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SmartNursing - a mobile application to improve communication in home care

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Abstract—This paper presents SmartNursing system and discusses how increasing capabilities of smartphone could benefit employees in working environment. A SmartNursing system is developed for home nurses working environment to fulfil their needs. The solution helps to improve communication among nurses, provide customized information and increase work efficiency. Developed system consists of mobile application, web based server and database. This article discusses the solution SmartNursing from design to implementation.

Keywords-home nursing, public health, mobile application, web server.

I. INTRODUCTION

Domiciliary care is provided by licensed personnel who constantly visit patients at their home and assists with daily tasks, such like giving medicine, bathing and cleaning. Domiciliary care is recommended for elderly generation that needs special care. People that needs care prefer home environment over nursing home [1]. Home adaptation and assistive technology substitute traditional health care in medical institutions reduce the costs [2]. This fact confirms a growing need for caregivers for people living in home environment. Eurostat projections (Europop2010) reveal that, over the next 50 years, the number of elderly people will grow dramatically [3], consequently, it rises new needs for home nurses. Current problem is a lack of interest of working as a home nurse. This job is seen as hard and tiring, every 5th home-nurse is emotionally exhausted and stressed [4]. In order to satisfy increasing needs of licensed personnel and provide better service to elderly people, it is vital to focus on home nurses.

A. Analysis

This chapter discusses the potential users of the system i.e. nurses and their needs. The use case of home nurses in Frederiksberg municipality in Denmark is explored in order to identify requirements for the system [5]. Interviews with the project manager of Frederiksberg Hjemmepleje and conversations with the home nurses illustrate the fact that communication among colleagues, access of information relevant to work, process of planning and organizing daily work need to be improved.

Administration of home nurses work is done by their leader. The leader of nurses is responsible for coordination of care to elderly and the patients that are in need of domiciliary care. It could be transportation, house cleaning, personal hygiene, meals, and other health and wellness related activities. Also, the leader distributes responsibilities for the nurses, thus every nurse provides care to several patients and in that way each patient gets different nurses to visit. The leader also prepares daily reports with information as required. Daily meetings with employees have significant role in planning and organising work. Every morning before the actual work starts, all nurses gather to discuss work experiences, working schedules, substitutes and to get a paper with relevant information for the next visitation. This manner of work requires extra time and is inconvenient for the nurses.

Communication among nurses that is other than during the meetings, is complicated, especially when the nurse wants to contact her colleague, who visits the patient after. Currently, either calling, messaging manually or contacting a group leader is necessary in order to convey a message to another nurse. It requires too much time and concentration, therefore communication tends to be avoided. Same is the case with information handling, if a nurse needs any information then she has to carry papers, when she loses the paper then she loses the information.

Furthermore, the job is physical and requires full concentration, therefore nurses cannot be distracted by side tasks such like making notes during the shift. Intuitive, easy to use and communication tool is necessary in order to improve home nurses working environment work. We live in the world that is so connected, most of the nurses have smart phones, but very rarely have any mobile applications supporting their work. Usually, they need to report and document important accidents that have happened during their shift and they do that when they return to the office. In addition to this, different users document in different, often incompatible, ways that makes hard to keep consistency in overall documentation. Home-nurses need a system that could improve working environment and tackle the problems mentioned above.

The idea that is evolved in this article is to create an innovative and well-designed application for smartphone considering the home nurses working environment, add different components and features that can improve communication and make daily work easier. After the introduction, this article is organized in this way: the survey of existing applications in the market is discussed in section II, and SmartNursing application is represented in sections III and IV, including modelling, design and implementation of application. Conclusion and suggestions for future work is covered in section V.

II. RELATED WORKS

There are many existing applications for nursing. Almost every application is focusing on medical approach and in their applications they provides a drug guide (Rx:), diseases and disorders (Sx, Dx, Tx), diagnosing tools etc. But still it is hard to find smartphone applications for the home-nurses working environment. Some well known applications for nursing are described below:

A. Nursing Constellation Plus

This application is developed by Skyscape Inc. and is probably the most expensive application for nursing in apple / android market that costs \$179.95. The application includes drug guide, and laboratory & diagnostic tests handbook. In technical words they have managed to bring the medical database into the smart devices. [6]

B. Abbo EMR

Abbo EMR is an electronic medial record program used for both patients and doctors. Doctors can dictate instructions, and a patient can listen it on his phone. In this application the target group is both patients and doctors. This application is developed by ZCO Corporation. [7]

C. Cell Trak

This application is made for home-care companies and includes a scheduler for the nurses, patient care plan, billing and pay role system. This application is made for those countries where home-care system is privatized for example USA. [8]

D. Intelligent home applications

In addition to mobile domain, intelligent home environment is an attractive subject for the research and development. For instance, INHOME project [9] introduces intelligent services at home (alarm-and-notification system, refrigerator), that control living environments so that enable independent living of elderly people at home and improve quality of life. AMIGO applications [10], such like Home Care and Safety, Home Information and Entertainment are based on home networking and connection among several devices, for example lighting system, mobile phones and PC. It has benefits in providing interoperability between services

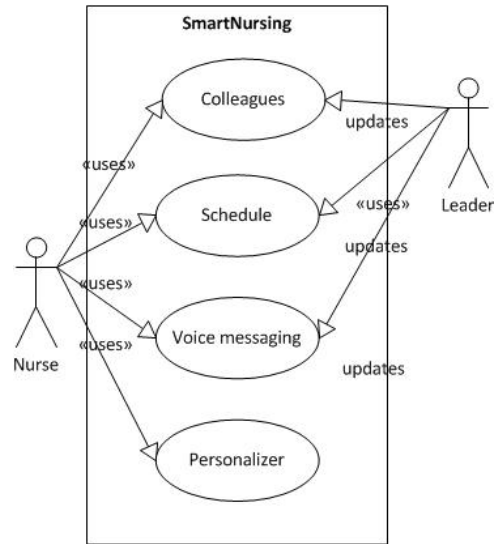


Figure 1. System use-case diagram

and devices and provides the users with communication that is independent from location and device. Furthermore, new studies focuses on grid technology that is necessary to provide high quality medical services in home environment[11] [12]. The grid is primarily targeted towards applications with high computing demands, that are used in hospital at home.

There is still a need of applications and solutions for Home care. All the above mentioned applications are created for a country where the working environment is different from Nordic countries. The drugs guide vary from country to country, thus such applications cannot be used in Nordic countries, in our case Denmark. Existing solutions, that target intelligent home environment, usually requires additional equipment pieces, sensors to be integrated into home environment. This paper focuses on the home nursing and utilizes smart phone capabilities to improve nursing services and daily nurses' work. The application automates common tasks, suggest better work organization and provides unique functionality to communicate by voice messages.

III. DESIGN

In the previous chapter the brief overview of existing applications is given. This chapter is focused on our developed SmartNursing system. The design, structure, different components and their functionalities are discussed. While designing application, consideration is showed for user experience and suitable interface. Figure 1 is a use-case diagram for SmartNursing system. Diagram is visualizing the users that are interacting with the system and the functionalities they perform. All functionalities are represented subsequently.

A. Profiler

Profiler is a functionality that is aware of the application's context. System starts with a profile based on context information. User can always change the profile if it does not suits the context. Purpose of the profiler is to provide customization. The user can select the settings for every profile and when a profile is changed the settings will be fetched from the database and applied. The user (home nurse) could make settings for specific working environment, for example, sound settings as silent or vibrate. Contrary the settings will be different for non working environment, such like home usage. In such way the functionalities are customized. Internal database is used to manage the profiles. Smartphone sensors fetch context information i.e. data from external system and based on context change the profiles. User status is very important for the home nurses to share information about availability of each nurse. A status of a person provides also an abstract glimpse of the situation of an employee before someone contacts. The idea is to embed the status of each contact in the address-book in order to provide an overview before someone actually contacts someone.

B. Voice messaging

Voice messaging is a functionality proposed to make easy communication among nurses and keep track of patient's history. Nurses can record a voice message from her mobile device and repeat the process again until the she is sure that the correct message is recorded. Then the nurse saves the message and it is saved on the home-nursing web-server. When the nurse from another shift arrives she can then listen to the recorded message and process it.

Voice messaging is beneficial for work organisation purpose, because all messages are available for the user accessing the system with web interface. Leaders are able to listen to the messages and add important information in the patients history, so that it could reach the nurses as information about the patient. This functionality brings value preposition in saving time, offering better care of a patient, and improving communication among nurses.

In order to avoid the nurses spending less time with the patients than they have to and using the work time doing their personal tasks, the application asks the nurse to check-in when she arrives at the patient's home and check-out when she leaves.

Figure 2 shows the overview of voice messaging system. This diagram represents the functions that a user can perform in this functionality. For example a nurse can record a message and upload it to the server, so that her colleague could listen that message.

C. Colleagues

Colleagues is a functionality to display the colleagues of the nurse in a list format or a map view. On selecting a



Figure 2. Overview of voice messaging functionality

specific colleague it is possible to see the further details of a selected colleague like contact information. The purpose of this functionality is to locate the colleagues either by viewing their details and calling them or by viewing them on maps. On user request the system will fetch the contact list from the web-server and display the list to the nurse. Further she can click on any contact to make a call. In case of viewing the colleagues on a map, the application gets the coordinates of all the colleagues from the web-server and displays them using Google Maps API.

D. Scheduler

Scheduler could be used to contain information about the meetings, and events that a nurse has to attend during the day. Smartphone automatically fetches the schedule from the web-server, tasks are saved in calendar as events and displayed in the day scheduler. The functionality is beneficial for the nurse, because she could prepared for the work before she actually starts the work. Group leader of the nurses is responsible to create of all the nurses in her group. Leader could access the system using web interface and she creates a schedule. On the smartphone application the nurse can check her schedule and get details of a patient who is in the list. Nurse can see a schedule of the specific date, that is created on the server. By default the system will show the schedule of current date.

E. User interface design

The application was designed applying Tracy Leonard all times rule of design that encourages the developers to remember personal experiences in order to evaluate design of applications and choose the best ones to be used as design guidelines [13]. Well-designed applications such like Evernote, Twitter, and Foursquare etc. have interfaces that provides desirable user experience, therefore for inspiration we have employed some features from their design. In the past software was designed regardless of the usability issues, so the user has to adapt the system somehow. This design approach is not appropriate today because the system must adapt to the user. That is why design criteria for mobile applications are so important. We have followed 5 steps principle to design the application [13]. These five steps include navigation, information visualisation, on screen interaction, notifications and responsiveness as well as emotion and expression. Subsequently, all of them are described in this section.

IV. IMPLEMENTATION

This section represents architecture of implemented system and technologies that were chosen for implementation. The system provides two user interfaces: one is for smartphone application and other one for web based interaction with a server. Smartphone interface is developed in android platform using Gingerbread version 2.3.3. As our target group is home-nurse, so the mobile interface is designed to be used by the nurses. Whereas web-interface has administration functionality and can be used by leader of nurses allowing her to create, replace, update and delete stored data. Web - server is necessary to overcome limited resources of smartphone and execute functionalities for smartphone [14]. The communication between the server application and smartphone client is based on JSON using RESTful web-services. We preferred REST over SOAP because it is light weight, human readable, and easy to build.

On the server side we are using Play! framework which is Java based web-server that connects with the database to performs insert, delete, update and select operations. We preferred Play! server over other open source servers because of it's structured environment and usability. We are using MySQL as database to store the data on the server. It is very important to choose the right technologies to make the product reliable and meet the requirements of the system. The technologies are selected based on the open source licensing, past development experience, reliability of software, and promising future of software. The paragraph continues with brief summaries of technologies used in implementation process.

A. Smartphone platform

We have selected Android as the smartphone platform. The market share of Android takes almost half market and

has been increasing significantly [15]. Apart from market share there are many other advantages of Android development and few of them are mentioned below.

- Android applications are not restricted to one distribution channel.
- On Android market application is distributed and in the market quickly i.e. without any reviewing process.
- Android applications are written in Java with w set of libraries.
- Android platform give access to many physical and virtual sensors.

Based on above mentioned reasons we choose Gingerbread i.e. Android 2.3.3 version to implement our prototype.

B. System deployment diagram

The deployment diagram, see Figure 3, represents structure of SmartNursing system that illustrates the components of the system and visualize the communication between these components.

C. Relational Database Management System (RDBMS)

MySQL RDBMS is open source and is the most popular database with 65,000 downloads per day. MySQL also provides MySQL Workbench - a tool for designing and modelling database. Reason for choosing this RDBMS is to have a stable database among other open source databases and moreover it is simple to use.

D. Web-server

Play Framework is chosen as a web based server development platform. The reason is that the main scope of application is to develop a mobile application, therefore preference web-server is the one with simplicity, easy to use, and Java support. Play Framework has these advantages:

- The biggest advantage of Play framework over other Java web applications is usability. For example you do not need to restart the server on static changes [16].
- Play framework jobs provide a way of running program logic in the background.
- With the help of CRUD, administrator's UI can build easily.
- It supports different IDE's integration for example Eclipse, IntelliJ IDEA.

E. 3rd party API

ZXing ("zebra crossing") is an open source, bar-code scanning library developed in Java. We have embedded ZXing API version 2.0 into our project for the scanning of bar-codes to identify a patient.

Google Maps is a web mapping service application and technology provided by Google, that powers many map based services. In SmartNursing application Google Maps is used to display the location of nurses on a map.

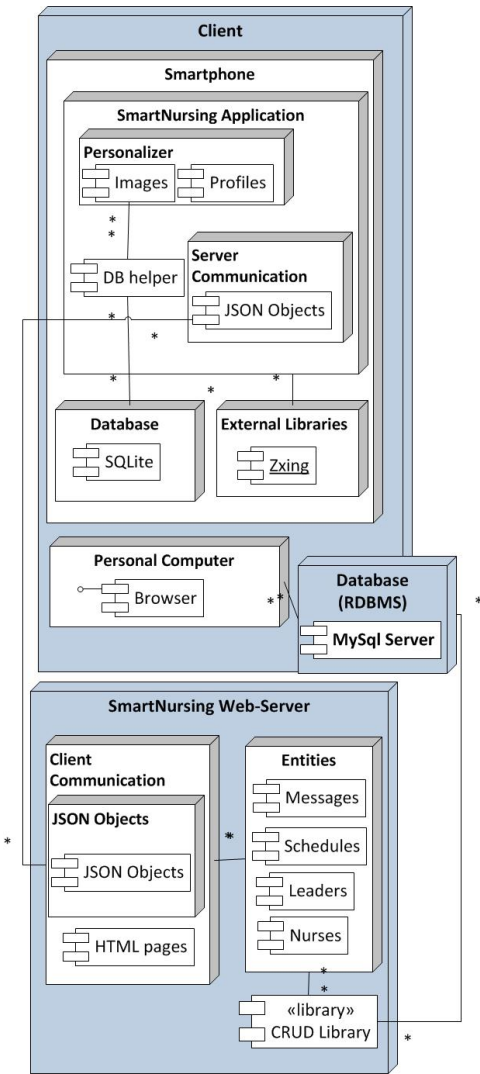


Figure 3. System deployment diagram

F. Graphical User Interface

As discussed in the last chapter that we have focused on the usability issue and we provide simple and useful design based on the requirements of the nurses. We have used dashboard concept to bring the idea of home-screen and link to the major functionalities are provided on the main screen. We have also embedded the profiler functionality on the main screen to make our dashboard more usable. We avoid the option menu to bring simplicity in the application. Our target users are nurses and it should require minimum time and efforts to use application. Therefore, we have tried to avoid hidden things and make the functionalities accessible. Figure 4 shows the main screen of application.

Main screen is combination of core functionality i.e. profiler and dashboard with link to other key functionalities. It is visualising the context information of the nurses from the selected profile.

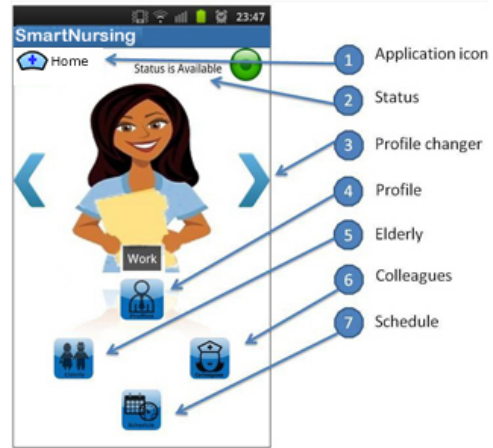


Figure 4. Main-screen components

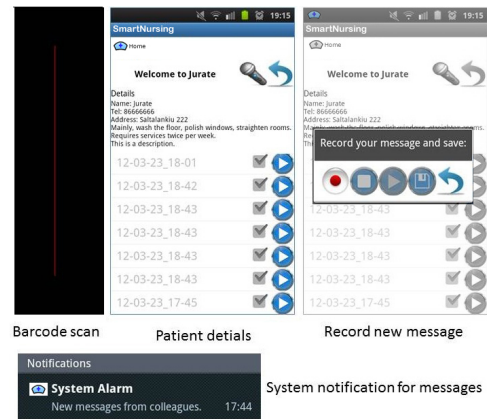


Figure 5. Voice messaging functionality

Voice messaging system with possibility to record a message is illustrated in the Figure 5.

Functionality is designed to improve communication among nurses and get easy access to information about patients. First of all, a nurse needs to identify a patient by a unique identification. We have used barcodes to identify the patients.

Nurses can scan the barcode from smartphone to get the id of the patient. On identification of the patient, system finds the patient in the database and sends the patient's information and related messages to the smartphone application. All unprocessed messages are displayed to the nurse. To record a new message there is a custom dialog that allows the nurse to record the message. After recording the nurse can listen to the recorded message. If she do not like the recorded message then she can record again, in that case before recorded audio file will be overwritten.

V. CONCLUSION AND FUTURE WORK

This paper shows how capabilities of smartphone could improve working environment for home nurses. Imple-

mented functionalities maximise benefits of smartphone at working place. They make daily work easier, reduces the stress and the nurse could do work with full concentration. Solution provides information that is needed at the time and improves process of communication among nurses by suggesting an easy, more convenient and time saving way to convey information via recorded messages. Our future research focuses on usability study of implemented application. The idea is to test performance of application by distributing it among targeted users - home nurses. Taking into account user experience and their suggestions, the system could be improved to make it more user friendly and efficient to use. Furthermore, security, utilization of more sensors to fetch context information and implementation of more functionalities. Possible future functionalities might be tracking of detailed patient history, calculation of working hours and scheduler for the patient, access based on context information etc. In addition to this, graphical interface of our application can be improved by providing more assistance to the nurses with interactive communication.

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