Serious Game Scores as Health Condition Indicator for Cancer Patients

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Abstract. In this paper we present INTERACT (Integrating Entertainment and Reaction Assessment into Child Cancer Therapy), a multidisciplinary research project aiming at creating a communication tool for pediatric patients after cancer treatment with HSCT (hematopoietic stem cell transplantation) in after care. The communication platform should foster communication between patients and clinicians, but also increase motivation for treatment compliance by using appropriate designs and gamification elements. A state of the art web interface enables the physicians to evaluate data submitted by the patients, joining data from various sources (lab data, survey data, physiotherapy performance) using HL7 and visualizing important changes. This contribution outlines the challenges of designing such a system and presents a solution for the medical data interface and evaluation.

Keywords: data standards; serious games for health; children

Introduction

Related Work and Literature Background

Health related computer games have been intensively researched in the near past, covering all kinds of desired positive aspects including education for coping with health problems, keeping up motivation when going through difficult times, strengthening treatment compliance, up to supporting therapy through physical exercises [1]. An important subgroup in this field are children and adolescents with any form of cancer, and since 2008 more and more game and multimedia projects for this particular group have been developed. Re-Mission and its successor Re-Mission 2\textsuperscript{2} are computer games specifically tailored to be played by children during and after cancer therapy. In a large randomized study the positive effect of playing Re-Mission on motivation and compliance of pediatric patients has been proven [2]. The game

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principle is based on fighting cancer cells inside an affected body, using abstracted weapons like chemotherapy, antibiotics and the body’s natural defenses. The game’s purpose is to strengthen positive emotion, increase self-efficacy, and shift attitudes toward chemotherapy. Combat [3] is a game similar to Re-Mission, where children can fight against the cancer cells in their bodies. Here empowerment is reached via identification with a fighting hero. In [4] the authors present the game Patient Empowerment (PE) Interactive exercise video game, designed to stimulate the self-efficacy of pediatric patients with cancer. The game tries to transform physical exercises into mental empowerment through metaphors involving cancer, hospital personnel etc.

Project Description: INTERACCT

In the multidisciplinary project (INTERACCT) a serious game system is developed, which should act as a communication tool between young and adolescent patients and their physicians. The patients suffered a cancerous disease and were treated with hematopoietic stem cell transplantation (HSCT). The aftercare of this therapy involves preparing the patients for their life after the transplantation and in this process the patients have to give feedback regarding their vital parameters to their physicians. Further, the patients should receive therapy measures from their physicians. The average duration of aftercare is between 12 and 24 months.

INTERACCT collects data from various sources (patient questionnaire, patient gaming behaviour, laboratory results), therefore a solution to merge this data and visualize it for the medical experts is required. In order to satisfy data standard issues, the patient questionnaire is highly oriented at LOINC [5], and the whole data model is designed to be compliant to the HL7v2/CDA standard [6] according to the Austrian CDA implementation guidelines [7]. The inclusion of laboratory data is performed using HL7v2 coded files, the framework supports extensions to include any relevant HL7v2 data. Where applicable, data entries have an appropriate LOINC code. During data entry definition, a LOINC lookup feature can be used withing the web application.

One issue of this paper regarding medical data is to show that up-to-date standards were used for the whole system, considering the possibility of extending the system through more external data sources and also project portability. Another interest on medical data is the question whether it is possible to demonstrate a change in a patient’s health status by keeping track of his/her gaming activity. To meet the requirements and expectations of the users, this gaming-activity requires to be carefully designed, and a survey questioning gamers of the target audience was conducted.
1. Methods

INTERACCT is developed by a multidisciplinary team consisting of medical experts, artists, software developers, game engineers and psychologists. Therefore the various methods are used, depending on the respective topic.

1.1. Software Engineering - User Centered Design

User-centered design (UCD) is a methodology used by developers and designers to ensure they’re creating products that meet users’ needs [8].

Combined with UCD, various expert talks and structural process analysis were conducted, to correctly understand the process of HSCT after-care, and therefore produce appropriate solutions.

1.2. Game Design - Explorative Design, Participatory Design Experiments

Explorative design is a term coined in recent years to describe an approach where design practices are utilized to facilitate research. The concept goes back to the John Deweys “Theory of Inquiry” [9], where he introduces the concept of “doing for the sake of knowing”. Donald Schon built on the work of Dewey, when he observed that much of the knowledge needed and used in the design process is not known a priori, but acquired during the design process as a result of interacting with the object to be designed [10]. This process, commonly referred to as ”analysis through synthesis”, is at the core of explorative design.

2. Results & Discussion

2.1. System Description

The system consists of two major components: the data entry system for the patients and the data evaluation system for the medical experts.

2.1.1. Patient Data Entry System

The data entry system for the patients is currently under development in Unity 3D [11]. The core functionality of the patient system will be embedded into an ”Island Game” with focus on collectible pets and procedural, adventurous content. On a daily basis the patients should enter a certain set of data through a simple input mask. This data set depends on the current treatment, assigned manually by the medical experts. Further, the patients will be encouraged to play specific mini-games within the game world. These mini-games follow a medical purpose, such as encourage fluid intake, improve the patients’ fitness level or train their ability to stay focused. The framework is designed to support late-on implementation of further mini-games, even after the initial deployment of the whole system.

2.1.2. Medical Data Evaluation System

The data evaluation system for the medical experts is under development as an ASP.NET / C# application. Therefore only an up-to-date browser is required to access
the system. Within the data evaluation system the medical experts are enabled to view all data entered by the patients, collected through the game-framework and external data, such as laboratory results, which is integrated through a HL7-based data interface. The joining and displaying of this variable data is developed from a strict user centered approach. The framework for various data items is designed to be flexible and scalable, so addition of treatment-relevant parameters can be added during runtime.

2.2. Solution Considerations

The solution will highly improve the efficiency of the medical team working with patients at home, facilitating therapy and daily life of these patients, since fewer hospital visits will be required. Working within a playful environment, the solution should find high acceptance in our target audience.

The audience is highly heterogeneous regarding various factors: age (about 8-18 years), gender, gaming habits and cultural & educational background. This means a high effort in our game design phase, which required us to conduct a widespread analysis of the preferences of (healthy) children. Regarding the untruthful entry of vital parameters our medical experts stated, that the compliance and honesty of the patients is usually very high. Further, most of the patients have parents at home, which supervise the treatment.

2.3. Prototype Development

2.3.1. Data Entry & Game Prototype

A Unity 3D [11] application was developed, which was tested on Windows 8.1 and Android 4.4.3. Data connectivity was tested and implemented through a JSON interface, running on a Windows 2012 Server instance.

The data entry is realized through clickable icons, which means high usability when entering data through a touch-screen device such as smartphone or tablet. A personal pet ("Avatar") walking on an island, which is generated through a random-algorithm, therefore the user should never visit the same island twice, which should encourage him to discover a new island every day. The Avatars are customizable in their appearance through colors and in-game items.

2.4. Medical Data Integration

2.4.1. LOINC

The data model and application is developed to be able to retrieve and parse information of LOINC codes. Therefore, if a vital parameter is listed in LOINC, a full integration of its properties will be provided. This includes used scales (0-5, 0-10, metric, etc.), units and full text description.

2.4.2. HL7v2

Since the integration of external laboratory data is mandatory, the data model is capable of handling HL7v2 messages. Through the use of nHapi [12] and an ASP.NET application, the HL7 message of the laboratory system of our project partner is parsed and injected into the INTERACCT database.
2.5. Future Work & Outlook

The next project steps are actual definitions of treatment profiles (sets of vital parameters, according to the medical condition) and implementation & testing of these profiles.

Further, game design experiments to evaluate expectations of children with cancer are planned. Based on these results, game prototypes will be designed and tested. Within these tests, the correlation of specific game scores, manually submitted user data and actual patient vital parameters will be compared. We anticipate a positive response by our target audience, since the current solution is rather outdated (manually written handbooks), and playing a video game is more likely to evoke positive feelings.

3. Conclusions

We have shown a profound concept of how a data entry system for young cancer patients could look like. The strong focus on design of the user interface is required, as the target population is very heterogeneous regarding disease, age, gender and educational level of the patients. Further verification of our hypotheses will be achieved through experiments in the target audience.

Regarding the use of game scores as indicator for health parameters, further prototype development is required. Once playable prototypes exist, this hypothesis will be tested in experiments in both healthy children and children with chronic diseases. Further, the linking between game scores and standardized medical data (LOINC/HL7) will be done during these experiments.

References