

Mobile X-Ray System Requirements

Inf 43 – Homework 1

October 31, 2023

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Introduction

The Mobile X-ray Software System is a cutting-edge Android application tailored for the medical industry design, designed to streamline and enhance the process of patient care in radiological contexts.

The Mobile Medical Device (MobileMedDev) company needs a new sub-app for their mobile application software. The application will allow field medics to take X-Ray scans of injured people in the field or ambulance.

Central to its capabilities is the feature that allows healthcare professionals to seamlessly enter a patient's name, subsequently dispatching medical notes to the attending hospital for timely and accurate analysis. Upholding the highest standards of patient confidentiality, the application ensures that all personal data remains secure and inaccessible to unauthorized users.

In addition to its primary function, the software plays a critical role in ensuring a safe environment by continuously monitoring integrated radioactive sensors to detect any potential radiation leaks. To provide unmatched connectivity and versatility, the system offers compatibility with x-ray devices through Bluetooth or a USB-C cable connection. As we move into an era of digital healthcare, this application promises to be an invaluable tool for practitioners, ensuring both patient safety and operational efficiency.

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Overview / Executive Summary	Addresses Mobile X-Ray's goals and what issues it is addressing.
Application Context / Environmental Constraints	Where the system will be used and what it will need to interact with.
Functional Requirements	Describes all aspects of Mobile X-Ray in detail, including capabilities and attributes. Describes in detail the goals of each functionality.
Software Qualities and Non-functional Requirements	Lists and describes non-functional requirements and software qualities in Mobile X-Ray.
Other Requirements	Lists all requirements not previously discussed in the earlier sections. It also includes a glossary of terms.
Assumptions / Risks	Discusses assumptions made about the software and potential risks associated with implementation.
Priorities / Implementation Phases	Lists the order of function implementation for the project.

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Future Directions and Expected Changes	Provides guidance to the programmers and engineers for software changeability and possible business directions.

Overview / Executive Summary

The ability to diagnose injuries rapidly can make the difference between life and death. The Mobile X-Ray application emerges from this very need - to empower field medics and paramedics with instantaneous, on-the-spot diagnostic capabilities without the constraints of traditional medical infrastructure.

The Mobile X-Ray application allows for quick X-Ray scans in field situations or ambulances, drastically reducing time lags in critical scenarios. With in-built radiation leak detection will ensure that the safety of the medical personnel, patients, and surrounding individuals is never compromised. Recognizing the sanctity of patient information, our application incorporates top-tier data protection mechanisms, guaranteeing privacy at all times. The Mobile X-Ray application is designed to connect effortlessly with the X-Ray device via Bluetooth or USB-C cable, ensuring reliable and consistent performance.

The Mobile X-Ray application will integrate with hospital databases to send medical notes for analysis. The application is designed for Android devices, and the tablet will have a 1TB hard drive. Each X Ray will be approximately 200MB. X-Ray devices with Bluetooth or USB-C connectivity are prerequisites. Field medics, EMT, and IT teams will directly interact with the application. Training modules may be introduced for these personnel to familiarize them with the new tool. Existing patient data protection policies, medical diagnosis protocols, and radiation safety guidelines might need reviews or updates to align with the application's capabilities and safety features.

Regarding some assumptions and potential hazards, it is assumed that the device running Mobile X-Ray is not malfunctioning and the system is able to alert the EMT, that Bluetooth as well as the connection will not fail, and that a low battery will alert. There is a potential risk that the Mobile X-Ray will not alert you to a radiation leak, which could result in health risks to patients and EMTs. If the device is connected to a public network, there is also the potential for the patient's personal information to be compromised.

Application Context / Environmental Constraints

The application is primarily designed for outdoor and on-the-move scenarios such as in the field, emergency zones, and within ambulances. However, it can also be used within hospital premises if needed. Tailored for mobile deployment, the application is optimized for Android tablets. Given the urgency and unpredictability of emergency medical

situations, mobile devices were chosen for their portability and ease of use. In the future this application might be expanded to a mobile MRI device.

The application is developed specifically for the Android OS. This platform was chosen because of its widespread adoption in various regions, ensuring a broader reach. The application requires Bluetooth or USB-C enabled devices for seamless connection with X-Ray machinery. Furthermore, a stable internet connection might be essential for immediate data transfer to hospital databases. The data will be sent over a 4G/5G grid and will be encrypted. Public Wifi must not be used; the hospital's secure wired network can be used.

The Mobile X-Ray may need to be integrated with advanced radiation monitoring tools or databases to cross-check and validate safety thresholds. It utilizes an equipped radiation sensor to monitor radiation leaks. These sensors are connected to the tablet via Bluetooth or USBC, and if a leak is detected, an event can be sent to the application to notify users.

The UI needed to be intuitive and simple to ensure that EMT could use the app efficiently without any extensive training. Large buttons that are easy to click, clear icons and a minimalist design were essential. Being in charge of patient information, the application should be integrated with top encryption and security protocols to ensure data confidentiality and protection. Also, the mobile X-ray application will connect directly to the hospital system for rapid transfer and analysis of medical records and scan results.

Functional Requirements

Diagram 1 displays the use case diagram of the Mobile X-Ray. There are three actors within Diagram 1; the EMT\IT User, the Patient, and Mobile X-Ray. The EMT\IT User has almost all of the functionality of the Patient User except signs to confirm taking x-ray. The Patient User has limited functionality, they can only access files about their basic information and consent to use X-Ray. The Mobile X-Ray takes care of all the actions that EMT user and Patient user makes on the app. Below are the textual descriptions of the function requirements and goals of the Mobile X-Ray app through use cases organized and detailed by actor.

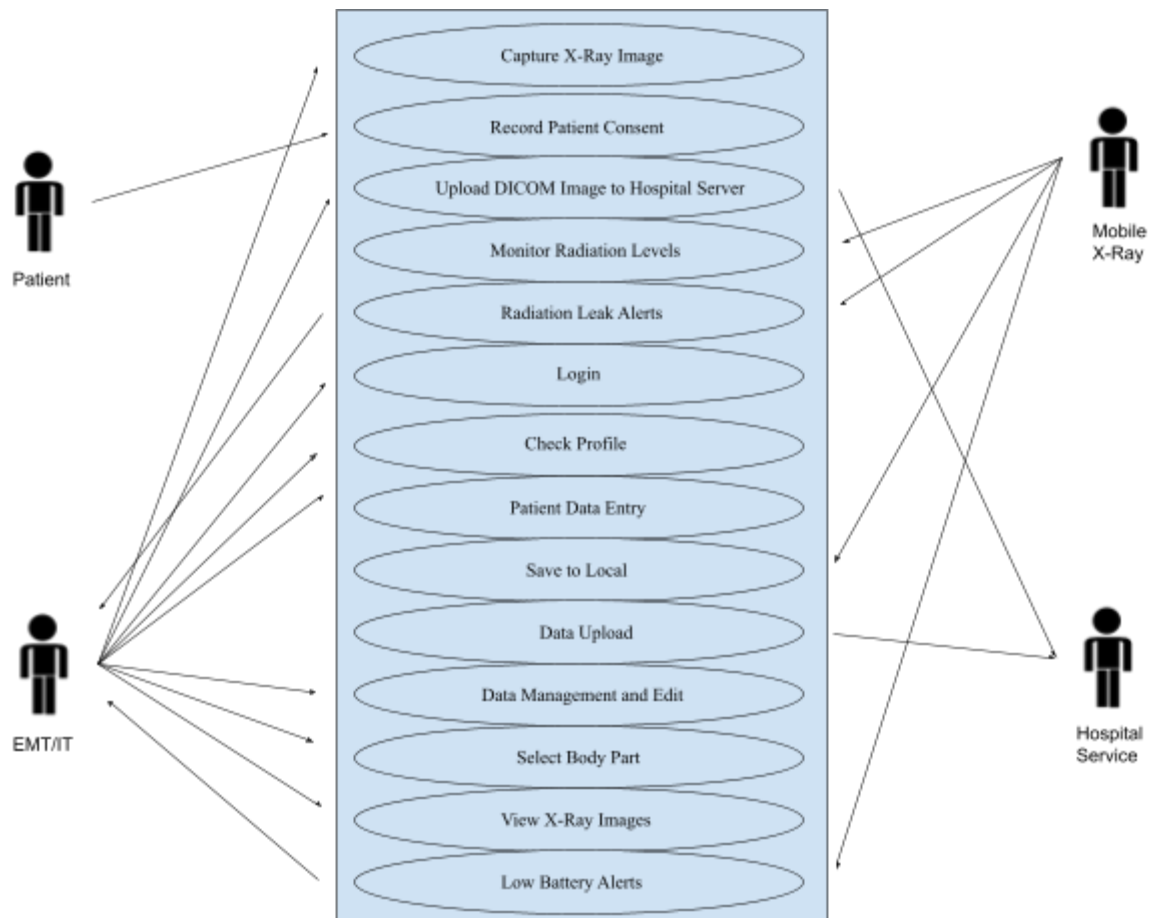


Diagram 1: Use Case Diagram of Mobile X-Ray

EMT/IT User:

- Capture X-Ray Image: The EMT or IT user initiates the Mobile X-Ray device to capture an X-ray image of the targeted body part as selected. This process ensures high-quality imaging while maintaining safety standards.
- Upload DICOM Image to Hospital Server: After capturing, the EMT or IT user can securely upload the X-ray image in DICOM format to the designated hospital server. This allows for immediate access by hospital professionals for analysis.
- Login: EMT or IT users must authenticate themselves through a secure login process to gain access to the Mobile X-Ray application and its features. Other ways, EMTs or IT can create QR code on their ID card that enables the app to scan so then it would save much more time rather than asking the EMT themselves to log in using their ID and passwords.
- Check Profile: Once logged in, users can view their profiles, which may contain details like their qualifications, duty shifts, and any notifications or alerts.
- Data Management and Edit: EMT or IT users have the ability to manage (view, edit, and delete) any data saved on the Mobile X-Ray device, ensuring accurate record-keeping.
- Select Body Part: Before capturing the X-ray, users can specify which body part requires imaging. This ensures targeted and effective imaging.
- View X-Ray Images: Post-capturing, users can view and zoom into the X-ray images on the device for a preliminary assessment.

- Patient Data Entry: Relevant patient data, such as name, age, symptoms, and any specific medical conditions, is entered into the system by the EMT or IT user, ensuring comprehensive patient records.

Patient:

- Record Patient Consent: Before any imaging is done, the patient's consent is recorded. This can be in the form of a verbal acknowledgment or a signed document, ensuring ethical practices. If the patient does not consent, then the EMT may not perform X-Ray on the patient.

Mobile X-Ray System:

- Monitor Radiation Levels: The Mobile X-Ray device is equipped with sensors that continuously monitor radiation levels, ensuring the safety of both the patient and the user.
- Radiation Leak Alerts: In the event of any unexpected radiation leak or over-exposure, the system immediately generates alerts until the situation is resolved, allowing for swift countermeasures.
- Save to Local: The system provides an option for the user to save data, including X-ray images, locally on the device, ensuring offline accessibility.
- Low Battery Alerts: The mobile X-ray system proactively alerts the user when the battery level falls below a certain threshold, ensuring uninterrupted operation. If the battery cannot be recharged immediately, the user should switch to a device with a mobile X-ray system, and the low battery device will save the data locally on its own.

Software Qualities and Non-functional Requirements

Usability	The application should be intuitive, user-friendly, and minimize the learning curve for EMTs and Hospital IT personnel. Once created QR code on the ID card of the EMT that enables the app to scan so then it would save much more time rather than asking the EMT themselves to log in using their ID and passwords. Tutorial or help modules can be incorporated for new users.
Reliability	Given its critical medical nature, the application should function without failures, ensuring consistent performance during emergencies. The software should undergo rigorous testing, especially for core functions like image capture and upload. Fail-safes should be built in to handle unexpected situations or errors. Radiation Sensor will fire notification to the X Ray Application, it will indicate the leak and leak threat level (High, Med, Low). The application will then provide instructions in a step by step process to resolve the situation. Instructions will be read from an XML file provided by the hospital. If less than 20% battery the user should be notified to either charge the tablet or switch to backup tablet.
Security	Protecting patient data and ensuring secure communication between the app and the hospital server is paramount. Use of end-to-end encryption for

data transmission, secure storage solutions for local data, and regular security audits. All sent data is encrypted before sending. The device will be locked and external remote login cannot be performed. For failed logins, 3 login attempts then the tablet or app will be locked. EMT's can then use the other backup tablet or store the system and not use it. Use will be canceled after 3 minutes of inactivity.

- Portability** The application should run on any Android version 10 or higher. The application should be built on scalable frameworks. Regular updates should be rolled out to maintain compatibility with newer Android versions and devices. The application should support Bluetooth and USB-C connectivity for smooth connection to X-ray devices. The application should be scalable for future expansion to mobile MRI devices.
- Scalability** As the user base grows or as the application integrates more medical tools such as MRI devices, it should handle increased loads seamlessly. The application's architecture should support modular additions.
- Space Efficiency** Given that it's a mobile application, efficient utilization of device storage is crucial. Implement efficient data storage and processing techniques. Storage will be cleared at each EMT shift, but not by the X-ray application program. When the storage space is full, it reminds users that they need to use another tablet. When the storage space is full, it will alert you that you need to use another tablet computer. X-ray images will be stored in a separate folder, and the folder name will be the patient's name and date/time. The folder name will be the patient's name and date/time.

Other Requirements

While we've covered the primary functional and non-functional requirements, there are invariably supplementary facets or details worth elucidating.

Additional Requirements:

- A built-in feature allowing users to provide feedback, report bugs, or suggest improvements can facilitate continuous enhancement of the application.
- Recognizing that EMTs might operate in zones with limited internet connectivity, an offline mode should be incorporated.
- As medical technology evolves, the application should be ready to integrate with upcoming devices or medical tools, such as mobile MRIs, ensuring it remains relevant and up-to-date.

Deadline:

Christmas 2021

Glossary of Terms:

DICOM	A standard for transmitting, storing, and sharing medical images. It
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	ensures compatibility and clarity across various medical tools and systems.
EMT	Professionals trained to provide emergency medical services in the field, often the first responders in medical emergencies.
MRI	A medical imaging technique used to visualize internal structures of the body. Unlike X-Rays, MRIs use magnetic fields and radio waves for imaging.
App	Application, software system that has a specific function or purpose.
X-Ray	X-rays are a type of radiation called electromagnetic waves. X-ray imaging creates pictures of the inside of your body.

Assumptions / Risks

Assumptions:

- The application assumes a certain level of internet connectivity for uploading DICOM images.
- It's assumed that EMTs and Hospital IT have the necessary infrastructure, including compatible Android devices, to run the application effectively.
- The device running Mobile X-Ray is not malfunctioning and the system is able to alert the EMT, that Bluetooth as well as the connection will not fail.
- Assume that EMTs and Hospital IT personnel will receive adequate training to familiarize themselves with the application, ensuring optimal utilization.
- The X-Ray equipment and related hardware are regularly maintained and calibrated, ensuring accurate and reliable readings.

Risks:

- In cases of software bugs or hardware malfunctions during emergencies, there can be potential harm to patients or delayed medical interventions.
- If patient consent isn't properly documented or if data confidentiality is breached, there could be significant legal and ethical repercussions.
- Given the sensitive nature of patient data, any breach poses not just a technological risk but also an ethical and legal one. It could result in lawsuits, financial penalties, and a tarnished reputation.
- Any malfunction in the radiation monitoring function of the application might lead to undetected leakages, posing serious health risks to both patients and EMTs.

Priorities / Implementation Phases

Must Have:

- Clean and usable interface
- Inactivity logout

- Radiation Leak Monitoring
- Image Upload to Hospital Server
- Safety Alerts
- DICOM Image Capture
- Patient Consent Mechanism

Should Have:

- Offline Mode
- Feedback and Reporting Mechanism

Nice to Have:

- Personalized Settings
- Advanced Security Settings
- Tutorial Modules
- Interoperability with Other Medical Software
- Customizable Alert Settings

Future Directions and Expected Changes

- Beyond mobile MRIs, there's a likelihood that the application might need to interface with other medical devices such as CT scanners, ultrasound machines, or even wearable health monitors.
- Depending on development costs, the extension adds languages other than English to Mobile X-Ray.
- While the X-Ray capture should be feasible offline, there should be a queuing mechanism to upload DICOM images once connectivity is restored.
- With telemedicine on the rise, an integrated feature allowing remote consultations where doctors can view X-Ray images in real-time and provide feedback could be invaluable.
- Leveraging AR to superimpose X-Ray images over a patient's body or guide the EMT during the X-Ray capture can enhance precision.
- With growing concerns about data privacy and increasing cyber threats, there will undoubtedly be a need for constant upgrades to encryption techniques and data protection measures.
- As the application might be used in diverse environments, from disaster zones to remote areas, ensuring it remains operational under various conditions (extreme temperatures, humidity, etc.) might become essential.
- As the application matures, it could offer more personalized experiences. EMTs might have profiles with preferences, frequently used features, or even a track record of their scans, aiding in continuous professional development.