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Technology applied to geriatric medicine

Design for personalized mobile health applications for enhanced older people participation

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ABSTRACT

Background: Today's digital society opens opportunities for the development of mobile health applications to support the medical care.
Methods and results: As a design example, an Android app is written for the Android ecosystem (Google, Mountain View, CA) using Android Studio as the integrated development environment and allows in this way for widespread implementation on personal devices of different sizes (smartphone, tablet). The resulting app is able to record the medication intake, log physiological parameters and perform cognitive assessment. In an additional step, the app is personalized by incorporating personal data (pictures of friends, family, hobbies…) in the assessment tests for cognitive functions. As this data becomes more and more available from social media, it can be easily integrated in these types of apps.
Conclusion: Due to this personalization, the older people participation is expected to enhance, a crucial aspect needed for the future widespread deployment of these systems.

1. Introduction

Mobile health (m-health) applications and their implementation on personal devices have an enormous potential in the future medical care of different kinds. The main reason for this evolution is the high accessibility of these devices and the widespread knowledge and developer experience exchange resulting in reliable and performing platforms and applications, supported by different technology leading companies. From a care point of view, these applications and devices also have the potential in improving the care by bridging the gap between personal care and external care. While personal care in a trusted environment (i.e. home setting) under relaxed conditions mainly results in subjective and non-controlled (quantitative) data, external care results in objective and controlled quantitative data however influenced by the stress enhanced conditions of the unfamiliar setting. Despite these attractive perspectives, deployment of these systems is hindered in different ways. In case of older people this is mainly due to their low ICT literacy and adoption [1,2].

The main objective of this work is the design of an m-health application with a clear personalization for the user. In this way, possibilities in the adaptation of a general m-health app to a personalized use are explored and an implementation in case of a specific user case (cognitive impairment) is realised. As the focus is on the design and the technical aspects of the application, the medical validation of the application with its different functionalities is out of the scope of the present study.

The remainder of this article is structured in the following way: the next section describes the methodology of the m-health application design. In the following section, the resulting app is described, including the different functionalities, as realised for the special user case of cognitive impairment. Thereafter, a discussion of the behaviour of the app is presented. Finally, the main conclusions are extracted.

2. Methodology

Mobile health applications deliver health services and information on mobile communication devices of different kinds. In this way their communication possibilities allow for server connected services like the updating of different medical records. Apart from this server side functionality, client side functionalities like self-monitoring and retrieval of medical information (terminal like access to specific medical databases) can be realised [3].

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A very prominent class of apps are games, which have an enormous popularity due to their attractive and personal designs. Following this resulting tendency of gamification [4], tests to assess the cognitive state of older people were incorporated in a personalized app. Apart from this personalization, the present app realises general e-health functionalities of collecting medical data and actions of the user.

2.1. Functionalities

As an exemplary design the following functionalities have been implemented in the current app.

2.1.1. Medication intake

Concerning the medication scheme, a list of medication with medication name, description and periodicity of intake is provided and can be adapted to a changing medication pattern. In order to support the correct intake, an intake alarming function can be activated to provide an acoustic signal to stimulate the intake action. Since an intake is to be confirmed on the personal device, the intake history is provided. In this way, the medication adherence is available and can be controlled.

2.1.2. Physiological parameter logging

As a typical physiological parameter the user's body weight can be stored at different times and a graphical overview of the weight evolution is provided. This logging can easily be extended to other parameters like blood pressure, heart rate and body temperature.

2.1.3. Cognitive assessment

In order to follow the cognitive state of the user, two game-like tests were implemented: a clock drawing test and a recognition test. In a clock drawing test the user is asked in a first stage to draw a clock (circle) and in a second stage to indicate a given time by drawing the small and large clock arrows. In the recognition test, the user is asked to recognize the content of different pictures, which are shown for a given time. The app is able to score both tests and the test results are recorded in the database for later review. The test history can be overviewed in order to follow the cognitive state of the user. The implemented tests are commonly used within the assessment of cognitive function [5,6].

2.2. Implementation

The resulting app is written for the Android ecosystem (Google, Mountain View, CA) [7] using Android Studio as the integrated development environment and allows in this way for widespread implementation on personal devices of different sizes (smartphone, tablet). The implementation is designed to support Android versions 4.0 or higher, which results in supporting about 94% of the nowadays Android devices sold worldwide [8]. For an m-health application the choice of the ecosystem is crucial since development guidelines are intended to guarantee compatibility with future ecosystem versions. The application code consists mainly in a database containing the different data and program settings and different graphical user interfaces targeted for the convenient interaction with the user.

2.2.1. Database

Due to the restricted device resources a compact database is needed for the storage and retrieval of the patient data and the program settings. This is supported in the Android ecosystem [7]. The current relational database consists of different tables keeping the records of the users, user data and test information. A basic schematic of the relations between the tables is given in Fig. 1. The table 'users' (for the user information) is coupled to the table 'medication' (for the medication data and intake history) and to the table 'weight' (for the logging of the body weight as a typical physiological parameter). The other tables are used for the clock drawing test ('clockgame') and the recognition test ('recgame', 'recpicture', 'pictures' and 'categories'), incorporating the game data and the result histories of the two games.

2.2.2. Graphical user interface

Using the Google guidelines [9], the user interface is a typical Android user interface, and will be adopted easily by new Android users. The general layout is of a navigation drawer type in which the different application parts are listed. It follows the Material Design style, which is introduced in Android 5.0 (Lollipop). Due to the compatibility layer in the Android ecosystem, this object is also supported in older Android versions [7]. In order to plot a graph of the evolution of the body weight the graph utility from an external open source library GraphView [10] is used. Since this library supports date and calendar objects, a graph from these data in the database can easily be displayed.

3. Results

The realised application starts with a first user interface, intended to identify the user and to propose the different application functionalities.

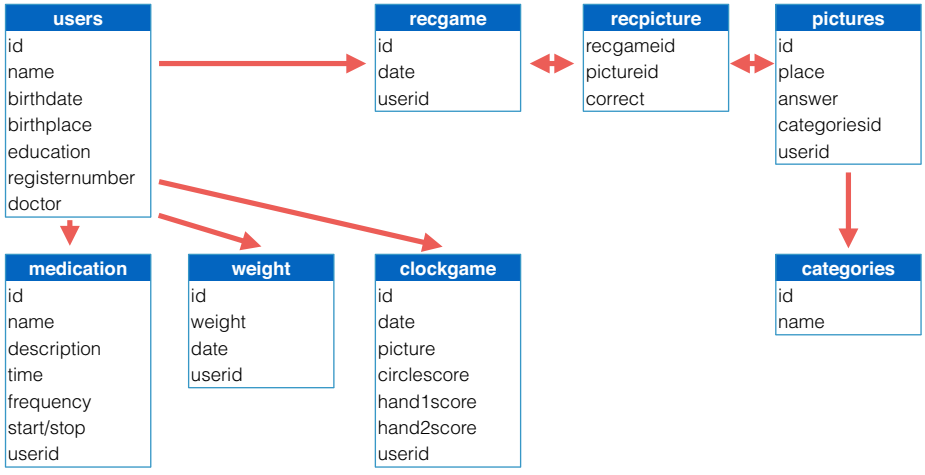

Fig. 1. Database structure.