

Project Report

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Introduction:

Hospitals are one of the critical places for mankind and thus it should be the place where we should apply the technology at its best to assist the staffs in carrying out their tasks. It is very difficult for the shift nurse's to collect the vital signs of the patient's and give instructions to the next shift nurse when she is having too many patient's allotted at a time.

In order to facilitate the user tasks, we should provide support for a user's efforts to operate the system successfully and effectively [1]. So, our proposed solution for this problem is to facilitate the nurses' tasks by providing a mobile application that can identify the patients and record their vital signs along with a possibility to leave notes for the next shift nurses about a particular patient with the ability to adapt to the environmental context, which is a new feature in the application. This also involves taking over some of the routine tasks, which does not need much intelligence or knowledge to do it, that may place heavy demands on the nurses' time that the nurse would normally have to perform herself during her shift time [1].

Motivation:

Usually, a nurse is assigned to many patients in a shift which will result that the nurse could not identify her assigned patients. Also, collecting vital signs from all of them is a hectic task most of the time, especially during the night time. Currently, hospitals use building number or floor number along with the room number with bed number to locate the patients. Sometimes, there are chances that the patient is not available to collect the vital signs from, then the nurse should mark this case in the patient's case sheet or inform the next shift nurse. Sometimes, the low lights make it difficult for the nurses to deal with the mobile application. Due to the hectic tasks assigned to the current nurse, she might forget to mention this small but serious issue to the next nurse and the patient is going to be affected by that. This can be a common problem during the night shifts or long shifts mainly because of the fact that either the patient is sleeping or the duty nurse is dead tired.

The proposed solution can easily identify the patients and their case sheets at any time and the nurses can leave notes or instructions for the next shift nurse's about a patient in his case sheet without the need of waiting or remembering it for a long time.

Project Summary:

This project proposes to use a unique QR code to identify each patient and open his or her file to the nurse and to the doctor through the mobile application. Nurse's can easily record their patients' vital signs and doctors can read out the vital sign readings at any time. If a nurse wants to leave some notes or instructions about a particular patient to the next shift nurse, she can leave a note inside the patient file in the application. This can be read by the next nurse when she opens that particular patient's profile. If there is some difficulty in using the application due to low light, the application will set itself accordingly.

Project Details:

The user interface adaptation for this project will be to facilitate the user tasks. Each patient in a hospital will be provided with a QR code to identify each unique patients with their MRN (Medical Record Number) stored in it. This QR code will be placed on the patient's wrist bracelets. Once the nurse approaches to the patient to collect the vital signs, she will use the application to scan the QR code. If the light in the room is very low, then the application will automatically turn on the flashlight, when scanning the QR code. Also the screen brightness will be adjusted depending on the light intensity. Once she scans the QR code, the patient information will be displayed on the application along with the room and bed number to verify the patient. She can then record the vital signs and save it. If there is a note to be left for the next shift nurse or some instructions to be conveyed, it can also be stored in the application. So, when the next shift nurse comes in and scan the patient QR code, the note will be displayed on the screen, so that she can easily see it. Also, the doctors can use the application to see the vital sign readings of their patient by following the same steps that the nurse does. An alternative way to access the patient's file, especially when the patient is not available, is by entering the room number and the bed number.

To implement intelligence, Vsign will need to sense the light of the particular room that the nurses are in (patients room mainly). For this, we will use a light sensor to sense the lux (unit of light Illuminance) and depending on the value, the system behaviour changes. If it is too low, then the flashlight turns on and the screen brightness adjusts and vice versa. This application is a context sensitive which will change its behaviour accordingly to the context of use. By implementing this intelligence, the nurses won't have to bother the other patients when reading the vital signs for a patient. The note field provided in the application will be helpful for the nurses to effectively communicate between the shift nurses. This would eventually make the work of the nurses and the doctors easier and which will lead them to focus more on the other factors that may affect the patients. However, this feature may not be feasible to be implemented in the given time frame.

Decision table

A decision table has been set up to get the work flow of the application. For the user nurse, there are two different conditions and five different actions. In the table 1, If the nurse is in the patient's room during the night shift and the conditions C2 and C3 are met, (that is C2: the level of light in the room is low, C3: QR code is present beside patient) a set of actions are performed in the MUI (Mobile User Interface), that is A1: Adjust the screen display brightness to high, A2: Turn on the flash of the camera to scan QR code. Similarly, different conditions are applied to make the following decision table.

	Condition	Rules			
		1	2	3	4
C1	The nurse is in the patient's room during night shift	-	-	-	-
C2	The level of light in the room is low.	Y	Y	N	N
C3	QR code is present beside patient.	Y	N	Y	N
Actions					
A1	Adjust the screen display brightness to high			X	X
A2	Turn on the flash of the camera to scan QR code	X			
A3	Use the alternate method to get user information		X		X
A4	Adjust the screen display brightness to 40%	X	X		
A5	Scan QR code without flash light (flash off)			X	

Table 1: Decision table

Vsign will use the mobile camera to scan the QR code and the application will process the QR code to retrieve the information stored in it. In a hospital, each patient will be having a unique identification number called Medical Record Number (MRN) used to uniquely identify each patient. So this QR code will contain the MRN of a particular patient. QR code will be generated when a new patient file opens (When a new patient admits to the hospital). This MRN will be saved in a database which is associated with the Vsign and all the patient details such as age, gender, address, diseases, vital sign readings, notes etc. So the MRN will be the primary key to locate the patient information in the database. This QR code will be printed on the patient's wrist band. When Vsign scans the QR code using the camera, the application processes the QR code and determines the MRN stored in it. Vsign will then use this MRN to locate the patient file in the database and retrieves all the user information from the database and displays it on Vsign application.

Even though there are two different user roles for this system, the user can use the same application interface to work with the application. The role can be either a doctor or a nurse. When a nurse wants to record the patient's vital sign, she just need to use the Vsign to scan the QR code from the patient's bracelet. She can then record the new vital signs of the patient in it. In case if a doctor wants to see the vital sign readings of the patient, he just

need to scan the QR code of the patient, and the reading will be displayed to him through the application.

Light levels in room

Activity	Illumination (lux, lumen/m ²)
Public areas with dark surroundings	20 - 50
Simple orientation for short visits	50 - 100
Working areas where visual tasks are only occasionally performed	100 - 150
Warehouses, Homes, Theaters, Archives	150
Easy Office Work, Classes	250
Normal Office Work, PC Work, Study Library, Groceries, Show Rooms, Laboratories	500
Supermarkets, Mechanical Workshops, Office Landscapes	750
Normal Drawing Work, Detailed Mechanical Workshops, Operation Theatres	1,000
Detailed Drawing Work, Very Detailed Mechanical Works	1500 - 2000
Performance of visual tasks of low contrast and very small size for prolonged periods of time	2000 - 5000
Performance of very prolonged and exacting visual tasks	5000 - 10000
Performance of very special visual tasks of extremely low contrast and small size	10000 - 20000

Table 2: Light levels in room

From the above table, we can see that the normal lighting in a public areas with dark surroundings comes in between 20-50 lux [3]. So as a fair level, we took the light intensity as **40 lux**. So the room lighting level goes below the 40 lux, flash light will be used for scanning the QR code and also the screen brightness will be set to **40%** [4]. If the light intensity is more than 40 lux, then no flash light will be used for the QR code scanning and screen brightness will be set to **100%**.

If a nurse wants to leave some notes or instructions about a particular patient to the next shift nurse, she can do the same procedure mentioned above to retrieve the patient's case file and thus using the options to create a note which is a new functionality in the application, she can leave a note in the patient's file. When the next nurse scans the same QR code, she can get to know about the notes, which is already left by the previous nurse, when she access the patient file and then actions can be taken accordingly.

In order to achieve this solution, the system should have access to a database where all patients' records are there. Then, the system will be able to retrieve the patient's information when nurse scan the QR code, which is on the patient's bracelet. After that, the system shall check if there is a note written on the patient's file from the previous nurse, and displayed it to current nurse. In addition, the system needs to read the light intensity of the environment, so the system can make actions according to these readings. A light sensor, which is built in the phone, will be used to gather this information.

Task analysis models:

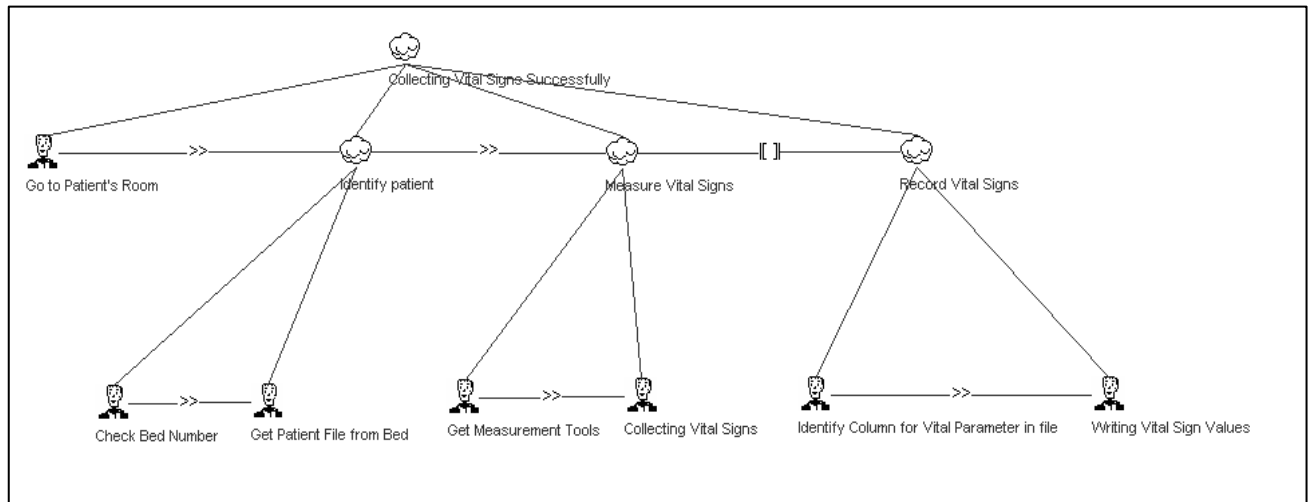


Figure 1: Nurse collecting vital signs from a patient [2]

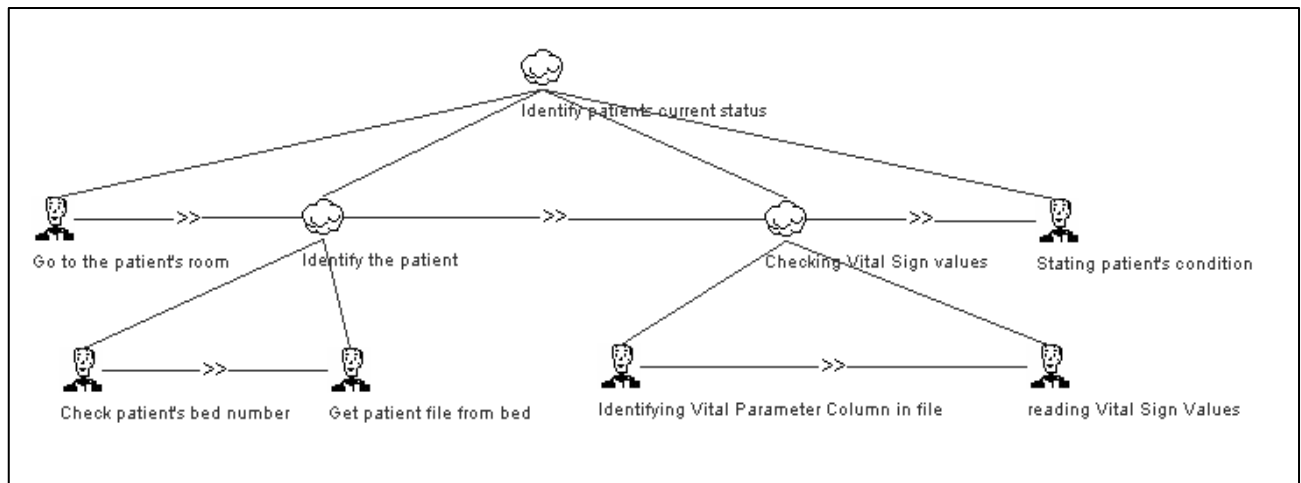


Figure 2: Doctor identifying current status of a patient [2]

Challenges

One of the major challenges encountered during the project was to co-ordinate the functioning of camera to scan the QR code along with the flash light. So, we had to choose one of them. Therefore, we discarded the flash light functionality since the QR code reader is more important. However, the app will show a notification about the status of the flash light at that environmental condition (eg: Low lighting at the room, then the flash light is ON).

Next challenge was that the original app does not support the older android versions and when we tried to test it with an old android version, it doesn't work properly. As a result, we didn't have the opportunity to test our code when we make changes to see if it is working or not. This led us to work with the emulator and android old version, which resulted in slowing our programming progress.

The Database of the original app was structured for one patient. So, we had to alter the database structure so it can store multiple patients with multiple entries. There was a big challenge in understanding the code since the flow of programming was difficult to understand and many of us were new to the android environment. Also, it took us some time to identify the programming method that was used by the previous programmer. For example, the program was not dropping the old tables from the database, but his concept was just adding new tables to the database. When we needed to add some new columns to the existing tables, we weren't able to add them because of it.

Evaluation

For conducting the usability, we have to check the efficiency, effectiveness and learnability of our application. In order to find out these important aspects, we chose two different usability testing methods namely Questionnaires and Think Aloud protocols. It is always better to conduct both of these techniques by the help of nurses and doctors since they are the primary users of Vsign in the hospital context. However, due to the limitation in getting appointment and availability in getting enough number of people to conduct our usability testing, we were not able to conduct the study by nurses and doctors. Therefore, our evaluation plan involved people from outside the hospital context. Though, they should have similar characteristics to that of doctors and nurses.

Our evaluation process was by choosing people to use our application and to perform the think aloud technique. We chose 6 people to perform the task and each two people will have the same condition and task. And each one will have two tasks which will utilise the two different patient file accessing methods (QR code and Room number with bed number). In the think aloud technique, we asked the user to perform a particular task in the application and also asked them to speak out of what they had in their minds while performing the task. Tasks were carried out in different environmental conditions and mental conditions like low light, high light or a situation where they need to leave a note about the patient. This was mainly focused on the response of the user when using the system and recorded their reactions. During the process, the user was provided with the application and was not disturbed or questioned until he finished his task. There wasn't any communication between the user and the person who is conducting the usability testing

once they started the think aloud technique, so that we could get more of their actual reactions on the application in a more real life manner. After the think aloud process, the user was given a set of 10 questions. These questionnaires and think aloud technique was mainly focused on the efficiency, effectiveness and learnability of the application.

1. Have you had difficulty in accessing the user profile and recording the vital signs?
2. Did the QR code worked well to get the user profile?
3. Was the screen sufficiently bright for you to read the text and perform the tasks in the Vsigns application during the specified condition, which is either low light or high light?
4. Was the screen brightness too intense for you to use the application?
5. Was the notes field sufficient for you to write an instruction or comment about a patient?
6. How easy was it for you to use the alternative method to access the patient file?
7. Did the alternative method showed the right patient file that was specified in your paper?
8. How easy was it for you to perform the given task? (Rate out of 5. 1: Difficult, 5: Very easy)
9. Easiness to learn the functionality of the app? (Rate out of 5. 1: Difficult, 5: Very easy)
10. Rate the idea of the application in a scale of 5 (1: Very good, 5: Ordinary)

Evaluation results

Some participants were unable to find the functionalities to perform the given task. Also couple of people got confused when entering new vital values since they were new to android applications. It's strange that some thought they could collect their own body vital signs using the application. People seemed to be amused to see the changes in brightness depending on the room lighting and it was comfortable for their eyes when the testing was conducted in different lighting conditions. Some people were quite new to the QR code, but they were able to work it out with the instructions that were given by the person who conducted the usability testing. When they were given the application initially without any instruction on how to operate the application, they seemed to be confused and had no idea what the application is for. The time taken to complete a simple task was too long. However, with practice they become more experts.

As a result, we can conclude that the users of this application should be given proper training instructions, so they can work with the application more efficiently. Also, it was quite significant to see that they improved their actions in the application with many attempts.

Conclusion:

Hospitals are the vital place for any human and thus we need technology to enhance the tasks in this context. Collecting the vital signs from a patient can be a hectic job some times when the nurses' are working in a long shift or night shift. There should be an efficient way to communicate between the current and next shift nurses to express the situation of a patient or letting them know about a particular problem. So Vsign application can be used to solve these problems by making it easier to record the vital signs by identifying each patient using a QR code which can be scanned and processed through the same application to get the patient record. Also it can be used to leave notes about that patient to the next shift nurse or future references for the same nurse. Even doctors can use this application to easily read the vital sign values of a particular patient just by scanning the QR code associated with each patient. A suitable intelligent user interface adaptation has also been made to this application which adapts with the variation of light intensity. This way, the tasks of a doctor or nurse can be made easier which will lead them to focus more on the factors that may affect the patient.

References:

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- [3] Light levels: http://www.engineeringtoolbox.com/light-level-rooms-d_708.html
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