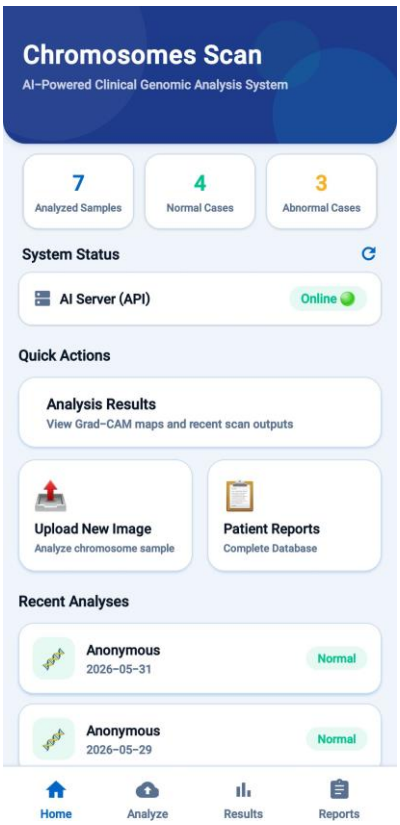
System Overview



Application Architecture

To develop an intelligent, clinical mobile platform for automated chromosome analysis that integrates deep learning architectures, explainable artificial intelligence (Grad-CAM), multi-modal genomic feature extraction, and automated medical reporting. The system empowers healthcare professionals to register comprehensive patient clinical profiles, execute real-time chromosomal abnormality detection, localize affected chromosome pairs, and dynamically extract biological DNA and RNA metrics via secure HTTPS communication with a high-performance remote AI backend server. Ultimately, the project aims to optimize diagnostic accuracy, significantly minimize cytogenetic analysis time, support evidence-based clinical decision-making, and provide an accessible, compute-efficient genetic screening solution for modern medical institutions.

Key Capabilities

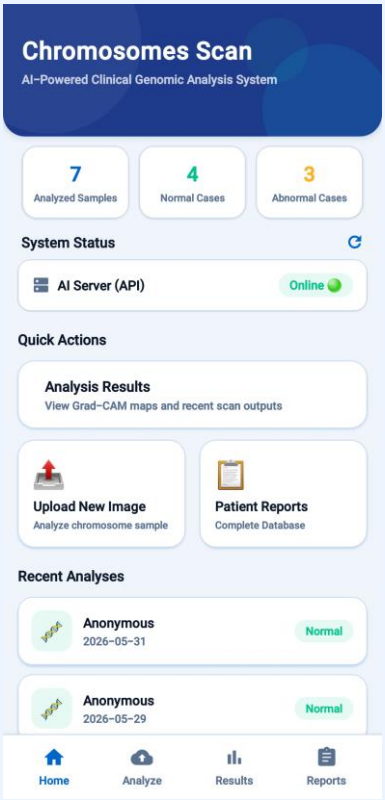
- Three specialized CNN models (RGB, Grayscale, Heatmap)
- Grad-CAM explainability heatmaps for anomaly localization
- Automated PDF report generation per patient
- Persistent local database with full case history
- Real-time server status monitoring

Supported Platforms

Android 10+ (API Level 29 and above)

Fig. 1 — Home Dashboard: system status, statistics, and quick-access panel.

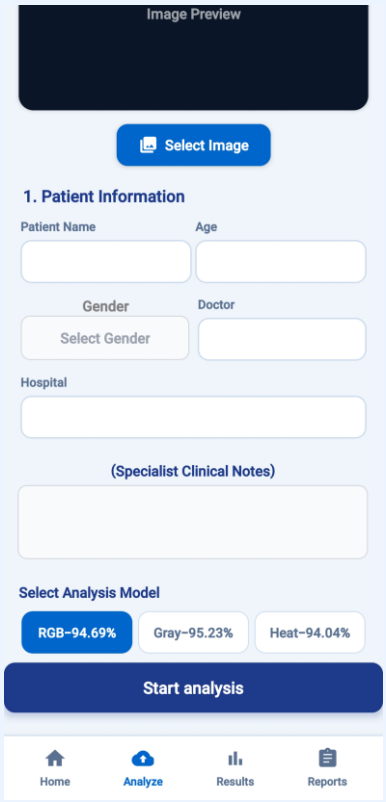
Step-by-Step Operating Procedure



01

Verify Server Synchronization

Upon initial boot, examine the top configuration panel. The application must reflect an **Online** connection status badge, indicating safe client-to-server HTTP synchronization.



02

Register Patient Biological Profile

Navigate to the **Analyze** navigation lane. Input dynamic validation demographics including Patient Name, Age, Supervising Clinician, and Hospital Center fields.

03

Acquire Chromosomal Image

1. Acquire Chromosomal Image

Tap Select Image to access your local device gallery and upload a high-resolution chromosomal spreadsheet (karyogram) acquired directly from your laboratory microscope setup.

2.Use Cytogenetic Rationale : Metaphase Chromosomes

In cytogenetic diagnostics, the captured chromosome images must be processed exclusively during the Metaphase stage of cell division due to the following critical biological factors:

Maximum Condensation: Chromosomes reach their peak coiling phase during this stage, becoming short, thick, and highly visible under digital microscopy.

Perfect Equatorial Alignment: The chromosomes line up uniformly along the cell's equatorial plate. This optimal spatial distribution prevents overlapping and crowding, which drastically improves AI segmentation boundaries and detection accuracy.

04

Select Target Neural Network

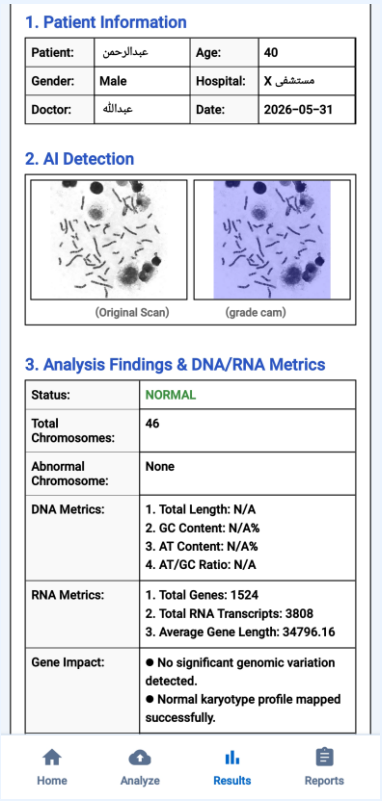
Choose the specialized CNN processing pipeline based on image contrast: **Gray-95.23%** for standard grayscale banding sheets, **RGB-94.69%** for color sheets, or **Heat-94.04%** mapping filters.

05

Invoke Automated Inference

Invoke Automated Inference

Trigger the Start Analysis command. The image is resized to 224×224 pixels and securely transmitted through secure channels for instant tensor evaluation.



06

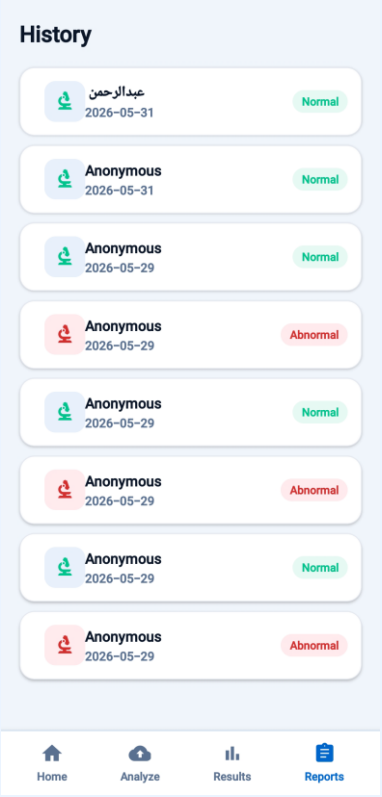
Evaluate Clinical Insights

The system will redirect you to the **Results** display panel to evaluate classification markers, localization of anomalies, dynamic molecular statistics, and explainable Grad-CAM heatmaps.

07

Export Standard PDF Document

Tap **Download PDF Report** to activate the device printing spooler. This compiles a clean, multi-line, verified medical report with no layout clipping or formatting bugs.



08

Persistent Database Caching

Close the interface or cycle system power safely. The non-volatile storage caching tier stores all patient logs under the **Reports (History)** tab, automatically modifying structural home panels.

Grad-CAM Visual Explainability

Gradient-weighted Class Activation Mapping (Grad-CAM) provides spatial localization of the model's decision regions directly overlaid on the chromosomal scan. Warm regions (red/yellow) indicate high activation zones associated with the classified anomaly, enabling clinicians to visually validate the AI's reasoning.

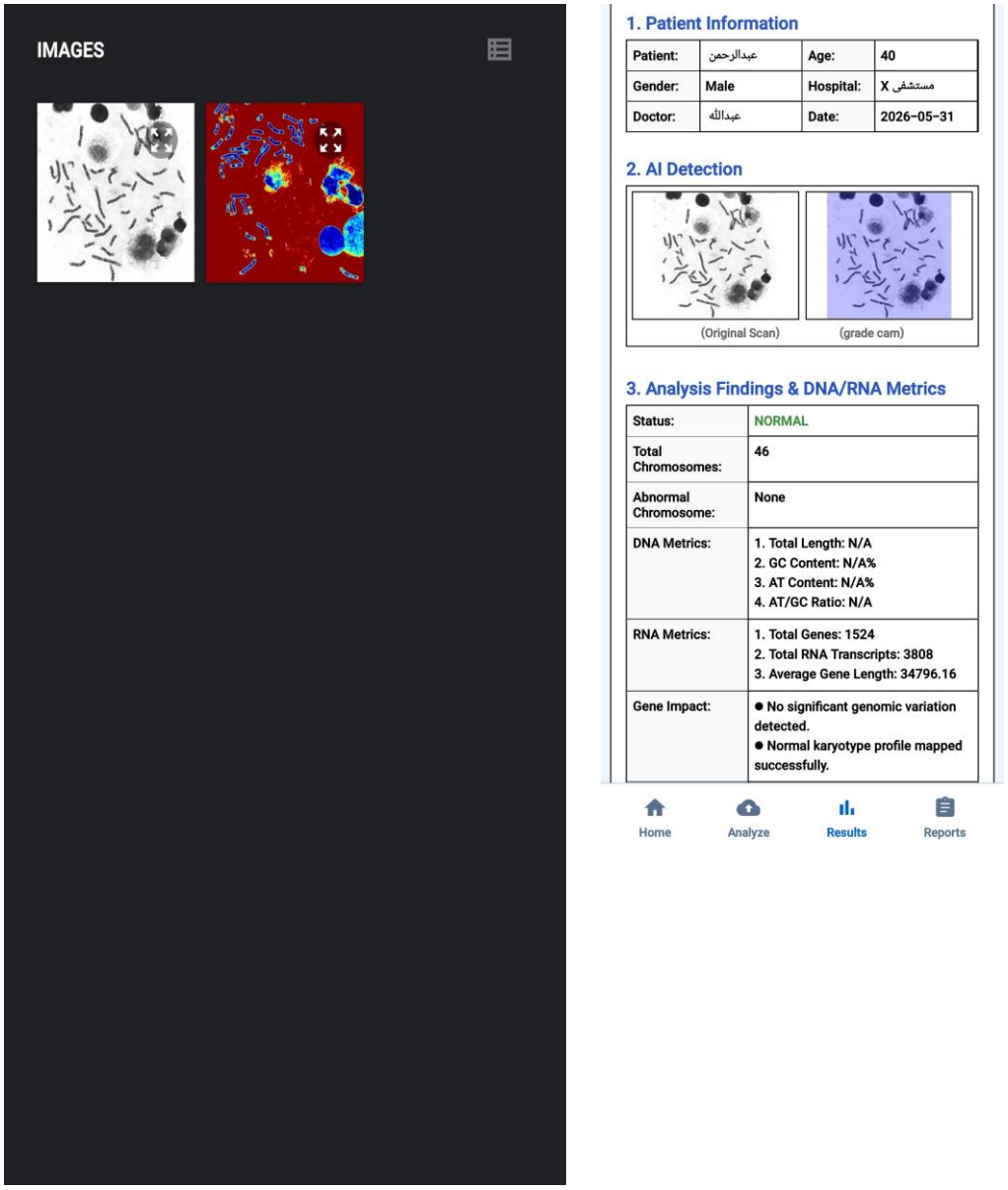


Fig. 2 — Left: Grad-CAM heatmap overlay on chromosomal scan. Right: Integrated results panel with molecular metrics and AI findings.

Technical Specifications

Parameter	Specification
Input Resolution	224 × 224 pixels (auto down-sampled)
Supported Formats	JPEG, PNG, BMP, TIFF (karyogram images)

CNN Architectures	RGB Model (94.69%), Grayscale (95.23%), Heatmap (94.04%)
Explainability Method	Gradient-weighted Class Activation Mapping (Grad-CAM)
Communication Protocol	HTTPS REST API — JSON response format
Local Storage	Non-volatile SQLite-based caching (AsyncStorage)
Report Output	Structured PDF — Patient + AI findings + Grad-CAM
Normal Reference	46 chromosomes (diploid human karyotype)
Platform	Android 10+ (API Level 29)