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Paper Seminar Presentation

Introduction

In an inherently strict field such as surgery the incorporation of new devices must be carefully planned out with the utmost scrutiny; it is indeed important to assess if a new technology will benefit the surgical team and/or patient. Due to the very nature of this term project (the iPad Mobile Surgical Console) it is quintessential to evaluate the ways in which the application is able to improve the surgical experience and then determine the optimal design and implementation. Two particularly important focuses of any application design are the limitations/challenges that must be considered and the design of the interface by which the user will interact with the application. Two papers have been selected that discuss each of these focuses.

Critical Review 1

*Note: this paper is not the primary critical review of this assignment but I found it a necessary and appropriate paper to touch on for the sake of the project

Remote display solutions for mobile cloud computing
Simoens, P., De Turck, F., Dhoedt, B., and Demeester, P. (2011) *IEEE* 0018-9162.

Summary

The authors of this paper discuss the role and limitations of mobile devices acting as remote displays in a cloud network. There are intrinsic limitations to a mobile device because of the desire to preserve the mobility of the device. Three technical challenges are presented: limited battery lifetime, display compression and bandwidth restrictions, and interaction response time. The paper discusses the advantages of offloading application logic to a server, but also the disadvantages that this creates. These disadvantages involve the now additional requirement of transmitting and receiving large

amounts of data. The aim of the paper is to propose several current solutions to these challenges, many of which have been drawn from other research.

The authors first address the limited battery lifetime that any mobile device faces. By offloading applications to the cloud (e.g. a server), one can save on energy consumption due to local processing. This offloading, however, creates an unusual paradox because the network bandwidth consumption and usage of the wireless network interface card must be assessed. The authors measure the cost per byte of data sent/received in four different states of the mobile device (transmit, receive, idle, and sleep) and find that. devices consume much of their battery life during the large idle time when users wait for updates. The authors of the paper developed a protocol to operate between the MAC layer and remote display protocol layer which allows the device to enter a power saving sleep-like cycle while continuing to receive updates.

Secondly, network bandwidth considerations regarding video streaming are discussed. The authors make a distinction between interactive video streaming (e.g. a 3D medical image viewer) and a video sreaming application (e.g. Youtube). Interactive streaming applications usually involve a large amount of data being sent over the network in a short period of time, creating peaks and bursts that often create redundancy and inefficient usage of the network. The authors briefly discuss a protocol that uses a hybrid cache-compression to minimize the amount of data sent during screen updates.

Lastly, the authors discuss the importance of considering the network latency and the user expectations. Depending on the type of application, users have different expectations for how quickly an application should respond to input. The authors propose two solutions: (1) implement *cloudlets* and (2) send display predictions. The first attempts to decrease

the number of hops in between the device and the server by dispersing resource rich machines throughout the Internet. The second attempt is to send display predictions based on what the user may input next.

Overall, the paper presents a valid response to the ongoing boom of mobile devices and the seemingly never-ending integration of these devices in everyday use.

Critique

The authors of this paper clearly envision the mobile device merely as a remote display device with limited input expectations. The paper provides several real challenges that must be faced and considered, however, the presentation of these challenges leaves much to the imagination. There are little quantitative results assessing the criticality of these challenges. For example, the discussion of battery consumption based on time distribution spent in different actions (typing and browsing) is lacking. To test battery consumption with regards to different states (transmit, receive, idle, sleep) an experiment should provide concrete data on the rate and power usage of devices performing only one task. The authors also failed to mention the impact that codecs can have on the functionality and usability of the target application. Nonetheless, the authors presented valid challenges that should be considered.

Relevance

This paper provides a ground framework of challenges to consider throughout the development of the iPad mobile surgical console. Though not all of the challenges presented in the paper are exactly relevant to the project, they may impact the

development in one way or another. The challenges and their importance to this project are tabulated below.

Challenge	Importance
Battery Lifetime Consumption	High
Network Bandwidth	Low
Interaction Latency	Medium

It will be imperative to consider the communication protocol and usage of resources to improve battery consumption of the iPad, especially since it has the probability of being used through a lengthy surgery. Interaction latency will be considered to a limited extent; user actions need to reflect immediately and the user should not have to feel like they are "fighting" with it. Network bandwidth is actually of lower importance since the iPad will be communicating with the server in a close setting as compared to the schematic presented in the paper.

Critical Review 2

*Note: Primary Critical Review

Lost in Menuspace: User Interactions with Complex Medical Devices

Nunnally, M., Nemeth, C., Brunetti, V., Cook, R. (2004) IEEE Vol. 34, No. 6.

Summary

The authors of this paper provide a case study of the performance of health practitioners and their ability to use an infusion pump with a programmable interface. Programmable infusion pumps allow practitioners to deliver at precise times short-acting intravenous agents whereas gravity-drip mechanisms only allow for long-acting drugs. The programming interfaces consist of an LCD screen with several buttons that perform different context-based functions. The efficacy of the system was tested by developing a quantification method of the process of programming the infusion pump, determining the

structure of the programming, and how existing incident reports can suggest a breakdown in the infusion device programming. The authors first developed a graphical schematic of all possible program routes by systematically programming one type of infusion pump. This allowed tracking of *Goal-Directed Keystrokes* – keystrokes that move the program sequence towards the goal. This is the means that the experimenters measure the progress of a user programming the pump. The experiment consisted of 14 anesthesiologists and 26 ICU nurses who were asked to perform 5 different infusion pump related programming tasks. The practitioners were asked to voice their programming process while their keystrokes were recorded and measured using the GDK schema. The authors gathered information regarding the number of practitioner years and years of experience with the pump and found no correlation with the %GDK of each task. This leads the authors to believe that a complex menu space can lead to programming difficulties no matter past experience.

Critique

Though it is difficult to debate the disadvantages of having a complex menu space, the experimental setup in this paper is not completely sound. Several factors are missing from the experiment. Among these, age of the user and broad experience with medical devices should have been considered. More generally, some sort of baseline of the practitioner familiarity with medical devices should have been established beforehand. An example of this disparity might be found in subjects 19 and 37. Whereas subject 19 has only had 2.5 years of experience as a practitioner and 0.92 years of experience with the pump, subject 27 has had 20 years of experience as a practitioner and 5 years of experience with the pump. Subject 19, however, earned 90.177% GDK as compared to

subject 37's 57.5% GDK. It seems evident that there may be an underlying issue regarding practitioner familiarity with medical devices.

It may also be interesting to know if the practitioners were ever presented with the schematic drawing that the experimenters devised to track the user actions. The authors make no mention of training or resources made available to the users. It may be possible that, with a flowchart diagram of input processes, the practitioners can use the pump more effectively.

Lastly, the authors mention that analyzing central tendencies of subject performance is "less revealing" than understanding how subjects varied from one another. It would definitely be important to see recurring mistakes or confusion in those subjects that performed poorly in the tasks to determine the underlying cause.

As a whole the experiment requires further refinement and analysis of sample experience to support the conclusions that the authors have made. However, this experiment does provide a glimpse of the critical breakdown that might occur with poor human-computer interface design.

Implications

Though the platform/device addressed in this paper is not the same as the iPad interface, the paper presents some very important considerations when designing the application. These include, but are not limited to:

- Use of labeled buttons
- Easy customizable input (e.g. String data types)
- Easy navigation and configuration

- Schematic workflow document for users

By keeping in mind the above considerations, hopefully there will be little gap of familiarity with the application between different users, no matter the experience, age, or practitioner role. In other words, these considerations will aim to develop an intuitive application.