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QR-Based Emergency Alert and Medical Profile System for Senior Citizens

Vibhor Kr. Vishnoi, Mohammad Kaif, Madhur Panghal, Ibrahim Saud, Mohammad Affan

Department of Computer Science and Engineering, Moradabad Institute of Technology

kaif8528576249@gmail.com madhurpanghal01@gmail.com sahibakhter0786@gmail.com
mohdaffan0017@gmail.com

Abstract

This research paper presents a comprehensive analysis and implementation of a QR-based emergency response and medical data management system, developed under the project titled Elderly Care. The system is designed to address the growing need for accessible, reliable, and real-time emergency solutions for senior citizens, enabling faster medical assistance and enhanced safety in critical situations. By combining QR code technology, geolocation services, and cloud-connected databases, the system ensures quick retrieval of health profiles and real-time alert mechanisms during emergencies. Additionally, it integrates an AI-driven recommendation engine that generates personalized health advice, such as dietary suggestions, wellness tips, and condition-appropriate physical activities, based on the user's medical data.

The proposed solution allows elderly users to register, submit medical data, and generate a unique QR code linked to their medical profile. This QR code can be scanned by bystanders, emergency responders, or caretakers, enabling instant access to crucial medical information and geolocation data. Integrated with services like Twilio for SMS notifications and browser-based geolocation APIs, the system alerts emergency contacts along with live coordinates during high-risk scenarios. The AI recommendation engine further analyzes factors such as age, chronic conditions, and medication records to provide tailored advice, which appears directly on the user's dashboard. This helps users maintain better health routines and supports caregivers in managing health-related tasks effectively.

The findings from this study highlight the impact of accessible tech solutions in safeguarding vulnerable populations. By combining real-time scanning, communication tools, AI-driven health recommendations, and data visualization, Elderly Care represents a scalable, cost-effective step forward in responsive healthcare for senior citizens.

1. Introduction

Modern healthcare, particularly when it comes to the elderly population, encounters several persistent challenges, among them being accessibility, effective real-time communication, and timely emergency response. As individuals age, they often experience a decline in mobility, cognitive sharpness, and overall health resilience, making them especially susceptible to unforeseen medical emergencies. In many such situations, the ability to instantly access the patient's medical history and accurately locate them can significantly influence the outcome of medical intervention. Despite advances in health monitoring technology, there remains a critical gap in systems that are both comprehensive and easy to use for this demographic.

The Elderly Care system was conceptualized to address this very need by blending simplicity with powerful technology. At its core, Elderly Care is a web-enabled solution that empowers elderly users—or their caretakers—to securely register and maintain essential health records online. These records include details such as blood group, existing conditions, medications,

allergies, and emergency contact numbers. Once a profile is completed, the system generates a unique QR code that is publicly scannable. This QR code acts as a gateway to the user's health profile, which can be accessed instantly without requiring authentication, making it ideal for emergencies where time and simplicity are of the essence.

Moreover, Elderly Care doesn't stop information retrieval. It integrates advanced real-time emergency support through GPS-enabled geolocation services and instant SMS alerting. In the event of an emergency, a designated button on the scanned profile page can be used to trigger an alert. This activates the user's geolocation, fetches coordinates via the browser's HTML5 API, and dispatches an SMS with the user's live location to all pre-registered emergency contacts using Twilio's SMS API.

To further assist elderly users in managing their health, Elderly Care features an AI-based recommendation engine. This engine generates personalized health tips based on the user's medical data, such as recommended dietary changes, physical activity suggestions (like yoga or walking), and general wellness advice (hydration, sleep, etc.). By continuously analyzing the user's medical profile, the AI system provides dynamic suggestions that adapt to their evolving health needs.

By combining accessible technologies such as QR codes, cloud databases, geolocation tracking, SMS alerts, and AI-driven recommendations, Elderly Care offers an innovative, cost-effective, and life-saving solution. It bridges the gap between health data availability and emergency response, ultimately promoting independence, dignity, and safety for elderly individuals living alone or in remote settings. The system also reduces the burden on caregivers and medical personnel by providing immediate, data-backed insight into a patient's condition, enabling faster and more informed decisions during emergencies.

2. Related Works

Several research efforts have been undertaken in the field of healthcare technologies for elderly support and emergency response. In [1], a system was developed that utilizes NFC tags to store basic medical data of elderly patients, which can be scanned by healthcare personnel for quick access. While helpful, this method requires specialized hardware and lacks integration with live communication tools.

Reference [2] explores a wearable health monitoring device that tracks heart rate and motion in real time, sending alerts through Bluetooth. However, such systems often rely on continuous wear and close-range connectivity, limiting their real-world applicability in emergencies.

In [3], a mobile application was proposed that stores user health profiles and allows manual SOS triggering. Although the app includes contact notification features, it lacks passive emergency response capabilities and real-time geolocation sharing.

Another approach in [4] introduced a QR-based patient identification system used in hospitals, enabling staff to retrieve medical history by scanning QR codes on patient wristbands. This solution is hospital-centric and not designed for public use or remote assistance.

Finally, [5] proposed an IoT-enabled fall detection system using accelerometers, but it required continuous internet and power supply, which may not be viable in all conditions.

These studies highlight the importance of health accessibility and emergency responsiveness. However, there remains a gap in delivering a low-cost, universally scannable, geolocation-enabled, and easy-to-deploy system specifically targeted toward the elderly. Elderly Care addresses these limitations with a mobile-friendly, QR-powered system designed for real-world emergencies. Additionally, by integrating an AI recommendation engine, the system offers a holistic approach to health management, promoting overall well-being alongside emergency preparedness.

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3. System Architecture

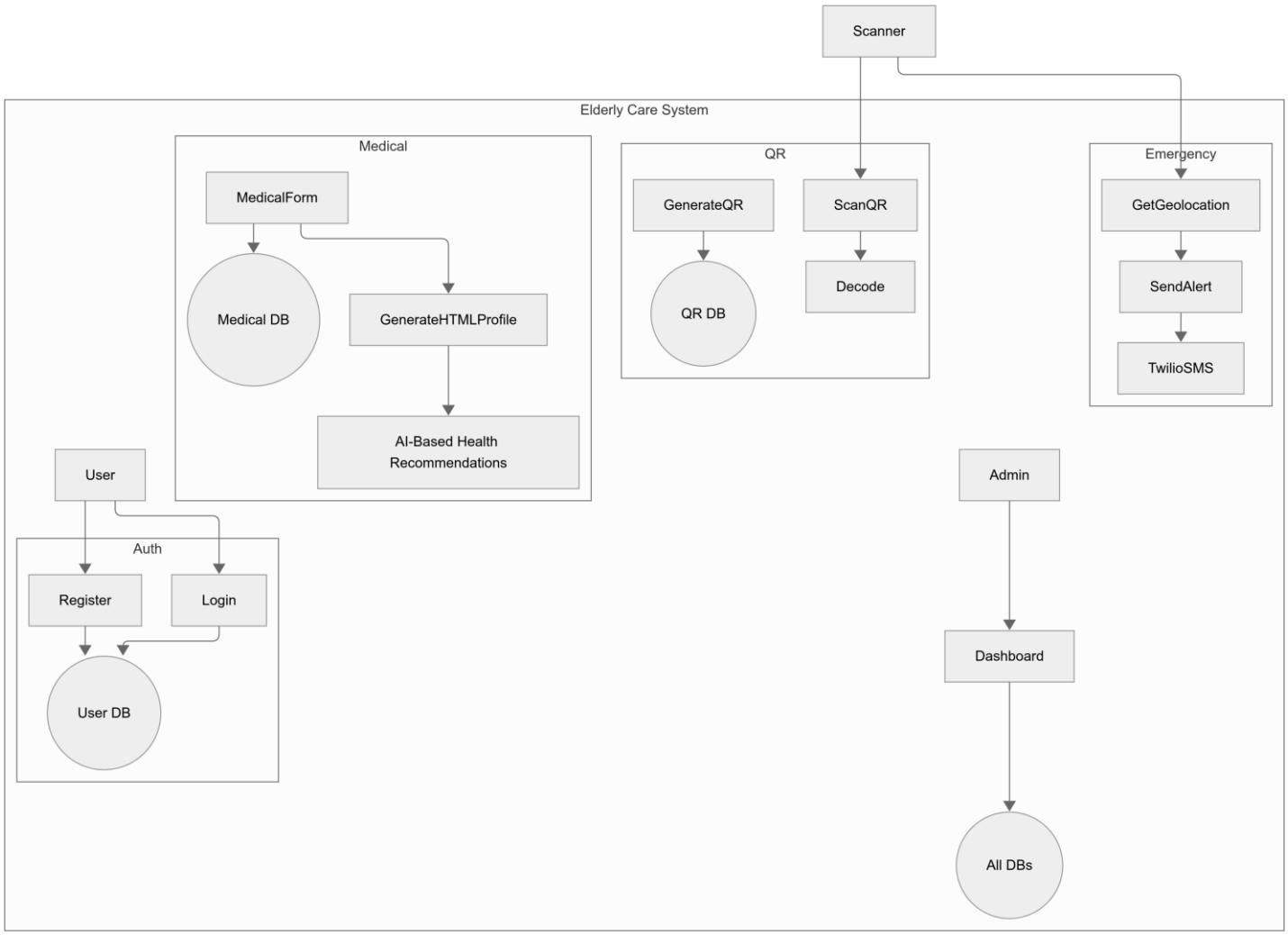

Figure: 1 System Architecture

3.1 User Module

- **User Registration/Login**: Each user creates a personal account using basic credentials.

- **Medical Form Submission**: Users fill out a detailed health form including chronic conditions, medications, blood type, allergies, and emergency contact details.

- **QR Code Generation**: A unique, scannable QR code is generated linking directly to the user's medical profile.

- **Profile Preview & Update**: Users can view and update their information, ensuring accuracy.

- **Health Recommendation System**: Based on the user's medical data (age, conditions, medications), the system provides tailored recommendations.

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3.2 SCANNER MODULE

- **QR Scanner Interface:** When the QR code is scanned via any browser or device, it loads the user's emergency medical profile in real time.
- **Instant Access Without Login:** Ensures that critical health data is visible without any barriers during emergencies.

3.3 EMERGENCY ALERT MODULE

- **Emergency Trigger Button:** Once the profile is loaded, an emergency button can be pressed to initiate help.
- **Geolocation Access:** The device's GPS is activated to fetch the user's current coordinates.
- **SMS Integration via Twilio API:** These coordinates and a help message are instantly sent to all registered emergency contacts.
- **Redirection to Live Map**: The receiver of the message can click on the location link to get directions in Google Maps.

3.4 HEALTH RECOMMENDATION MODULE

- **Personalized Health Suggestions:** Recommendations are dynamically generated based on the user's chronic illnesses, medications, age group, and health data.
- **Diet Recommendations:** Tailored dietary suggestions help users manage conditions like diabetes, hypertension, or cholesterol.
- **Physical Exercise Guidance:** Based on user capability and medical conditions.
- **General Tips:** The system displays daily or weekly wellness tips.
- **Future AI Integration:** The system architecture supports potential integration of AI for predictive health alerts and trend analysis.

3.5 ADMIN MODULE

- **Admin Login:** Secure access for system management.
- **User Dashboard:** View, edit, or delete user data as needed.
- **Audit Logs & Analytics:** Track user activities, QR scans, and alert triggers for insights and security.
- **Data Deletion Requests:** Admins can handle deletion requests submitted by users.

3.6 Database & Backend Structure

- **NoSQL Database (MongoDB/Firebase):** Stores user data securely.
- **QR Mapping Storage:** Links each QR to its respective user ID.
- **APIs & Routing (Node.js/Express):** Handles frontend requests, scanner page generation, and SMS operations.

4. Implementation Methodology

4.1 Profile and QR Integration

The first step involves capturing detailed medical data from users through an HTML-based form. This form includes fields such as blood group, chronic illnesses, medications, allergies, and emergency contacts. Once submitted, the data is validated and stored securely in a cloud-hosted NoSQL database (e.g., MongoDB or Firebase).

Upon successful data submission, a backend API triggers the generation of a unique QR code linked to the user's profile URL. This QR code is displayed on the dashboard and can also be downloaded as an image for printing or sharing. When scanned, it redirects the user to a public, read-only version of the medical profile that does not require authentication.

4.2 Personalized Health Recommendations

The system features a recommendation engine that provides personalized health suggestions based on user data, including age, chronic illnesses, and medication. It offers tailored advice on diet, wellness, and physical activities, helping elderly users maintain better health routines.

Designed to be scalable, the system can integrate AI-based prediction models in the future for smarter, automated health guidance.

4.3 Emergency Trigger and Geolocation Services

The QR profile page includes an "Emergency Alert" button. When activated, the system fetches the user's current location using the HTML5 Geolocation API. The coordinates are then formatted into a Google Maps link.

Using Twilio's SMS API, the system sends this location, along with a custom emergency message, to all stored emergency contacts. This real-time alert feature ensures that help can be dispatched to the exact location without delays or manual intervention.

4.4 Admin and Security Management

An admin portal allows system administrators to view, modify, or delete user data as needed. It also provides access to activity logs, such as QR scan timestamps and triggered alerts. To ensure privacy and security, role- based access control is implemented, and profile data is stored using encrypted HTTPS protocols.

4.5 Testing and Validation

Unit testing and simulation of real-time QR scans, geolocation permissions, and SMS triggers were carried out across multiple devices and browsers. The system consistently demonstrated low latency, fast loading times, and reliable message delivery.

5. Results and Analysis

5.1 System Performance

The system was found to be stable and responsive across a wide range of devices and browsers. QR codes were scannable even from printed versions, with average loading times of less than 1 second on 4G and Wi-Fi networks. Emergency SMS

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messages were successfully delivered within 2–4 seconds of activation. Geolocation was typically accurate within 10–15 meters, enabling responders to find users quickly.

5.2 Snapshot: User Profile

Each user's health profile contains vital medical data such as blood group, chronic conditions, medications, allergies, and emergency contacts. The snapshot illustrates how the profile is structured and how quickly this information can be accessed by both emergency responders and caregivers. The profile is easy to update and allows for real-time adjustments to reflect any changes in the user's health status.

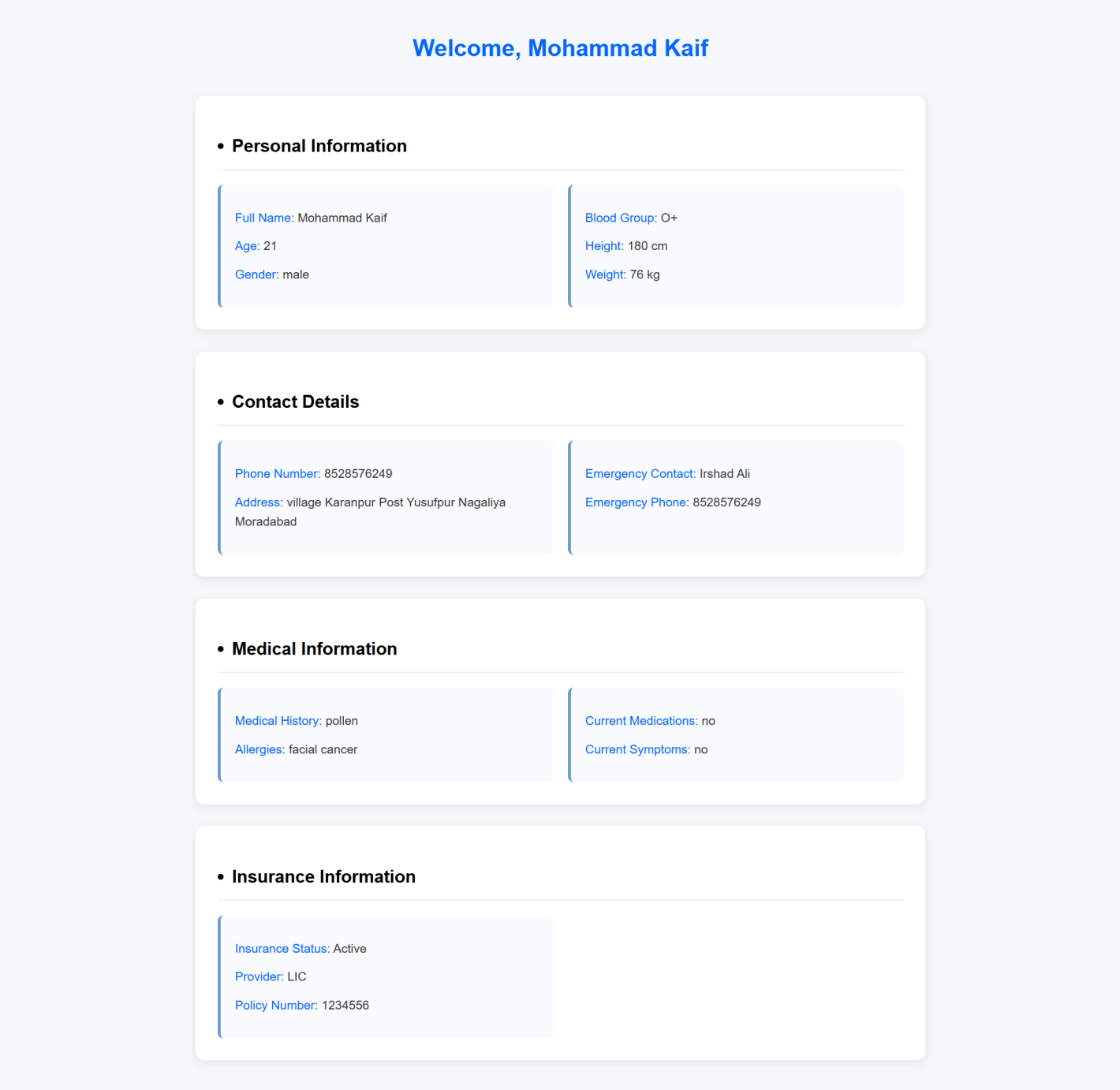

Figure: 2 User Profile

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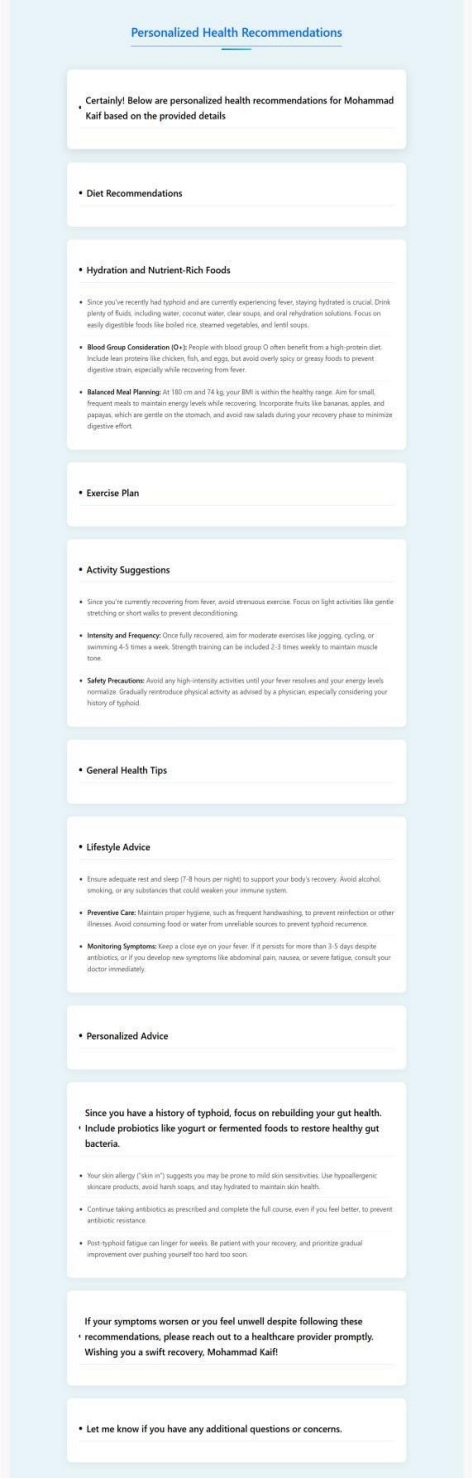
5.2 Snapshot: Recommendation Engine

The AI-driven recommendation engine provides personalized health advice to elderly users. The snapshot displays the types of recommendations offered, including dietary tips (e.g., low-sugar meals), wellness suggestions (hydration reminders), and condition-appropriate physical activities (e.g., yoga or walking). These personalized suggestions are tailored based on the user's medical profile and are shown on the user's dashboard for easy access and follow-up.

Figure: 3 Personalized health Recommendation



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5.3 Snapshot: QR-Based Medical ID Card

Each user receives a unique QR code linking to a read-only digital medical profile. It displays key information such as blood group, medical history, allergies, and emergency contacts. The card is mobile-friendly, loads quickly, and ensures essential health data is easily accessible in emergencies.

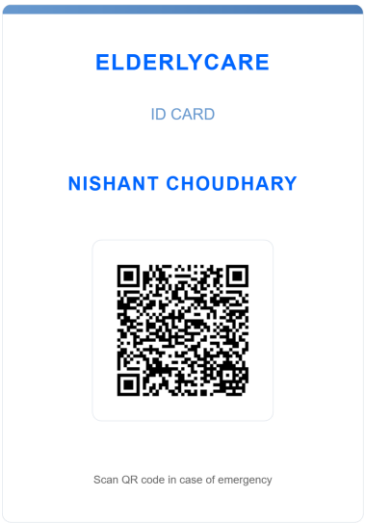

Figure: 4 ID CARD

5.3 Snapshot: Decoded QR Page

When a QR code is scanned, the decoded page displays the user's medical information in a structured format. This snapshot highlights the detailed view of the medical profile, including key details like medical history, allergies, and medication records. The page is designed for quick readability and contains a link for direct access to the user's emergency contacts and live location in case of an emergency.

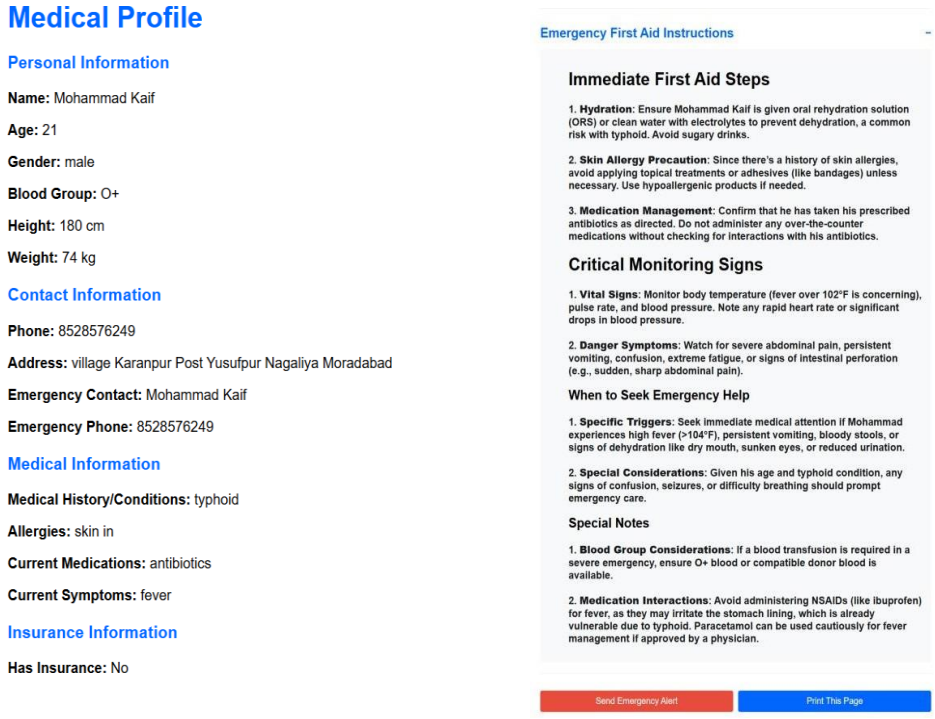

Figure: 5 Decoded QR Page

5.4 User Feedback and Compatibility

Feedback from testers highlighted the system's ease of use, even for elderly participants with minimal technical experience. The interface was rated as intuitive, and the emergency process was fast and reliable. Compatibility tests showed the system performed equally well on Android, iOS, and all major browsers, ensuring accessibility for a wide range of devices.

6. Technical Challenges and Solutions

6.1 Real-Time Location Access

Challenge:

Accurate geolocation is critical for emergency alerts. However, relying on browser-based GPS APIs often resulted in inconsistent or delayed location data due to user permission prompts, signal interference, or device limitations.

Solution:

To mitigate this, the system leverages the **HTML5 Geolocation API** with fallback options. Users are prompted with a clear permission message. Additionally, the app logs the last known location if GPS fails, ensuring at least partial tracking.

6.2 SMS Delivery Delays and Rate Limits

Challenge:

Twilio's free tier restricts the number of SMS messages sent per day and may introduce delays during high traffic.

Solution:

A notification queue system was implemented to handle retries and prevent duplicate alerts. Paid API tiers were explored for production deployment, and alerts were restricted to only trigger once per session to reduce overload.

6.3 QR Code Security and Accessibility

Challenge:

Making the health profile accessible via QR code without login introduced privacy concerns.

Solution:

QR links are made public **only in read-only format**, with no edit permissions. Sensitive fields like contact numbers and addresses are partially masked or shown only when necessary. Profile links include randomly generated tokens that prevent guessing.

6.4 Admin Authentication and Role Separation

Challenge:

Ensuring that only authorized users can manage or delete sensitive data while regular users access only their profile.

Solution:

Role-based access control (RBAC) was implemented in the backend. Separate dashboards were developed for users and admins, and actions like deletion or bulk edits are protected via JWT tokens and server-side validation.

6.5 CROSS-Platform Compatibility

Challenge:

Ensuring the system functions reliably across various devices and browsers, especially during QR scans and alert triggers.

Solution:

The interface was built using responsive design principles and tested on multiple platforms. QR codes were generated using standardized formats, ensuring they work on any QR reader.

7. Future Enhancements

7.1 Proposed Enhancements

Proposed enhancements refer to suggested improvements or modifications to a system, process, or product to

increase its efficiency, functionality, or user experience. These enhancements can be applied to software, hardware, business operations, or any technological system.

7.1 Voice-Activated Emergency Triggers

To improve accessibility for visually impaired or physically limited users, voice-activated commands (e.g., "help" or "emergency") can be integrated using the **Web Speech API**. This would allow users to trigger emergency alerts without physically tapping a button.

7.2 Wearable Device Integration

The system can be extended to work with **wearable health trackers** such as smartwatches or fitness bands. These devices can provide real-time vitals (e.g., heart rate, oxygen level) and automatically trigger alerts when abnormal values are detected, adding proactive safety.

7.3 Multilingual Support and Accessibility Features

To cater to a broader user base, the system could offer **multilingual interfaces** and accessibility features such as screen reader support, high-contrast mode, and larger fonts for better usability by elderly users across different regions and abilities.

7.4 AI-Based Health Insights

In future iterations, **AI models** can analyze historical health data to detect patterns or predict health risks. For example, frequent emergency triggers can flag high-risk users to their caregivers or doctors for preventive interventions.

7.5 Blockchain for Secure Health Records

To enhance data security and transparency, a **blockchain-based medical record system** can be integrated, providing tamper-proof health data history and secure access logs for patients and healthcare providers.

7.6 Solar-Powered Emergency Devices

In rural or off-grid areas, solar-powered QR badges or emergency alert devices can be distributed, ensuring continued system operation even without electricity or mobile phones.

- Predictive alerts using AI analytics
- Blockchain for secure medical data access logs
- Solar-powered QR badge deployment in rural areas

8. Conclusion

The Elderly Care system offers a practical, efficient, and accessible solution to the growing need for responsive elderly healthcare. By combining QR code identification, real-time geolocation, and automated SMS alerts, the platform ensures that critical medical data is available instantly in emergency scenarios. This significantly reduces response time and allows caregivers or responders to act with informed precision.

Designed with simplicity and reliability in mind, Elderly Care eliminates the need for complex logins or costly hardware. Its intuitive design makes it usable for both tech-savvy and non-technical users, while cloud integration ensures secure and scalable data handling. The system performs reliably across different devices and browsers, making it a universally

accessible tool.

In addition to emergency support, the system incorporates an AI-powered recommendation engine that delivers personalized health advice based on user data such as age, medical history, and medications. These recommendations—ranging from dietary tips to wellness routines and activity suggestions—encourage better daily health management for elderly users, promoting long-term well-being alongside real-time safety.

In summary, Elderly Care demonstrates how lightweight, web-based technologies can improve emergency readiness while supporting proactive health practices. With future upgrades such as enhanced AI models, voice-based triggers, and wearable device compatibility, the system has the potential to evolve into a comprehensive health support framework for senior citizens across diverse environments.

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