Maatran: Revolutionizing Maternal Care through Remote Monitoring and Risk Prediction

Supplementary Document

Kulsum Kamal[1], Niladri Shekhar Das[1], Subroto Rakshit[1], Rudraneel Dutta[1], and Sovan Saha[2] *

[1] *Dept. of Computer Science and Engineering, Institute of Engineering and Management, Sector V, Kolkata, India.*

[2] *Dept. of Computer Science and Engineering (Artificial Intelligence and Machine Learning), Techno Main Salt Lake, Sector V, Kolkata, India.*

** Corresponding Author, Email address: sovansaha12@gmail.com*

1. System Architecture

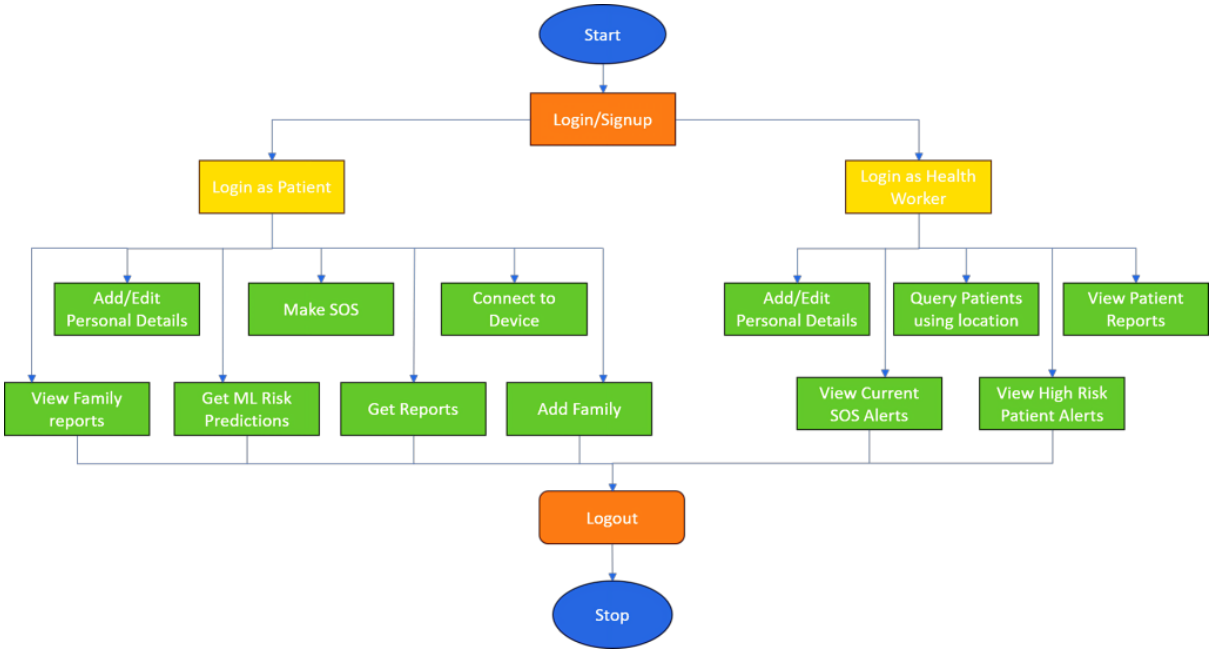

Fig. S1. **Maatran App Features.** The above figure shows the complete workflow and features available to a patient or admin in the app.

In this high-level system diagram:

The Maatran app has two primary user modes: "Patient" and "Health Admin."

- Patients access the Patient Dashboard, where they can edit their profiles, manage family connections using unique shareable keys, and remotely monitor sensory data via Bluetooth hardware. They can also view reports of family members and send and receive SOS alerts and high-risk alerts.
- Health Admins access the Health Admin Dashboard, where they can view all alerts and high-risk alerts generated by patients and query patients based on their locations.

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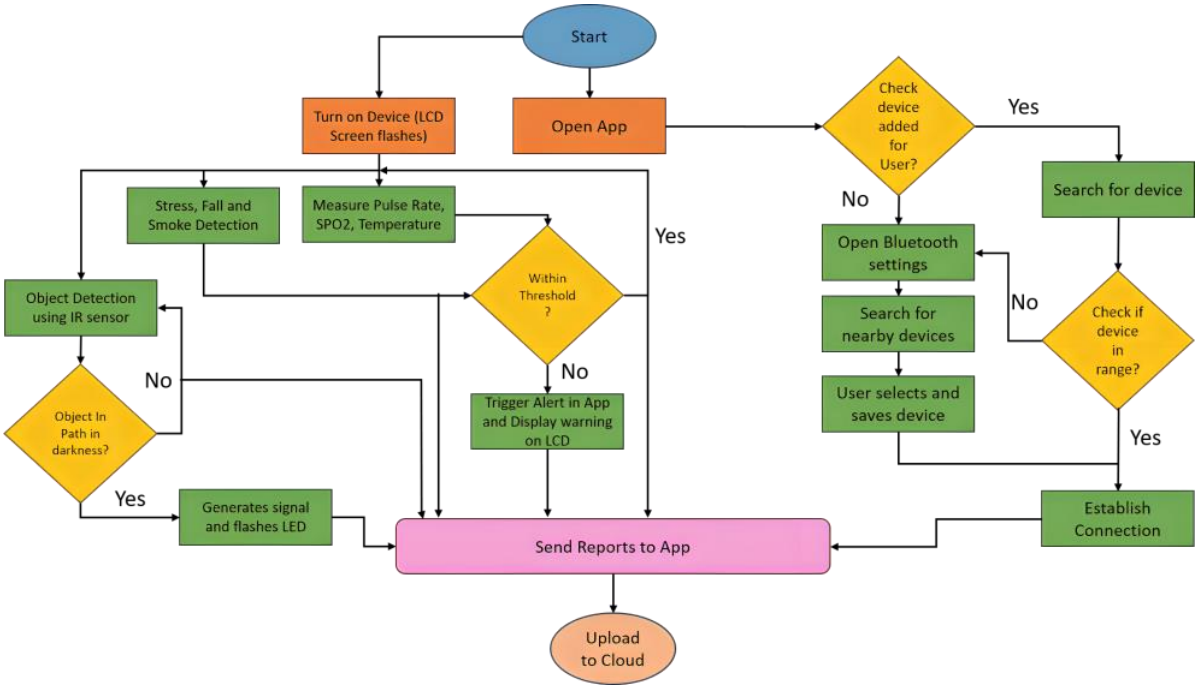
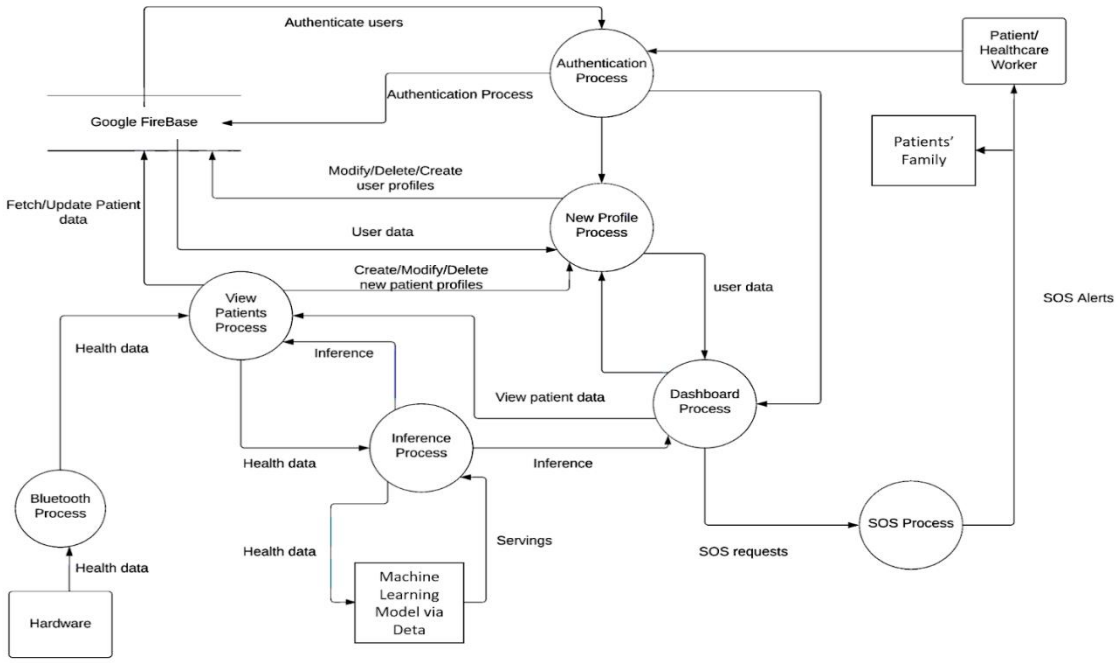


Fig. S2. **Maatran Health Monitoring Services.** Each module is accompanied by triggers and alerts in direct communication with the app.



Fi. S3. **High Level System Design of the Maatran App.** All user processes and transactions are highlighted in the above figure.

2. Roll, Pitch and Yaw Derivations:

ADXL335 (accelerometer) is used to measure the roll, pitch, and yaw, that are used in turn for orientation estimation.

1. A roll is a counterclockwise rotation of α about the z-axis.
2. A pitch is a counterclockwise rotation of β about the y-axis.
3. A yaw is a counterclockwise rotation of γ about the x-axis.

Equation of Rotation Matrix (from Roll, Pitch and Yaw):

$$R(\alpha,\beta,\gamma) = R_z(\alpha)\, R_y(\beta)\, R_x(\gamma) = \begin{pmatrix} \cos\alpha\cos\beta & \cos\alpha\sin\beta\sin\gamma - \sin\alpha\cos\gamma & \cos\alpha\sin\beta\cos\gamma + \sin\alpha\sin\gamma \\ \sin\alpha\cos\beta & \sin\alpha\sin\beta\sin\gamma + \cos\alpha\cos\gamma & \sin\alpha\sin\beta\cos\gamma - \cos\alpha\sin\gamma \\ -\sin\beta & \cos\beta\sin\gamma & \cos\beta\cos\gamma \end{pmatrix}. \tag{3.1}$$

Suppose an arbitrary rotation matrix

$$\begin{pmatrix} r_{11} & r_{12} & r_{13} \\ r_{21} & r_{22} & r_{23} \\ r_{31} & r_{32} & r_{33} \end{pmatrix} \tag{3.2}$$

is given. Note that $r_{21}/r_{11} = \tan\alpha$ and $r_{32}/r_{33} = \tan\gamma$. Also, $r_{31} = -\sin\beta$ and $\sqrt{r_{32}^2 + r_{33}^2} = \cos\beta$ Solving for each angle yields

$$\alpha = \tan^{-1}(r_{21}/r_{11}), \tag{3.3}$$

$$\beta = \tan^{-1}\left(-r_{31}/\sqrt{r_{32}^2 + r_{33}^2}\right), \tag{3.4}$$

$$\gamma = \tan^{-1}(r_{32}/r_{33}). \tag{3.5}$$

There is a choice of four quadrants for the inverse tangent functions. Each quadrant should be chosen by using the signs of the numerator and denominator of the argument. The numerator sign selects whether the direction will be above or below the x-axis, and the denominator selects whether the direction will be to the left or right

of the y-axis. This is the same as the 2 function in the C programming language, which nicely expands the range of the arctangent to $[0, 2\pi)$. This can be applied to (3.3), (3.4) and (3.5) and expressed as

$$\alpha = 2(r_{21}, r_{11}), \tag{3.6}$$

$$\beta = 2\Big(- r_{31}, \sqrt{r_{32}^2 + r_{33}^2}\Big), \tag{3.7}$$

$$\gamma = 2(r_{32}, r_{33}). \tag{3.8}$$

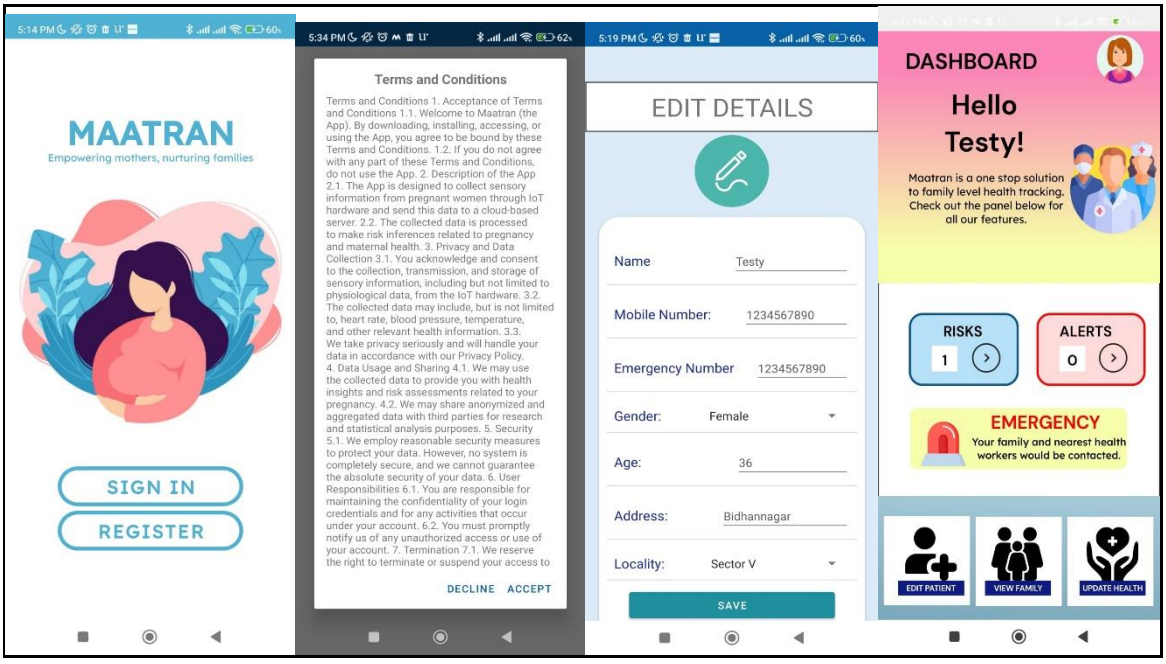
3. Maatran - The App

As of this moment, the application is still in its prototype phase, and therefore can only be downloaded through GitHub.

Steps to download and install the app:

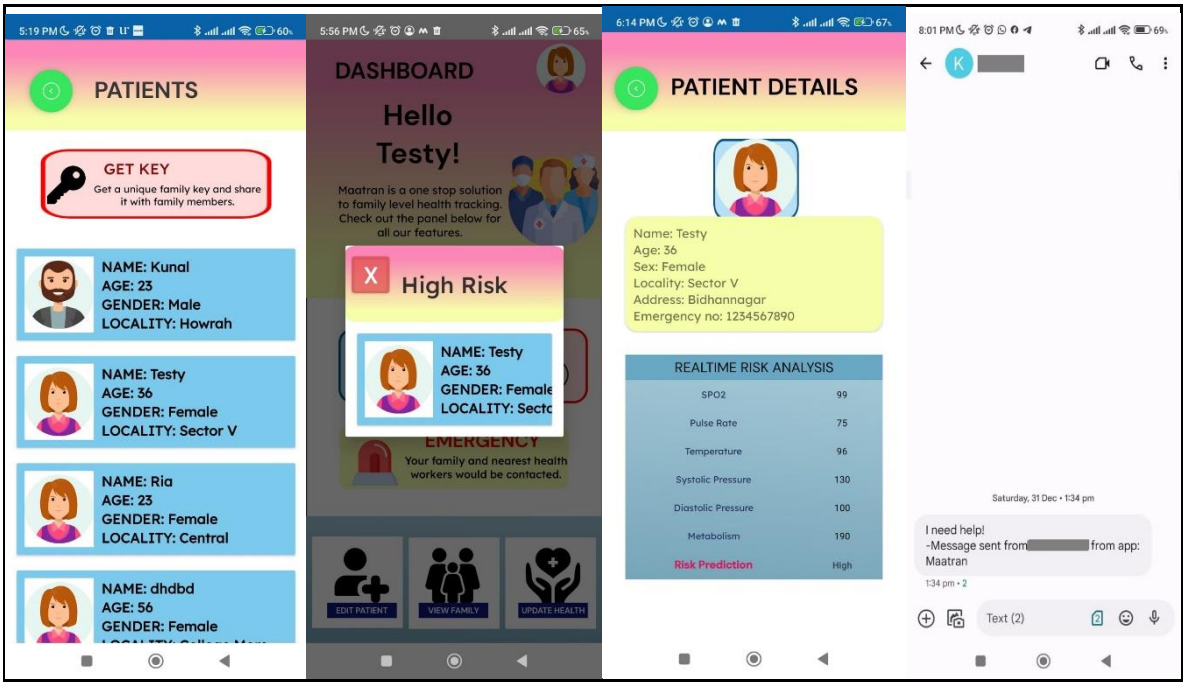
1. Navigate to the Maatran public repository (https://github.com/SegFault03/MAATRAN) and click on the 'Releases' option on the right-hand side of the page.
2. Once you've opened the releases tab, navigate to the bottom of the page, expand the dropdown arrow under 'Assets' and click on the link called 'Maatranv2.2.3-release.apk'
3. A pop-up should appear on your device asking for your permission to download the 'apk' file. Grant the required permissions and install the apk once it has been downloaded.
4. Once the app has been successfully installed, open it and grant the necessary permissions to take advantage of all the features that it has to offer.

App Features:



(a) (b) (c) (d)

Fig. S4. **App Screens of Maatran.** The figure above shows the features and the dashboard of the Maatran app from a patient's account. (a) Landing page of Maatran (b) Terms and Conditions Declaration during sign up. (c) Details taken for a patient (d) Dashboard from a patient's account.



(a) (b) (c) (d)

Fig. S5. **Patient Information and Reports.** (a) Family member reports can be tracked. Members can be added via a unique family key. (b) High Risk Alerts of family members are shown on the app. (c) A patient's report. (d) An SOS alert message.

4. Comparison of Maatran

The following table shows a feature based comparison of Maatran with other commercial devices available that are focused on remote health tracking.

Table S1

Features	*Device 1*	*Device 2*	*Device 3*	*Device 4*	*Device 5*	*Device 6*	*Device 7*	*Device 8*	*Device 9*	*Maatran*
LCD display 20 x 4	☒	☒	☒	☒	☒	☒	☒	☒	☒	☑
Heart-rate tracker (24/7)	☑	☑	ECG: ☑	ECG: ☑	ECG: ☑	ECG: ☑	ECG: ☑	ECG: ☑	ECG: ☑	☑
Call and SMS notification	☑	☑	☒	☒	☒	☒	☒	☒	☒	☑
Android app	☑	☑	☒	☒	☒	☒	☒	☒	☒	☑
Sleep tracking	☑	☑	☒	☒	☒	☒	☒	☒	☒	☒
iOS	☑	☑	☒	☒	☒	☒	☒	☒	☒	☒
GPS	☒	☒	☒	☒	☒	☒	☒	☒	☒	☑
Automatic Heart rate monitoring and alert	☑	Heart rate: ☑ Alert: ☒	Heart rate: ☑ Alert: ☒	☑	...	Heart rate: ☑ Alert: ☒	...	Heart rate: ☑ Alert: ☒	Heart rate: ☑ Alert: ☒	☑
Alarm notification	☑	☑	...	...	☒	☒	...	☒	...	☑
Remote tracking	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒
SOS	☒	☒	☒	☒	☒	☒	☒	☒	☒	☑
Disconnection alert	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒
Mobile Finder	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒
EDA Sensor	☒	☒	☒	☑	☒	☒	☒	☒	☒	☒
Electromyogram (EMG Sensor)	☒	☒	☑	☑	☑	☑	☑	☑	☑	☒
Body Temperature Senosr	☒	☒	☒	☑	☒	☒	☑	☒	☒	☑
Electrooculogram (EOG Sensor)	☒	☒	☒	☒	☒	☒	☒	☒	☑	☒
Electroencephalogram (EEG Sensor)	☒	☒	...	☒	☑	☑	☑	☑	☑	☒
Wireless Connectivity	☑	☑	☒	☒	☒	☒	☒	☒	☒	☑

Emotion Detection (Grove GSR Sensor)	☒	☒	☒	☒	☒	☒	☒	☒	☒	☑
Distance Senosr (IR Sensor)	☒	☒	☒	☒	☒	☒	☒	☒	☒	☑
Acceloro meter	☒	☒	☒	☒	☒	☒	☒	☒	☒	☑
Smoke Detection (MQ 135 Sensor)	☒	☒	☒	☒	☒	☒	☒	☒	☒	☑
Market Price	₹2,299	₹6,527	...	...	...	...	...	...	...	₹3,000