AFTER WE WERE ACCEPTED TO THE SUIT PROGRAM CONDUCTED BY HAVELSAN, WE CHANGED OUR PROJECT TO POST-DISASTER COMMUNICATION.

CMPE 491 / SENG 491

Senior Design Project I

Project Specifications Report

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1. Introduction

The increasing frequency and severity of natural disasters have highlighted the critical need for real-time emergency response systems that can effectively assess risks and provide immediate support to those affected. In response to this need, this project proposes the development of a sophisticated emergency management system that leverages sensor data to detect potential hazards such as seismic waves, temperature fluctuations, and water levels. The system will incorporate both mobile and web applications to communicate alerts to users and monitor their safety. This project aims to offer a solution for disaster management, utilizing modern technology to improve response times, facilitate coordination, and enhance overall public safety.

The system will be composed of two main components: a mobile application for end-users and a web-based platform for administrators. The mobile app will allow users to report their safety status during a disaster, share emergency contact details, and receive alerts. It will also feature tools for managing emergency contacts and updating personal information. The web application will serve as a monitoring hub for administrators to evaluate incoming data from sensors and user responses, take appropriate actions based on the information received, and forward critical alerts to emergency services or designated contacts when necessary.

The primary goal of this system is to improve the efficiency and effectiveness of disaster response efforts. By integrating sensor data with user communication, the system will provide a real-time picture of the situation, enabling swift decision-making and better coordination between individuals and authorities. In addition, the system will empower users to take proactive steps to ensure their safety, fostering a sense of preparedness and resilience in communities at risk.

1.1 Description

This project involves the design and development of a disaster management system that uses sensor data to detect and assess emergency situations. The system is designed to monitor three critical environmental factors during natural disasters: seismic waves, temperature, and water levels. These sensors will be placed in areas prone to disasters, where they will continuously collect and send data to a central platform.

When abnormal readings are detected by the sensors, alerts will be sent to the central system,

which will process the information and trigger notifications to both the web application and mobile apps. The mobile app will serve as a tool for individuals to report their safety status, either confirming that they are "safe" or indicating that they are "in danger." If a user indicates they are in danger, their personal information, including their name, contact number, and location, will be sent to their designated emergency contacts and monitored by the system administrator. These contacts will receive instructions or be redirected to appropriate channels for further action, ensuring that help is provided as quickly as possible.

The mobile application will offer several essential features:

- **User Registration & Login:** Users can create accounts, log in, and securely access the system.
- **Manage Contacts:** Users can add or remove emergency contacts, ensuring that the right people are notified in case of an emergency.
- **Alert System:** Users can receive and respond to emergency alerts, confirming their safety or reporting danger.
- **Profile Management:** Users can update their personal information, including contact details and emergency contact lists.

The web application will focus on providing administrators with the tools to evaluate incoming data and make informed decisions:

- **Sensor Data Analysis:** Administrators will receive real-time data from the sensors and evaluate the severity of the situation.
- **Monitor User Responses:** The system will track responses from mobile app users, alerting administrators to see if users are in danger or if there are communication delays.
- **Incident Management:** In case of emergency, administrators can quickly send alerts to emergency contacts or redirect users to further resources.
- **User Database:** Administrators can access and manage a list of registered users, ensuring that no user is overlooked in times of crisis.

This system will enhance public safety by providing accurate, real-time information during emergencies. It will also support timely interventions and ensure that individuals can quickly get the help they need. With its integrated communication system, the platform aims to improve disaster preparedness and response efforts on both individual and community levels.

1.2. Constraints

Sensor Technology and Accuracy:

It is vital that the sensors used accurately detect events such as shaking or water level. However, the quality and sensitivity of the sensors can affect the accuracy of the data detected.

False positive or negative notifications can mislead users and cause unnecessary diversion of emergency services. Therefore, regular calibration of sensors is essential.

Network Infrastructure:

There is a high probability of GSM or internet infrastructure collapse in emergencies. The effectiveness of alternative communication technologies such as Bluetooth Mesh depends on factors such as the coverage area and battery life of the devices.

Communication interruptions may occur in rural areas or weak signal areas.

Application Performance:

In large-scale disasters, the push notification system needs to send notifications to thousands of users at the same time in a fast and error-free manner. Server capacity should be scaled to meet this load.

The mobile application should run smoothly even on older or low-performance devices.

Data Storage and Management:

Users' personal information needs to be stored securely. However, the management and rapid access of large amounts of data can pose technical challenges.

Database redundancy and recovery solutions should be provided.

Emergency Protocols:

During a disaster, users are expected to respond quickly and accurately to the notifications they receive. However, situations such as panic or loss of consciousness may make it difficult for users to use the application correctly.

Logistical constraints (traffic, road closures, etc.) should be taken into consideration to ensure

that emergency services reach the stage on time.

Sensor Placement and Maintenance:

Placement of sensors in the right places and regular maintenance are critical for the effectiveness of the system. However, maintenance and repair work can be difficult in hard-to-reach areas.

Long-term durability of flood sensors in the sewerage system should be ensured.

Data Privacy:

Users' personal information (emergency contact information, location data, etc.) is sensitive and must be stored in accordance with legal regulations such as KVKK (Personal Data Protection Law).

Legal obligations may arise during data transmission to third parties (relatives or emergency services) in emergency situations.

Responsibility and Liabilities:

Damages that may occur as a result of misinformation of emergency services or delays caused by system failure may give rise to legal liability. These risks should be assessed within the scope of the project.

In case of misuse or unauthorized access to user data, legal sanctions may arise.

User Trust:

Sharing users' personal security information should be treated with ethical caution. Security breaches may damage user trust.

If the accuracy and reliability of the system cannot be ensured, the possibility of users being at risk due to false information may pose an ethical problem.

1.3 Professional and Ethical Issues

The emergency management system project developed for natural disasters raises many professional and ethical issues such as the processing of sensitive user data, ensuring transparency, and maintaining public trust. Although the project aims to increase the safety of individuals in disaster situations and enable faster intervention, it is critical to act in accordance with ethical principles such as the IEEE Code of Ethics in this process.

Data Privacy and Security (ACM Code of Ethics and Professional Conduct [1]; IEEE Code of Ethics [3])

One of the most important ethical issues within the scope of this project is ensuring data privacy and security. The system collects and processes sensitive data such as users' location, security status, and contact information. This data must be protected against risks such as unauthorized access or misuse. The ACM Code of Ethics clearly emphasizes the responsibility of engineers to protect the privacy of individuals and to use data only for specified purposes.

Strong encryption methods and secure communication protocols must be applied to protect data. In addition, users must be clearly informed about how their data is collected, processed, and shared. Misuse of user data not only violates ethical principles, but also undermines trust in times of crisis and can put users' safety at risk.

Accuracy and Transparency (IEEE Code of Ethics [3]; ACM Code of Ethics and Professional Conduct [1])

Accuracy and transparency in the operation and capabilities of the system are of critical importance. IEEE Code of Ethics states that engineers should be honest in their work and make realistic claims about their projects. In this context, the features of the system, such as the accuracy of sensor data and the limitations of response mechanisms, should be clearly explained.

Data received from sensors must be processed correctly and presented to users or administrators when necessary. Limitations of the system, such as when sensors have a margin of error in certain environmental conditions, should be clearly stated to prevent users from being misled. Sharing incorrect information or a non-transparent approach can lead to ethical violations and loss of user trust in disaster situations.

Social Responsibility and Public Safety (IEEE Code of Ethics [3]; The Software Engineering Code of Ethics, IEEE Computer Society [2])

The main goal of this project is to increase public safety by improving disaster response. The

IEEE Code of Ethics states that engineers should make positive contributions to society and avoid harm. The system should provide accurate and timely notifications, enabling rapid response and increasing the safety of individuals.

In addition, the system should carefully manage notifications so that users do not experience unnecessary stress. Notifications should be clear, relevant and should be made only when necessary. Unnecessary notifications that may cause panic or alarm can negatively affect the effectiveness and reliability of the system.

Professional Responsibility and Competence (IEEE Code of Ethics [3]; ACM Code of Ethics and Professional Conduct [1])

The team developing the system should adhere to the highest standards of professional responsibility and competence. IEEE Code of Ethics requires engineers to be honest and realistic and that projects should be based on solid technical foundations. Considering the complex nature of disaster management systems, it is essential for the project team to continuously learn and develop skills.

Decisions made throughout the project should be made in line with ethical principles, prioritizing social benefit and safety. This approach ensures that the project is successful not only from a technological perspective but also from an ethical perspective.

Environmental Sustainability (The Software Engineering Code of Ethics, IEEE Computer Society [2]; IEEE Code of Ethics [3])

This system should enable rapid response to emergencies while also considering long-term environmental impacts. The development of energy-efficient equipment and the adoption of sustainable practices are in line with the IEEE Code of Ethics principles of avoiding environmental damage and making positive contributions. The environmental impact of the system should be minimized, especially in regions with energy and infrastructure constraints.

As a result, this emergency management system offers significant opportunities to improve disaster response, while also carrying serious professional and ethical responsibilities. A system that complies with the principles of the IEEE Code of Ethics should be developed in accordance with core values such as confidentiality, transparency, integrity, social benefit, and environmental sensitivity. This approach will ensure that the project not only meets technical requirements, but also gains the trust of users and creates a positive impact in society.

2. Requirements

Functional Requirements

Sensor Data Collection and Monitoring

- The system shall collect real-time data from IoT sensors (seismic, temperature, water level).
- Sensors will trigger alerts when readings exceed configurable thresholds.
- A central server will receive the alerts in order to verify the disaster risk.

Disaster Detection and Notification

- Users in affected areas will receive an “Are you safe?" notification.
- Critical alerts will bypass the “Do Not Disturb" settings for urgent delivery.

User Response Collection and Analysis

- Users can say "I am safe" or "I am not safe." in response.
- Real-time responses will be recorded in a central database.
- Users who don't reply will be marked as potentially unsafe.

Emergency Contact and Response Team Notification

- Unsafe users or non-responders will trigger automatic notifications to emergency contacts.
- Real-time user notifications will be sent to emergency response teams.

User Profile and Emergency Contact Management

- Users are required to set up emergency contacts and create profiles.
- Users can add, modify, or remove emergency contacts.
- Profile and contact information will be synchronized with the central system.

Real-Time Monitoring and Dashboard Display

- User statuses and real-time sensor data will be shown on an online web-based dashboard.
- A map showing user locations and disaster-affected areas will be part of the dashboard.

Automated Safety Escalation and Follow-Up

- Users who don't respond will be reported and their contacts informed.
- The system may periodically resend safety prompts to unresponsive users.

Disaster Simulation and System Testing

- Administrators can simulate disaster events for testing.
- System performance metrics (e.g., notification speed, response times) will be recorded.

Location-Based Alerts and Geofencing

- Users in impacted areas will receive alerts according to their geolocation.
- Accurate location tracking will enhance alert relevance.

Incident History and Reporting

- The system will log disaster events, notifications, and user responses.
- Users can access incident history in their profiles.
- Administrators can generate performance and incident reports.

User Notifications and Feedback

- Confirmations will be sent to users when they submit safety responses.
- For extended disaster occurrences, check-ins will be sent out on a regular basis.

Accessibility and Device Compatibility

- The app will be available for both Android and iOS.
- High contrast modes and screen readers will be among the accessibility features.
- Battery usage will be optimized during extended disaster events.

Predictive Analysis and Early Warnings

- Real-time sensor data analysis will be done by the system to detect disaster patterns.
- Predictive alerts will be sent for potential disaster escalation.

Redundancy and Failover Support

- Regular backups of important data will be made in case of emergency.
- When the system is unavailable, backup servers will be used.

Integration with External Emergency Systems

- The system will provide APIs for external entities to access relevant data.
- Data will be automatically shared with external agencies after disaster confirmation.

Non-functional Requirements

Performance

- The system will process alerts and notify users within 5 seconds.
- During disasters, the system must be able to accommodate multiple users without experiencing any performance issues.
- High loads should be supported by the backend, especially during peak disaster times.

Reliability

- The system must be available during emergencies with backup systems in place.
- It should remain functional even with partial failures, using alternative communication methods.
- User data regarding emergency contacts and status must remain consistent during system failures.

Security

- Users' emergency contact and health data must be securely encrypted both in transit and at rest.
- Access to administrative functions must be limited to authorized personnel with secure authentication.

Usability

- The mobile app should react rapidly and have an easy-to-use user interface in emergencies.
- People with disabilities should be able to use the app thanks to features like voice commands.
- The system must support multiple languages to accommodate users during disasters.

Maintainability

- The system should be modular to allow easy updates or replacements of components.
- The system must comply with government and disaster management regulations.

Environmental Requirements

- Sensors and mobile applications should be energy-efficient and capable of operating during long emergencies.
- Sensors must be weatherproof and resilient to harsh conditions, including fires and floods.

3. References

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