Hybrid Patient Record – Supporting Hybrid Interaction in Clinical Wards

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***Abstract*—Despite the widespread dissemination of the electronic health record, the paper medical record remains an important central artefact in modern clinical work. A number of new technological solutions have been proposed to mitigate some of the configuration, mobility and awareness problems that emerge when using this dual record setup. In this paper, we present one such technology, the HyPR device, in which a paper record is augmented with an electronic sensing platform that is designed to reduce the configuration overhead, provide awareness cues and support mobility across the patient ward. Our demo will show the *HyPR* device and setup in order for conference attendees to experience the technology *'in action'*.**

***Keywords*—hybrid patient record; electronic health record; hypr; ehr; nomadic work; hospitals**

I. Introduction

The patient record is an important central artefact that is used in medical work in hospitals to coordinate, communicate, configure and archive complex plans and workflow involved in treating patients. In the last decade, the Western world has invested substantial amount of resources into introducing IT technology into the healthcare domain. Especially the process of digitizing and integrating all patient related information into a central electronic system has a been a core focus of many hospitals in order to increase availability, security and efficiency of using medical information.

However, despite the widespread introduction of the Electronic Health Record (EHR), paper patient documents and records remain to play an important central role for coordination, communication and configuration of clinical work [2]. Paper documentation is used as transitional artefacts [3] to bridge the gap between the day to day work in the hospital and the workflows provided by the EHR in use. Some studies even show that the paper record is still even being used as full archival patient record [5]. At its core, the physical and collaborative affordances of the entire paper record are difficult to replace or support in the EHR. Therefore, many hospitals employ a dual record that is composed of both an electronic and paper version of the record. Using such as double record, introduces a number of configuration, mobility and awareness problems related to managing, understanding and using this parallel workflow.

In order to support the use of dual medical records in hospital, we proposed the Hybrid Patient Record (*HyPR*) device [4] as shown in Fig. 1. The HyPR device works as a mediating sensing platform that is attached to the paper record and augments it with a notification systems (applying dynamic colored lights and sound), room-based location tracking and proximity aware integration with a tablet to support quick and ad hoc access to electronic patient information. Prior publications document the design and technical implementation of the HyPR device [4], the underlying technical infrastructure [6], as well as provide detailed insight into the collaborative use of this kind of hybrid technologies during collaborative clinical work [5]. This paper provide a summary of the design and the technical implementation of the HyPR technology.

Fig. 1. The Hybrid Patient Record (*HyPR*) device augments the paper patient record with color configuration and location tracking, while allowing clinicians to pair a tablet which shows the digital information associated with the paper record.

II. Design

As seen in Fig. 1, the HyPR consists of three parts: (i) the traditional paper medical record, (ii) a tablet or mobile phone that is used to access the electronic record and (iii) a mediating HyPR device. The HyPR device is a rectangular plastic plate with the same dimensions as the physical paper medical record to insure that it does not break the operational consistence of the paper documents. The HyPR device is attached to the bottom of the paper medical record as a permanent augmentation of the paper artefact to create a "*smart paper record*". The HyPR device provides three features: (i) *pairing* of the tablet and the paper record using proximity sensing; (ii) *light and sound* system that can be used to augment the record and/or to notify other clinicians; and (iii) an integrated *location tracking* unit that allows clinicians to locate the record.

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A. Pairing

Clinicians can pair their mobile unit, such as a tablet or smartphone, with the HyPR device by simply placing the tablet or phone on top of the paper record. The HyPR device will detect the mobile unit through Near Field Communication (NFC), and the underlying infrastructure will push the digital data that is associated with the paper medical record to the paired mobile unit. This mechanism allows clinicians to easily *align* paper and digital information while moving throughout the hospital. The central purpose of this simple alignment mechanism is to reduce the amount of *configuration work* [7] needed to interact, share and communicate patient information that is distributed across digital and paper documentation.

B. Sound and Light Augmentation

The HyPR device is equipped with an array of RGB colored LEDs and a loudspeaker. This physical notification systems can be used by clinicians to communicate workflow and patient status information, such as 'patient ready for ward round'. The colored lights can be used to, e.g., indicate and communicate an Early Warning Score (EWS) of the patient, visualize the associated or attending physician to the rest of the clinicians, or indicate if a new blood result test has arrived for that patient. The colored lights can also be set to blink in specific patterns in order to indicate a change or warning for that patient case. The sound mechanism can be leveraged to find the record in case it is not visible but, e.g., hidden under a pile of records or stuck in a cupboard. Sounds can also be used to trigger warnings or notify clinicians of new information. In general, both the sound and color can be utilized by clinicians to externalize workflow status information, and share information through direct physical computing using their paired mobile device or a remote large interactive display and desktop computer.

C. Location Tracking

The HyPR device is tracked by a room-based ultrasonic location tracking designed for the medical domain[1]. This allows clinicians to look up the exact location of the HyPR device and its associated paper record at all time. Using the application on their mobile devices, clinicians can immediately see in which room the paper record is situated, thereby dramatically reducing the amount of mobility work needed to find and use the record in a clinical setting [1]. The location tracking can also be leveraged to optimize, filter or customize the user interface on a paired tablet.

III. Technical Implementation

Fig. 2 shows the electronic architecture of the *HyPR* device. The HyPR device is built around an Arduino ATmega168 chip (16 MHz); a RFID module with an antenna (125 kHz); a Texas Wifi CC 3000 module with antenna; an array of three high power RGB LEDs; a 2kHz range buzzer; an integrated rechargeable battery pack with an USB connector; a power switch; and a 35–45 kHz ultrasound tag with a dedicated 3V lithium battery.

[1] http://www.sonitor.com/

The device utilizes the HyPR device infrastructure, which is an activity-aware patient management and information system designed to support multi-device location-aware collaborative workflows in patient wards [4]. The HyPR infrastructure is build on top of a generic distributed activity-centric infrastructure (detailed in [6]) that includes support for multi-device information management, context-awareness and ad hoc discovery and pairing of devices.

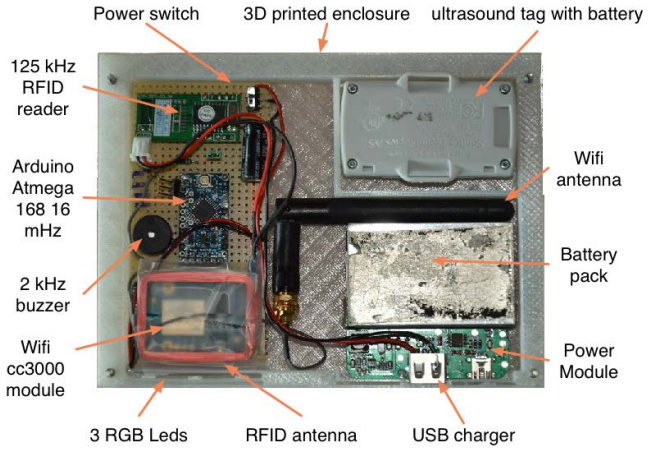

Fig. 2. The electronic architecture of the *HyPR* device [4].

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