**ABSTRACT**

The development of graphical user interfaces (GUIs) has been an emergent demand in the area of healthcare technologies. Specifically for respiratory healthcare there is a lack of tools to produce a complete multimedia database, where respiratory sounds and other clinical data are available in a single repository. This is essential for a complete patients' assessment and management in research/clinical settings. Therefore, this study aimed to develop a usable interface to collect and organise respiratory-related data in a single multimedia database. A GUI, named LungSounds@UA, composed by a multilayer of windows, was developed. The usability of the user-centred interface was assessed in a pilot study and in an evaluation session. The users testified the utility of the application and its great potential for research/clinical settings. However, some drawbacks were identified, such as a certain difficulty to intuitively navigate in the great amount of the available information, which will inform future developments.

**Keywords:** Graphical User Interface (GUI), Multimedia Database, Respiratory Parameters, Respiratory Sounds

**INTRODUCTION**

The prevalence of respiratory diseases increased to the point where they have become the fourth most common cause of death worldwide (Health Statistics and Informatics Department, 2011; World Health Organization, 2008). Therefore, in the last decade, significant research efforts have been dedicated to improve diagnosis, monitoring and treatment of respiratory diseases (Dinis, Campos, Rodrigues, & Marques, 2012). The diagnosis and monitoring of these common...
diseases is facilitated by pulmonary auscultation (Murphy, 2008; Sovijärvi, Vanderschoot, & Earis, 2000), which has suffered substantial developments since the stethoscope invention by Laennec, being the computerized techniques the current trend to detect and characterize breath sounds (Marques, Bruton, & Barney, 2006).

Nevertheless, pulmonary auscultation findings must be interpreted with caution, given its subjectivity and put into context with other clinical findings (Welsby & Earis, 2001). To ensure the easy access to all relevant respiratory data, avoiding the dispersion and loss of respiratory clinical information (Koppel et al., 2005), there is a need to develop a single application which merge data in a single multimedia database. Gross et al. (2003) performed a first attempt to combine in a single database respiratory-related data (Gross, Hadjileontiadis, Penzel, Koehler, & Vogelmeier, 2003) however, no detailed information about the interface was given. Furthermore, not all the relevant respiratory-related data needed to perform a complete respiratory patient’s assessment and management, was addressed.

In respiratory health care it is crucial to have the auscultation findings along with relevant clinical parameters (namely: vital signs, spirometry, six minute walk test, pain evaluation, imaging report, clinical analyses, chest examination and other signs and symptoms) in a single repository to facilitate patient’s diagnosis, monitoring and treatment (Donner, Ambrosino, & Goldstein, 2005). The growing need to develop effective and user friendly graphical user interfaces (GUIs), which comprises all necessary respiratory data, has been a great challenge in the development of computer-based health care environments (Patel & Kushniruk, 1998). Therefore, the aim of this study was to develop an adaptive and usable interface to collect and organise respiratory data in a single multimedia database. This valuable repository allows to correlate findings from the pulmonary auscultation with other respiratory parameters or/and other relevant information, facilitating the clinical decision making.

**METHODOLOGY**

The GUI named LungSounds@UA was developed in the scope of a pilot study within the project “Adventitious lung sounds as indicators of severity and recovery of lung pathology and sputum location” (PTDC/SAU-BEB/101943/2008). The interface was informed by the literature and the need felt during the course of the project to collect and merge all relevant respiratory data in a single multimedia database. The application was developed in Matlab® (Mathworks, 2009) because of its rapid prototyping characteristics and to simplify the integration of implemented automatic detection algorithms, e.g., Dinis et al. (2012) and Oliveira et al. (2013).

This study followed the system development life cycle (SDLC), which is characterised by: i) planning, ii) analysis, iii) design, iv) implementation, and v) maintenance/support (Kushniruk, 2002); as well as the prototyping and iterative usability testing (Kushniruk & Patel, 2004).

The assessment of the developed application was performed in two ways: i) within a pilot study, conducted by two respiratory researchers in fifty-seven physiotherapy sessions of six patients with lower respiratory tract infection; and ii) in an evaluation session performed by four health professionals.

**DESIGN PRINCIPLES**

The focus of an user-centred interface is to provide maximum usability, however, determining the usability consequences of the implemented design decisions is challenging (Dix, Finlay, Abowd, & Beale, 2004). To overcome this difficulty, and consequently increase the usability of the LungSounds@UA interface, the general
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