



Design and Development of Android Colposcope for Cervical Cancer Screening

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Abstract: Cervical cancer is a significant cause of illness and death among women, especially in rural areas where access to specialized screening tools is limited. Traditional screening equipment, such as colposcopes, are expensive and require clinical infrastructure, making them impractical for field use. To address this issue, we developed CerviHealth, a portable cervical cancer screening system consisting of a React Native-based mobile application and a USB camera connected to an Android device. The system enables healthcare workers to register patients, collect symptoms, capture cervix images, and upload data to cloud storage for review by remote doctors. Doctors can log in, review cases, provide diagnoses, and generate reports. The app also includes an appointment scheduling feature with support for rescheduling in case of unavailability. CerviHealth uses Firebase for secure cloud storage and real-time updates. By combining mobile technology with low-cost imaging, the system provides an effective solution for early cervical cancer screening in underserved communities.

Index Terms - Colposcope, Cervical Cancer, React Native, Firebase Storage, USB camera, Healthcare workers.

I. INTRODUCTION

Cervical cancer remains one of the most common cancers among women worldwide, particularly in developing countries. In rural areas, women often lack access to regular medical checkups and advanced screening methods. Early detection of cervical cancer can significantly reduce mortality, but existing diagnostic tools like traditional colposcopes are costly, stationary, and require clinical expertise, making them inaccessible in remote settings. To solve this challenge, we have developed CerviHealth, an Android-based colposcopy system that combines mobile technology, cloud services, and portable imaging hardware. This system allows healthcare workers, such as ASHA workers, to perform cervical screenings in field locations using a USB camera connected to an Android smartphone. The camera captures high-resolution images of the cervix, which are then uploaded to a secure cloud platform where doctors can review and provide remote diagnoses. The CerviHealth application includes role-based access for three types of users: patients, healthcare workers, and doctors. Patients can register, view their reports, and book appointments. Healthcare workers can input patient details, capture cervix images, and manage appointment requests. Doctors can review uploaded cases, provide diagnostic comments, and generate downloadable PDF reports.

A major feature of the system is the appointment management module, which allows patients to schedule consultations with healthcare workers or doctors. If the selected provider is unavailable, the appointment can be rescheduled, and both parties are notified in real time. The app is developed using React Native with JavaScript and TypeScript, styled using CSS, and uses Firebase Storage for cloud-based image storage and

real-time data handling. CerviHealth aims to make cervical screening accessible, timely, and scalable, particularly in resource-limited environments.

II. MOTIVATION

Cervical cancer is a leading cause of death among women in rural India due to lack of early screening. Traditional colposcopes are expensive and not feasible for use in remote areas. There is a pressing need for a low-cost, mobile-based solution to enable field-level diagnosis. Community health workers often lack tools to collect and transmit cervical health data effectively. Mobile technology can bridge the gap between patients and doctors through remote diagnostics. empowers rural screening by enabling image capture, cloud upload, and doctor-led diagnosis.

III. OBJECTIVES

- To develop a mobile-based colposcopy system using a USB camera and Android application to support cervical cancer screening in rural and low-resource settings.
- To enable healthcare workers to collect patient information, capture cervix images, and upload data securely for remote diagnosis by medical professionals.
- To integrate role-based access with features like secure login, appointment scheduling, real-time notifications, and downloadable diagnosis report generation.

IV. PROBLEM STATEMENT

Develop an Android-based colposcope application to facilitate early detection of cervical cancer by enabling healthcare workers to capture cervical images. The app allows specialists to remotely analyze these images and generate diagnostic reports. This system aims to improve timely diagnosis and accessibility in underserved areas, ultimately reducing cervical cancer-related deaths.

V. PROPOSED SYSTEM

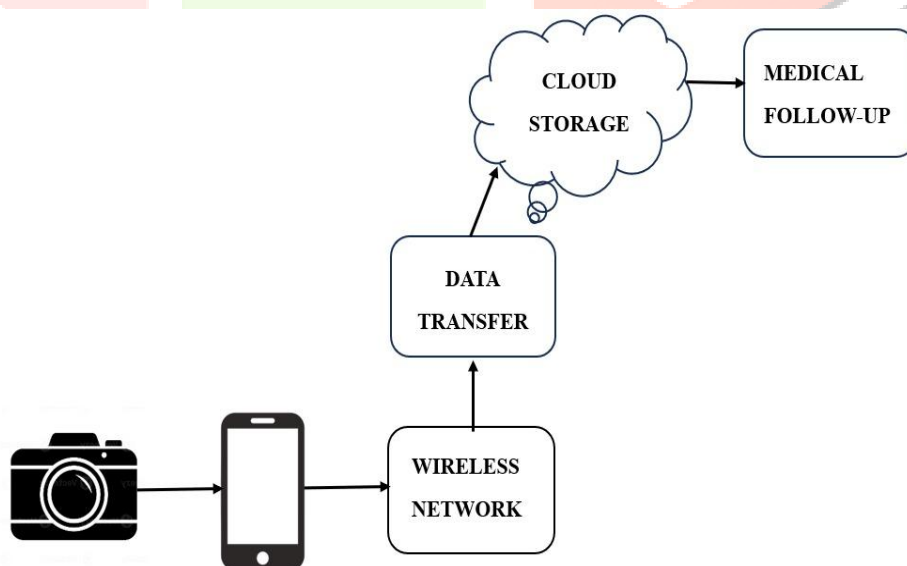


Fig 1: Block diagram of proposed model

Fig 1 represents a mobile-based solution for cervical cancer screening using a colposcope application. A USB camera connected to a smartphone captures high-quality cervical images. Patient information and images are collected through the app and transmitted securely via a wireless network. This data is uploaded to cloud storage, ensuring safe and centralized access. Doctors can remotely log in to review the images and patient details for diagnosis. Once the evaluation is complete, they generate and upload digital reports. These reports are then accessible to both patients and healthcare workers. The process supports timely follow-up and improved medical care in remote areas.

VI. METHODOLOGY

- **Role-Based Login:** Users including healthcare workers, doctors, and patients sign in using their assigned credentials. The app displays features specific to each user type.
- **Patient Data Collection:** Healthcare workers record patient details such as name, age, and symptoms before capturing images.
- **Image Capture:** A USB camera connected to the mobile device is used to take clear images of the cervix.
- **Data Upload:** The captured images along with patient data are securely uploaded to Firebase cloud storage.
- **Doctor Notification:** Once the upload is complete, doctors are notified that new images and records are available.
- **Remote Image Review:** Doctors log into the system to review the images and medical details remotely.
- **Report Generation:** Based on their assessment, doctors create and upload a digital diagnostic report.
- **Report Access and Notification:** Patients and healthcare workers receive alerts and can view the report through the app for further medical steps.

VII. SYSTEM REQUIREMENTS

Hardware Requirements

- **Android Smartphones:** These devices are used by healthcare workers to run the Cervi app during health screenings. They help collect patient information, take cervical images, and upload data to the cloud. Their touchscreens make app usage simple and smooth. The portability of these devices makes them ideal for rural visits. They are affordable and widely available, making them suitable for fieldwork.
- **USB Camera:** A USB camera can be connected to the Android device using an OTG cable for capturing cervical images. It offers better control and can be positioned more precisely than built-in cameras. This makes it easier to take clear and focused images during screenings. The camera works with the app through supported drivers or camera access tools.

Software Requirements

- **Frontend**
 - **React Native:** Framework used to build the mobile app's user interface with JavaScript and JSX, enabling native Android UI development from a single codebase.
 - **Expo SDK:** Provides access to native device features such as camera and file system, simplifying frontend functionality and user experience.
- **Backend**
 - **Firebase Platform:**
 - **Firebase Authentication:** Secure user login using Google accounts and mobile number OTP verification.
 - **Firebase Storage:** Cloud storage for cervical images uploaded from the app.
 - **Cloud Firestore :** Real-time database managing user data, screening results, and appointments.
- **Development Tools**
 - **Node.js and npm:** JavaScript runtime and package manager to handle dependencies and run development scripts.
 - **Expo CLI:** Command-line interface to initialize, run, and build the React Native app for Android.
 - **Visual Studio Code (VS Code):** Lightweight, extensible code editor used for writing, debugging, and managing the app's source code.

- **APK Packaging:** The app is built into an APK file for direct installation on Android devices, ensuring native performance and full device access.

VIII. SYSTEM IMPLEMENTATION

As illustrated in Figure 2, the mobile application is designed to streamline the workflow between three user groups: patients, healthcare workers, and doctors, each accessing role-specific features for efficient interaction.

The system begins with a splash screen, followed by a login and registration interface. New users must register by entering their personal information, verifying an OTP sent to their mobile number, and linking their Gmail account for secure access, while existing users can log in using their email and password. Once authenticated, users are directed to a customized dashboard based on their role.

- Patients can manage personal details, schedule appointments, view diagnostic reports, and receive health-related alerts, helping them stay informed and involved in their care.
- Healthcare workers can add new patient records, enter relevant health data, and use a USB-connected camera with the mobile device to capture cervical images during screening. This data, along with images, is uploaded to a cloud platform, where it becomes accessible to doctors for review.
- Doctors can then log in to evaluate incoming cases, examine the submitted images, generate diagnostic reports, and refer to previous records to track patient progress over time.

A common settings section is available to all users for updating profiles and adjusting preferences, and the application ensures secure logout at the end of each session to protect sensitive information. This integrated workflow supports real-time collaboration between healthcare workers in the field and remote doctors, enabling timely diagnosis and decision-making even in locations lacking specialist availability. By simplifying the process of patient registration, image acquisition, cloud-based data sharing, and expert consultation, the system provides an efficient framework for delivering healthcare services, particularly in rural or low-resource settings. It reduces the need for patients to travel long distances for expert opinions while giving doctors access to necessary clinical information remotely.

Overall, the system enables continuous care, promotes early detection through field-level screening, and enhances communication between all stakeholders involved in the diagnostic process.

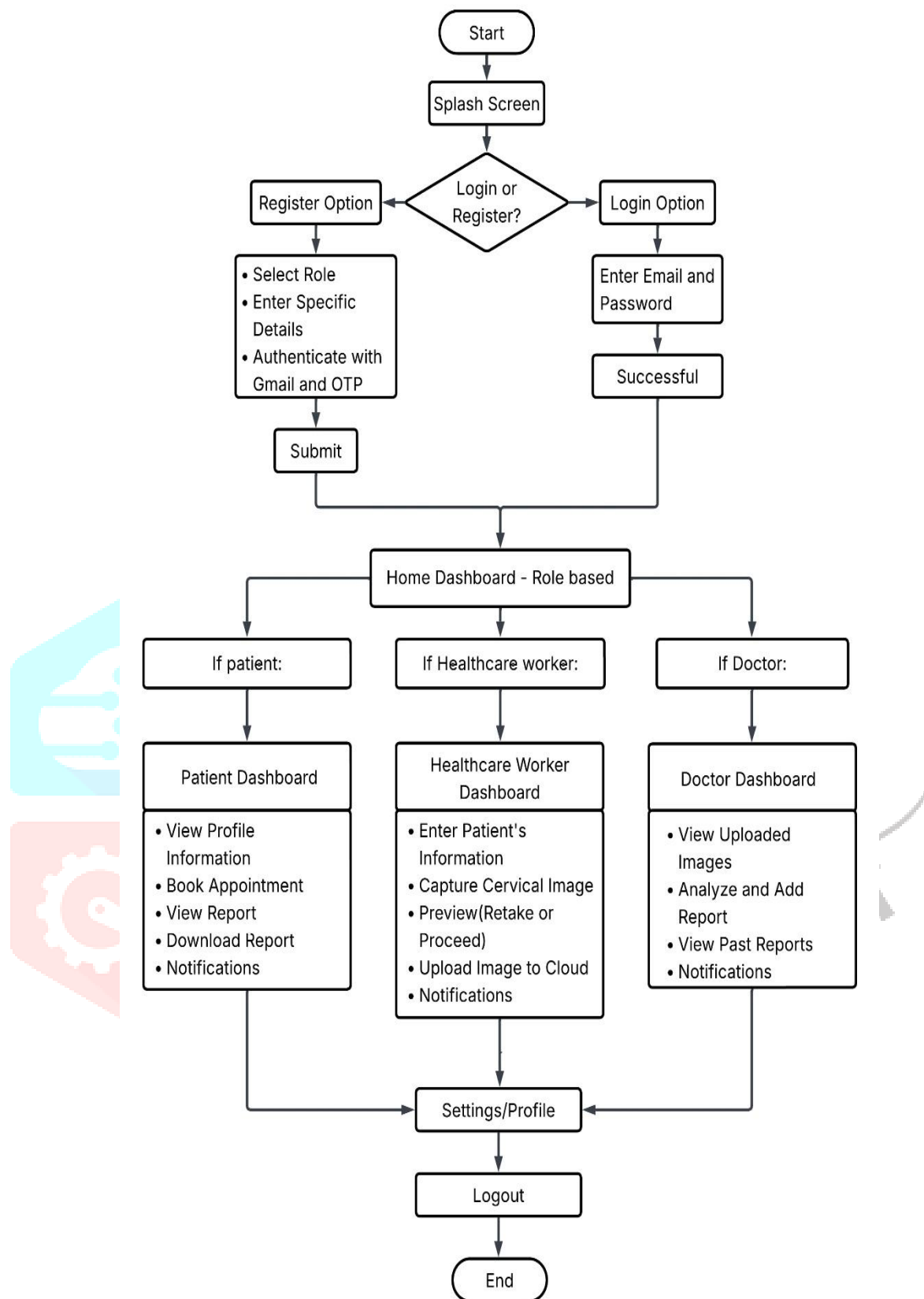
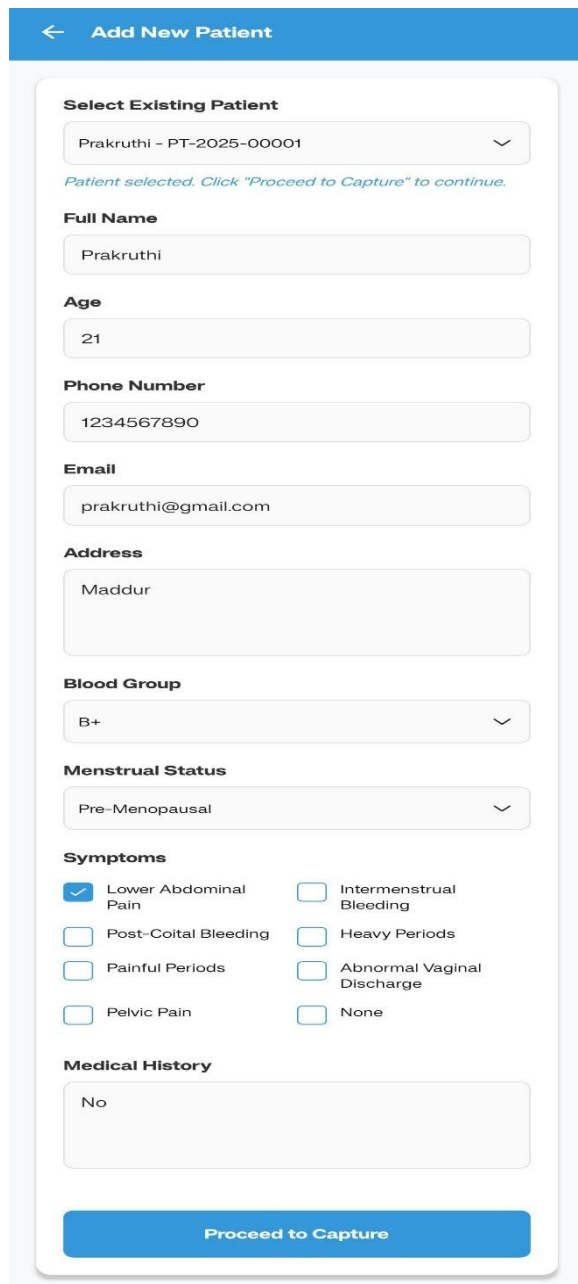


Fig 2: Flowchart of the proposed system

XI. RESULTS AND DISCUSSION

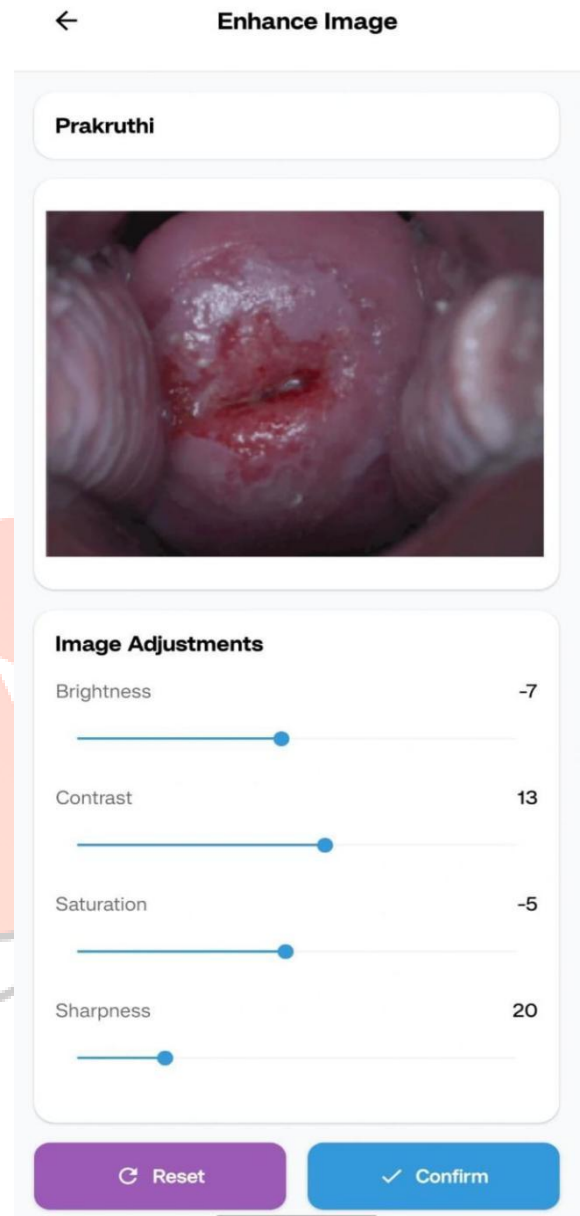
The proposed system is developed to streamline cervical screening by connecting patients, healthcare workers, and doctors through android-based colposcope application.

The following figures illustrate the Healthcare Worker user interfaces and key steps involved, including patient registration, image capture and enhancement, report uploading, and data access for diagnosis.



The screenshot shows the 'Add New Patient' screen. It features a blue header with a back arrow and the title 'Add New Patient'. Below the header, there is a section for 'Select Existing Patient' with a dropdown menu showing 'Prakruthi - PT-2025-00001'. A message below the dropdown says 'Patient selected. Click "Proceed to Capture" to continue.' The form includes fields for 'Full Name' (Prakruthi), 'Age' (21), 'Phone Number' (1234567890), 'Email' (prakruthi@gmail.com), 'Address' (Maddur), 'Blood Group' (B+), and 'Menstrual Status' (Pre-Menopausal). There is a 'Symptoms' section with checkboxes for 'Lower Abdominal Pain' (checked), 'Intermenstrual Bleeding', 'Post-Coital Bleeding', 'Heavy Periods', 'Painful Periods', 'Abnormal Vaginal Discharge', 'Pelvic Pain', and 'None'. A 'Medical History' section has a text field with 'No'. At the bottom is a blue button labeled 'Proceed to Capture'.

Fig 3: Patient Registration and Symptom Entry Screen



The screenshot shows the 'Enhance Image' screen. It has a blue header with a back arrow and the title 'Enhance Image'. Below the header, there is a section for 'Prakruthi' with a dropdown menu. The main area displays a colposcopy image of the cervix. Below the image is a section for 'Image Adjustments' with sliders for 'Brightness' (-7), 'Contrast' (13), 'Saturation' (-5), and 'Sharpness' (20). At the bottom are two buttons: a purple 'Reset' button and a blue 'Confirm' button.

Fig 4: Image enhancement screen

Fig 3 is the patient entry screen where the healthcare worker fills in personal, symptom, and history details before capturing the image.

Fig 4 allows the healthcare worker to adjust the cervix image using brightness, contrast, saturation, and sharpness controls.

The following figures illustrate the Doctor interfaces and key steps involved. This dashboard shows case statistics and allows doctors to review reports, view images, and add diagnoses. The key interface screens are shown below.



Fig 5: Doctor Dashboard Screen

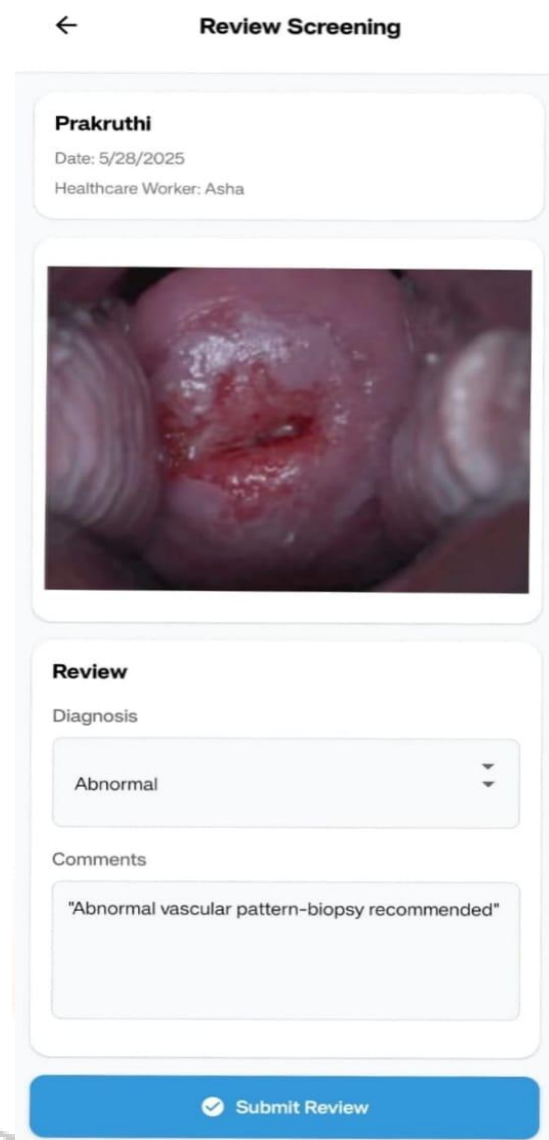


Fig 6: Review Screening Form Screen

Fig 5 Displays total reports, pending reviews, abnormal cases, and visual trends. Allows quick access to report actions.

Fig 6 Used to review new screening cases. Includes patient info, image, diagnosis selection, and comment input.

The following figures illustrate the Patient interfaces and key steps involved. This dashboard offers features to book appointments, schedule screenings, and review past visits, including the screening report.

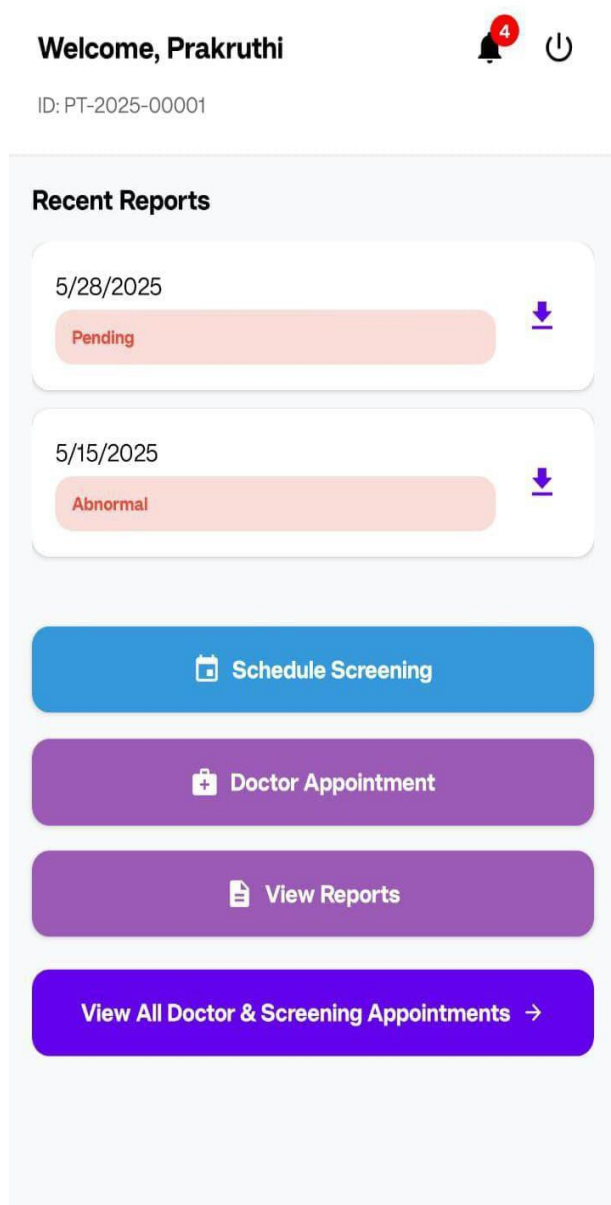


Fig 7 : Patient Dashboard



Fig 8: Cervical Screening Report

Fig 7 displays the patient dashboard showing report history and options to schedule screenings, view reports, or book appointments.

Fig 8 shows a digitally generated cervical screening report with patient details, screening status, doctor's comments, and an image link.

X. MERITS

- **Early Screening:** Helps identify cervical changes at an initial stage to enable timely care.
- **Portable and Low-Cost:** Uses an affordable USB camera and Android phone, making it suitable for rural and remote areas.
- **Real-Time Remote Diagnosis:** Doctors can view images and give diagnoses without being physically present, saving time and effort.
- **User-Friendly Interface:** Simple dashboards for patients, healthcare workers, and doctors make the system easy to operate.
- **Secure Data Handling:** Firebase ensures encrypted storage, role-based access, and safe transmission of medical records.
- **Appointment Management:** The built-in scheduling feature improves communication and reduces missed consultations.

XI. DEMERITS

- **Internet Dependency:** The system requires a stable internet connection for uploading images and accessing reports, which may not be available in very remote locations.

XII. CONCLUSION

CerviHealth is a helpful mobile app that supports early screening for cervical health problems, especially in rural and remote areas. It allows health workers to take clear images using a smartphone and safely send them to doctors for quick advice. This helps find signs of illness early, so treatment can begin on time. The app is easy to use and works well even in places with limited resources. By storing data securely in the cloud, it keeps patient records safe and easy to access. CerviHealth makes it possible to bring important health services to women who may not have regular access to hospitals. Overall, it helps improve early care, reduce delays, and support better health for women everywhere.

Future Enhancement

A key future improvement for CerviHealth is adding AI to analyze cervical images automatically. This would help detect early signs of problems quickly and accurately, even without immediate expert review. It would speed up diagnosis and allow healthcare workers to act faster. AI integration would make screening easier and more reliable, especially in places where doctors are not always available. This feature would strengthen early detection and improve patient care.

XIII. REFERENCES

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