MACHINE LEARNING-ASSISTED, LOW-COST ANDROIDE-ENABLED COLPOSCOPIC IMAGING SYSTEM FOR RURAL HEALTHCARE

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Keywords:

AI-Based Image Analysis, Android-Based Colposcopy, Cervical Cancer Screening, Deep Learning (CNN), Low-Cost Diagnostic System, Machine Learning, Rural Healthcare Telemedicine.

Introduction:

1. Cervical cancer: cancer of the cervix, the lower part of the uterus.
2. Caused almost entirely by a persistent human papillomavirus (HPV) infection.
3. The disease often develops slowly from precancerous cell changes.
4. Colposcope is a medical device equipped with a binocular microscope and light source.
5. It is used to examine the cervix, vagina, and vulva under magnification a process called colposcopy.

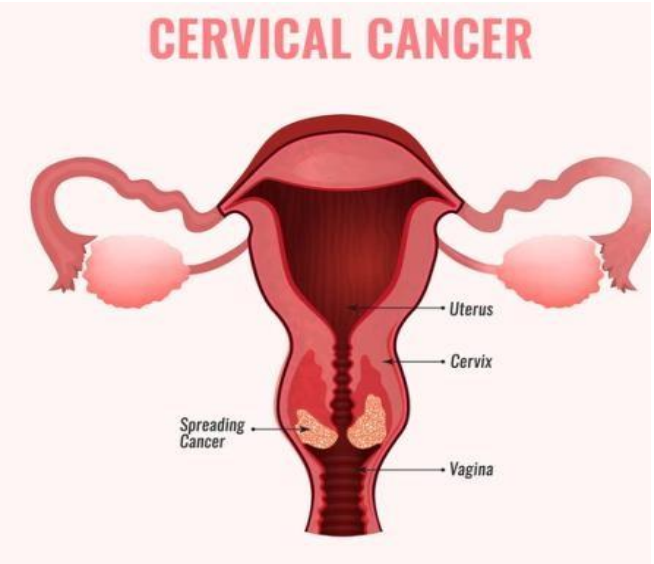

Figure 1: *Cervical Cancer*

Objectives:

1. **Technical Objective**
   Develop and train a machine learning model capable of automatically detecting precancerous cervical lesions to support real-time clinical decision-making.
2. **Healthcare Impact Objective**
   Improve screening accessibility by enabling trained and semi-trained healthcare workers to conduct cervical screenings in rural and resource-limited areas.
3. **Scalability & Sustainability Objectives**
   Establish a sustainable implementation model through collaboration with government bodies and NGOs, and create simplified training and deployment protocols for community health workers.

Methodology:

1. Image Acquisition
High-resolution cervical images are captured using a USB-based digital colposcopy camera connected to an Android smartphone running the Cervi Health app.

2. Mobile Preprocessing & Data Handling
Captured images undergo basic preprocessing (resizing, noise reduction, color correction). Patient details are securely recorded within the app.

3. Secure Wireless Data Transfer
The app securely uploads images and metadata to the cloud using encrypted Wi-Fi or mobile data transfer protocols.

4. Cloud Storage & Repository
All data is stored in a secure, scalable cloud repository, ensuring organized record management and easy access for authorized healthcare professionals.

5. AI-Based Image Classification
A lightweight deep learning model (e.g., MobileNet-V2 or EfficientNet-Lite) automatically classifies images into normal or abnormal categories, assisting early identification of precancerous lesions.

6. Remote Medical Review
Doctors access the cloud dashboard to review images, AI predictions, and provide diagnoses or follow-up instructions, enabling timely remote care delivery.

Result and Conclusion:

Result

Fig2.1: Cervi Health App Launch Screen

Fig2.2: Mission and Vision Screen

3.1: Patient's Dashboard:

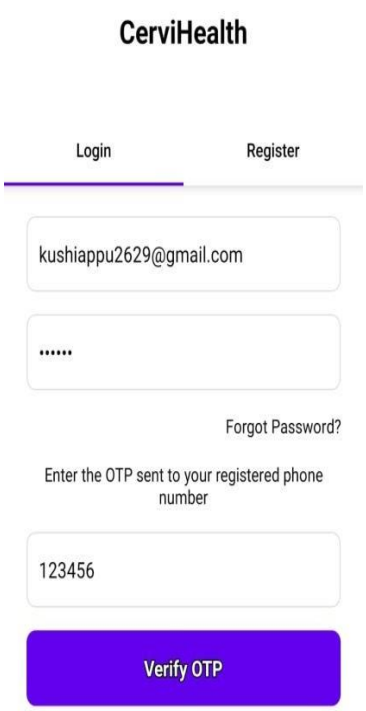

Fig 3.1a): User Login

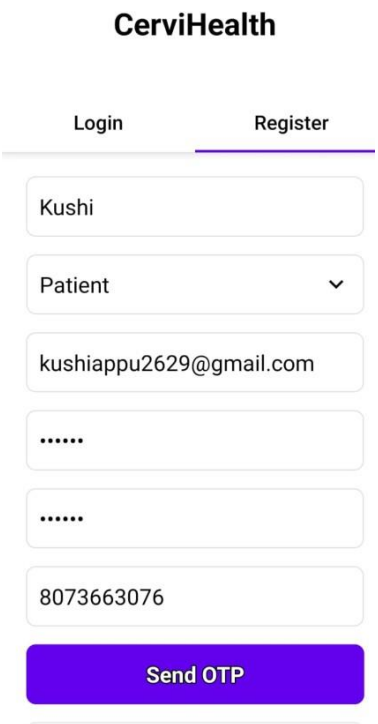

Fig 3.1b): User Registration

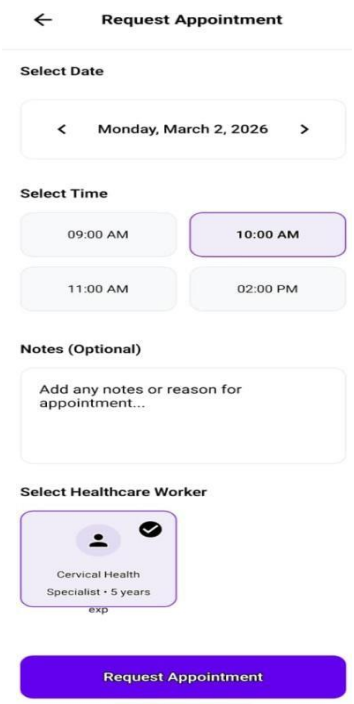

Fig 3.1c): Patient's Dashboard

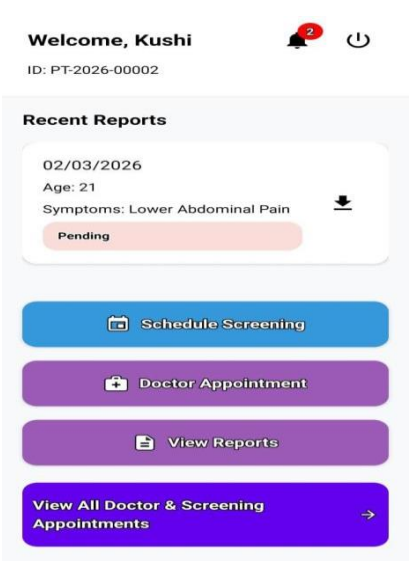

Fig 3.1d): Request Appointment with Healthcare

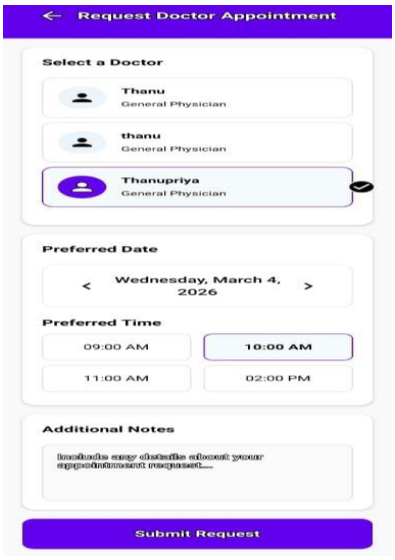

Fig 3.1e): Request Appointment with Doctor

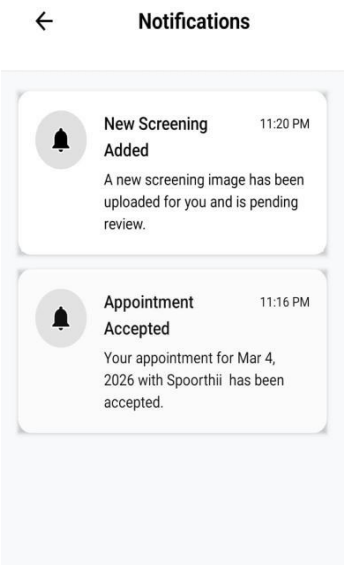

Fig 3.1f):Notifications

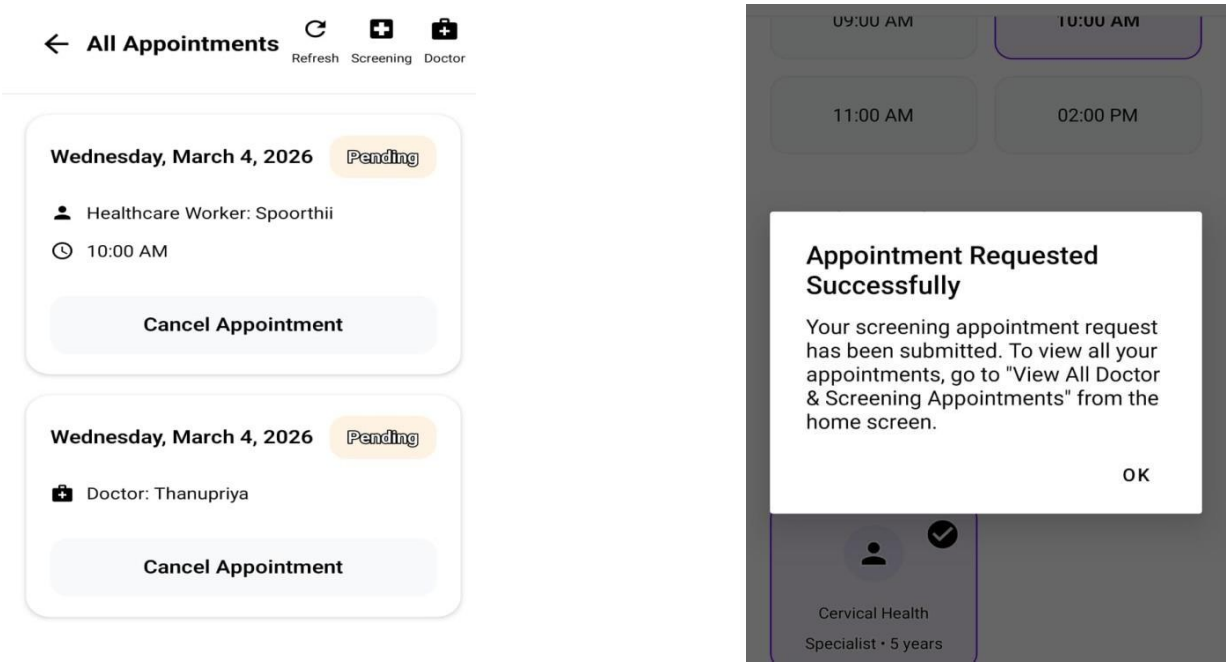

Fig 3.1g): View all appointments

3.2:HealthCare Worker's Dashboard:

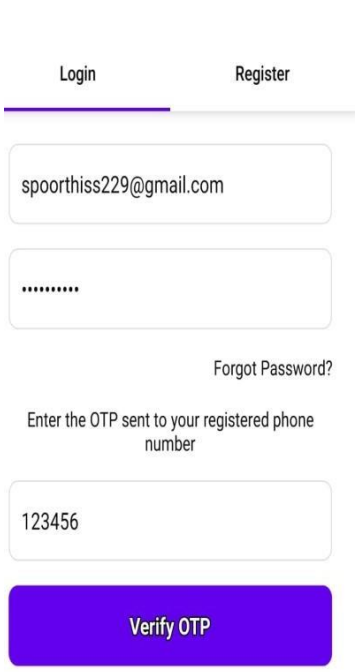

Fig 3.2a): User Login Details

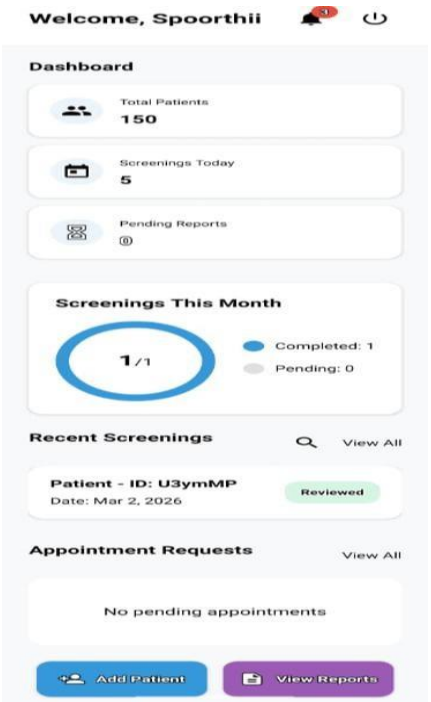

Fig 3.2b): HealthCare worker Dashboard

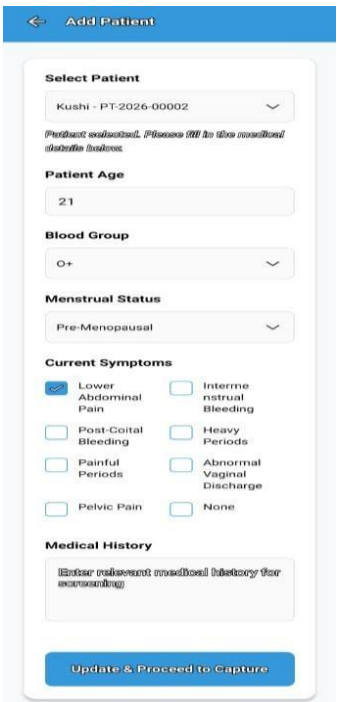

Fig 3.2c):Add Patient Details

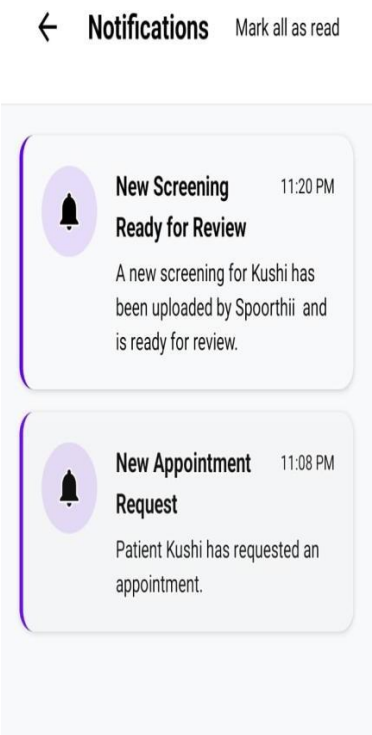

Fig 3.2d): Notifications

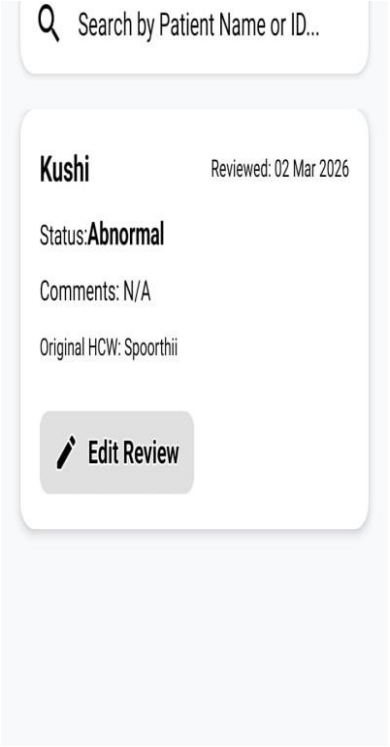

Fig 3.2e): Reviewed Reports

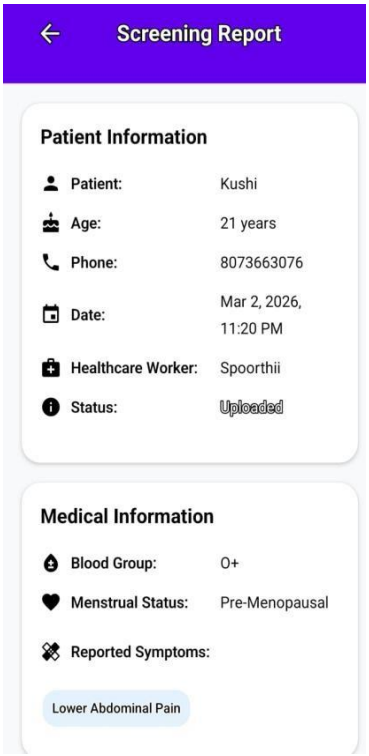

Fig 3.2f): Screening Reports

3.3: Doctor's Dashboard:

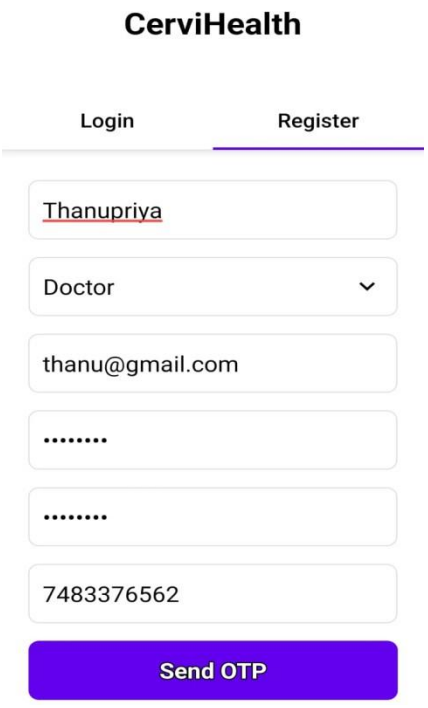

Fig 3.3a): User Registration

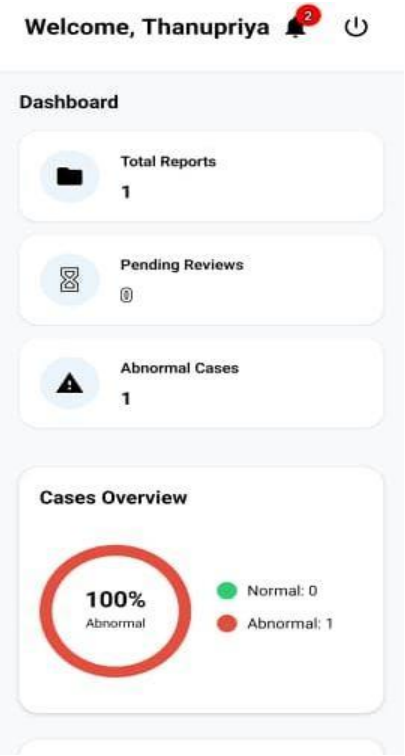

Fig 3.3b) Doctor's Dashboard

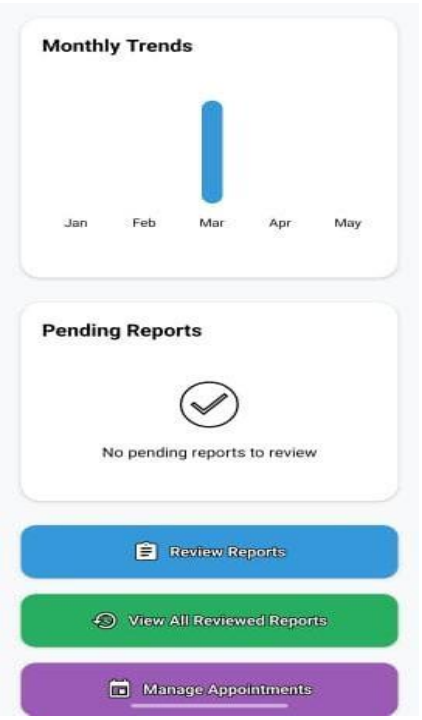

Fig 3.3c) Extended Doctor's

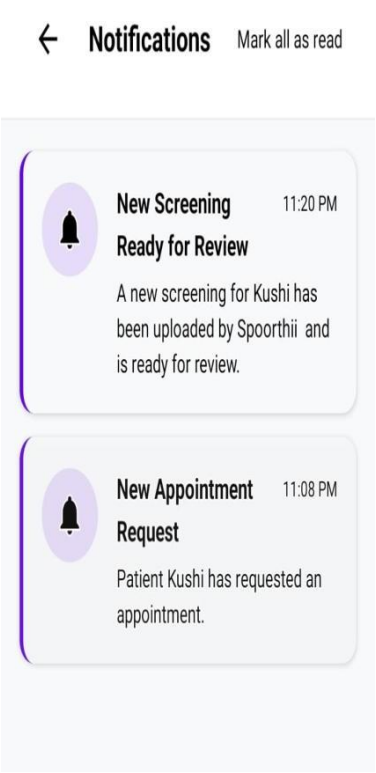

Fig 3.3d): Notifications

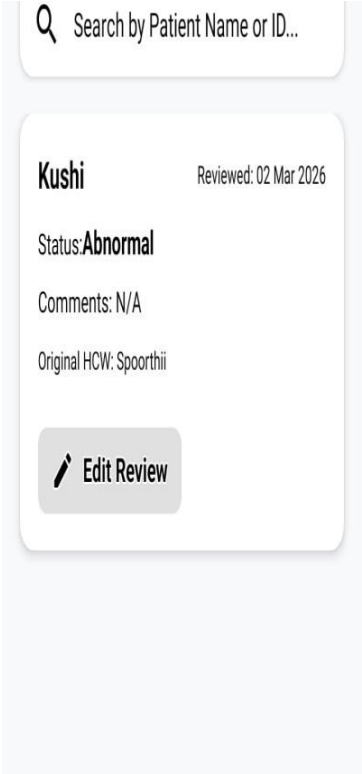

Fig 3.3e): Reviewed Reports

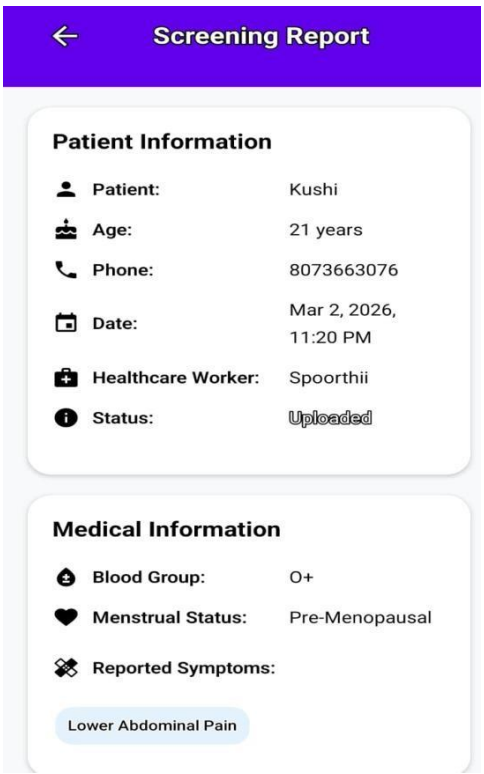

Fig 3.3f): Screening Report

The implemented system successfully performs automated analysis of colposcopy images and generates classification results.

1. Results show improved accuracy, consistency, and reduced dependency on manual interpretation.
2. The optimized model supports real-time processing on an Android platform suitable for low-cost devices.
3. The current outcomes demonstrate the practical feasibility of deploying the system for rural cervical cancer screening.

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Future Scope:

1. **Integration of Advanced AI Models**

   Future enhancements can incorporate more sophisticated deep learning architectures such as transformer-based models and explainable AI techniques to improve diagnostic accuracy and provide interpretable results for clinicians.

   Continuous model training using larger and diverse datasets can further enhance robustness and adaptability across different population groups.

2. **Real-Time Edge Deployment and Offline Capability**

   The system can be extended to support on-device (edge) AI processing, enabling real-time analysis without reliance on internet connectivity. This would significantly improve usability in remote areas with limited network access, ensuring uninterrupted screening and immediate feedback during field operations.

3. **Expansion to Comprehensive Women’s Health Screening Platform**

   The proposed system can be scaled into a multi-disease screening platform by integrating modules for detecting other gynecological conditions or cancers.

   Additionally, integration with national health programs, electronic health records (EHR), and telemedicine networks can enhance large-scale deployment, monitoring, and continuity of care.