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UNIVERSITÀ DEL PIEMONTE ORIENTALE

SUPPORTING DATA COMMUNICATION AND PATIENT ASSESSMENT DURING EMERGENCY TRANSPORTATION

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TECHNICAL REPORT

SUPPORTING DATA COMMUNICATION AND PATIENT ASSESSMENT DURING EMERGENCY TRANSPORTATION

SEPTEMBER 27, 2016

1 INTRODUCTION

In this technical report we describe how to configure a Client-Server architecture for using a set of mobile apps for **Technology-Enhanced Emergency Management (TEEM)**, designed for supporting data recording and transmission during patient transportation by ambulance. Our approach is organized as a client-server architecture, where different mobile apps, running on smartphones/tablets in the ambulance, act as clients (**Operator app** and **Device apps** described respectively in **Subsection 2.1** and **2.2**) and send monitoring data to a server (described in **Section 3: Server-Side**), residing at the hub center "Neonatal Intensive Care Unit" (NICU) of Alessandria Children Hospital, Italy.

2 CLIENT SIDE: THE MOBILE APPS

The client-side of our framework provides a set of mobile apps which enable the travelling personnel to input, transmit and record data during patient transportation by ambulance. This set of mobile apps allows to automatically send all the recorded data to a server at the destination center.

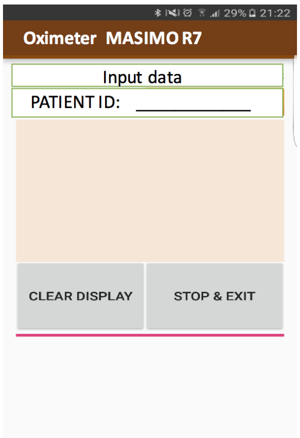
In particular, the device apps (see *subsection 2.1*) are a set of mobile apps, interfaced to the monitoring devices in the ambulance, that automatically send all the recorded data to a server at the destination center. The operator app (see *subsection 2.2*) allows to input additional data with respect to the ones being automatically sent by the device apps, or to substitute a device app in sending the information, if the device is not in use. The traveling personnel is also enabled to insert other significant patient data, or comments.

All the mobile apps have been developed and designed to runs on smartphone devices with at least mobile operating system Android 4.4 "KitKat".

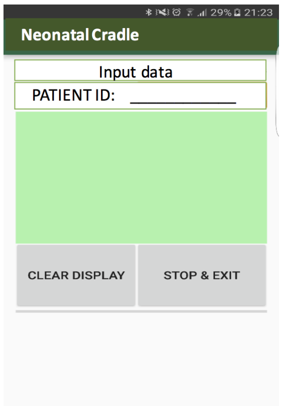
2.1 DEVICE APPS

Each device app (run on a smartphone or tablet) is directly connected to the device via cable RS-232-Mini USB. The only functionality of a device app is the one of reading the monitoring data produced by the device, and of sending them to the server. However, every device produces data in a different format, and requires transmission at a different baud rate.

Figure 1 shows the interface of two device apps towards the ambulance personnel. Both apps (Oximeter app shown in Figure 1a and Neonatal cradle app shown in Figure 1b) just allow the user to input the patient's identifier (**PATIENT ID**), and then to activate the connection towards the server side of the architecture. The display can be cleared on demand by pressing a dedicated button; another dedicated button allows the operator to stop the data transmission and to exit the app.



(a) Oximeter app interface



(b) Neonatal cradle app interface

Figure 1: Interface of device apps

The devices have a standard built-in RS-232 interface with no hardware or software flow control (handshaking). Serial port RS-232 has specification and settings illustrated in Figures 2 and 3 . These settings are factory-provided and cannot be adjusted by the user.

Type	RS-232, 9 pin Sub D (female)
Pins:	Pin 2: TxD Pin 3: RxD Pin 5: Gnd
Note:	Hardware Handshake is not supported

Figure 2: RS-232 Port Specification

Typ	RS-232
Baudrate	38400 Baud
Parity	none
Stopbits	1
Data bits	8
Handshake	no

Figure 3: RS-232 Port Configuration

2.2 Operator app

Figure 4 shows the login activity which allows the physician to log in and use the operator app during emergency patient transportation by ambulance.

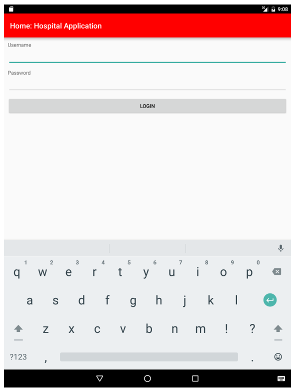
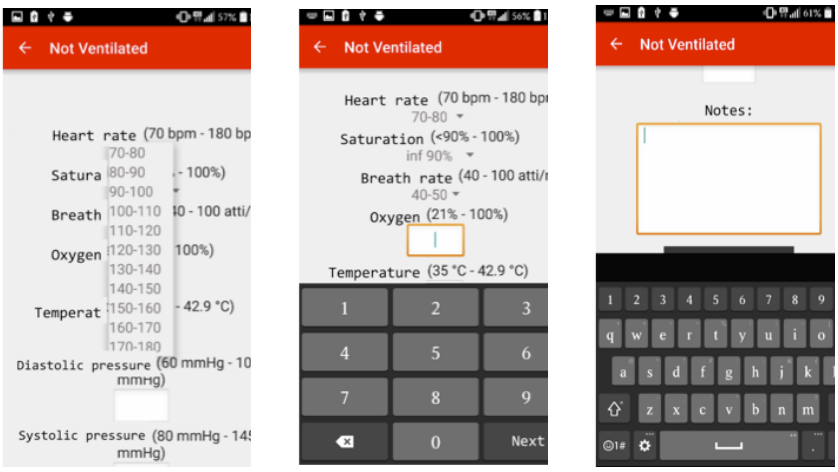


Figure 4: Snapshots of login activity

Figure 5 presents three different activities in the operator app that allow the user to input some data for a non-ventilated transportation. Figure 5a: heart rate is being inputted according to admissible ranges of correct values. Figure 5b: oxygen saturation is being inserted in the range (21%-100%) - if the number is outside the admissibility range, an error message will appear. Figure 5c: additional textual notes.



(a) (b) (c)

Figure 5: Snapshots of 3 activities in the operator app

3 SERVER-SIDE

The backend usually consists of three parts: a web server (provided by Apache HTTP or Microsoft Windows Server), a PHP module, and a database (provided by MySQL). The server component of the architecture receives the data sent by all the apps, and stores them in the database. In our current implementation, the server has the following properties:

- **Windows edition**: Windows Server 2012 R2 Datacenter

- **Processor**: Intel(R) Xeon(R) CPU E5-2690 0 @2.90GHz
- **Installed memory (RAM)**: 4.00 GB
- **System type**: 64bit Operating System, x64-based processor

Figure 6 shows the login form on a server-Side web-page residing at the hub center - Neonatal Intensive Care Unit (NICU) of Alessandria Children Hospital, Italy. The specialist physician, by using username and password, logs onto the server and receives the data in real time. Moreover the specialist physician is allowed to analyze real time data to send immediate feedback to the operators in the ambulance.

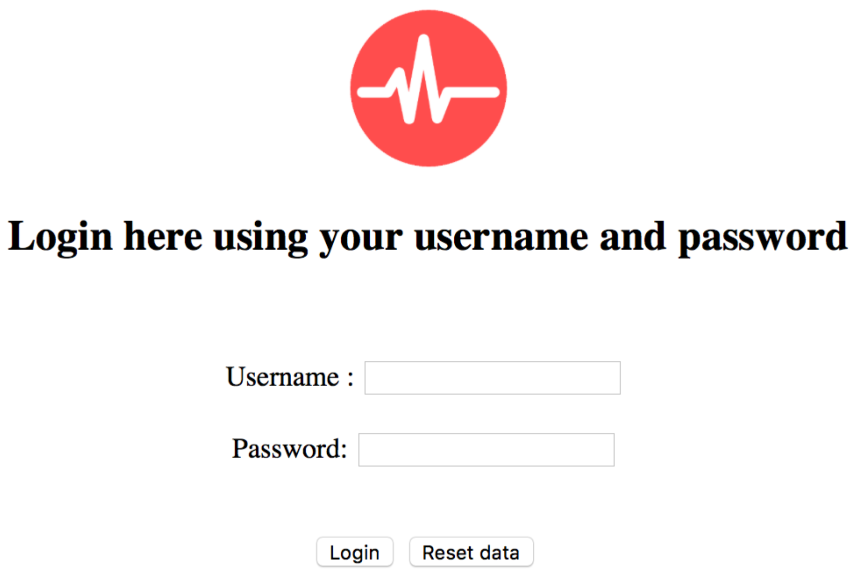


Figure 6: WebForm for user login

Figure 7 shows the set of server side tasks allowed to the specialist physician residing at the hub center. The system allows the specialist to search for patients by name, show real-time data and view the history of the recorded monitoring data during transportation by ambulance.

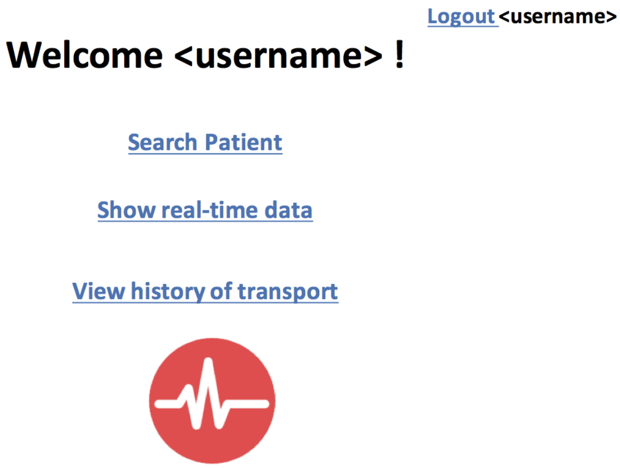


Figure 7: List of user-operations

Figure 8 presents different types of transportation: {*Pre-Transport*, *Not-Ventilated*, N-CPAP Ventialted, *BELEVEL Ventilated* and *IPPV* }.

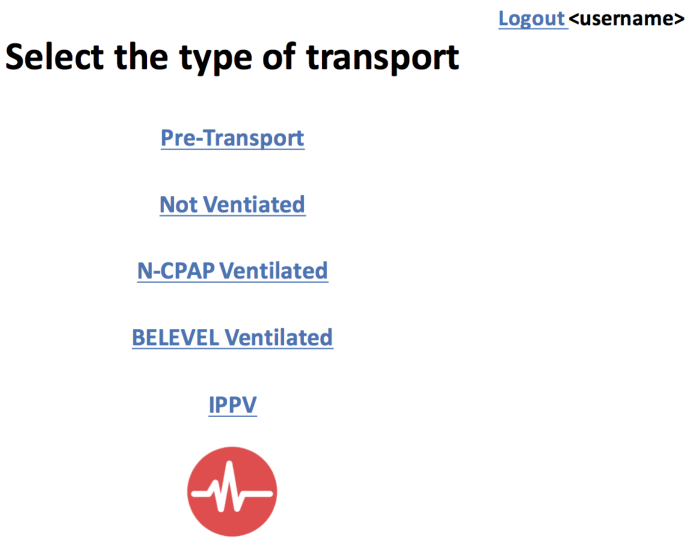


Figure 8: Type of transport

By selecting **Search Patient** (web-page shown in Figure 7), the specialist is allowed to choose different types of search, which are shown in Figure 9.

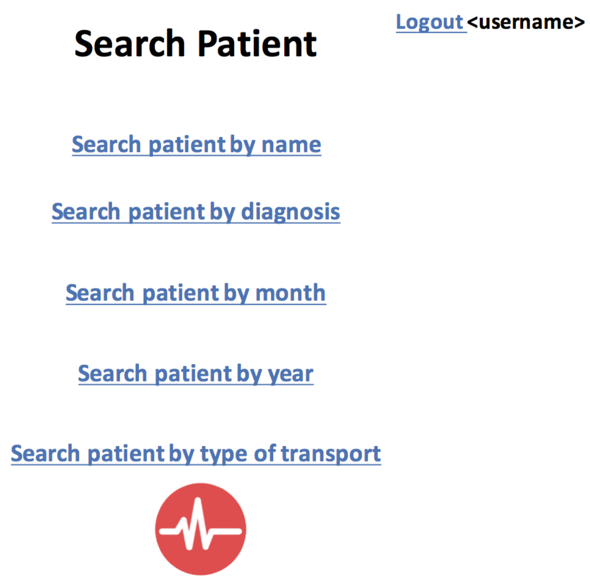


Figure 9: Different types of search

3.1 Installing Apache HTTP Server on Microsoft Windows

The Apache HTTP Server Project installed on our Microsoft Windows Server is release of version 2.4.23 of the Apache HTTP Server ("Apache" and "httpd") downloaded from

https://httpd.apache.org/download.cgi

3.2 Installing PHP on Microsoft Windows Server

The version of PHP running on Apache HTTP Windows Server is *Current Stable PHP 7.0.11* downloaded from

https://secure.php.net/get/php-7.0.11.tar.bz2/from/a/mirror

Server-side users can authenticate by entering their credentials (username and password) using the following link

https://<IP-Server-address>/TEEM/Login.php

3.3 Installing MySQL Server on Microsoft Windows

The recommended method to install MySQL Community Server 5.7.15 on Microsoft Windows (x86, 32/64-bit) is to download MySQL Installer from

http://dev.mysql.com/downloads/installer/

and configure all of the MySQL products on your operating system.

4 CONTACTS

Should you have any questions about Technology-Enhanced Emergency Management (TEEM) do not hesitate to contact us. For general questions you can contact Prof. Stefania Montani (stefania.montani@uniupo.it), Prof. Massimo Canonico (massimo.canonico@uniupo.it) or Dr. Manuel Striani (manuel.striani@unito.it).