

# SMC: Next-Generation User Interface for Medical Cabinets

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# Chapter 1

## Introduction

A lot of patients suffer from diseases that obstruct their memory, which will make it difficult for them to remember which medications they need to take at which times. In a lot of cases, medications could be critical for the patient, and forgetting them might lead to serious health complications. This means that patients often need to be reminded to take their medications, whether it is a family member, a nurse or a reminder app on their phone that need to remind them. This comes with certain problems: The patients does not have true Independence. They rely on other people to be reminded to take their medications. Also, often times it happens that reminders on the phone are ignored or forgotten by the patient (e.g., due to severe memory problems, or limited technical capability). It is thus clear that there is a need for a system that assists the patients with their medications.

To this end, the SMC (Smart Medical Cabinet) system is a solution that could be life-changing for a lot of patients. This cabinet should have the possibilities to automatically detect the medications inside it using a camera sensor and a machine learning model that could identify the medicines. Furthermore, the user should also have the possibility of adding a schedule to specific medicines of the cabinet. This can be done either manually, or by scanning the doctor note using the phone camera or an additional camera outside the cabinet.

The main idea is to have a next-generation user interface for medical cabinets that assists patients with their medical needs by reminding them to take their medications, and make it easy for them to identify these medications inside the cabinet.

## Chapter 2

# Features

### 2.1 Recognition of items and medicines

The system will try to recognize which items are placed inside the cabinet. This happens using the camera that is built into the cabinet. New medicines can be added to the system in various ways:

- The medicine can be placed inside the cabinet. The camera sensors will take care of recognizing the medicine. It can however happen that the system does not recognize the medicine (e.g., due to the name being unclear, or because it is made locally by the pharmacy). In this case, the user can also add the medicine to the system using the screen of the system.
- The medicine can be added manually using the screen.

### 2.2 Matrix System

The system uses a matrix system to determine where certain medicines are placed inside the cabinet. This could be helpful for lighting up the LED matrix to identify for the user which medicines they need to take (as explained in section ???).

### 2.3 Matrix LED for easy recognition

Whenever it is time for the user to take certain medications, the user will receive a notification on their phone, as well as on the screen of the system. Furthermore, the back of the cabinet will light the area behind the medications in order to make it easier for the user to identify which medications they need to take. This can be very helpful for people who have difficulty reading or remembering names of medications due to their condition.

## 2.4 Connectivity

The system has built-in WIFI as well as Bluetooth to make it easier to connect to the phone of the user. The users can install a phone app that links to the cabinet system. Once both devices are linked, the user can receive notifications on their phone when they have to take their medications for instance. It is also possible to change the settings for medications (e.g., if the schedule needs to be changed, it can be done using the phone).

## 2.5 User Interface

The cabinet has a display through which the user can set up the device, edit the settings for medications and schedules, add new users. Beneath the display there is a camera that is used to scan doctor or pharmacy notes and add them to schedules.

## Chapter 3

# Building Plan

The system should be built in a user-centered manner. This is why we should first gather some requirements from the field. To do so, we need to identify our target groups first.

### 3.1 Target Groups

The main target group for this product would be patients who have difficulty remembering their schedules and medications. This system should make it easy for them to know when they have to take which medications. Retirement homes and hospitals are also a target group for this kind of system. By having such a cabinet in the rooms of the patients, it makes it easier for the staff to identify which medications each patient needs to take, reducing the amount of human error that could lead to medical complications for the patient. In order to identify the needs of the users, patients, nurses and doctors need to be interviewed in order to determine what they would want to add to such a system.

### 3.2 Functional Requirements

- The user can easier add medications to the system.
- The system should help the users identify the location of the medications inside the cabinet (e.g., using a back-lit panel in the back of the cabinet that lights the area behind the medication).
- The user can add their food schedule (breakfast, lunch, ..) in order for the system to know when the users need to take medications of which schedules depend of the food intake.
- It should be possible for the user to add schedules for their medications either manually or using a doctor or pharmacy note. The system should be able to handle different kind of notes.

- The system should remind the user to take their medications according to the schedule. This can be done by sending a notification to the user's phone, or by displaying the reminder of the screen of the system.
- The user can communicate with the system using voice commands (e.g., "Show me where Paracetamol is").
- The cabinet should be able to (when possible) recognize whether the medications are running low (e.g., almost no tablets available) and inform the patient about this. Informing the patient could be through a voice system assisted with the back-lit panel (e.g., the system yields which medications are running low, and the back-lit panel lights the area behind the medications using a red color).
- (Optional) It should be possible to add multiple users to the system. The system should make it easy for the users to identify their schedules and avoid conflicts between different users (e.g., by having a distinct color that lights up for each user and a voice system that yields which color is associated with which user).

### 3.3 Technical Requirements

- To identify which medications are added to the cabinet, the system should have a machine learning algorithm that is able to predict the medications that are added to the system. This could be for instance a text classification algorithm, that detects the name of the medications using the cameras inside the cabinet. The system should also take into account that not all medication packages are the same and differences of the packages should not hinder the system's classification of the medications.
- Similarly, a machine learning algorithm can be used to identify the doctor or pharmacy note and translate it to a schedule that is used in the system to remind the user when they need to take their medications.
- The system should have a database in place that stores all the medications, as well as the schedules for each medications. It should be possible for the system to recover in case of a power outage for instance.
- The system has a back-lit panel (a matrix of LED lights for instance) that light up the areas behind the medications in order to make it easy for the user to identify them.
- The system should have a matrix coordination system in place in order for it to know where medications are placed inside the cabinet. This makes it easier for the back-lit panel to light up in the correct locations.
- The system can be built on a microcontroller or a single-board computer unit, such as a Raspberry Pi. Sensors, such as cameras and sensors to

detect when the cabinet door is open/closed, can be added to the micro-controller or to the computer.

- Since medications are sensitive information, all data should be exclusively stored locally in the cabinet.
- Additional requirements can be added.

### 3.4 Required Hardware

- A medical cabinet.
- A computer (e.g., Raspberry Pi 4 model B)
- A camera (at least 2, probably 3: Depending on how the cameras are going to be placed inside the cabinet).
- 7" touch screen display.
- A microphone.
- speakers.
- a matrix of LEDs (can be built manually, or recycled from old screens).

### 3.5 Potential Limitations

Like any system, this system might, and will, have some limitations. Some of the expected limitations can be:

- Setup: Part of the target group is elderly people. A great part of the elderly people is not technologically advanced, and thus may not have sufficient experience to set up a system of this scale in their house. One can say that a family member can help. Another possibility, which is likely the preferred one, is training a group of technicians during the deployment phase of this product and having them install the product for the elderly people.
- How will the repairability of the product be? if a certain "pixel" of the matrix is broken, how would this affect the rest of the system (functionalities)?