

Design of a Framework to Promote Physical Activity for the Elderly

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Abstract. Physical inactivity is estimated to be one of the leading risk factors for global mortality and it is associated with several illnesses, such as type 2 diabetes, cardiovascular diseases and various types of cancers. To tackle this issue and promote physical activity amongst the elderly, a system that computes automatically, in real-time, the score of a Boccia game was developed. The objective of this paper is to infer the best design possible for the User Interface (UI) that displays this information. To achieve this, two surveys were conducted involving 45 participants. In the first survey, the participants were asked what features they would like to see in the UI. Based on these remarks, the authors designed an UI, along with several variations. The preferences between these variations were afterwards evaluated in the second survey. Thus, the final design of the UI was validated before being shown to the elders.

Keywords: Human Factors · Boccia · Interface Design · Physical Inactivity

1 Introduction

The overall level of physical activity declines with age [1], consequently making older adults one of the most sedentary age groups. According to Matthews et al. [2], adults aged more than 60 years have been identified to be the most physically inactive group in the United States. Physical inactivity is the fourth leading risk factor for global mortality [3] and it is associated with an increased risk of various diseases and disorders, such as type 2 diabetes, coronary heart disease, hypertension, obesity and different types of cancer [4].

Taking into account the aforementioned risks, it is paramount to develop a strategy for promoting physical activity in the elderly, which can have a panoply of benefits at an advanced age, such as prevention of functional loss [5], blood pressure control [6] and reducing depression symptoms [7] and mortality rate [8]. The approach taken by the authors of this paper was the development of a system based on a computer vision algorithm that automatically computes the real-time score of a Boccia match and displays it in a User Interface (UI) [9,10]. The purpose of this system is to make the overall Boccia game experience more enjoyable for the player and to encourage him/her to play more often, thus promoting physical activity practice.

The present paper focuses on the design of the UI that displays the score of the game. Before showing the UI to the elders, two surveys were conducted to infer the general public's opinions and preferences and validate the overall design. These surveys included questions regarding the usefulness of the proposed system, understanding of the UI's content by the user and preferences between different pairs of UIs, varying in text font size, colour and organization of graphic elements.

2 Background

Design, in many instances, holds the key for an efficient interaction between man and technology. Bearing this in mind, it is crucial to certify that the design of any UI is satisfiable for the user and that its content is intuitive and comprehensible. Due to the current increase of the elderly population, emphasis should be given to the design directed for this age group, taking into account impairments that are characteristic of late age. However, considering the system proposed by this paper, special attention should be given to impairments related with vision.

There are several suggestions and guidelines regarding designing for older adults. Most of the suggestions found in literature related to vision comprise text characteristics, such as font size, type and contrast with the background [11]. However other features, such as the colour of the graphic elements, should also be taken into account. For instance, Lee and Park [12] studied how the colour environment of a display can influence its usability on older adults. The survey conducted concluded that larger font size, brightness contrast between the text and the background, along with clear, dynamic, high-chromatic colour combinations were preferred by the seniors.

Regarding digital games, there has also been a growing acceptance by the elderly [13]. For example, Gerling et al. [14] developed a game that allowed older adults to go on virtual walks through a park while competing in small mini-games, using Nintendo's Wii Remote and the Balance Board for control. This acceptance further encourages the development of innovative solutions, such as the system proposed by the authors of this paper.

2.1 The Boccia Game

Boccia is a simple precision ball game which was selected by the authors due to its easy adaptability to individuals with different types of motor skills impairments. This game is often played in the nursing home where the system proposed by the authors is intended to be tested. However, in this case, the rules were altered in order to be understandable to some of the residents that have cognitive limitations.

According to the caretakers from the nursing home, the players are divided into two teams, the red team and the blue team. Both teams are composed by three players, who are given two balls each, of the respective team colour. The game itself is divided into three segments called "ends". In each end, the players take turns at throwing their balls in order to hit a white ball, called *jack*, which is placed in the centre of the court before the game is started. Every time a player hits the *jack*, he/she earns one point for his/her team. When all three ends finish, the points earned by each team in each end are summed and the team with the higher total of points is declared the win-

ner. In the eventuality of both teams finishing with an equal amount of points, the team that placed the ball closer to the jack during the final end is the winner.

3 Methods

The study to validate the design of the UI was based on two surveys. The participants included caretakers from a nursing home and day care centre for the elderly in S. Torcato, Guimarães, in Portugal, along with students from the University of Minho. Both surveys were filled by the same participants. Of the 45 participants, 75% were males and 25% female and the average age was 26, ranging from 20 to 58 years. All participants were informed about the objectives of the surveys and their identity was kept anonymous. Moreover, none of the participants was familiar to the UI, thus all answers were unbiased.

The first survey questionnaire consisted in a series of statements regarding two main areas: general motivation towards implementing a system that displays the score of a Boccia game, and which are considered the most important visual components to be included in the user interface. For each of these statements, participants indicated how much they agreed by using a Likert scale scale that ranged from “very irrelevant” (score of 1) to “extremely relevant” (score of 5). On the other hand, the second survey was conducted with the objective of assessing the system’s usability and user’s satisfaction towards it, based on a UI designed considering the answers to the first survey. Furthermore, the participants were asked to choose between three pairs of different versions of UI, considering different text font sizes, darker or brighter colours and graphic elements organization (elements displayed horizontally or vertically).

4 Results

Regarding data analysis, an alpha level of 0.05 was set for the computer analysis (SPSS, version 24) of statistical significance of the results. Besides, the data was found to be approximately normally distributed.

Regarding the results from the first survey, in Table 1, means, standard deviations and t-test statistics on the attitude towards preferred visual elements are represented for both caretakers and students’ groups.

Table 1. Means, standard deviation and t-test statistics on the attitude preferred visual elements

Items	Caregivers		Students		Independent Sample t-test statistic Sig.
	M	SD	M	SD	
Current Score	4.00	0.58	3.93	0.13	0.89
Individual Score	4.00	0.58	3.4	0.17	0.36
Total Team Score	4.33	0.67	4.00	0.13	0.51
Team Score from each end	4.00	0.58	3.43	1.33	0.28

Rules Description	3.00	0.58	2.67	0.20	0.67
Number of the end being played	2.67	0.33	3.62	0.17	0.14
Indication of the current player	4.00	0.58	3.76	0.15	0.67
Game Duration	2.33	0.33	3.45	0.16	0.08
Court field view	3.67	0.33	3.45	0.19	0.61
Recommendation of the amount of force to be used in the throwing and its orientation	3.67	0.88	3.31	0.188	0.63
Date & Time	2.67	0.33	2.60	0.18	0.91

Agreement was very high for general motivation towards implementing a system that displays the score of a Boccia game (agreement of 3.93) and that it would motivate the elderly to participate more often (agreement of 3.67). Furthermore, the participants considered the most important elements to be the ones displaying information about the Boccia Game score followed closely by visual aid when throwing the ball. On the other hand, the least important elements were considered to be the “Date & Time”, “Game Duration” and “End number being played”. Besides, no significant differences were found between the caretakers and students’ answers.

Based on the aforementioned remarks, an UI was designed with focus on information about the scores. This UI is depicted on Figure 1.



Fig. 1. UI designed based on the information extracted from the first survey.

Information regarding the red and blue team are depicted on the right and left side of the UI, respectively. At the top, from each side, it is possible to observe the current score of the end being played. In the tables below, one can see the points obtained at the final of each of the three ends. Finally, it is represented, at the bottom, the total points of each of the team.

The results from the second survey are represented in Table 2, where means, standard deviations and t-test statistics on the user’s satisfaction towards the developed UI are represented for both caretakers and students’ groups.

Regarding the participants choices between three pairs of different versions of the UI depicted in Figure 1, it was inferred that the majority preferred an UI with larger text font size (77.1%), darker colours (67,4%) and the organization of graphic elements displayed vertically as illustrated in Figure 1 (89,1%). Once again, no significant differences were found between the caretakers and students’ answers.

Table 2. Means, standard deviation and t-test statistics regarding preferred visual elements

Items	Caregivers		Students		Independent Sample t-test statistic Sig.
	M	SD	M	SD	
It is preferable to use a different way to display the information	3.00	1.00	2.76	0.14	0.69
The information presented in the graphical interface is useful	4.00	0.33	4.02	0.11	0.95
The presented tool is satisfactory	3.00	1.00	3.81	0.12	0.12
The information is displayed in a clear and understandable way	3.00	0.58	3.81	0.16	0.20
I did understand the information related with the team score	4.00	0.33	4.12	0.13	0.81
I did understand the information related with the team during the three ends	4.00	0.33	4.12	0.12	0.80
I did understand the information related with the total team score.	4.00	0.33	4.10	0.12	0.82

5 Final Remarks

This paper focused on the design of a UI to display the score of a Boccia match in real time. A study based on two surveys was performed in order to evaluate what users wished to see in such a UI and to evaluate the user satisfaction towards an UI design based on the latter. The output from both surveys helped designing and validating an UI to be tested during a Boccia game played by the elderly. Overall, the participants preferred an UI focused on just displaying information about the Boccia Game, with large text font size, darker colours and graphical elements displayed vertically as depicted in Figure 1. According to data from the second survey, the participants also showed to be relatively satisfied with the preliminary version (Figure 1) and properly understood its content.

The majority of the participants were of relatively young age, which may not be representative of the opinion from different age groups. However, it was important to have a way of validating the UI before showing it to the elders.

Regarding future work, this system will be integrated within the iBoccia framework [17], which features the use of various sensors for monitoring elderly physical activity and display the extracted data to the caregiver. It is planned to test the whole system during a Boccia match at the nursing home and evaluate the level of satisfaction from elders.

Regarding further development of the UI, based on the results from the first survey, it is also planned to display visual aid when throwing the ball, regarding the orientation and force that should be applied by the player. An indication of the current player's turn will also be implemented by displaying the player's photo on the screen. These additions are predicted to further motivate the elderly to engage in the game and, therefore, practice physical activity more regularly.

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