Mobile and Adaptive HMI

Project Assignment

Topic: Develop mobile and adaptive HMI for guiding visitors in a hospital to reduce the time in critical areas.

(Cordova Based Application)

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1. Group Description and Task Distribution

Name	Imm. No.	Study Background	Task Assigned
Manas Suri	12103228	Mechatronics Engineering	Back-End Development
Nikhil Kumar Verma	12102717	Mechanical Engineer	Pre-Design Phase and Documentation
Tarek El Khoury	00821733	Mechanical Engineer	UX Design Phase and Documentation
Pranjal Mujmer	12101417	Mechanical Engineer	Front-End Development
Manit Gera	12102410	Mechanical Engineer	Analysis, Card Slotting, Wireframes, and Scribbles

2. Pre-design phase

2.1. Initial Understanding of the Project

The improved quality of life and longer life expectancy that modern healthcare provides are unprecedented. However, the industry's efficiency is significantly hampered by an operational crisis, pervasive bureaucracy, and outdated management techniques that place undue demand on medical workers. As a result, the cost of healthcare services rises, the number of people with affordable healthcare falls, and the quality of care suffers due to employee weariness and an unproductive working atmosphere. It is also a hindrance for patients and visitors —the term 'Over Crowding' results from unmanaged and unprecedented visitors. In several nations worldwide, hospitals get overcrowded, including critical areas like emergency departments and medical stores. Overcrowding in a hospital causes issues for patients and staff, such as longer wait times, ambulance diversion, length of stay, medical errors, patient death, and financial impact to hospitals.

Hospital overcrowding is a complicated problem. An app is suggested to tackle these hurdles, which could be a part of the hospital management system, where the application is initially configured by the hospital only. The need to increase the productivity of healthcare organizations is a requirement, if not an end goal, to provide service to the most significant number of people who require it. Not only management and medical personnel bear this obligation, but also legislators and software programmers. The latter can create a dependable application that addresses some previously discussed concerns while increasing efficiency.

With the development of mobile technology in the 20th century, it is viable to depend on smartphones for essential purposes such as 'Booking an appointment.' Appointment scheduling apps are online applications that hospitals employ to allow their customers to manage their appointments at their leisure. The best thing about them is that they do away with the necessity for a human phone operator who will spend all their time manually entering and verifying appointments in a calendar. Hospitals can save a lot of time and money by using a digital tool like an appointment booking app instead of hiring a full-time employee and avoid costly human errors (appointment overlap, overbooking, not filling incorrect details, etc.). Furthermore, both customers and staff can access online scheduling tools at any time and from any location.

The developed project is one of its kind. It is an application developed using Cordova. It is not only an appointment scheduling application, but it is supposed to have many other features which are helpful in crowd management in a hospital and managing the entire suite of functionality for it. The features will be discussed further in the report. The HMI developed is tested and produced by the team through their area of expertise and necessary support from the advisor. Sensor and haptic output features are included for the smooth experience of the customer. The UX development will be discussed at the end of the report.

2.2. Requirements of the Application

As discussed in the introduction, the requirements for a solution that solves this overcrowding situation in hospitals are specific. Some of the featured necessities are explained below:

- Appointment Booking: One of the significant reasons for application development is to control unnecessary hospital overcrowding. There are thousands of cases recorded where mismanagement of appointments leads to various resources, be it human resources or financial ones. Time is money for both the service provider (Hospitals) and users (Patients and Visitors). That must be developed to save the necessary steps and unrequired hassle. Due to unnecessary overcrowding, sick people must wait too long to receive essential care, the total length of stay in hospital increases, walkouts by patients needing admission, decreased quality of care, and so on. An appointment management system can cure all these problems and is efficient enough.

- Data Management: For decades, data management of the visitors has been done manually. A separate person is employed for the same, filling in details of patients and visitors all day and night long. The requirement of an efficient data management tool suffices the omission of a register and an employee. The data is managed correctly and orderly but is secure and accessible anytime, anywhere by the hospital management. Customers and patients do not have to fill in the details repetitively. Using an application for the same is a quality provider for patients and visitors simultaneously.

- Navigation: Not everybody visits the hospital every day, so usually, people are unaware of the pathways and directions in a hospital. And nowadays, hospitals are not a single building anymore, making it more difficult to find your actual destination. With an app like this, people can find their absolute paths and save their time and lesser load on hospital staff. They can reach their destination without any hassle and avoid critical areas.

- Crowd Management: With this application, people know where and when. This gives hospital staff a sigh of relief, noticing the number of visitors categorized with the purpose and place of visit. The crowd is automatically managed if it knows where it should go. The critical areas like elevators, emergency wards, containment zones, etc., are usually overcrowded with the people who’re just passing by or are unaware of the place. Apps like ours are helpful in such scenarios.

- Access to the required pathways: The security system in many hospitals is automated, controlled, and accessed by the permitted personnel. It is hectic for the hospital staff to always be available for the people who don’t need them as much as others. The application provides access to the pathways and automated gates using QR codes and NFC technology. Patients and visitors need not be dependent on hospital staff for any instruction.

2.3. Users of the Application

Users of the application should be able to use smartphones and can be categorized as follows:

- Patients who are looking for appointments.
- Visitors to the patients.
- Buyers for medicines from pharmacies in hospitals having prescriptions.
- Patients' family and friends looking for basic facilities such as WC or canteen etc.
- Hospitals' owners are equipping their facility with technology.

2.4. Customers of the Application

- People are visiting the hospitals with multiple floors and buildings.
- People who cannot find the required medicine in usual pharmacies and only visit their hospital.
- Visitors to the patients who care to have access to the hospital by themselves.
- People who want to have a structured appointment booking method and avoid long queues.
- People who don't want to overcrowd the hospital.
- Hospital owners are looking for tech. Solutions and upgrades to the existing facilities.

2.5. Use Cases of the Application

Use-Case 1: A user wants to book an appointment with a doctor.

> Button: Request an appointment and visiting pass → Type in: Details Name, Age, Gender, Email id, Phone no., Date of appointment, Time, Description for specific needs, upload an optional file for references→ Button: Submit → Button: Visit a doctor → Type in: Doctor's name, Department, Urgency status, Description(optional) → Button: Submit → Receive QR code (Appointment Letter).

Use-Case 2: A user wants to visit a patient.

> Button: Request an appointment and visiting pass → Type in: Name, Age, Gender, Email id, Phone no., Appointment Date, Time, Description for specific needs, upload an optional file for references→ Button: Submit → Button: Visit a patient → Type in: Patient's name, Relation with the patient, Patient's description(optional) → Button: Submit → Receive QR code (Visitor's Pass).

Use-Case 3: A user wants to order medicines from a pharmacy in the hospital for pick up.

> Button: Order for Pharmacy → Type in: Name, Date, Time, Mobile no. → Upload: Prescription → Button: Submit → Receive QR code (Visitor's Pass).

Use-Case 4: A user wants to find a way to the reception.

> Button: Request an appointment and visiting pass → Type in: Name, Age, Gender, Email id, Phone no., Appointment Date, Time, Description for specific needs, upload an optional file for references→ Button: Submit → Button: Way to reception → Select: Building, Department, Floor → Button: Submit → Get the directions and access QR Code.

Use-Case 5: A user wants to download the map of the hospital.

Button: Download the MAP.

Use-Case 7: A user wants to visit the billing counter.

Button: Request an appointment and visiting pass → Type in: Name, Age, Gender, Email id, Phone no., Appointment Date, Time, Description for specific needs, upload an optional file for references→ Button: Submit → Button: Visit the billing counter → Select: Building, Department, Floor → Button: Submit → Get the directions and access QR Code.

Use-Case 8: A user wants to find the way to the WC.

Button: Request an appointment and visiting pass → Type in: Name, Age, Gender, Email id, Phone no., Appointment Date, Time, Description for specific needs, upload an optional file for references→ Button: Submit → Button: Way to WC → Select: Building, Department, Floor → Button: Submit → Get the directions and access QR Code.

2.6. Utility, Usability, User Experience, and Quality of Experience

1.1.1. Utilities:

- Book, an appointment with a doctor.
- Visit a patient.
- Access hospital's map.
- Call emergency numbers.
- Order medicines from the pharmacy.
- Moving in hospital (WC, canteen, reception, billing counter, etc.).

1.1.2. Usability:

- Select your doctor, date of appointment, time of appointment.
- Browse through the hospital map.
- Get access to the locked doors based on your appointment timings and destination.
- Use of NFC and QR codes for easy and contactless access.

1.1.3. User Experience:

- Push notifications.
- Haptic output.
- Instant .doc file download for appointment confirmation.
- QR code support for access.
- Touchless support using NFC.
- Navigation, in and outside the hospital.

1.1.4. Quality of experience:

- Emergency call support on the device.
- Warm welcome at the beginning of the application.
- High-speed operation, no loading time.

- No advertisements.
- Easy and understandable interface.
- Instant QR code generation.
- Smooth NFC operation.
- Secure for use.

2.7. Customer Analysis.

To gain the views and interests of the potential customers, surveys were carried out. Google forms were used to serve the purpose. Random interested people were asked to fill in the state (Colleagues, friends, social media, etc.) to get a rough picture of the potential customer and their expectations from an application of such kind.

Questionnaire for the Hospital Management:

https://docs.google.com/forms/d/1vL0UR_8P3Ej4yHetfYDw-lIk6SMpdAXUv0Lw6FG_oF8/edit?usp=sharing

Manageable no. of people participated in the survey, and it can be summarised as follows:

Users of the application: **Young males/females.**

Usability on which device: **Mobile phones.**

Expected destinations of Users: **Patients' room, Doctors' room, Pharmacy, Reception, Cash/Billing Counters, Cafeteria, Washroom**.

Pre-registration: **5/5**

Entry pass: **4/5**

Details of destination: **5/5**

Guided route with hospital map and landmarks: **3/5**

Entry in the area using NFC: **5/5**

Collection of user data and saving it for future use: **No.**

Visitor movement tracker: **No.**

Emergency, Help button: **Yes**

3. UX Design Phase

In this phase, the personas, the card sorting, the scribbles, and the wireframes will be discussed to see how the team best executed this idea.

3.1. Personas

While creating the personas, one must keep in mind the goal of this process, and that is to create a stereotype of users that have similar requirements in using the application; for this application, six personas have been suggested as the following:

- Persona 1: Manuel Neuer

  25 years old, mechanical engineer, good knowledge in technology

- Persona 2: Thomas Muller

  60 years old, retired baker, low expertise in technology

- Persona 3: Joshua Kimmich

  46 years old, hairdresser, average knowledge in technology

- Persona 4: Niklas Sule

  54 years old, police officer, low understanding of technology

- Persona 5: Serge Gnabry

  51 years old, Math teacher, average expertise in technology

- Persona 6: Leroy Sane

  32 years old, sports trainer, a good understanding of technology

The people's real names have been hidden for privacy reasons, and they have been assigned random football player names. Also, since gender is not an essential aspect of the user experience of this application, that information has been disregarded as well. What mattered when choosing the personas was their age and knowledge in the tech field. This is a critical audience where one must consider the client's age to be old enough to need it regularly but not old enough to need assistance in everyday life things because this application is not intended for people who can't function independently. So, the age threshold has been set to 60 so that no time is wasted on patients who already need assistance all the time. This application targets to reduce overcrowding at the hospital and organize the traffic as much as possible.

Another type of personas is the average age user who doesn't necessarily need to see the doctor or buy medicine but is a regular passer or visitor in the hospital. Like before, mobile and technical field knowledge is the crucial aspect here. This is why two personas have been chosen with the age of 25 and 32 because these ages have been exposed for a long time to applications and technology.

3.2. Card Sorting

In this part, the personas have been divided into three groups. There are two people from different levels of technological knowledge in each group. Each group has been assigned to give feedback on the best way to do one use case out of the previously mentioned use cases.

Group 1: Manuel Neuer and Thomas Muller

This group has been assigned to work on the appointment booking with a doctor; they have been given the following cards:

1. Home page	2. Fill in data	3. Entry Pass Generation
4. Request a doctor appointment	5. QR code	6. Hospital map

After discussing the cards with the group, they have agreed on the following trajectory:

1 → 4 → 2 → 3 → 5 → 6

Group 2: Joshua Kimmich and Niklas Sule

This group has been assigned to work on the visiting pass, which in general should be the same as the doctor appointment request, and this is the result:

1. Home page	2. Fill in data	3. Entry Pass Generation
4. Request a Visitor pass	5. QR code	6. Hospital map

Also, the same results were obtained as in the previous use case after discussion, the trajectory was agreed as the following:

1 → 4 → 2 → 3 → 5 → 6

Group 3: Serge Gnabry and Leroy Sane

This group has been assigned to determine the trajectory needed to order medicine from the pharmacy; for this group, different cards were assigned as this is another task than the previous two. The following cards were posted:

1. Home page	2. Fill in data	3. Submit prescription
4. Request medication	5. Visit medical store	6. Get approval

After discussion, the group saw best the trajectory for the use case to be done is:

1 → 5 → 4 → 2 → 3 → 6

3.3. Scribbles

The scribbles are made based on the results obtained in the card sorting phase. The following figures 1, 2, and 3 are the scribbles made by the team to illustrate the results best.

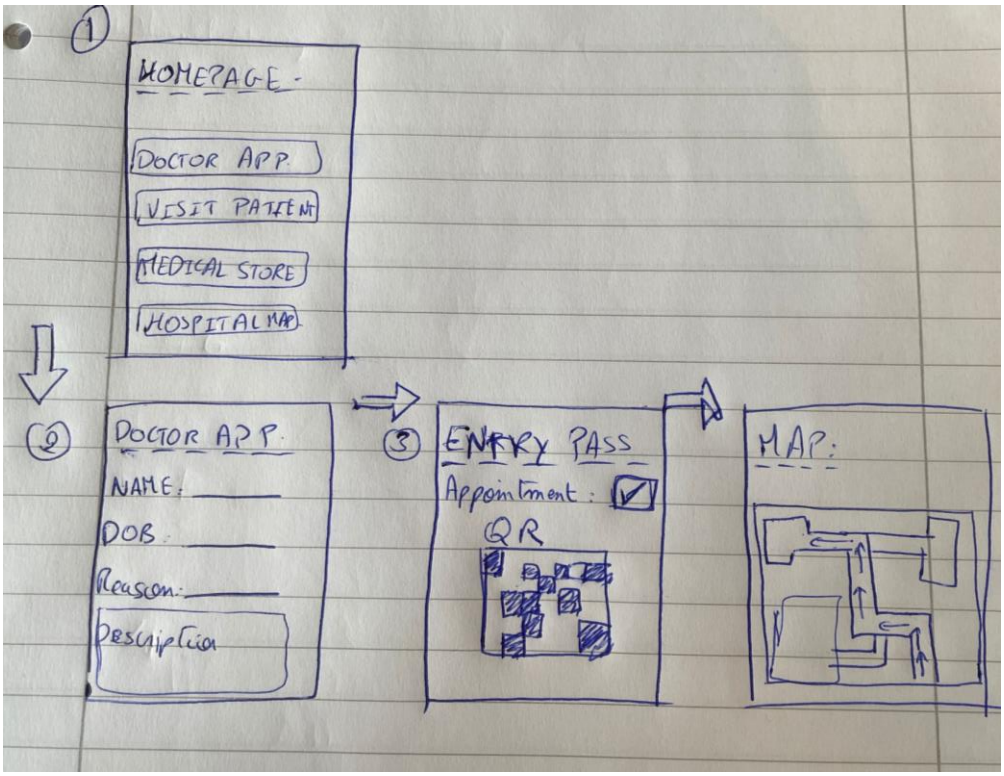

Figure 1: Scribbles of use case 1

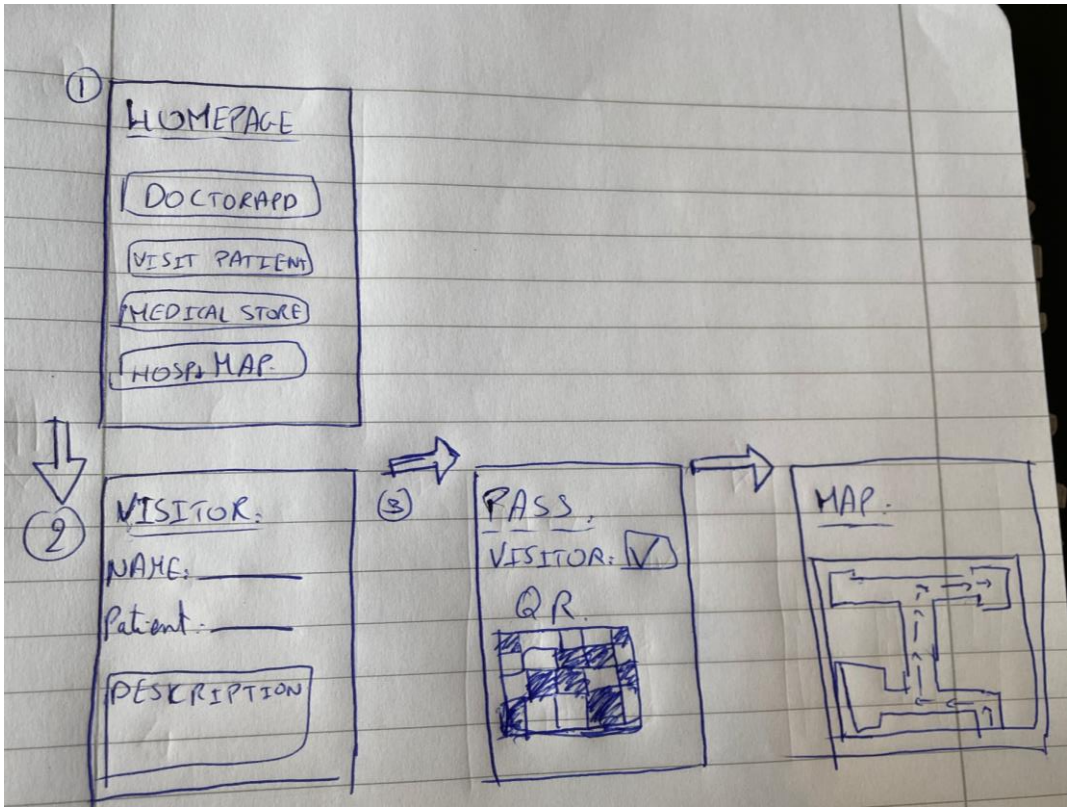

Figure 2: Scribbles of use case 2

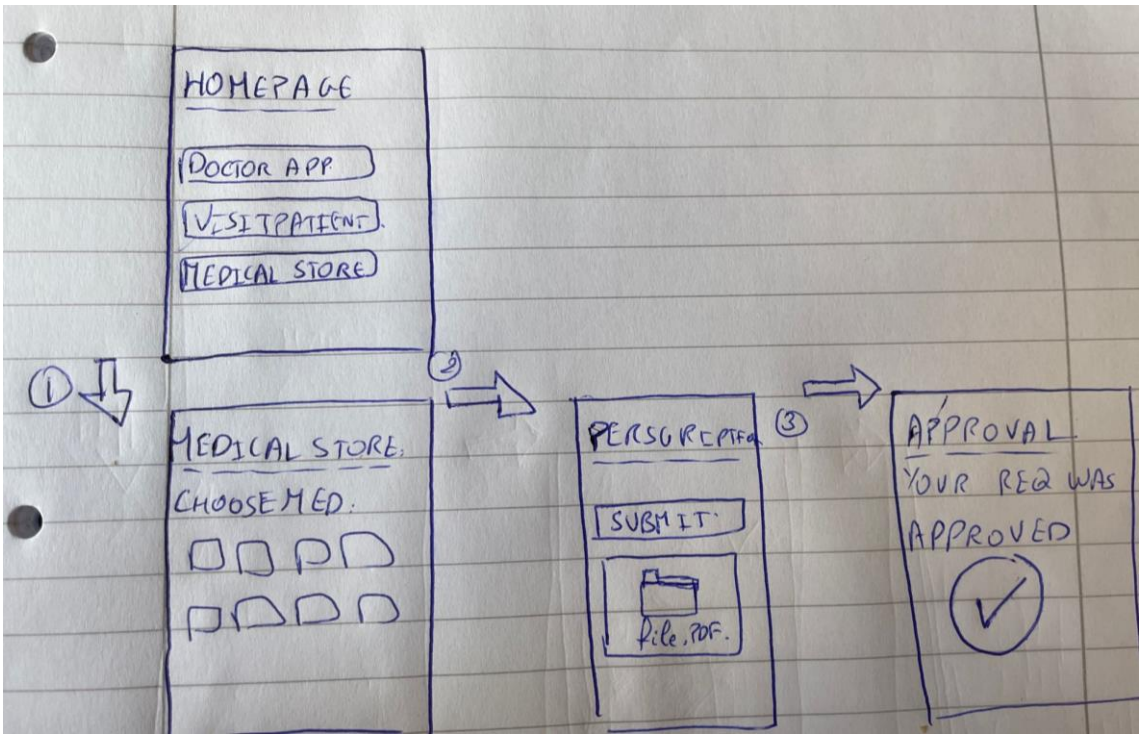

Figure 3: Scribbles of use case 3

After doing the scribbles, they were passed to the groups. Instead of assigning one scribble to one group, the team has decided to let all the groups see all the scribbles and take their feedback; the three groups agreed that the scribbles were efficient and easy to navigate. Scribbles are essential because the developers can ensure that the audience group gives their honest opinions. They see that these are just scribbles and editing them makes it easy to give their honest opinion and feedback. Thus, the team has decided to move on to the wireframes.

3.4. Wireframes

In figure 4, the wireframe of the application has been made after the approval was received from the groups regarding the scribbles.

Wireframes are a more advanced design illustration than scribbles because they are digitally made. They are designed up to a certain scale ratio of 1:1, so this is the step that moves things closer to the application itself. It is important because the groups can now have a more profound idea about the application. Still, one thing about wireframes is that they are not colored and don’t account for the graphic scenes in the application.

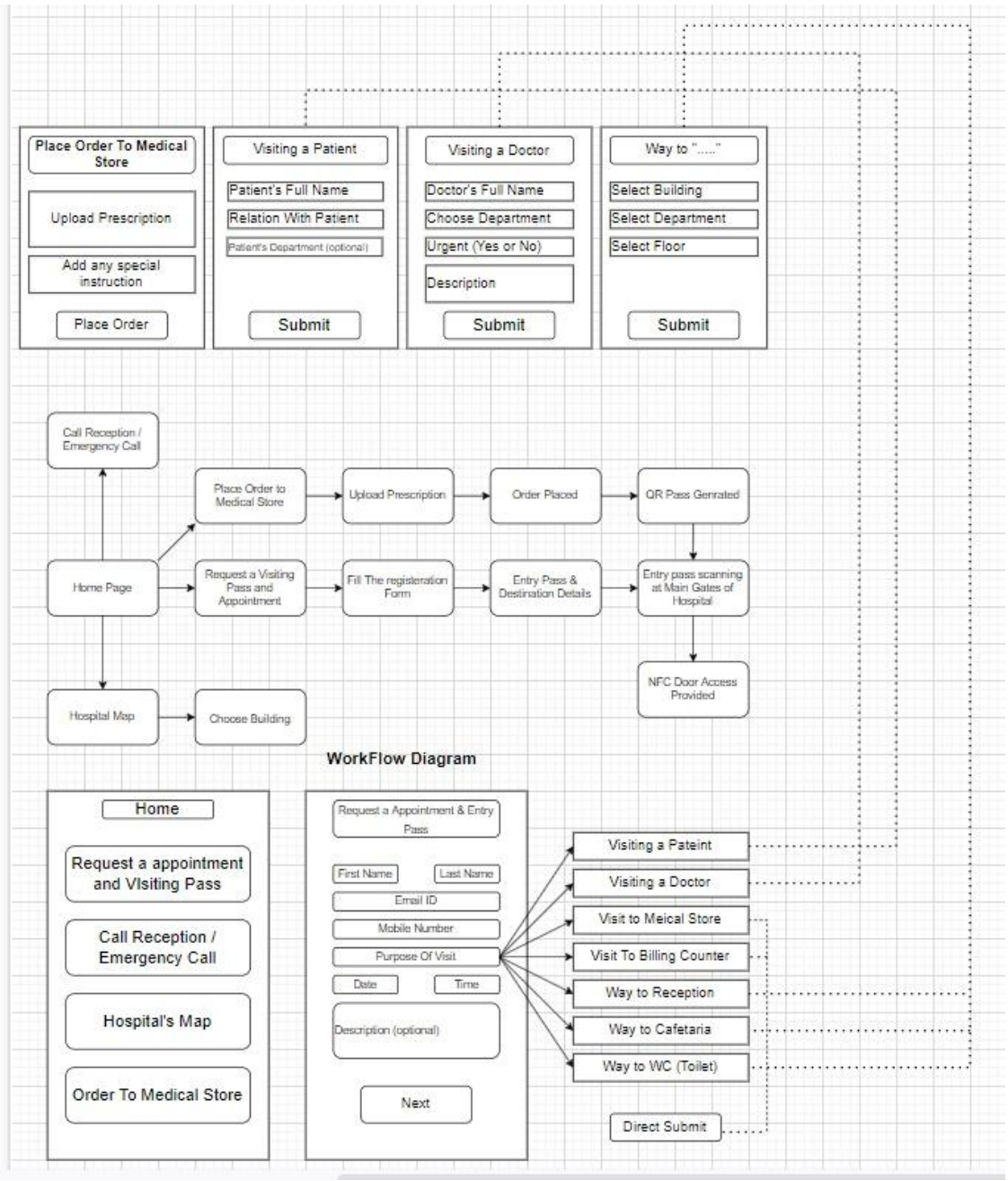

Figure 4: Wireframe

4. Sensor Technology and Output Haptics

Two types of sensors have been incorporated in the following project:

QR Code Scanner (Camera Sensor):

To obtain a picture of 1D and 2D barcodes, image-based barcode readers use an area array sensor like those found in digital cameras. The code is then located and decoded by a microprocessor running specific image-processing software before being distributed across a network. In essence, a QR code functions similarly to a barcode at the grocery. It's a machine-readable image that can be read instantaneously with a Smartphone camera. A QR code comprises a series of black squares and dots that represent various kinds of data. When your Smartphone scans this code, it converts the information into a form that humans can understand.

Simply put, a QR code is a piece of data that has been encoded. A QR code can include alphabetic, numeric, binary, or Kanji data (Kanji is a form of Chinese characters used in the modern Japanese writing system).

In our project, the same camera-based QR code scanner is being used to represent a document containing users' information. It is going to use the smartphone's camera to read the output.

NFC:

NFC (short for Near Field Communication) is a wireless transmission technology that allows for contactless data exchange between devices or objects at a distance of up to 10 centimeters. The technical aspects of NFC have been thoroughly defined by the relevant standards committees (ISO 18092, ECMA 340, ETSI TS 102 190).

The exchange of information between two devices or items held close to one other is a common NFC application. You can, for example, grant content access and integrate services like contactless payment and electronic ticketing.

- Frequency band: 13.56 MHz (license free)
- Transmission rate: 106 kbps, 212 kbps, and 424 kbps
- Range: maximum 10 centimetres
- Operating modes: read-write mode, peer-to-peer mode, card emulation mode

In our project, NFC is being used to let the users enter the security gates and provide them access to the required areas and paths that they need to cover to reach their destination.

The mode of output used is Vibration Hepatic. Every time one of the following actions occurs, the vibration sensors get activated and respond.

- QR Code is successfully scanned.
- NFC is used.
- QR Code is generated.

5. Visuals from the Application

Understated are some screenshots from the application:

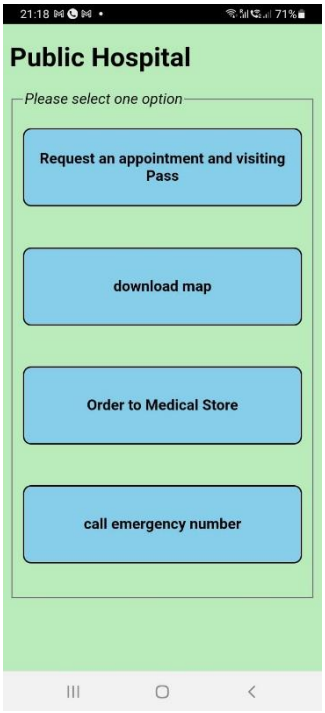

Figure 5: Home Page of the Application

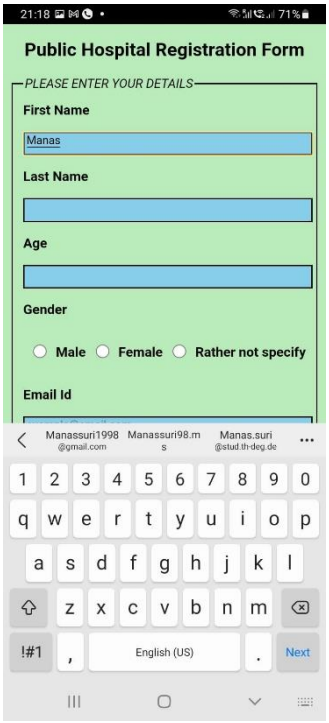

Figure 7: Details to be filled by the patient & visitors.

Figure 8: Operations in the application

Figure 6: QR Code received after confirming an action

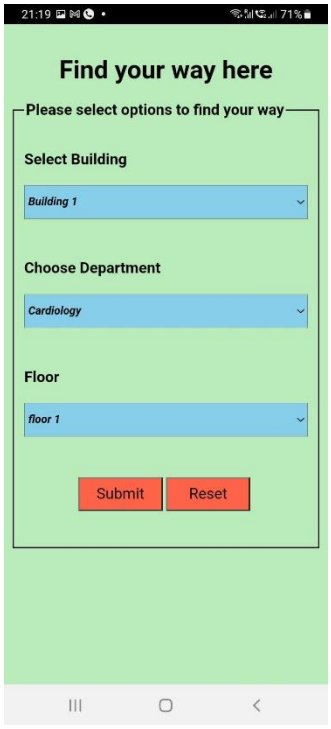

Figure 9: Screen for path finding