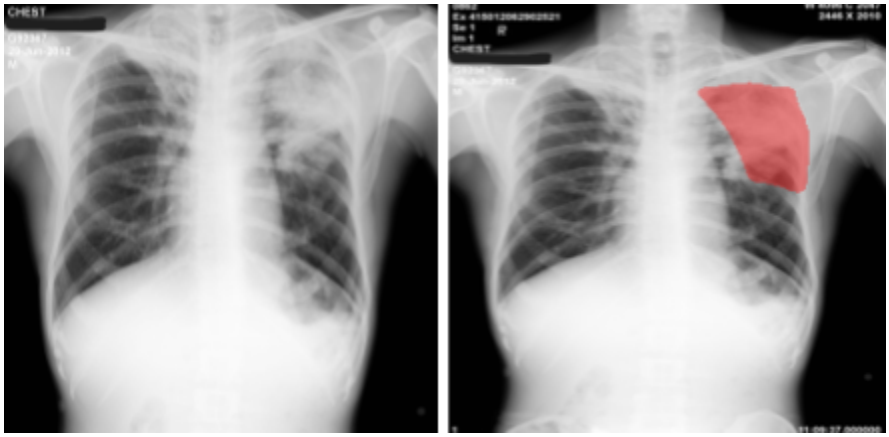

Fig. 2. Lung Opacity Heatmap Visualization

2. Indian Patients Chest X-Ray Dataset Collection and Annotation

The Chest X-Ray image uploaded will be used for both Diagnosis and Data Collection. The Chest X-Ray data will be saved in the C-DAC Chennai server. Hospitals are requested to get permission from the medical ethics board for sharing data with C-DAC, Chennai, if required.

The data will be used by C-DAC Chennai for improving the accuracy of the underlying software solution. The doctors are requested to use the checkbox “Untick for Correction” to correct the wrongly predicted ‘Chest X-Ray disease manifestation’ by the Software Tool. This will allow the doctor to input correct findings. The correct findings will be used to enhance the software in the next version.

System Requirements

The tool is intended to be used by the target audience: Doctors. Following are the minimum facilities required for using software:

a) Input : X-Ray images in digital format (-*.jpg,*.png,*.dcm,*.bmp)
b) PC/Laptop with Operating System : Windows/Linux
c) Browser : Google Chrome/Mozilla Firefox
d) Internet Connection

Using XRAYCAD

XRAYCAD version 1.0 has been designed to be an extremely simple and easy-to-use AI diagnosis support system that requires minimal effort from the user. Users must know how to use a browser and access a website to start using XRAYCAD.

Userflow

Using XRAYCAD is a simple 4 step process to get the consultation you need.

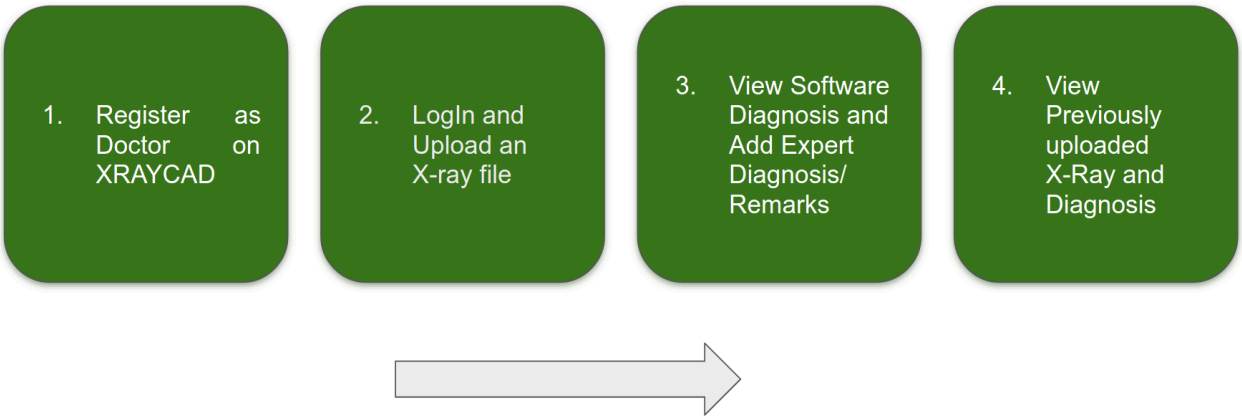

Fig. 3. User Flow

Apart from above functionalities XRAYCAD also provides option for view past uploaded X-Ray images and diagnosis, similar X-Ray images

Homepage

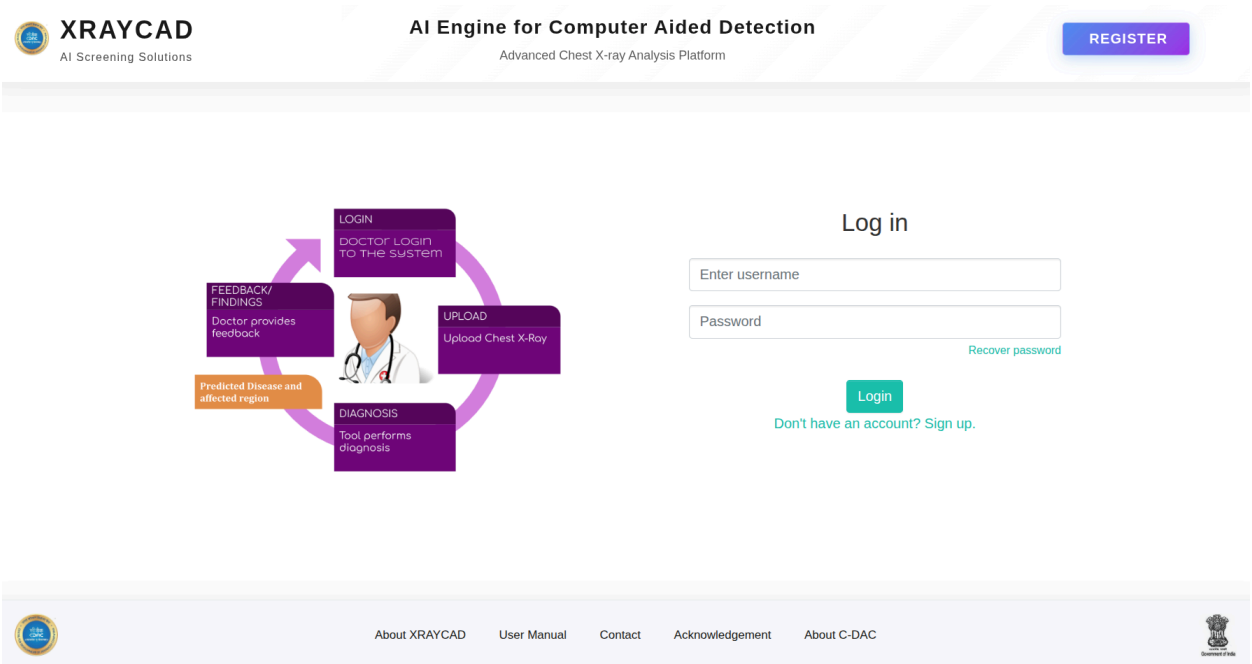

Fig. 4. System Homepage. The initial landing page of the XRAYCAD application.

Step 1: Registering with XRAYCAD for the first time

All new users must register on the XRAYCAD website before logging in and trying to use the facility. Refer to the following steps to Signup with XRAYCAD:

1. Visit https://xraycad.bosschn.in/

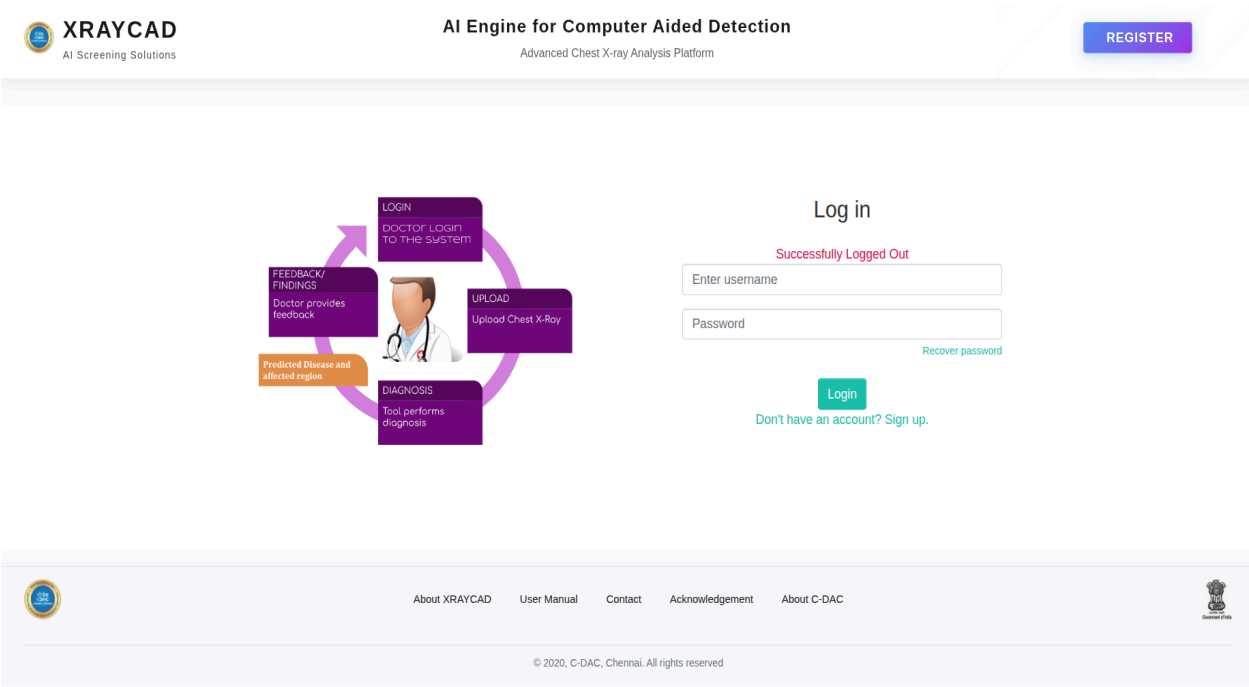

Fig. 5. Login Page of XRAYCAD

2. Click the SignUp link on the homepage. The user can also click on the Register link at the top for registration. Ref. Fig. 6.

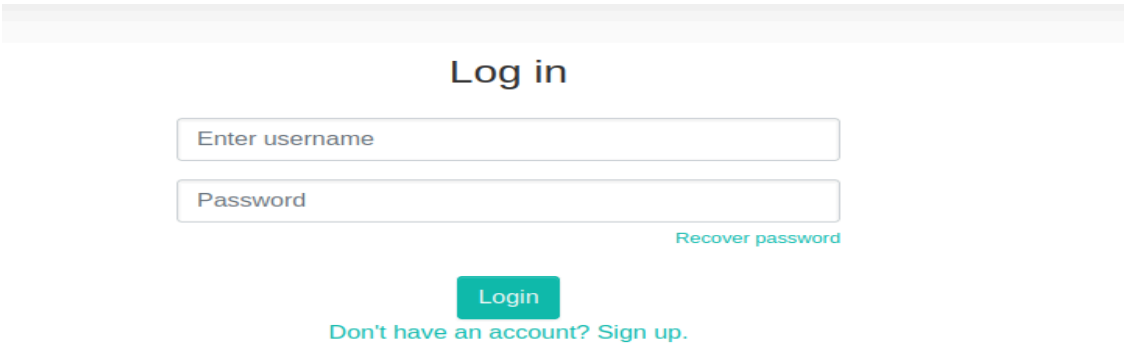

Fig. 6. Click SignUp for new user registration

3. Type in Name, username, email, password, phone number and specialization. Ref. Fig. 7.

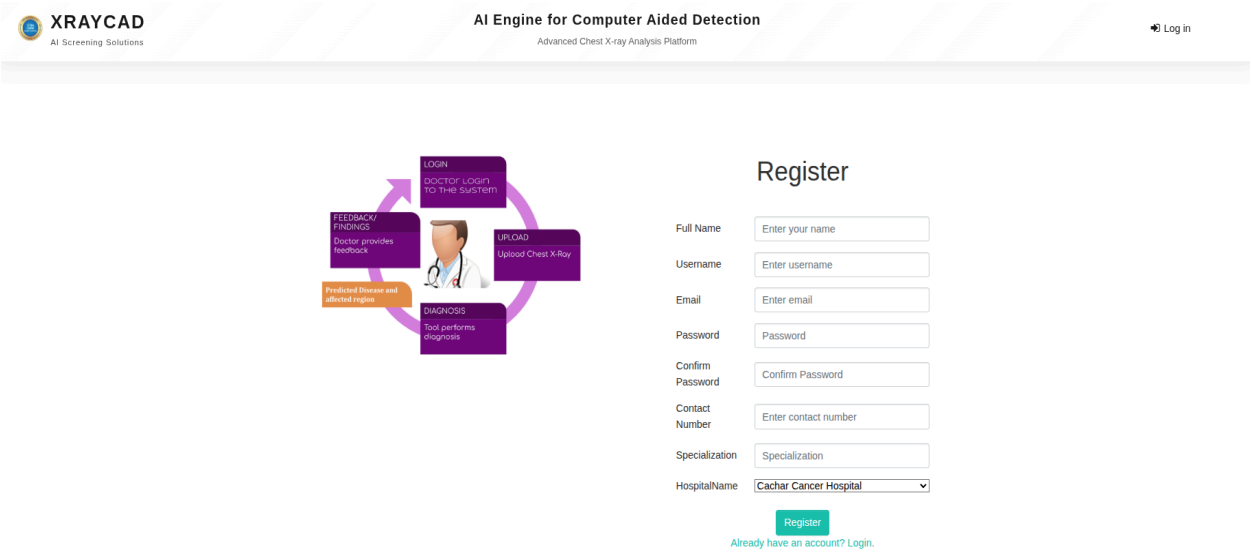

Fig. 7. Registration Page for New Users

4. Click on the register button to complete the registration process.

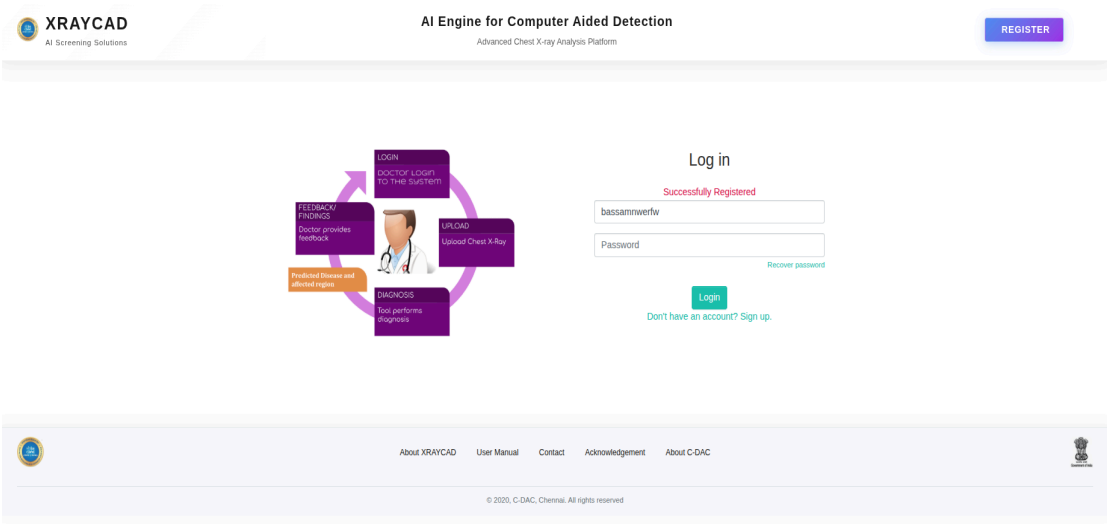

Fig. 8. Successfully registered message shown in homepage

Step 2: Logging in to XRAYCAD

1. Enter your username and password in the textbox, then click the login button. Ref. Fig. 9.

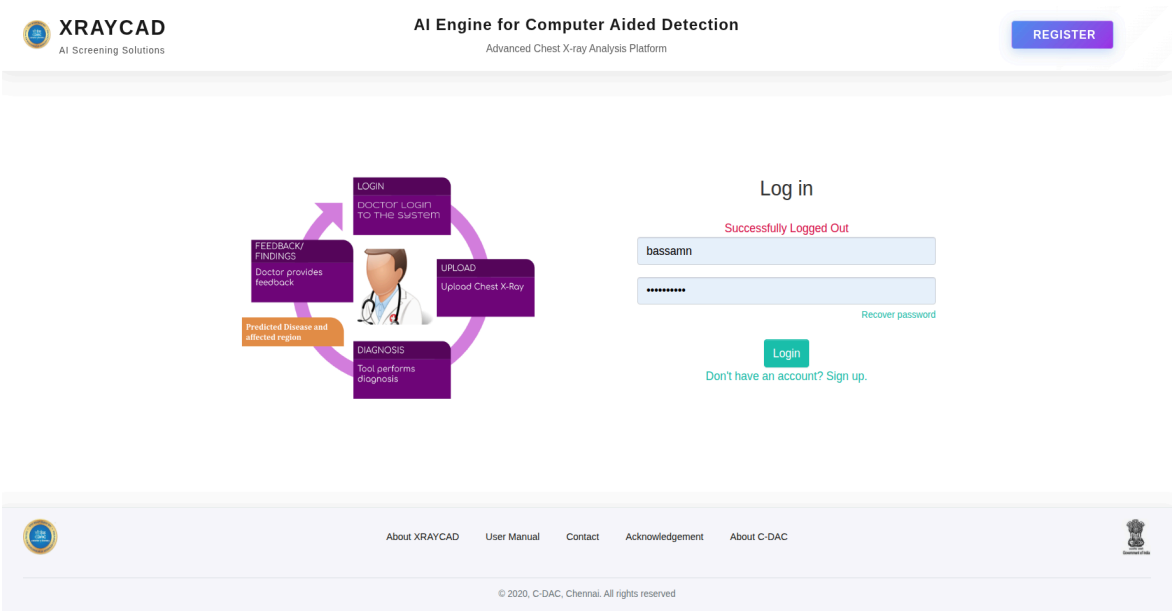

Fig. 9. Logging in with username and password

2. Click on the 'Upload New X-Ray' button to upload an X-Ray file. To view previously uploaded files, click on the 'View Uploaded XRAY' button. Ref Fig. 10.

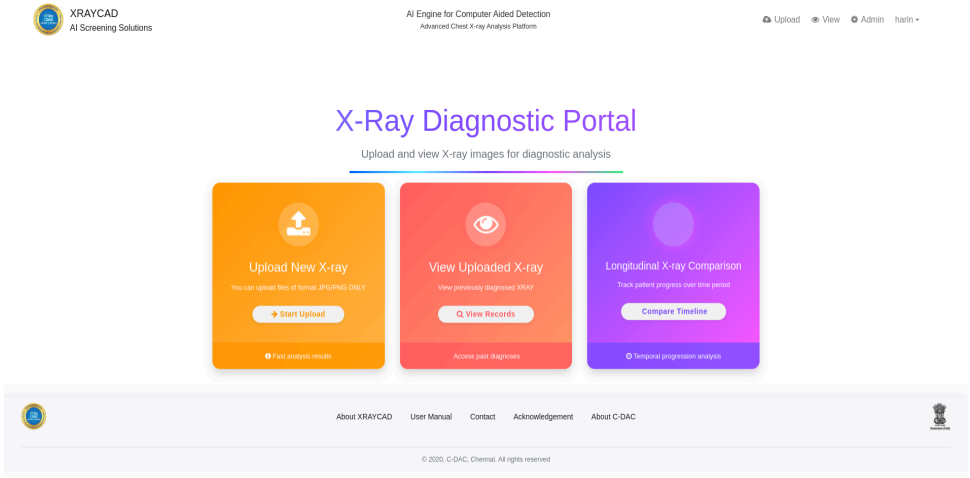

Fig. 10. Dashboard for Uploading, Viewing X-Ray Files and Longitudinal X-Ray Comparison

Step 3: Uploading a new image into XRAYCAD

1. You can upload Single file/Multiple files associated with a patient. You can also upload a directory containing X-Ray images to the portal. Ref. Fig. 11. Choose radio buttons:

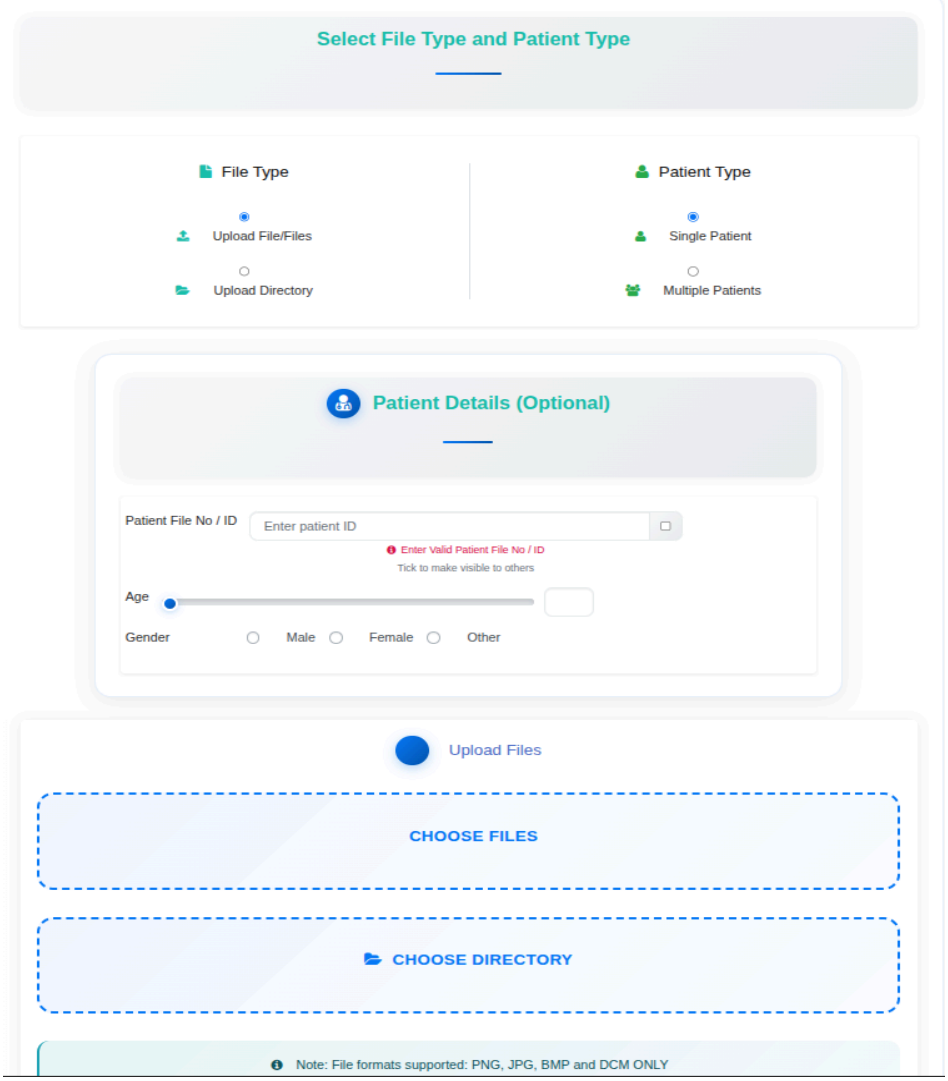

Fig. 11. Upload page in XRAYCAD

2. For single patient, following steps can be followed
    a. Enter patient file No., patient name, age and gender. These details are optional entries. Ref. Fig. 12.
    b. You can make 'tick to make visible to others' checkboxes ticked, if you are comfortable with sharing the information with other login users.
    c. Use 'Choose File' Button to upload a new XRAY image from your computer.

d. Click the ‘Upload’ button to upload an image. The uploaded image will be saved in database

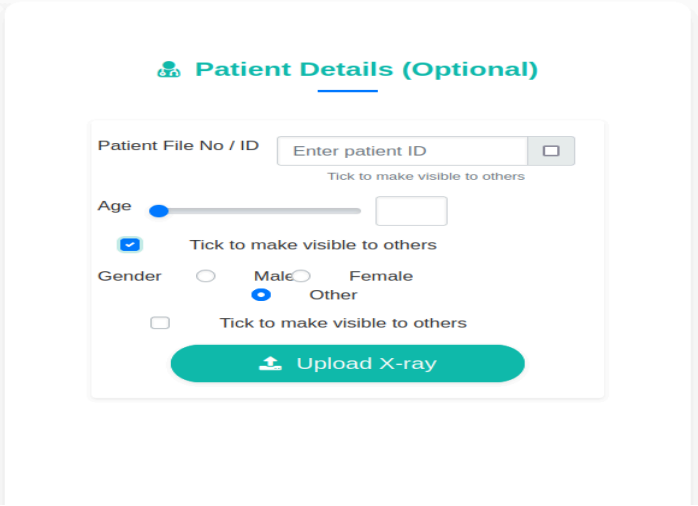

Fig. 12. Patient Detail Entry Form.

3. For multiple patients, you need to select multiple files or Browse the directory. Choose appropriate radio buttons. Ref. Fig. 13.

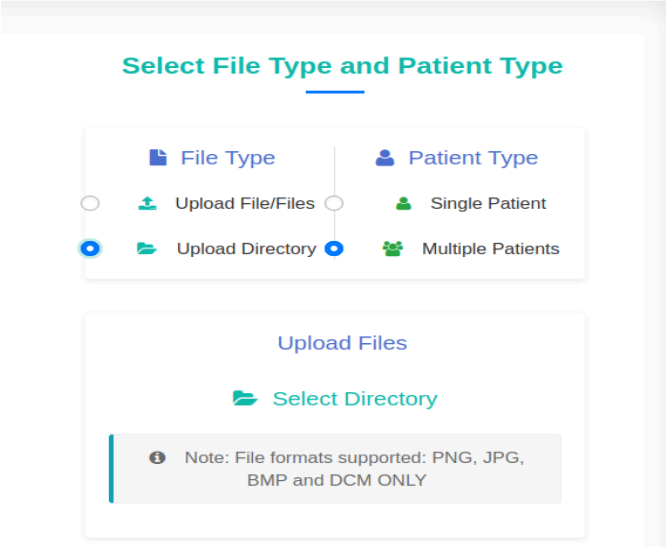

Fig. 13. File Selection Screen.

4. Multiple file selection is shown below. Ref. Fig. 14.

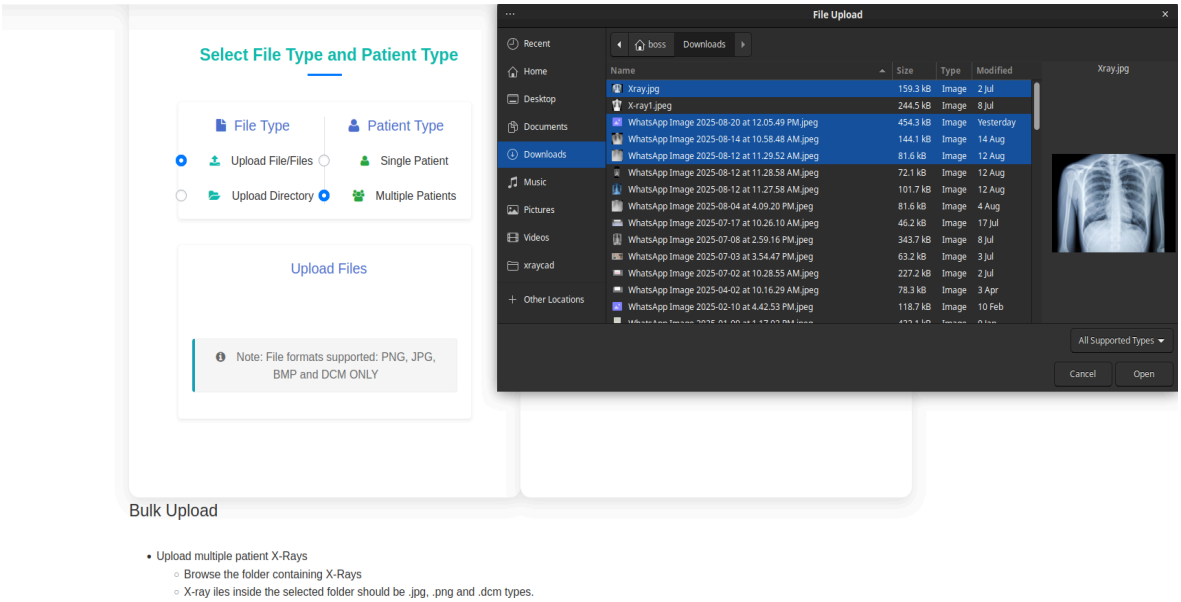

Fig. 14. Multiple File Selection Screen.

5. You can upload a directory of maximum 2 GB size to the XRAYCAD.
   A large directory will have waiting time. It is requested that the upload page should not be refreshed during the process. Directory upload process is shown below. Ref. Fig. 15.

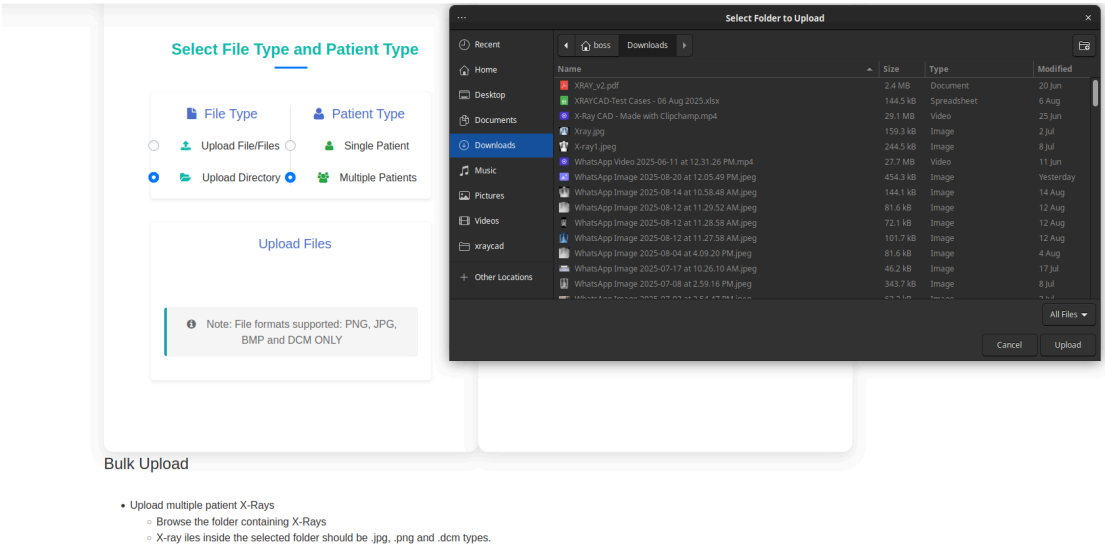

Fig. 15. Directory Upload Selection Screen.

6. The upload process will show the X-Ray image, Image verification info. The images which software feels are not an X-Ray due to markings or wrong images are shown in GUI with a warning message and with an unticked checkbox. Users can forcefully upload that X-Ray image by ticking the associated checkbox, if required.

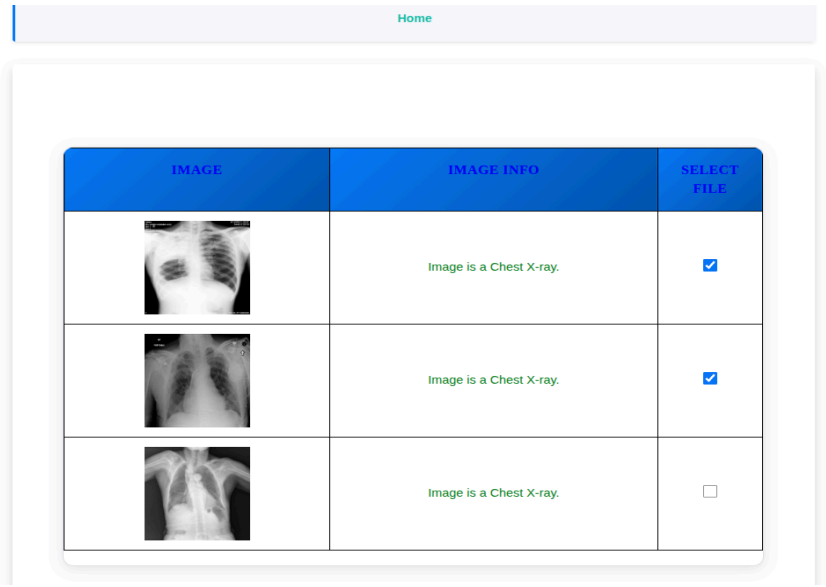

Fig. 16. Image Verification Success Results

7. Click the upload button in the below screenshot, Ref. Fig. 17., to complete the upload process.

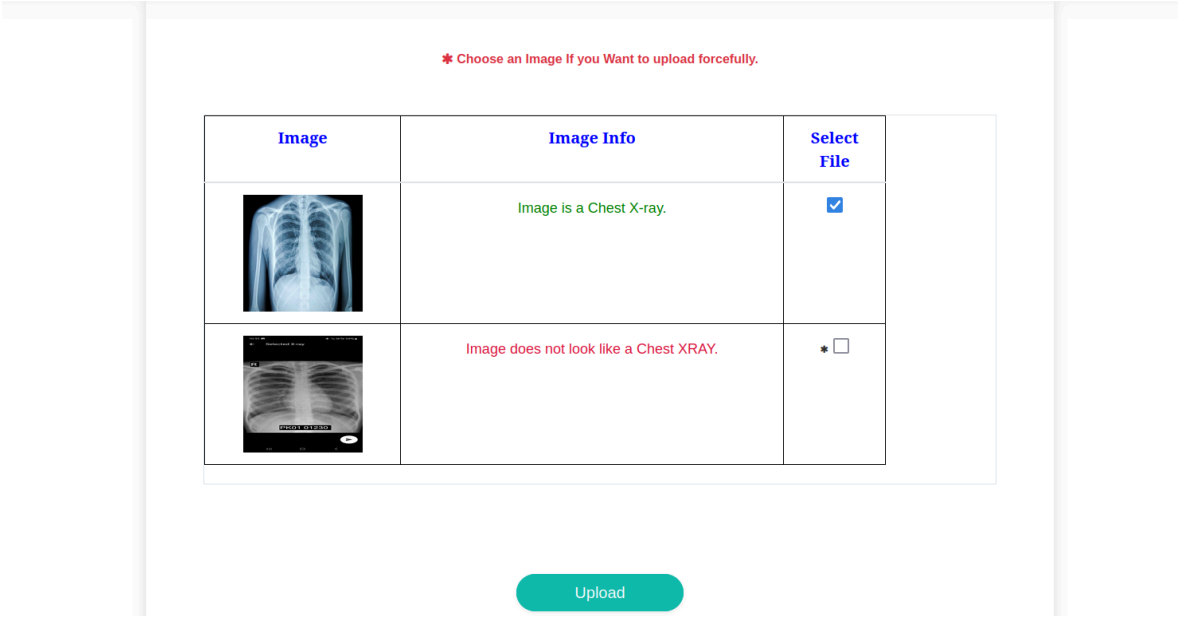

Fig. 17. Image Verification Failed Results

8. You can view the uploaded files and software proposed diagnosis as shown below in Fig. 18.

Step 4: Algorithm Diagnosis and Expert Diagnosis

1. You can see the ‘Input X-Ray Image’ and ‘Proposed Algorithm Diagnosis’ on the page. If the doctor/user agrees with the proposed diagnosis, he/she can click the submit button with the default “I agree for Proposed Diagnosis” Button clicked.

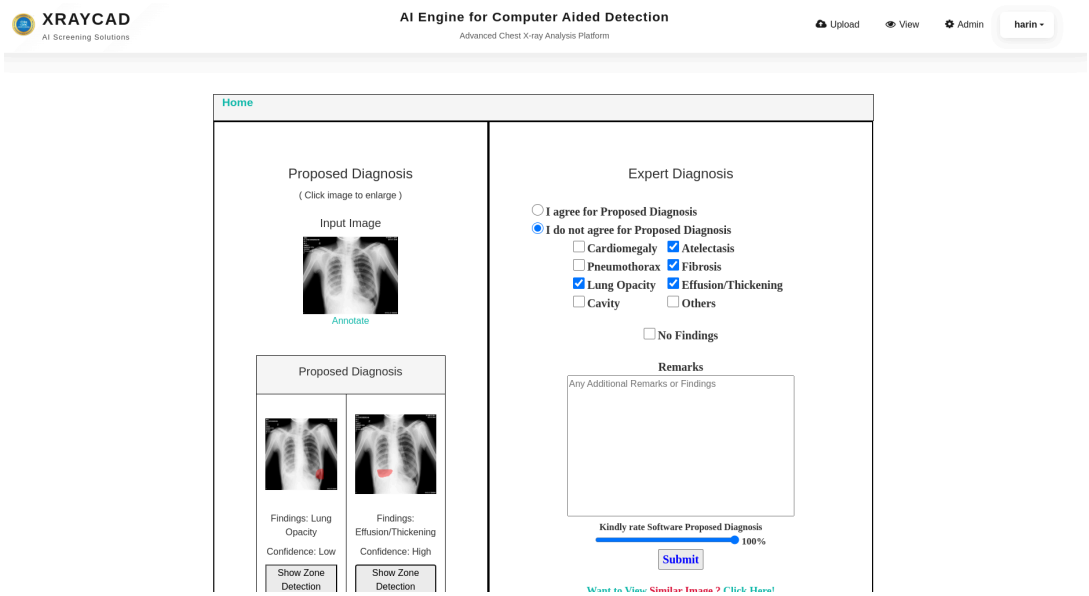

Fig. 18. Proposed Algorithm Diagnosis and Expert Input Interface

2. If the doctor/user wants to suggest some diagnosis other than the proposed diagnosis, he/she can click on “I do not agree for the Proposed Diagnosis” radio button. This allows the doctor/user to select a new set of correct findings. Users can also fill in the remarks column for future reference, Ref. Fig. 19.

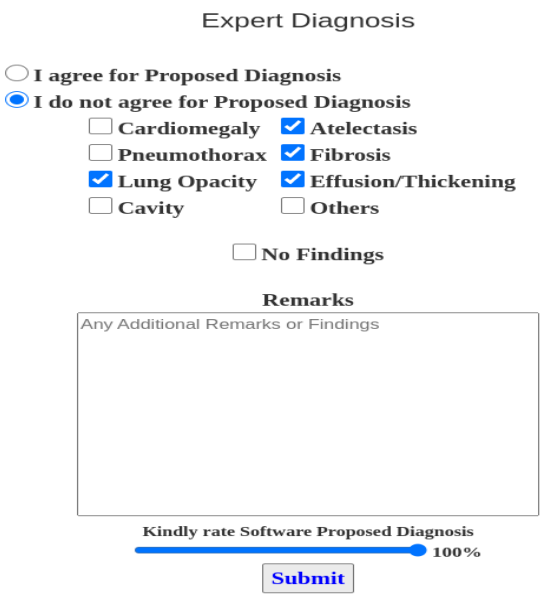

Fig. 19. Form for Expert Diagnosis Input

3. Users can click on the proposed diagnosis image to view the enlarged image with red heatmap markings. Also users can view the zone wise disease manifestation results, Ref. Fig. 20.

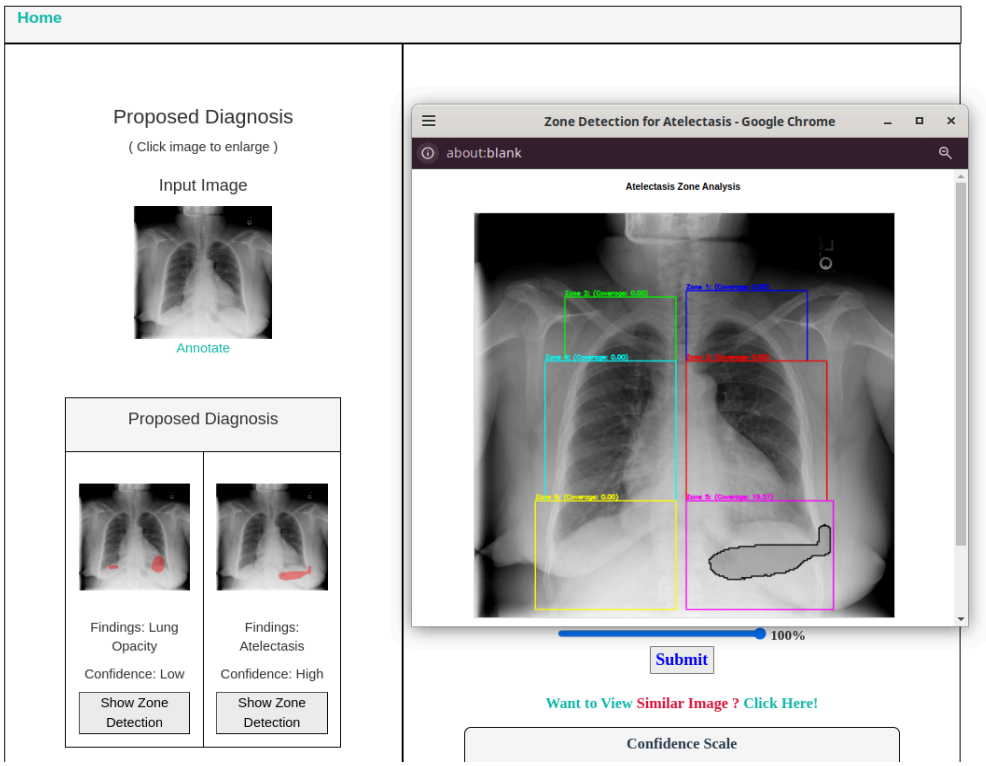

Fig. 20. Zone Detection result shown on clicking of Show Zone Detection Button

4. Users can annotate the X-ray image for disease localization. Once the area is marked, the user can label and add additional remarks, Ref. Fig. 21.

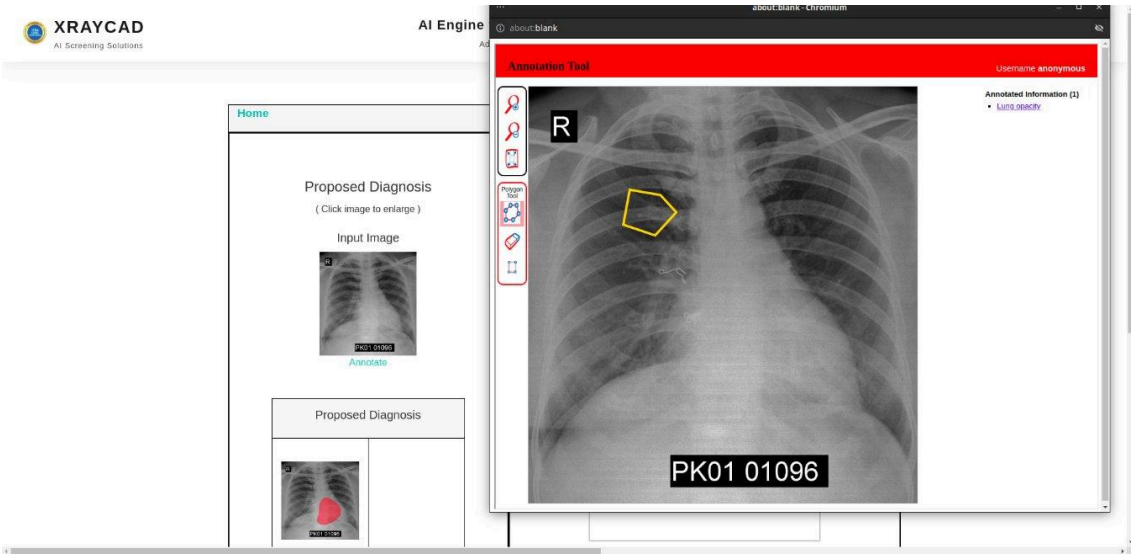

Fig. 21. Annotation page for marking areas on clicking of Annotate Button

5. Users can click on the Similar Image link to view X-Rays diagnosed with the same set of diseases, Ref. Fig. 22.

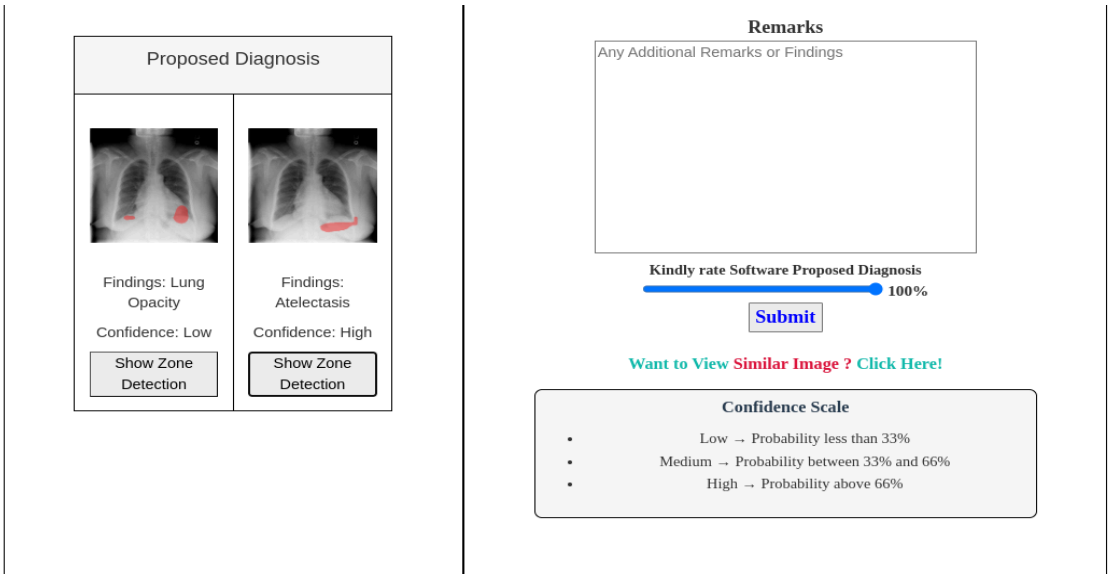

Fig. 22. Similar Image button on Expert Diagnosis Form

6. Users can click on the proposed diagnosis X-Ray to view X-Rays of patients diagnosed with the same disease, Ref. Fig. 23.

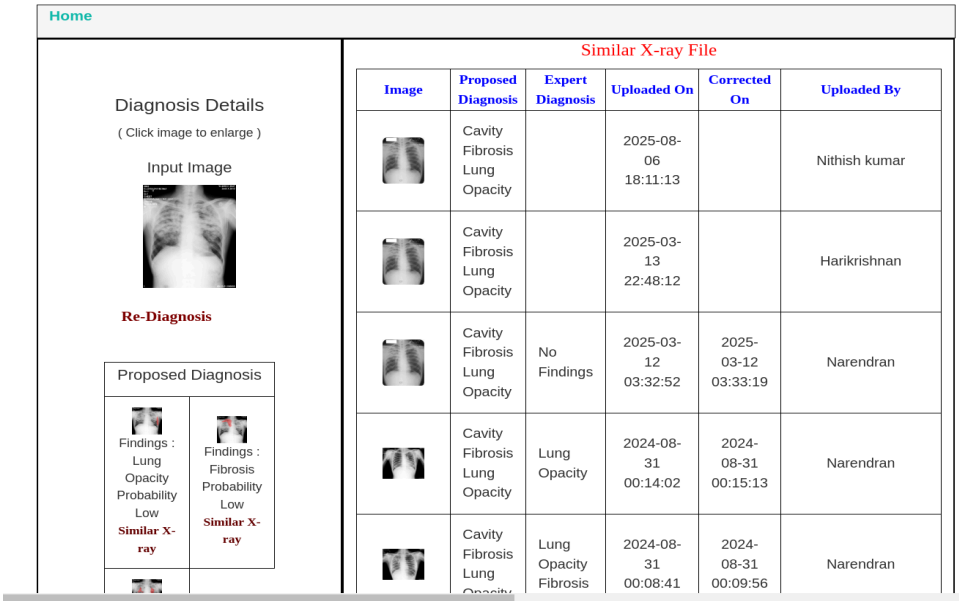

Fig. 23. Similar Image Retrieval Results

Viewing previously uploaded X-Ray images and diagnosis

1. Users can view the previously uploaded X-rays by clicking “View Uploaded X-Ray”, Ref. Fig. 10. The View page can also be used to Re-diagnose and annotate the previously uploaded X-rays, Ref. Fig. 24.

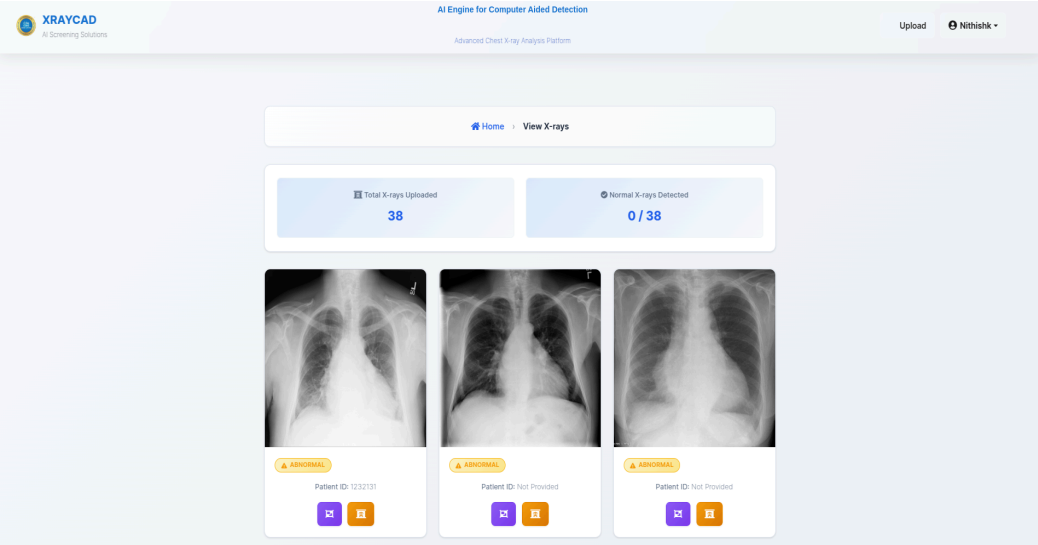

Fig. 24. Page Showing Previously Uploaded X-rays. Re-Diagnosis and Annotate Options are available for each Image.

Longitudinal X-Ray Comparison

XRAYCAD provides a longitudinal comparison feature that allows users to view multiple X-Ray images of the same patient taken at different points in time. This helps doctors visually assess disease progression, improvement, or stability. The system displays both images side-by-side along with the corresponding algorithm predictions, enabling more informed clinical decisions.

Step 1: Open the Longitudinal Comparison Page

1. Click on Longitudinal X-Ray Comparison in the Home Page, Ref. Fig. 10.

Step 2: Uploading X-Rays for Comparison

1. Users can either upload new X-rays or select from the previously uploaded X-Rays, Ref. Fig. 25.

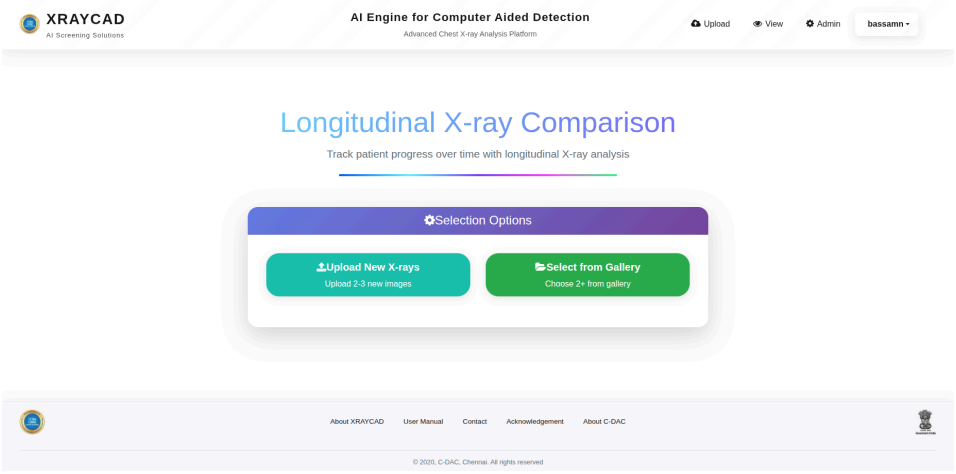

Fig. 25. Longitudinal X-Ray Comparison Page

2. To upload new X-rays, first, upload the baseline image, then the follow up image. Users can add additional images as well, then click on Analyze Progression, Ref. Fig. 26.

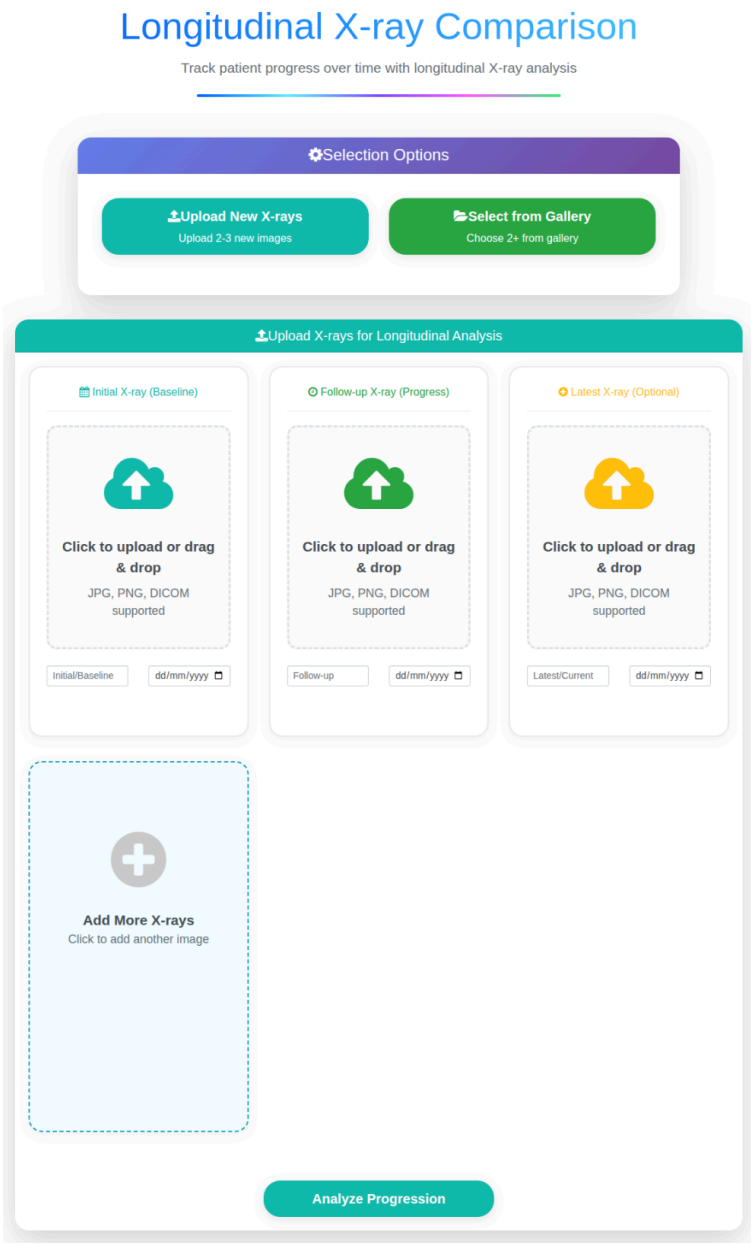

Fig. 26. Upload multiple images for comparison

Step 3: Results Longitudinal Comparison Page

1. The results will be shown under each uploaded image with the remarks of Status-quo, Improving and Deteriorating, Ref. Fig. 27. To view the heatmaps, click on the disease to view their corresponding heatmaps of diseased areas, Ref. Fig. 28. In the comparison summary, the common diseases as well as the unique disease detected in the follow up image is also shown.

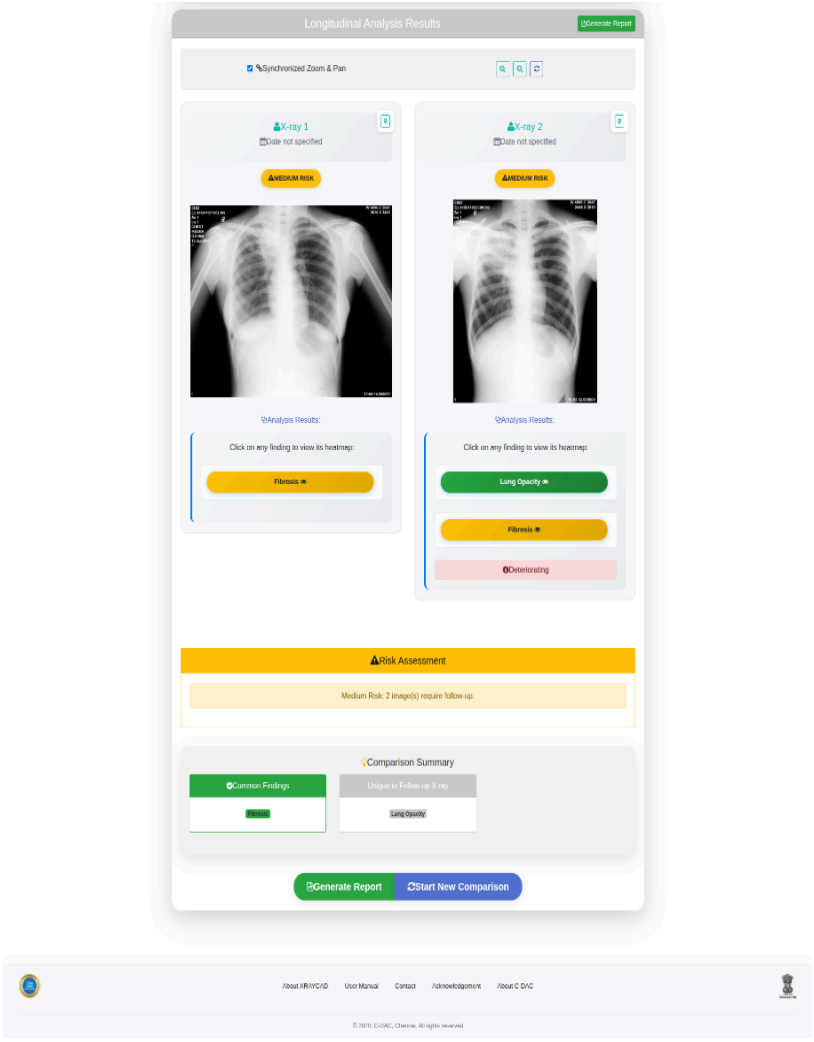

Fig. 27. Results of the X-Ray Comparison

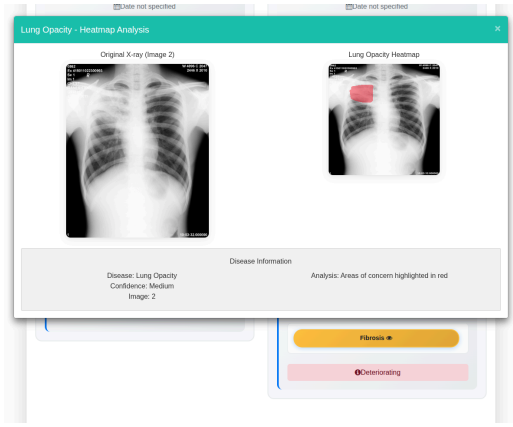

Fig. 28. Heatmap visualization for each disease detected

Step 4: Comparison Report Generation

1. Users can generate report of the findings by clicking the Generate Report button. Click the Print Report to download the report in PDF.

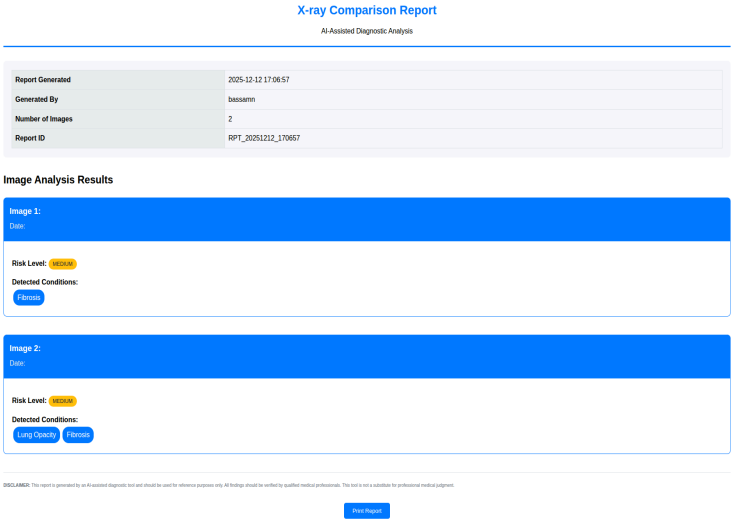

Fig. 29. Generated Comparison Report

Support, Questions, Comments and Feedback

If you face any problems while using XRAYCAD or if you have any suggestions, questions, comments or feedback, please visit the contact page at https://xraycad.bosschn.in

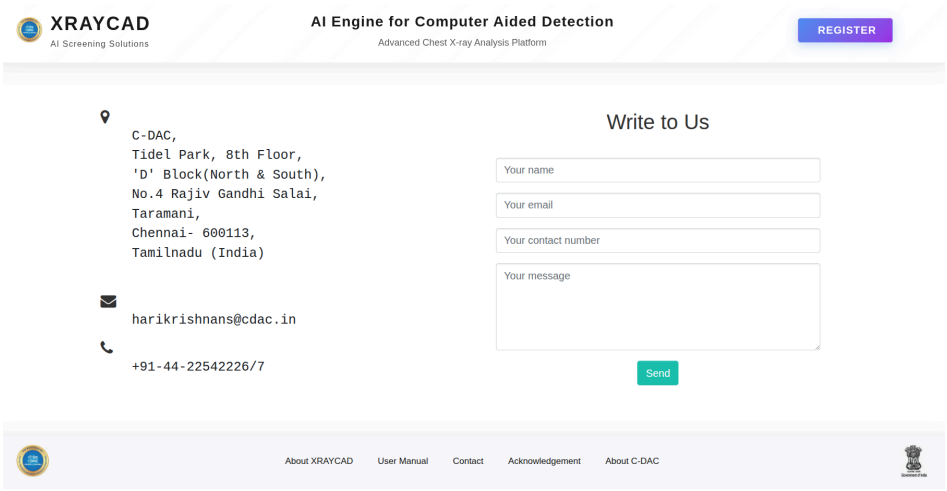

Fig. 30. Contact and Support Information Page

Suggestions & queries may be directed to the XRAYCAD team at:

Harikrishnan V S
Scientist-E
Centre for Development of Advanced Computing
Tidel Park, 8th Floor,
'D' Block(North & South),
No.4 Rajiv Gandhi Salai,Taramani,
Chennai- 600113, Tamilnadu (India)
Phone:+91-44-22542226/7 Ext:247
Fax: +91-44-22542294
Mob:9790847089
Email: harikrishnans@cdac.in