

Serious Game for Autism Children: Review of Literature

Helmi Adly Mohd Noor, Faaizah Shahbodin, Naim Che Pee

Abstract—Autism Spectrum Disorder (ASD) is a pervasive developmental disorder which affects individuals with varying degrees of impairment. Currently, there has been ample research done in serious game for autism children. Although serious games are traditionally associated with software developments, developing them in the autism field involves studying the associated technology and paying attention to aspects related to interaction with the game. Serious Games for autism cover matters related to education, therapy for communication, psychomotor treatment and social behavior enhancement. In this paper, a systematic review sets out the lines of development and research currently being conducted into serious games which pursue some form of benefit in the field of autism. This paper includes a literature review of relevant serious game developments since in year 2007 and examines new trends.

Keywords—Serious Game, Autism, Education, Therapy

I. INTRODUCTION

AN American psychiatrist, Leo Kanner (1943) described Autism as a condition that resulting from a brain disorder that takes place during the first 2 and a half years of childhood. Autism Spectrum Disorder (ASD) regarded as the presence of three aspects of impairment, namely; social cognition, communication and imagination. These three impairments are categorized as the most familiar of the serious developmental disabilities [1]. This neurodevelopment condition has a frequency of one in 110 children in the USA and one in 625 children in Malaysia [2,3]. These autistic children are known to be diverse in group and the manner of how the autism manifests in each child is different as well [4].

Table 1 shows the 5 main types of autism and their characteristics [5]. Children with autism look normal, nonetheless the condition forces them to experience world in a very different way.

TABLE I
TYPES OF AUTISM

Types	Characteristic
Autistic disorder	Markedly abnormal or impaired development in social interaction and a markedly restricted repertoire of activity and interests, usually noted within the first years of life.
Asperger's syndrome	Severe and sustained impairment in social interaction and the development of restricted, repetitive patterns of behavior, interests and activities. No clinically significant delays in language acquisition.
Rett's disorder	A specific and highly distinctive pattern of development regression following a period of normal functioning through the first five months after birth. Has been diagnosed only in females.
Childhood disintegrative disorder	Marked regression in multiple areas of functioning following a period of at least two years of apparently normal development.
Pervasive developmental disorder not otherwise	Severe and pervasive impairment in the development of reciprocal social interaction, but the criteria is not met for a specific pervasive developmental disorder.

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Autism Spectrum Disorder (ASD) is a pervasive developmental disorder which affects individuals with varying degrees of impairment [17], even though there are numerous consistent factors present in all or most autistic people. For example, it is common that these individuals lack fine or gross motor control, enjoy interacting with technology and video games [18], and become fixated with a particular subject area referred to as a special interest, such as dinosaurs, trains, or outer space

The number of children diagnosed with autism is growing [6]. In spite of great strides in early diagnosis, the outcomes for a majority of children with autism are still poor, with a few able to live independently when they reach adulthood [7,8,9]. Pertinent to that, research on serious game based for autistic children is done by many in the computing field.

For 40 years, the term serious game has commonly been used by many. To illustrate, in 1968 Clark Abt dubbed his book "Serious Games". It illustrates his work in educational-curriculum development, school-system planning, industrial management and technological planning and forecasting where he examined war-games (a mixture of mathematical analysis and the group interaction) and simulations to coach managers, students and teachers. His definition of such games is that they: "have an explicit and carefully thought-out educational purpose and are not intended to be played primarily for amusement. This does not mean that serious games are not, or should not be, entertaining" [19].

There are several definitions of serious games:

"Serious game: a mental contest, played with a computer in accordance with specific rules, that uses entertainment to further government or corporate training, education, health, public policy, and strategic communication objectives"[10].

"Serious Games" is defined as digital games and equipment with an agenda of educational design and beyond entertainment [11].

"the label [serious games] refers to a broad swathe of video games produced, marketed, or used for purposes other than pure entertainment; these include, but are not limited to, educational computergames, edutainment and advertainment [...] and also health games and political games. [...] in theory, any video game can be perceived as a serious game depending on its actual use and the player's perception of the game experience" [12].

Serious games aim "to use new gaming technologies for educational or training purposes. it investigates the educational, therapeutic and social impact of digital games built with or without learning outcomes in mind" [13].

"there is no one single definition of the term "serious games", although it is widely accepted that they are games "with a purpose". In other words, they move beyond

entertainment per se to deliver engaging interactive media to support learning in its broadest sense” [14].

Since there are numerous methods and definitions, hence for the objectives of this paper the term serious games will be narrowed down to digital games with the aim of certain predefined skills or knowledge for a primary purpose other than pure entertainment. The terminology “serious” is employed to refer to products used by industries such as education, management, defense, healthcare, scientific exploration, religion, engineering and politics.

The aim of this paper is to provide a review of serious games for autism development.

The specific objectives are described below:

- To review the technologies classification those are most suitable for developments.
- To review the serious game classification.
- To review serious games for autism developments.
- To share findings from previous work.

The rest of the paper is organized as follows. Section II describes the findings to study the serious games technologies classification and Section III presents the reviewed serious games classification. Section IV will have a serious games for autism and lastly Section V concludes the paper and suggests future work for the research.

II. FINDINGS

This section enlightens on the criteria followed by the authors choosing the relevant serious games, the main technologies employed in their development and the potentials around the interaction and multiplatform.

To identify some published articles describing representative developments in Serious Games areas, a systematic review was conducted. Only articles from 2002 and 2011 were selected. The search has focused on serious games for autism as a result of the extensive array of serious games.

A. Technologies Classification

The technologies used in serious games development for autism includes 2D and 3D stand-alone and online computer game, virtual reality, mobile devices, touch screen computer and tabletop and interaction games. Autism games technologies classification is shown in Table II.

TABLE II
AUTISM GAMES TECHNOLOGIES CLASSIFICATION

Technologies Classification	Author/Year
Computer	Arshia <i>et al.</i> , 2011
	Emilia Barakova <i>et al.</i> , 2007
	Samantha <i>et al.</i> , 2009
	Anika Anwar <i>et al.</i> , 2011
	Maite Frutos <i>et al.</i> , 2011
	Mohammed E. Hoque <i>et al.</i> , 2009
	Min Young Choi <i>et al.</i> , 2010
	Md. Mustafizur Rahman <i>et al.</i> , 2010
Mobile devices	Md. Mustafizur Rahman <i>et al.</i> , 2011
	Zelai <i>et al.</i> , 2011
Touch Screen Computer And Table Top	Alberto Battocchi <i>et al.</i> , 2009
	Megan Davis <i>et al.</i> , 2007
Interaction	Qiang Wang <i>et al.</i> , 2010

B. Computer Game

A computer game, also known as a PC Game (personal computer game), is a video game played on a personal computer or notebook/laptop, rather than on a video game console or arcade machine. Earlier personal computer games often needed a keyboard for gameplay, or more commonly, required the user to buy a separate joystick with at least one button [22]. Players are required to control a keyboard and a mouse simultaneously in most modern computer games. Sometimes, these players can use gamepads and joysticks as well. Normally, computer games employ additional measures to offer interactivity and information to the player. Speakers and headphones are utilized as sound reproduction devices since audio is virtually universal. Haptic peripherals, such as vibration or force feedback, is used as other type of feedback.

C. Virtual Reality

The term Virtual reality can best be described as a three-dimensional, computer generated environment which can be experienced by a person. In doing so, the person is immersed within the virtual environment and he or she is given the ability to manipulate objects or operate some activities.

In developing serious games, virtual reality is employed. This technology allows the development of a wide variety of fields in serious games. Most importantly, VR allows the recreating of different situations or environment that would be unachievable to rebuild in the real world. To illustrate, with the existence of VR, a traumatic experience can be duplicated and hence aids individuals' rehabilitation [23]. Furthermore, VR enables the user to be fully involved by utilizing different hardware that allows the user to reciprocate with the serious games.

Virtual reality is often used to describe a wide variety of applications commonly associated with immersive, highly visual, 3D environments. The development of CAD software, graphics hardware acceleration, head mounted displays, Data Acquisition Glove, 3D vision goggles, the mouse or keyboard, 3D LCD Screens and Sensor body.

D. Mobile Devices

Nowadays, mobile devices are prevalent in our lives. Their numerous potentials make them educational friendly. A mobile game is a video game played on a cell phone, smart phone, PDA, tablet or any portable devices. This excludes dedicated handheld video game system such as PS2, Xbox or Nintendo DS.

Windows Mobile, Google Android, Palm OS, Symbian, OD, Adobe Flash Lite's BREW, WIPI, Apple iOS, or Windows Phone 7 are platforms and technologies commonly used to develop these mobile games. In addition, Java is the most prominent platform for mobile games nevertheless it has a limitation in performance which leads to the adoption of numerous native binary formats when it comes to more sophisticated games.

E. Touch Screen Computer and Table Top

A touch screen is an electronic visual display that has the ability to identify the tactile presence and location within the display area. Generally, it refers to touching the device's display with a finger or hand. To add, passive objects can also be detected by a touch screen. More often than not, devices such as game console, all-in-one computers, tablets and smart phones employ the touch screen technology.

There are two vital features of touch screen. First and foremost, it permits the user to interact immediately with what is displayed without using other controllers such as mouse or touchpad. Secondly, the user does not need to use any other intermediate handheld devices. In fact, such displays can be linked to terminals such as computers or networks. Moreover, these displays play a fundamental role in the design of digital devices such as PDAs, GPSs, mobile phones and video games.

F. Interaction

In this day and age, it has become a trend to transform well-known traditional games into a computerized version. This is done so that it can be played online and it gives it the capability to compete with modern video games. The aim is to make the games more appealing and thus to enhance user's experience. Interaction may be one of the areas that need to be developed with extreme care, depending on the activities and skills to be worked on each of the games and target group. Keyboard and mouse are not always suitable since the technology has advanced and there are a series of possibilities predominant in this area. Nowadays, there are interfaces that are created to read brain's electrical signal called Electroencephalography (EEG) and turn it into movement in virtual environment [24]. And in the future these interfaces can be useful for individuals with impaired mobility.

III. SERIOUS GAMES CLASSIFICATIONS

Problem solving is the key purpose of designing serious games. Serious games can be pleasurable and entertaining nevertheless, their primary purpose is to train, investigate or advertise. Every now and then a game will purposely sacrifice fun and pleasure to facilitate the player's desired progress.

Serious games can be classified into several types. Nonetheless the classification is not yet confirmed since there are a number of terms that are commonly used:

- **Edutainment:** A combination of education and entertainment.
- **Games-Based Learning or "Game Learning":** These games have defined learning and training outcomes. Generally they are designed in order to balance the subject matter with the gameplay and the ability of the player to retain and apply said subject matter to the real world [20].
- **Simulation Games:** games used for the acquisition or exercise of different skills, to teach effective behavior in the context of simulated conditions or situations. In practice, are widely used simulation driving different vehicles (cars, trains, airplanes; e.g. FlightGear), simulation of management

of specific industries (e.g. Transport Tycoon), and universal business simulation, developing strategic thinking and teaching users the basics of macro-and microeconomics, the basics of business administration (e.g. Virtonomics).

- **Games for Health:** such as games for psychological therapy, or games for cognitive training or physical rehabilitation uses. Technology and mental health issues can use Serious Games to make therapy accessible to adolescents who would otherwise would not find a psychotherapist approachable.

- **Exergaming:** games that are used as a form of exercise. The concept of Exergaming involves new ways of playing and new video game competitions that recreate sports, leisure time exercise and healthy exercise.

- **Art Games:** games used to express artistic ideas or art produced through the medium of video games

- **Productivity gaming:** games which reward points for accomplished real-world tasks using to-do lists.

- **Gamification:** is the use of game design techniques and mechanics to solve problems and engage audiences [25]. Typically gamification applies to non-game applications and processes (also known as "funware") [26] in order to encourage people to adopt them. Gamification works by making technology more engaging [27], by encouraging users to engage in desired behaviors [28], by showing a path to mastery and autonomy, and by taking advantage of humans' psychological predisposition to engage in gaming [29]. The technique can encourage people to perform chores that they ordinarily consider boring, such as completing surveys, shopping, filling out tax forms, or reading web sites [27]. Available data from gamified websites, applications, and processes indicate potential improvements in areas like user engagement, ROI, data quality, timeliness, or learning [30].

- **Advergaming:** The use of games for advertising. The approach can include numerous different ways of advertising more or less well-known from other media. This also includes interactive video games that enable the user constantly exposed to the advertised brand or product. It can have product placement, banners in-game or just traffic triggers.

Video games genre are categorized by gameplay. On the contrary, Serious games differ from normal video games and thus, they are categorized by purposes. This category includes simulations games, educational games, advergaming, political games, or evangelical games [15]. Additionally Julian Alvarez and Olivier Rampnoux (from the European Center for Children's Products, University of Poitiers) have attempted to classify serious games in 5 main categories: Advergaming, Edutainment, Edumarket game, Diverted game and Simulation game [21].

Belanich et al (2004) identified that the ability to provide feedback to students about their performance was important and should be provided according to the learners' needs and the task at hand. An advantage of using serious games for training is the ability to provide this timely feedback [18].

IV. SERIOUS GAME FOR AUTISM

Until now, the serious games for autism developed for two purposes, first is for therapy and secondly for education (include learning and training). Autism serious game purpose is shown in Table III.

TABLE III
AUTISM SERIOUS GAMES PURPOSE

	Purpose	Author/Year
Education	(Concept of Money)	Arshia <i>et al.</i> , 2011
	(Social Skill)	Emilia Barakova <i>et al.</i> , 2007
		Samantha <i>et al.</i> , 2009
	(Communication Skill)	Anika Anwar <i>et al.</i> , 2011
		Maite Frutos <i>et al.</i> , 2011
	(First Aid Learning)	Zelai <i>et al.</i> , 2011
Therapy	(Narrative)	Megan Davis <i>et al.</i> , 2007
	(Communication Skill)	Mohammed E. Hoque <i>et al.</i> , 2009
		Md. Mustafizur Rahman <i>et al.</i> , 2010
		Md. Mustafizur Rahman <i>et al.</i> , 2011
	(Visual motor Coordination, Social Skills, Sensory Integration)	Min Young Choi <i>et al.</i> , 2010
	(Electroencephalogram (EEG) game)	Qiang Wang <i>et al.</i> , 2010
	(Social Behaviors)	Alberto Battocchi <i>et al.</i> , 2009

A. Autism Serious Game for Education

Serious games for education are designed to help teacher or student during the teaching and/or learning process.

Arshia *et al.*, (2011) presented a personalized computer game based on digital story-telling concept that helps the children of age ranging from 9 to 14 years old with autism to understand the use of money. It also teaches the autistic children the social behavior appropriate while shopping. The game is developed on BYOB (Build Your Own Block, an advanced offshoot of the game engine Scratch).

Emilia Barakova *et al.*, (2007) presented a design process, the outcome, and preliminary tests of an interactive toy that expresses emergent behavior and can be used for behavioral training of autistic children, as well as for an engaging toy for every child. The researcher exploits the interest of the autistic children in regular patterns and order to stimulate their motivational, explorative and social skills. As a result the researcher developed a toy that consists of undefined number of cubes that express emergent behavior by communicating with each other and changing their colors as a result of how they have been positioned by the players. The user tests have shown increased time of engagement of the children with the toy in comparison with their usual play routines, pronounced explorative behavior and encouraging results with improvement of turn taking interaction.

cMotion, proposed by Samantha *et al.*, (2009) which use virtual humans to teach emotion recognition and programming concepts to children. Having multiple facets, cMotion is designed to teach the intended users how to recognize facial expressions and manipulate an interactive virtual character

using a visual drag-and-drop programming interface. By creating a game which contextualizes emotions, it is hope to foster learning of both emotions in a cultural context and computer programming concepts in children. The game will be completed in three stages which will each be tested separately: a playable introduction which focuses on social skills and emotion recognition, an interactive interface which focuses on computer programming, and a full game which combines the first two stages into one activity.

Anika Anwar *et al.*, (2011) have developed an interactive computer game for the autistic children for improving the fluency in their speech. The researcher made a computer game where the player had to utter the names of the objects shown in the computer screen within a small period of time.

Maite Frutos *et al.*, (2011) proposed the system provides a solution to the learning and enhancement of habitual language in kids and teenagers with an autism spectrum using a simple and easy game focused on their personal needs and characteristics. This game is composed by two separated applications: the management application and physical game. The results are represented as a bar chart with the % score of the correct pronunciation of each word. These results can be exported and stored so as to keep a temporal register of final user's progression.

A serious game based on first aid education for individuals with autism using android mobile devices has been introduced by Zelai *et al.*, (2011). The main aim is to create a system composed of a set of Serious Games oriented to first aid education: what to do in certain situations, basic knowledge about healthcare, medical specialties, employing the use of technologies such as the Android operating system implemented on mobile phones or tablets. In this research, not only technological results have been analyzed, but the opinions of users and specialist taking part in the application's validation and initial testing have also been taken into account.

TouchStory is a software game proposes by Megan Davis *et al.*, (2007) which aims to improving the understanding of narrative by children with autism. TouchStory: a picture-based software game developed specifically for children with autism that aims at improving their understanding of narrative. This research underlying conceptual framework intends to investigate to what extent can improve the understanding individual children with autism have of narrative through the introduction of simple picture-based tasks that address primitive components of narrative.

B. Autism Serious Game for Therapy

Mohammed E. Hoque *et al.*, (2009) introduced a novel intervention towards customizing speech enabled games to help them produce intelligible speech. In this approach, they clinically and computationally identify the areas of speech production difficulties of our participants. They provide an interactive and customized interface for the participants to meaningfully manipulate the prosodic aspects of their speech.

Over the course of 12 months, they have conducted several pilots to set up the experimental design, developed a suite of

games and audio processing algorithms for prosodic analysis of speech. Preliminary results demonstrate the intervention being engaging and effective for their participants.

Md. Mustafizur Rahman et al., (2010) developed interactive computer game which will be helpful in increasing intelligibility in the speeches of autistic children and can be used as a therapy besides the traditional approaches. The research establishes the effectiveness of this therapy.

Interactive therapy system design for children with autistic spectrum disorders has been developed by Min Young Choi et al., (2010). This study discusses the potential use of an interactive design as assistive technology for such children. The experience gained in the collaborative design of the interactive therapy system (ITS). The key methods include a collaborative design with rapid interactive prototyping, heuristic evaluation, user-centered process, VR technology, tangible interface, and scenario-based contents. They applied these methods to the ITS and proved the efficiency of interactive design as an assistive technology through clinical experimentation. Five types of social skills training scenarios has been developed and one type of visuomotor coordination ability assessment scenario.

EEG-based "Serious" Games Design for Medical Applications proposed by Qiang Wang et al., (2010). In this research, a review on neurofeedback game designs and algorithms, and propose design, algorithm, and implementation of new EEG-based 2D and 3D concentration games. They reviewed EEG-based games neurofeedback games, algorithm embedded in neurofeedback games and game engines. The experimental result show that it is effectuated used as feature extraction methods. Fractal dimension method was embedded in the neurofeedback games to enhance the efficiency of classification algorithm. Possible futures in medical application of the games are proposed.

Alberto Battocchi et al., (2009) presented the design and an initial evaluation of the Collaborative Puzzle Game (CPG), an interactive game designed with the purpose of creating a technology-supported activity for fostering collaboration in children with Autistic Spectrum Disorder. Results show that shaping interaction with a set of system-provided rules called "enforced collaboration" makes interaction more complex but has a positive impact on children's collaboration.

V. CONCLUSION AND FUTURE WORK

Serious Game is relevant to address some human's problems such as autism. In this paper, a systematic review of serious games development and research in the field of autism is discussed. In the literature, studies show that games are very effective in the areas of therapy and education for autism children.

Serious games provide a leeway to move past this one-dimensional, narrowly fixed type of assessment. As a matter of fact, by combining other forms of conventional assessment with modern methods, video games can be assessed on a regular basis. In addition, this situation provides the

possibilities to create assessment that is more complex and complete.

From Corti (2005) said that "Assessment is the future of serious game". For now, there a no similar serious game those focus to identify the autism level. **For future work, our intention is to develop autism level identification by using serious game to identify high functioning, medium functioning and low functioning of autism children.**

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