

A Mobile Application for Supporting Surgical Workflow

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Abstract—This paper presents a mobile application to enhance safety and efficiency in the operating room. The application plays a crucial role in preparing the surgical personnel and gaining useful help as needed in real time. Seamless integration of information is implemented to support surgical workflow beyond spatial constraints.

Keywords—mobile application; surgical workflow; operating room; information integration.

I. INTRODUCTION

It is reported that about 40% of the medical accidents occur in the operating rooms (ORs) and around 20% of them can be prevented in advance [1][2]. Since the OR is the most cost-intensive sector in the hospital, the optimization of workflow processes is of particular concern for health care providers, managers, and administrators [3]. In order to enhance safety and efficiency in the OR, a prototype system named Surgical Workflow Manager (SWORM) has been implemented as a surgery management platform capable of planning, recording, and adapting the surgical processes in regular sequence [4].

Timely communication between team members is crucial in such a complex and hectic environment as the OR. The SWORM is basically devised to run inside the OR, but all personnel needed do not always stay in the room. For instance, a circulating nurse may engage in more than one surgery at once, and other doctor who takes outpatients may be asked to give the surgical team advice on a certain situation. However, they face difficulty in grasping the current situation in the hallway or elsewhere. A mobile application is thus proposed in this paper to meet the demands of understanding and intervening in surgical workflow even outside the OR. This paper does not focus on the SWORM but its mobile application. The application makes the SWORM feasible around the OR by seamless integration of information.

The rest of this paper is organized as follows. Section II describes the service architecture and main functions of the mobile application briefly. Section III describes development environment and discusses the results of a case study. Section IV concludes this paper.

II. ARCHITECTURE AND FUNCTIONS

The surgical workflow should be summarized concisely and represented intuitively at the mobile application. The

SWORM transmits the surgical processes and their selected information to the application in real time, and obtains feedback from the designated mobile users who are away from the OR during the intra-operative period. The application currently consists of three consecutive pages: surgery list, process list, and detail process information. The overall architecture is depicted in Figure 1.

The Surgery List page provides a brief summary of scheduled surgeries as shown in Figure 2(a). After browsing the list including surgery names, assigned ORs, and scheduled dates, the user can select a specific surgery to identify its patient, disease, surgeon, and scheduled time. The Surgical Process button leads the user into the Process List page. The EMR, Staff, and Resource buttons are intended to access the corresponding legacy systems, but not activated yet.

The Process List page shows planned surgical procedures with highlight on the ongoing one. If a profession is called or asked for feedback on any procedure, a message button labeled by profession appears beside the procedure to unfold the messages (e.g., S, N, and T for surgeon, nurse, and technician each). Each button is also distinguished by color: green means the message completed, red at hand, and yellow coming up. In Figure 2(b), for instance, a supervising surgeon outside the OR may skim through the list trying to make sure whether every procedure is performed without loophole. After finding the request on the Test Stimulation procedure, he/she can move into the Detail Process Information page to make a useful response.

The Detail Process Information page provides the overall status of a selected procedure as shown in Figure 2(c). The page not only displays formal indicators such as duration and parameters of the procedure, but also contains intra-operative records such as patient's state, operative photos, and compliance with the checklist. The user can give the team in the OR helpful advice and information by writing comments or uploading photos relevant to the given situation.

III. APPLICATION

The mobile application has been constructed in a hybrid app development environment. This app is written with web technologies (HTML 5, CSS, and JavaScript) and currently runs on Android only. At the server side, the SWORM uses HTTP and Ajax for I/O interfaces, and MySQL as a database. The data created by the SWORM and mobile application are stored in and retrieved from the database directly.

The application is applied to a real Deep Brain Stimulation (DBS) surgery for trial use, and evaluated by its developers and users. All of the functions are performed well as intended. While a supervising neurosurgeon and an anesthetist stayed outside the OR, they could intervene effectively in the surgery by monitoring its workflow, capturing the messages, and sending some advice. An X-ray (C-arm) technician received a call before needed, and she moved into the OR with the equipment on time. Even though limited, interviews from the users show that the mobile application would increase convenience, and consequently be useful in enhancing safety and efficiency in the OR.

IV. CONCLUSIONS

This paper proposed a mobile application for surgical decision support. Exchanging information between inside and outside the OR has been made by the phone calls mostly. Instead, this service enables a user outside the OR to monitor surgical workflow and intervene in the ongoing surgeries as needed. Usefulness of the service was evaluated restrictedly in the perspective of surgical safety and efficiency.

The usability test is expected to improve user interfaces and details of each function in the near future. For instance, when someone is needed, the application will send the

selected user an alarm to notify the event, and then lead the user into the related page. The test results should be analyzed and evaluated quantitatively to ensure the performance of the application as well.

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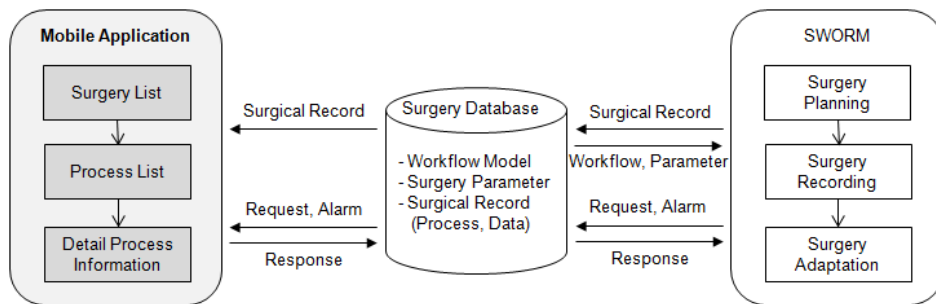


Figure 1. Overall architecture of a surgical mobile service.

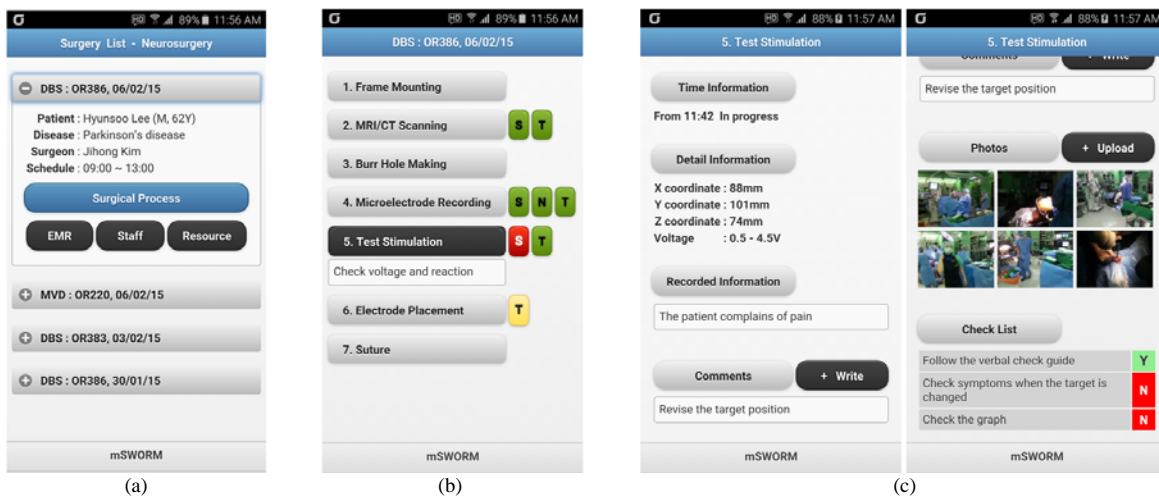


Figure 2. Snapshots of the mobile application: (a) Surgery List page, (b) Process List page, and (c) Detail Process Information page.