

Digital Game Aesthetics of the iStoppFalls Exergame

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Abstract. The objective of this paper is to provide an overview of the iStoppFalls exergames, in association with digital game genres and aesthetics. This paper aims to present the links between game theory and the developed exergames presented in this paper, resulting in a series of proposed recommendations. Although there is a growing body of work associated to exergames and health rehabilitation there is little work focusing and identifying game theory and exergames. For the future development of exergames a series of proposed recommendations have been suggested to facilitate researchers, practitioners and participants in gaining further understanding of the use of exergames for health rehabilitation in particular, fall prevention. To the knowledge of the authors, the iStoppFalls is the first ambient assisted exercise program (AAEP) which utilizes 21st Century digital game technology with a primary focus on fall prevention.

Keywords: Rehabilitation, Fall Prevention, Perceptual Opportunities, Digital Games

1 Introduction

Life expectancy across Europe is set to increase and the statistics indicate this population explosion is not going to slow down in the coming decades. It is estimated by 2020, the European population will increase from 894 million to 910 million people, and this is especially prevalent for populations aged 85 years and older. It is anticipated the age of the population from 2020 will be 14 million people which will rise to 40 million by 2050 [1].

Amongst ageing cohorts, the experience of falls is a common occurrence, due to the decrease of strength and balance, to changes in gait, falls can be experienced indoors, via tripping over rugs or outdoors whilst walking to and from the garden. Digital game technologies have been utilized in recent years for the purpose of health rehabilitation [see 2]. The utilization and implementation of such technologies may aid older adults to conduct regular physical activity in the comfort of their home resulting in a decrease of the risk of falling. An example is the iStoppFalls system which has been designed and developed to facilitate physical activity amongst adults aged 65+ years. Exergaming is relatively new and has become a fashionable area of games and health research since the release of the Nintendo™ Wii console (2005). It is suggested

that there is a potential for exergaming to facilitate physical activity as a means of delivering home based exercises offering several positive elements to prospective users focusing on compliance and adherence to exercise:

- Utilization of exergames have the benefit to engage users of all ages but in particular older adults in physical activity which in turn has the potential to reduce fall risk;
- They may ensure higher compliance with exercise intervention than complete standard exercise interventions;
- Exercise within the home offers the possibility for older adults to engage in innovative forms of exercise than with conventional options (gym class or community based exercise programs); they provide a way of tracking exercise compliance over time; and have the potential to provide encouragement and motivation, if compliance starts to fail.

Exergames have the ability to provide users with a competitive environment leading to the experience of engagement and fun. The notion of exercise, coupled with gaming may have the advantage to motivate persons to complete the required exercises, whilst positively engaging with the virtual environment (VE). With the influx of academic interest associated to gaming and health there has been various studies utilizing the Sony Play Station® (PS) EyeToy as a means of interaction via gesture to assess the feasibility of this technology for similar purposes. Earlier studies have sought to design and develop purpose built hardware/software for the same objectives [see 2]. More recently the Microsoft™ Kinect console (2010) can facilitate users to interact with digital games through gesture and speech recognition without the need of a game pad or remote. To date there is little published research within the health and gerontology fields focusing on the utilization of the Kinect console, with the exception of iStoppFalls.

Little work has focused on the aesthetics and game theory being implemented into exergames and purpose built technologies aimed at prospective health benefits towards older users. However, one study designed and developed the PlayFit system by [3] aimed at reducing sedentary behavior amongst teenagers. The aims of this paper are: (1) to provide an overview of digital game aesthetics theory, (2) identify and discuss the aesthetics which have been exploited in the iStoppFalls project, and (3) propose a series of recommendations to develop this work further for future exploitation amongst users of the iStoppFalls system and general exergames.

2 Defining Digital Games

Genres can be associated with a variety of entertainment mediums, for example: literature, films, television programs and digital games [4]. Several researchers [4-12] have attempted to define the term game genre to aid a greater insight for researchers and consumers, taking into account the classification of digital games to facilitate consumers with suitable information based upon age and content descriptors. Marston and McClenaghan [13] have attempted to provide a greater understanding of the exergame genre reviewing previous taxonomies created by [4], who aimed to identify

genres via activities performed within games. Mueller et al. [7] integrated game elements into four groups (Parallel/Non-parallel', 'Competitive/Non-Competitive', 'Exertion/Non-Exertion and Combat/Non-Combat) and focuses on user's perspectives rather than hardware. Adams [8-9] suggests there are more facets associated to the categorization of genre including: setting, audience, theme and purpose. Further [8-9] contends that games are determined by gameplay, including the challenges faced by gamers and performing the necessary actions to complete the challenge of task. Oh & Lang [10] constructed a matrix comprising of terms associated (e.g. exertainment, dance simulation and physical gaming) from 23 articles and the most popular term was exergaming. Lindley [11] uses a classification pane initially 2-D utilizing ludology, narratology and simulation. However, a 3-D plane is introduced by adding gambling to the plane in addition to fiction/non-fiction and virtual/physical. Swayer & Smith [12] taxonomy takes a different standpoint whereby genre (education, advergames, and games for health) and sector (government, defense, healthcare, and corporate) are primarily considered.

Prospective recommendations by [13] included: game analysis of online and off-the-shelf games to identify exact game elements; establish serious game guidelines to aid clinicians/ users', consider and revise the current classification systems and implement a games for health classification system to facilitate clinicians and users with suitable software, execute longitudinal studies to gain in-depth understanding of utilizing game software for rehabilitation and finally, identify a constructive methodology, to assist with a suitable taxonomy for all sectors.

3 Digital Game Aesthetics

Many digital games incorporate or illuminate aesthetics to their players. Murray [14] deems interactive digital environments (IDE's), such as games, to incorporate three elements. These may be individual or combined within one game:

- Immersion is experienced during play when a particular gamer experiences the feeling of being lost in the environment or story.
- Agency is described when control occurs by the gamer in the digital environment.
- Transformation is to feel or become someone else or something else which many gamers experience during play.

The aesthetics defined by [14] were taken from the properties of IDE's which include: (1) procedural which comprise of a set of rules and rule based descriptions of places, people and objects used by gamers during play. (2) Participatory is described by the break-up of the digital environment enabling the gamer to value and understand the pleasure(s) gained, (3) spatial is described as the portrait of a navigable space either in a game or digital format, for example a website, conversation or a 3-D environment, and (4) encyclopedic is the availability of digital environments offering the potential to deliver information which is too vast for the human mind. The experience of aesthetics does not provide an overall understanding to the meaning but can provide a positive notion of pleasure [4]. Therefore, in relation to the emergence of a new digital medium, Murray [15] presents three stages:

- “The embryonic medium – users participate in the new medium prior to the technology itself being available to support it;
- The incunabula medium – is available in part at least, but users are still learning how to specifically create for the medium and;
- The fully fledged medium – new forms arise which are specific to the medium and make the most of its capabilities.”

Murray [14] summarizes, the majority of VE’s are in stage two (The incunabula medium), based upon the notion of not knowing exactly what the environments are trying to do. Alternatively, the formal abstract design tools (FADT) framework proposed by [15] comprises of: (1) intention, (2) perceivable consequence, and (3) story. In the following section, these three elements are explained:

Intention is the pleasure experienced by the user while understanding the purpose of the game and deciding what the subsequent action(s) should be to progress onto the next level. Perceivable consequence and agency are similar within gaming. Users experience the pleasure of agency through the intent of actions and the perceivable consequence(s) of the actions during play. For many in the gaming community, story is obvious. However, there may be countless stories, or a background story, which provides an insight into the quest (if it is an adventure game), but for some as [4] suggest, games like Tetris, actually do not have a story or narrative. Therefore, users have the opportunity to create their own story through play. Moreover, some could argue when play has ceased, a story has been formed from the player; the player is telling the story to a friend based on their success.

Exploration of perceptual opportunities (PO) has been undertaken by [4]. PO’s are items comprising of a role within digital content exhibited via game play. The approach to designing and understanding the inter-relationships of PO’s is known as perceptual modeling. A modeling technique can aid the understanding of the PO relationships within larger structures or environments, in particular, a digital game and has the possibility to represent game play overtime. A PO map [4] illustrates the relationship of attributes found within a game environment and their structures which configure these inter-relationships. Each attribute and sub-group will be explained in the proceeding section.

3.1 Understanding Perceptual Opportunities (PO)

Fencott et al. [4] explains; sureties are everyday details which are predictable within the environment. This type of detail can be identified through elements such as lamp posts or incidental items. The real world is generally a chaotic world and this can be followed through into a VE. Furthermore, sound can be implemented to add to the atmospheric ambience of the VE during game play.

Surprises are used in an environment to provide an emphasis [16] and to precipitate conscious learning. The inclusion of surprises is to deliver a purpose and to accumulate users providing an experience. This facet can be implausible but beneficial to the environment however, they can be plausible but unexpected. There are three basic types (1) attractors, (2) connectors and (3) rewards [4].

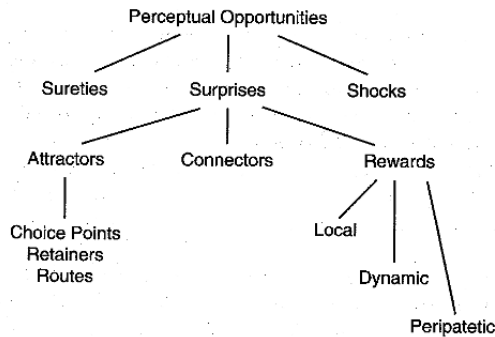


Figure 1: PO Map and contributing attributes [4]

Attractors are used to draw the attention of a gamer to a particular object. They can be seen or heard and can be mysterious, active, sensational and complex. Choice points are associated with attractors and provide a choice of alternative goals for the same attractor. Retainers; are a group of surprises that constitute sites of interest to the user, which may include interaction, and seek to provide the purpose of the VE. Routes can be implicit or explicit, drawing visitors around the VE which aim to display all important content. Surprises can also have connectors; which assist in the satisfaction of goals in response to the attractors via four facets: (a) basic interaction technologies, (b) information objects (maps or signposts), (c) online assistance and (d) the degrading of reality, the removal of detail to deflect visitors back to areas of interests. Rewards; can be various including local, peripatetic and dynamic, and they can deliver a specific memorable experience and ensure visitors linger in a certain area from time to time [4].

The iStoppFalls project comprises of several technologies and interfaces to facilitate the users with physical activity including educational material, three exergames and a social networking component via Google TV. For the purpose of this paper, the authors will focus on the exergame aspect, comprising of three different variations of one game to facilitate with the balance training taking into account the principles of the Otago program [17], these are: Hills ‘n’ Skills, the Bumble Bee Park and The Bistro.

3.2 iStoppFalls Exergame Components

Three key points were ascertained for training balance skills and comprised of (1) weight shifting (2) knee bending and (3) stepping. One or more of the different key points were implemented into the three games whereby, the level of difficulty is increased and the following points were reviewed for inclusion into each game:

- Reduce upper limb support (a chair as option for upper limb support is provided);
- Reduce base of feet support;
- Include arms (for example reaching); and

- Combine the three key point's weight shifting, knee bending and stepping step by step.
- Include dual tasks to shift or divide attention

Across all three games, the user is shown a series of icons situated on the screen (c.f. Figure 2). The 'Kinect tracked 100%' icon displays to the user their stance at that point in time and is located at the bottom left hand side of the screen. At the bottom right hand side of the screen, there is an icon displaying 'Level, Points and Progress' which informs the user of his/her progress. Situated along the bottom of the screen, the words 'Pause, Instructions, and Abort' are shown allowing users to engage and recap with the VE at their convenience. Finally, the icon 'SMM not recording' informs the user that their senior mobility monitor (SMM) is not collecting data. However, this would change to SMM is recording, if the SMM is connected which it is when the participants are undertaking their training schedule.

A series of dual tasks have been implemented into the later levels of Games 1 and 2. One of the dual-tasks is a series of mathematical equations (subtraction and addition) where an equation is displayed to the user via the screen. The user is required to choose the correct answer from four options, by raising their left or right hand. Additional dual tasks are implemented into the games, which require participants to count birdhouses, and memorize objects. As the level of difficulty increases so do the tasks. For example, the first task is to memorize three objects, than four etc.). The level of difficulty also increases for the mathematical equations, for example; single-digits will be displayed followed by double digits (e.g. 4+5; 22-13). Finally, coins have been implemented into the game levels, which users can collect as they travel around the circuits. If a user collects a coin, they are rewarded with points.



Fig. 2: iStoppFalls exergame interfaces

3.2.1 Game 1 – Hills ‘n’ Skills

The purpose of the game is to solve a slalom course, the user receive points for time, passed gates, and additional tasks. To start the game, the user is required to stand up straight in front of the Kinect and to pay attention to the automatic count-down. If they need to avoid an obstacle then they lean their body to the left or right side. Snowmen have been implemented as additional obstacles. Points are rewarded by correctly passing a gate but no points are rewarded or deducted if they collide with a snowman. A total of 51 levels have been developed and implemented into the Hills ‘n’ Skills game. The level of difficulty is increased after level 17 by reducing the

spaces between the gates as the participant is demanded to shift his/her weight more often.

3.2.2 Game 3 – Bumble Bee Park

The purpose of Game 3 is to walk through a park and avoid bees. There are 45 levels in the Bumble Bee game, which allows to increase the level of difficulty reducing the lower limb support by starting with a low step and finish on a high step in the higher levels. The initial game interface illustrates several facets of interest to the user: which are different to the common elements explained above. The main element is the path which the user ‘walk/step’ along to complete the level. Coins are placed around the footpath, which the user has to collect and avoid the bumble bees coming towards the avatar. Dual tasks have been implemented into this game, and follow a similar process as previously explained.

3.2.3 Game 2 – The Bistro

The objective of The Bistro game is to collect a series of ingredients to make a sandwich or a smoothie. The primary focus of movement is to either step or to lean and shift the body weight to the left or right side. There are a total of 22 levels. Initially, the user is required to collect all of the ingredients which are falling from the ceiling. As the user progresses through the levels, a recipe list is displayed showing the user the exact ingredients needed to complete the recipe. The ingredients are collected by the user leaning or stepping to the left or right and collecting the specific ingredient into the bowl. If the user collects all of the correct items in the correct order, a tick is shown at the side of the word and the ‘green button’ which enables the user to ‘make the smoothie.’ If the user is unable to collect a certain ingredient, then a red cross is displayed at the side of the item. A spider has been implemented into the game which appears intermittently. The user is expected to avoid the spider, whilst collecting the ingredients. If the user does not avoid the spider or is unable to collect the items, they are thrown into the rubbish bin. A cookie has been implemented, enabling users to gain extra points if it is collected into their bowl.

3.3 Aesthetics of the iStoppFalls Exergame

In the following section the aesthetics of the exergame are identified and explained. Sureties: throughout all three games, the VE has been built to reflect a real setting for example, in Game 1 the types of sureties identified are rocks, trees, snow/men, gates, firs, and a finishing post. In Game 2, users can see trees, flowers, and natural foliage. Game 3 displays a typical coffee counter comprising of equipment (e.g. coffee maker), seating and signage found in a café.

Shocks: have been implemented to facilitate the execution of exercise but to add a sense of engagement within the VE. Additionally, in Game 1, users will experience the appearance of snowmen, appearing at different levels of the game, and in Games 2

and 3 bees and spiders appear intermittently. This makes the user lean to the right or left to avoid the animal and continue with the game objectives.

Surprises: can be found throughout all of the games, resulting in additional tasks (e.g. mathematical equations, memory tasks), while executing a stepping motion, bending or leaning exercise. Attractors: can be found immediately in Games 1 and 2, by following a certain path to complete the task. In Game 2, once the user has completed reading the instructions, by executing the stepping motion, the user will understand the avatar will 'walk' around the path. Additional attractors include coins, memory items (e.g. bird houses), and in addition to Game 1; snowmen, and gates. In Game 3 there is the recipe which the user has to follow and collect the correct items listed.

Choice points: are particularly noticeable in Game 1. While the user is skiing down the mountain, they are aware that they need to avoid the snowmen, ski through the gates (to gain points), collect the coins, complete the dual-task questions and reach the finish line. Routes: are simple across the three games. In Game 2, there is one primary route which is the path. Game 1, is the mountain hill, associated with the placing of gates/snowmen to form the 'route' and in Game 3, the user is expected to step or lean the length of the counter. Connectors: throughout Games 1-3, show a variety of detail to provide a sense of realism to the user within the VE. However, because of the game objectives each VE is not overloaded with connectors. There are several icons which provide the user with further information associated with their exercises, game level(s) and points. There are additional buttons accessible to the user placed at the bottom of the screen in the centre of the screen (Pause, Instruction and Abort). These buttons facilitate the user to choose their actions within the game or gain further information if they require a re-cap of a particular exercise. Rewards: are gained by the user by collecting coins, selecting the correct mathematical answer, or choosing the correct item or colour. Additional points are rewarded if the user completes the paths in the Bumble Bee game quicker, or in the Hills 'n' Skills game, if they bend their knees they will ski quicker resulting in further points. And in the Bistro game, if the cookie is caught points are added. Points are deducted if the user does not select the correct answer.

3.4 Aesthetic Framework – Murray (1997)

The aesthetics associated to the iStoppFalls exergame defined by [14] are procedural, based upon a specific set of algorithms implemented into the system which result in a set of rules being completed by the target audience (adults aged 65+ years) to complete the task. However, taking into account the work by [18], procedural rhetoric encompasses processes, logic and system rules, which [18] suggests, can shape persuasion and expression. One may think that the work by [18] could be integrated into the iStoppFalls exergame, based upon the example within the political section, which [18] claims can teach one about the political process through procedural rhetoric. However, it was never the intention to teach users about fall prevention directly through the iStoppFalls exergame, although educational material is provided to participants about fall prevention. Therefore, from this point onwards we will stick

with the aesthetics of [14]. In Game 1, the user is expected to ski down the mountain, whilst avoiding snowmen, and going through the designated gates while collecting coins, answering mathematical equations, counting a certain number of objects in a specific colour and complete the question with the correct answer. In Game 2, the user has to walk around the path in the park avoiding bees, and executing dual-task exercises. In Game 3 depending upon the level of the game, the user is expected to collect all of the falling ingredients or in the later levels, collect a select number of ingredients as shown on the recipe list. As explained by [14], the emergence of new digital mediums the exergames can be categorized as stage 2 the incunabula medium. For example, designers and developers have the knowledge and skills to produce an exergame, yet there is still further knowledge needed to fully understand what is required of an exergame specifically aimed at a health benefit such as fall prevention.

3.5 Aesthetic Framework – Church (1999) - FADT's.

With regards to [15] aesthetics; story is relevant in so much as; the user is provided with the information to complete the circuit in Games 1 and 2 while avoiding obstacles through a series of exercises within a specified time limit. Users may create their own story relevant to their exercise program. For example; as users progress through the different levels, they may choose to tell and demonstrate to their friends, family and the research team. With this notion, it is suggested, a user could create their own story, of their game experiences as [4] proposed with Tetris. Intention can be identified by users, who experience the pleasure of the game while understanding the objectives of the environment. This is particularly relevant when associated to activities of daily living (ADL). For example; the participants in the real world are familiar with a park, restaurant, and sporting events. Finally, perceivable consequence may be experienced by users who are required to physically interact with the environment through body movement. All games require users to physically interact with the environment to complete and progress from one level to the next. Previously, interaction has been related to user's motion while holding a traditional game pad. However, there is no such technology in this project and therefore, physical movement by the user's body to initiate game interaction is required.

4 Recommendations for Future Work based on Exergames

The authors propose a series of recommendations which have been categorized into themes and it is anticipated these recommendations could provide designers, developers and users the ability to gain full capability from exergames which have a fall prevention focus:

Safety

- The ability to have additional support such as a chair for users who are categorized as frail. This would maintain a safety support;
- Individualized program and progression to avoid under- or overexertion

Interface of the Exergame

- All instructions should be clear and concise;
- Icons depicting the level, user progress and the type of course should be easily recognizable, and understandable;
- All icons should be easily recognizable and the use of voice recognition should be suitably implemented for users to be able to access this function;

Design of the Exergame

- All instructions should be clear and concise;
- No unnecessary features (colors, music, information) which distract the attention of the user from the basic intention/task/information;
- Implementing video to illustrate exercises should contain a series of instructions, the inclusion of suitable models and visual representation should be clearly defined;
- Gaining user feedback throughout the design and development is necessary to maintain suitable information for the final deployment;
- Consider and analyze videogame theory constructed by Bogost which could enable further design and developments associated to procedural rhetoric.

User motivation and engagement

- Integrate suitable leaning and bending exercises for all users (frail and active) providing an individualized program and progression for training;
- Positive and motivating feedback should be implemented to maintain user engagement;
- If the user executes a move that they shouldn't, (e.g. bumping into a snowman) points should not be given. However, points should also not be deducted to maintain motivation and engagement;
- Implementing dual tasks should be suitable for the level of the game, enabling the user to complete the questions sufficiently. Dual tasks should not be placed between obstacles such as snowmen and gates (Hills 'n' Skills game) which could result in a practical problem of reaching the answer sufficiently within the given time period. Therefore, dual tasks should appear at suitable distances throughout each level.
- Game challenges should facilitate user motivation resulting in completion of the exercise;
- Game difficulty should be steadily increased as the user progress through each level. Initially, if it is too difficult, this may prevent users from continuing their exercise program;

Study Execution

- Qualitative data collection is crucial to gain additional information from the users. Data collection could be in the form of one-to-one interviews and/or focus groups. The type of data collection which researchers could consider is:

- Users experiences during the study;
- Users challenges to using the technology;
- Elements of the game to be considered for a future re-design; and
- Take up of digital game play which has a health and physical fitness focus based upon the game development.

Choosing the correct quantitative approaches is crucial for such studies. There are a variety of physical and cognitive tests which can be utilized to assess fall prediction. If a future multi-centred study was to be conducted, researchers and clinicians need to discuss and agree upon a set of assessment tests which can be transferable into multiple languages and executed sufficiently.

5 Conclusions

To summarize, this paper has presented the theory of game aesthetics in conjunction with a purpose built AAEP to facilitate fall prevention aimed at adults 65+ years. This paper has shown based upon [14,15] theories have been implemented. In conjunction with the proposed recommendations, it is suggested these recommendations may facilitate researchers and developers to design and develop suitable exergames, primarily associated to fall prevention. Further, by taking into account the recommendations, this may assist users to engage more with purpose built AAEP's which would result in individual health benefits. Additional work is needed in the area of exergames and game theory to gain in-depth understanding of this phenomenon, especially in regards to health and fall prevention, which could facilitate design, development, execution of future studies and enable adherence and user engagement.

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