

# Analysis and Classification of Serious Games for Elderly

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## Abstract

Serious games aim at providing benefits beyond pure entertainment and are a growing area of research. Furthermore, not only the number of serious games increases but also the range of application areas. Today, serious games address physical cognitive social and psychological needs for a different target audience with multiple devices. Serious games are often classified by benefits or purpose within a specific application area, but classifications focused on different user- and game-specific aspects are still rare. In this paper we provide an overview on a selection of serious games for elderly people by extracting and summarizing common categories used to classify games on a general level and especially serious games. Furthermore, a collection of serious games for elderly based on literature research as well as a classification using the summarized categories is presented. By those means, serious games for elderly shall be structured and not sufficiently covered approaches of providing benefits be identified.

## 1 Introduction and Motivation

Digital games are often more than just a leisure activity. A serious game is a specific type of game whose primary purpose goes beyond pure entertainment by teaching knowledge or training skills (Klauser et al., 2011). For this reason, serious games are increasingly drawn into the focus of scientific research, providing potential benefits in physical (Göbel et al. 2011), cognitive (Derboven et al., 2011), social (Derboven, 2010; Abeelee et al., 2010), and psychological (Harley et al., 2010) conditions of different people.

Elderly people are a main target group for serious games, since their needs of assistance grow due to age specific phenomena (Chou et al., 2010). With increasing age physical and social abilities of elderly people often decline, leading to special social and psychological requirements (Holt-Lunstad et al., 2010). Serious games can address these requirements by different means of providing benefits for the elderly, ranging from digital support for the social connection of generations (Derboven et al., 2011) to physiological issues such as physical exercise or rehabilitation (Burke et al., 2009; Brox et al., 2010).

Due to the increasing number and relevance of serious games, classifications are needed to maintain an overview of past and currently available games, their technological and methodical background as well as existing gaps that may be filled.

There have been some attempts of classifying serious games according to e.g. aspects of health (Brox et al., 2010; Bronikowska et al., 2011). Ratan et al. (2009) published a classification for Serious Games in 2009 but reviewed only games till 2007. For this reason, their classification misses important developments and current inventions of intuitive, physical interfaces like Microsoft's Kinect and Nintendo's Wii Remote. However, approaches to apply the vast body of knowledge from general game-research have so far been limited, although serious games often aim to be appreciated as a "game". Consequently, serious games should not only be analyzed and classified in relation to their specific field, but also by wider classifications from games research. Such classification should ideally allow for a more systematic overview and make existing gaps such as non-addressed genres more visible to both the research community as well as developers from the games industry.

To address this need, this paper sets out to provide a classification of serious games for elderly people based on common classifications to transfer game related knowledge into the knowledge of serious games in the context of AAL. To achieve this, we will first identify and present proper game classifications from game-related research, including general game classifications, serious game classifications, and specific classifications for games for the elderly. In a second step, we will present the results of a literature review we conducted to identify a subset of serious games for elderly people created in the past years. Finally, the list of identified games will be classified according to the discussed categories of games.

## 2 Common Game Classifications

Due to the huge amount of available products and services it is a common approach to classify games into different categories. Within the area of games research, typical classifications include a separation by target group characteristics, or content characteristics. Furthermore, games can be divided by technical aspects (e.g. graphics, input devices or platform) as well as business models (e.g. boxed games, micro transactions, free-to-play, or subscriptions).

In the context of classifications of serious games for the elderly some of the categories like business models may not be as useful as some serious games with a scientific background are not commercially exploited. Therefore, this paper focuses on the common classifications by genre, user group, and technical aspects to present possible classifications for this specific area. In the following chapter an overview of classifications, which are selected from both literature and practice, including genre, audience, platform, input method, and single- vs. multi-user modes will be presented.

## 2.1 Genre definitions

The most common classification for media in general – including games – is by genre. Game magazines and game databases use genres to assort games into different categories. The classification of games into genres has evolved over the past years and became an accepted practice (Ye, 2004). In addition to traditional media-related genre definitions like *action* or *family* genres, multiple genre types have been generated to describe games (Ye, 2004; Pinelle et al., 2008). The classification in this paper is aligned to widely accepted genre definitions and combined in a single definition for each genre. The resulting definitions are mainly based on a synthesis of the genres used by the USK (Unterhaltungssoftware Selbstkontrolle), the PEGI (Pan European Game Information), and the well-known gaming website GameSpot. All included genre descriptions were structured into the ten genres adventure, arcade, puzzle & classic, platformer / action adventure, management, role-playing games, shooter, simulation, sports & fitness and strategy (PEGI, 2011; USK, 2011).

## 2.2 Target audience

In general, a game addresses a specific target audience. The audience has an influence on the design of the game itself (e.g. complexity of game mechanics, style of graphics or character design, the interface, or the story). User groups have certain characteristics that allow a classification, e.g. player personality, or social status, whereas age is the most common classification aspect. Age groups may be defined according to previous sales of games in order to derive interests e.g. for certain genres, or special titles (PEGI, 2011; USK, 2011). In contrast, when classifying serious games for elderly people, the target audience is already in focus of the classification itself. Therefore, a separation into different user groups will be limited to games that are specifically designed for elderly people, or games that may be used in inter-generational contexts.

## 2.3 Technical Aspects

In addition, it is possible to classify games by technical aspects. Konzack et al. specify two layers of technical aspects to classify games: hardware and program code (Konzack et al., 2002). Due to the fact that the program code is not available for public examination or use in most cases, this category will not be considered. However, the software will be analyzed regarding the functionality the game offers. The hardware layer contains information like the platform and the input device. To enable further classification, one of the considered categories will be the platform, represented by the specifications *PC*, *console* and *mobile devices*. Additionally, each of these platforms usually offers different input and output channels. Because almost every output channel includes a display, this aspect will not be used as a distinctive category. Nevertheless, since the input device has a major impact on the gameplay and sets requirements for the player's motoric skills, the category input devices will be used further. It includes the input methods *traditional controller*, *visual-tracking*, *touch* and *sensor-based* input. Functionalities that can easily be divided into categories are *single-* and

*multiplayer* modes. This aspect indicates whether a game allows integrating other players into the game via the World Wide Web (WWW), a local area network (LAN), or a local multiplayer mode.

To summarize the game specific categories, there are four categories that may be used for classifying serious games for the elderly and will be used in part four. They consist of genre, platform, input device, and mode. To include not only game specific aspects, but also those applying to serious games, the following chapter will point out classifications used for serious games and usable categories will be elaborated. In order to highlight possible classification methods, a general description of serious games is presented, which leads to potential benefits gained through the application of serious games. Furthermore, serious games usually address specific target audiences, which will also be illustrated in detail.

### 3 Serious Games Classifications

A serious game is a type of videogame whose primary purpose goes beyond pure entertainment, by e.g. teaching knowledge or training skills (Harley et al., 2010). The term “serious game” is strongly connected with the term “game-based learning” which describes the application of games for teaching competences and skills in a selected area of knowledge or the informal learning while playing a game. An advantage of serious games compared to conventional forms of education is a higher level of intrinsic motivation to use the system and a positive emotional experience (Gee, 2007). Serious games are used for different purposes in a wide range of application areas like physical training, mental training, or rehabilitation (cf. part 1). The classification by Brox et al. separates clinical health games into the categories “education-“, “exer-“, and “persuasive games”. Furthermore, they also assort the games into different target groups by age (“child”, “adult”, and “senior”) (Brox et al., 2010). In contrast to this work, Bronikowska et al. (2011) classify serious games according to their potential improvements on a specific health factor (e.g.: information processing speed, attention or mental set shifting) and by the required skill to master the game (e.g.: reflex, eye-hand coordination or strength). For the classification of serious games for elderly in this paper a joined version of these categories is used. The classification categories should provide an overview on the kind of improvement or support a serious game addresses. These categories are based on a subset of categories developed by Göbel et al 2012 and are divided into the aspects *physical, cognitive, psychological* and *social*.

In the context of AAL (Ambient Assisted Living) the main target group is elderly people. The term *elderly* is hard to define because there is no general agreement on the age at which a person becomes ‘old’. The World Health Organization proposes an age of 60+ as a working definition for elderly people, which is used in this paper. Because the group of elderly people is a very heterogeneous group, it is typical to additionally consider the living environment of the elderly to define the target group. This aspect of the AAL field is very important to estimate the interests and needs for the elderly person. For the classification of

serious games for elderly this aspect affects the decision which potential benefit is important. Also, each serious game in this special field may use a slightly different definition of target groups regarding age, living, or health condition. Those needs depend on the aim of the game and will therefore not be considered separately.

What appears to be important is the physical, cognitive, psychological, or social need the serious game addresses. Especially the target group of elderly people often experiences age-related limitations or diseases (Chou et al. 2010). Therefore, Schieber (2003) refers to the most common age-related issues consisting of decreased cognitive, motoric, and recognition abilities and further decreasing social connectedness with age. With the help of serious games such problems can be addressed and combined with other arrangements in order to improve the living conditions of elderly people (Ijsselsteijn et al., 2010). Besides specialized classifications (e.g.: living condition, illnesses or previous knowledge) normal games try to refer to a specific target group regarding certain criteria (e.g. age, gender or hobby's), games for elderly often address different target groups for an intergenerational approach (i.e.: the game "age invaders" (Khoo & Cheok, 2006) or on an specific elderly target group (i.e.: "multitouch memory game" (Gamberini et. al., 2009). Because of this the classification of the user group into *intergenerational* and *elderly* will be used as an additional category for this evaluation. To describe serious games in general Göble et al (2011) created a meta language for Serious Games called MDF-SG. This language provides a structured way to note different aspects of serious games, including information about: the content, involved partys, general infos about the game (i.e.: language), application field and the game itself (i.e.: genre & story) or economic factors and technical details. This paper focuses on the overview of the current status of Serious Games. The classification used for this approach are similar to the MDF-SG categories but focused on the benefits and the target group of elderly people.

## 4 Classification of Serious Games for Elderly

To classify serious games for elderly people the same classifications as in games or serious games apply. Considering that all games for elderly people are meant to be games, they should fit into common categories of a game (Göbel et al. 2012), and further those games represent serious games, because they aim at training, improving, or supporting certain skills, context, or knowledge. Consequently, the above mentioned categories genre, platform, input, mode, potential benefit, and user group will be used for this classification.

### 4.1 Method

Within the research field of AAL, many researchers and industrial developers try to use games to reach different goals (e.g. physical activation) of their target group. To get an overview on the current state of the art this paper creates a collection of existing literature and publications in this field. To achieve this, the following steps of work were performed:

1. Find universal game classifications for different sets of gaming categories: classic games, serious games & serious games for elderly.

2. Analyze current literature to achieve a clear overview on the research in this field.
3. Combine the results by applying the discovered categories on the found serious games.

Several classification sets for games, serious games, and games for the elderly have been considered and summarized in the categories presented in part three. They include descriptions of different game related sources like gaming magazines (GameSpot) or official organizations for games (PEGI & USK). To present these results, the extracted categories were grouped into technical aspects including platform and input, as well as mode and game play aspects, which include genre, user group, and potential benefits. Therefore, part four focuses on finding a way to access current games. Only games developed or improved in the past six years (since 2006) were included. By those means, the classification includes only recent games with a contemporary technological background. The time range was also set to avoid an immoderation of analyzed games. Considering the goal to classify serious games for elderly by their potential benefit, only those extracted games that were evaluated were analyzed. This filtering required the search for publications evaluating benefits for the elderly and on an intergenerational level. Scientific papers presenting serious games were extracted from the databases ACM, IEEE, and SpringerLink. These sources were selected due to their approved level of quality for international scientific publications. These sources do not include all serious games related research sources. Because of the huge amount of serious games launched in the past years we had to pick only a small sample size to analyze it for categories. Because we took sources which include a wide spectrum of different topics the serious games we found should represent the average properties of serious games within research and industry. To screen the huge amount of publications in these sources we filtered the content by year (2006 and younger publications) and by the terms “serious game, elderly” or “serious game, intergenerational”. In total, over one hundred different papers on serious games for elderly were collected. Yet, many papers focused on the same games with different aspects and evaluations. Therefore, it was possible to select a specific subset of 24 games focused by scientific research that match the criteria, which were then analyzed and classified according to the above mentioned categories. However, since most games are commercially not available, the classification is restricted to the information given in the papers. When applying the filters, a lot of games which are currently available or which are in the current focus of interest were found, providing an overview on the current state of the art. This overview for serious games for the elderly is classified by typical game specific categories.

## 4.2 Results

Within the classification of the literature review, 18 out of 24 serious games run on a PC, two games on a console, one on a mobile device, and three could not be classified (N/A) according to the information given in the papers. When classifying the input, some of the games fit into more than one category and use more than one input method. 11 out of 24 games each use visual tracking and/or sensor based input, while three games work with classic controllers, and also three may be controlled by touch input.

The games modes were also classified into multiplayer, single player, and both options. 11 games offer a multiplayer mode (6 of them multiplayer only), and 18 could be played using a single player mode (12 of them single player only).

| Game  | Platform   | Input  | Genre    | Benefit    | User | Mode   | Author                     |
|---|------------|--------|----------|------------|------|--------|----------------------------|
| Age Invaders  | PC         | CC, SB | AR, P&C  | PH, CO, PS | IN   | MP     | Khoo & Cheok, 2006         |
| Atomium Minigame  | N/A        | VT     | AR, SI   | SO, PH     | IN   | MP     | Abeele & De Schutter, 2010 |
| Balance Games (Dynamic & Golf)  | PC         | SB     | S&F      | PH         | EL   | SP     | Billis et al., 2010        |
| Buk Rythm Game  | N/A        | SB     | SI       | CO         | EL   | SP     | Park, 2009                 |
| Eldergames  | PC         | TO     | P&C      | CO         | EL   | SP, MP | Gamberini, et al., 2009    |
| ErgoActive  | PC         | SB     | S&F      | PH         | IN   | SP     | Göbel et al., 2011         |
| Game Prototype to Avoid Falling                                       | PC         | VT     | S&F      | PH         | EL   | SP     | Lange, et al., 2010        |
| Gesture-based Games (Virtual Soccer, Mosquito Invasion, Human Tetris) | PC         | VT, SB | S&F, P&C | SO, PH     | EL   | SP, MP | Riece, et al., 2011        |
| Hermes  | PC         | TO     | P&C      | CO         | EL   | SP     | Buiza et al., 2009         |
| Merobrixx   | PC         | SB     | P&C      | CO         | EL   | SP     | Klauser et al., 2011       |
| Muntermacher  | PC         | VT, SB | S&F, P&C | CO, PH     | EL   | SP     | Graf et al., 2011          |
| Rehabilitation Gaming System  | PC         | VT     | S&F, AR  | PH         | IN   | SP     | Cameirão et al., 2009      |
| Save aMazed Princess  | PC         | VT, SB | P&C      | SO         | IN   | MP     | Al Mahmuda, et al., 2010   |
| Sharetouch  | PC         | TO     | S&F      | SO         | EL   | MP     | Tsai & Chang, 2009         |
| SilverGaming  | N/A        | SB     | S&F      | SO, PH     | EL   | SP, MP | Gerling, et al., 2011      |
| Table TalkPoker   | PC         | CC     | P&C      | SO         | EL   | MP     | Shim et al., 2010          |
| Tangram alike Game  | PC         | VT     | P&C      | CO, PS     | EL   | SP     | Zapirain et al., 2010      |
| TheraGame   | PC         | VT     | S&F      | PH         | EL   | SP     | Kizony et al., 2006        |
| TranseCare  | PC         | CC     | S&F,SI   | SO         | EL   | MP     | Derboven et al., 2011      |
| VitaBalance   | PC         | SB     | S&F      | PH         | IN   | SP     | Göbel et al., 2011         |
| Walk 2 Win  | Mobile     | SB     | S&F,CA   | SO         | EL   | SP, MP | Mubin et al., 2008         |
| Webcam Games (Arrow Attack, Bubble Trouble, Rabbit Games)             | PC         | VT     | AR, S&F  | PH         | IN   | SP     | Burke et al., 2009         |
| Wii Fit   | Console    | VT     | S&F      | PH         | IN   | SP     | Nintendo                   |
| Wii Sports  | Console    | VT     | S&F      | PS,SO,PH   | IN   | SP, MP | Nintendo                   |
| Gameinsam   | Samsung TV | RC     | P&C/SI   | SO, CO     | IN   | MP     | Hermann et al. 2012        |

Table 1: Classification of serious games for the elderly (**Input**: classic controller (CC), sensor based (SB), touch (TO), visual tracking (VT), Remote controller (RC); **Genre**: Arcade (AR), Puzzle & Classic (P&C), Sports & Fitness (S&F), Simulation (SI), Classic Adventure (CA); **Benefit**: physical (PH), cognitive (CO), psychological (PS), social (SO); **User**: intergeneration (IN), elderly (EL); **Mode**: single player (SP), multiplayer (MP))

The genre classification is based on the combined categories stated in 3.1. However, since many games consist of a genre-mix, more than one category fits in many cases. 14 games could be assorted to the genre Sports & Fitness, 10 to the genre Puzzle & Classic, four to the genre Arcade, three to the genre Simulation, and one to the genre Adventure. No game of the genres Management, Role playing games, Shooter, or Strategy could be classified. Further-

more, the potential benefit was analyzed according to end-user evaluation conducted in literature. Also, this category included many games that provided more than one benefit.

### 4.3 Discussion

Looking at the classification, it becomes clear that most of the serious games for elderly classified in this paper were developed to be played on a PC platform. Only two of the scientifically mentioned games – both commercial games – can be played on a console. This might result of the resources available in research. However, since many of those PC game do not use classic controllers, the platform only has a minor influence on the play. Most of the games analyzed in this paper use tracking methods – either visual or sensor tracking. There is no significant correlation of genre and input. However, considering that most games are classified as Sports & Fitness game, a majority of tracking methods for body movements should be concluded. It also becomes clear, that most Sports & Fitness games that promise physical benefits use tracking methods, which might be due to the technology of movement tracking. There is also no clear correlation of genres and potential benefits. This hints at a possible use of diverse genres to provide cognitive, physical, psychological, as well as social benefits depending on the game itself. Also, it is noticeable that the genres Management, Role-playing games, Shooter, or Strategy were not covered by the selected games. Additionally, there were only few Adventure and Simulation games. Regarding a possible use of all genres for serious gaming, some genres have not been sufficiently covered by games used in the considered scientific papers. Furthermore, the results indicate, that there are more games using single player modes than multiplayer modes, which is yet of minor interest considering the small difference. However, it should be noticed, that only four out of 15 games with a physical benefit offer a multiplayer mode. Most of those games only include a single player mode. In summary, there are different kinds of serious games for elderly people – whether specifically designed for the elderly or used in an intergenerational context. While visual and sensor tracking is often used as an input method in the focused games, classic controllers and touch input are used infrequently. Most of the recent games concentrate on physical and social benefits, supporting the outcome that most of the games were classified into the genres Puzzle & Classic as well as Sports & Fitness. Other genres are not or only rarely used for the support of elderly people.

## 5 Future Work

This paper provides an overview of game classifications, which were extracted from different sources and represent current classifications to categorize games in various ways. Furthermore, existing serious games for elderly people were identified using specific filter criteria. By combining the information on game classifications and serious games for elderly a summary is presented. In total, this paper defines characteristics in 6 categories to classify games, serious games and serious games for elderly. 24 games developed in the past six years could be presented and categorized.

Within this classification it is shown that most serious games address only a few possibilities normal games have already fully discovered. For example, the integration of multiplayer modes, the use of popular genres, or different kinds of input devices connected with potential benefit have not been fully explored. The summary shown in table 1 provides a structured overview of the state-of-the-art development. This information can be used to increase the outcome of serious games in the context of AAL by combining results of traditional game research and research on the use of serious games for elderly people. These combinations can help to understand which potential serious games provide for scientific research, as well as in game development.

Further research will be needed to analyze the single items in more detail. Especially regarding the connection between the discovered game genre and the potential benefit of traditional games and serious games will be the focus of further researches. This will help to increase the application of games in the context of AAL by providing a detailed analysis.

This work also provides a foundation to ascertain which categories of serious games potentially increase the benefit for elderly people in the context of AAL. Additionally, the connection between the different gaming categories and the classifications for serious games like the potential outcome are important to indicate possible areas to focus on in further developments. These results can be used to discover innovative areas within game development, and to point out not yet used areas for serious games in this context.

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