Augmented reality social story for autism spectrum disorder

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Abstract. Augmented Reality is a technique that can bring social story therapy into virtual world to increase intrinsic motivation of children with Autism Spectrum Disorder (ASD). By looking at the behaviour of ASD who will be difficult to get the focus, the lack of sensory and motor nerves in the use of loads on the hands or other organs will be very distressing children with ASD in doing the right activities, and interpret and understand the social situation in determining a response appropriately. Required method to be able to apply social story on therapy of children with ASD that is implemented with Augmented Reality. The output resulting from this method is 3D animation (three-dimensional animation) of social story by detecting marker located in special book and some simple game which done by using leap motion controller which is useful in reading hand movement in real-time.

1. Introduction
Autism Spectrum Disorder (ASD) is a pervasive developmental disorder that affects the children in terms of interpersonal communication, social interaction, and imaginatively level in play. Many children with autism tend to self-stimulatory, such as hand-flapping, gloved, swaying or repetitive vocalizations [1]. Difficulty in realizing emotional change, lack of empathy with others and difficulty in responding appropriately to a disorder in social interaction for people with autism [2]. One therapy that can be done at the initial level of healing is social story.

A social story is a short story that can be used to help children with ASD in interpreting and understanding social situations and in determining a response appropriately in specially designated styles and formats [3]. Social story can be written or visual that can describe various social interactions, situations, skills, concepts and behaviour common to the community with the purpose of sharing social information that is accurate, convincing and easy to understand by children with ASD. Usually, the social story as therapy is done directly by the therapist to the autism children. This is done by read the story directly without visual support or with visual support but still with the visualization of two-dimensional (2D) which is considered still less accurate. A less interesting look can distract so that the message conveyed by the story will not be up and received by the children.

As the times progressed, a technology called Augmented Reality (AR) was established that can combine virtual world with its real state, which can be implemented in cultural preservation [7][8][9], historical virtual game [11], medicine and psychology. With the technology it also bring the side of medical therapy into the virtual world in the form and actual use.
2. Identification of Problems
Augmented Reality is a technique that can bring social story therapy into virtual world to increase intrinsic motivation of ASD children. By looking at the behaviour of children with ASD who will be difficult to get the focus, the lack of sensory and motor nerves in the use of loads on the hands or other organs will be very distressing children with ASD in doing the right activities, and interpret and understand the social situation in determining a response appropriately. Therefore it is necessary the method to be able to apply social story on therapy of children with ASD which is implemented with Augmented Reality.

3. Previous research
Zhen Bai, et al [4] has conducted a study using Augmented Reality method by applying target children with ASC (Autism Spectrum Conditions) at age 4 - 7 years and have been diagnosed positively with ASC. They make markers in the form of toys that are reflected through a screen that has an effect as a mirror.

Lizbeth Escobedo and Monica Tentori [5] in 2014 conducted research to help teachers or autistic child therapists provide additional visual support through the use of mobile-based augmented reality methods. The study was conducted over 8 weeks in 3 classrooms, each class consisting of 7 teachers or therapists and 14 children with autism. They are discussed how to train ASD children using virtual systems and augmented reality.

In 2014, Lakshmiprabha et al [1] studied the uses of Augmented and Virtual Reality (AR / VR) systems to train children with autism based on Applied Behaviour Analysis (ABA) techniques in viewing the behaviour of the child. The system helps in teaching children with asd in recognizing new images and objects and the use of appropriate words and sentences.

Qingguo Xu, et al [6] conducted a study using augmented-reality glass platform method for ASD by installing cameras and microphones as inputs used for interviews to be conducted on ASD children.

4. Research methods

4.1. Augmented reality
Augmented Reality is the incorporation of existing objects in the real world with virtual worlds in certain places and circumstances that run interactively in real time and there is integration between objects in three dimensions (3D objects), virtual objects integrated with the real world.

Augmented reality (AR) technology enables technologies that combine virtual worlds generated by computer sensors in the form of graphics, sound and video with real world in real-time. The purpose of AR is to add information and meaning to an object or real space.

4.2. Social Story
Social story is a short story that can be used to help children with asd in interpreting and understanding social situations and in determining a response appropriately in specially designated styles and formats. Social story can be written or visual that can describe various social interaction, situation, skill, concept and the behaviour common to society with the purpose of sharing social information that is accurate, convincing and easy to understand by children with autism.

4.3. Leap Motion
Leap Motion Controller is a hardware sensor tool that supports hand and finger movements as input, which can be equated with functions like a mouse, but does not require direct contact with the hands or touch. Leap Motion Controller is a tool that aims to track hand and finger movements to perform a brief game on this research.

4.4. General Architecture
The general architecture of Augmented Reality Social Story can be seen in Figure 1.

![Figure 1. General Architecture Augmented Reality Social Story](image)

This stage describes the general architecture of the application as shown in Figure 1:

- **Input**
  Markers are placed on sheet books that used as a place to show the 3D animations.

- **Process**
  The markers on the book sheets and Leap Motion Controller are placed between the camera and the screen. The use of Leap Motion helps the hand to move virtual 3D objects that will be detected and recognized by the camera. After that compare marker book with marker that available on database. If the information is appropriate then proceed to the estimate of laying the virtual objects on the marker contained at the book sheets. Then, done rendering process.

- **Output**
  The resulting output is an Augmented Reality object and 3D animation in the form of a social story on the book marker.

5. **Result and Discussion**
After testing the application by following the test plan, the results are stored as evidence that the application has successfully passed the test phase.

Test results obtained include:

- Implementation of AR Camera on marker detection done with a distance and certain condition.
- Augmented Reality and hand motion reading with leap motion goes well.
Figure 2. Augmented Reality Social Story

In Figure 2, can be seen that augmented reality shows a social story in the 3D animation.

Figure 3. Augmented Reality Social Story using Leap Motion Controller

In Figure 3, shows augmented reality with social story view integrated with leap motion controller. In this scene the user is invited to play with some simple games using leap motion controller.

Figure 4. Child with autism using Augmented Reality Social Story

To examine the level of system use approval, the system was tested for three children with autism who were in therapy. When using the system, they are accompanied and guided by the therapist. Testing of children can be seen in Figure 4.

After that, the therapist is allowed to fill out a questionnaire containing some questions and statements about the level of conformity therapy to the system. All questions and statements are paired with Likert scale to get the results. Where on the scale do not agree is worth 1, less agree is worth 2, agree is worth 3 and strongly agree is worth 4.
Average Value = \frac{\sum (R \times AV)}{MAV \times R_{Total}} \times 100

Keterangan:
R = Respondents
AV = Answer Value
MAV = Maximum Answer Value

Tests of the system performed on three people with autism who was accompanied by each therapist (respondent). Based on the calculation with Likert scale, the average value of each statement at the level of system use approval can be seen in Figure 5.

Based on the results of questionnaires that have been done to three respondents, all respondents chose to agree that the first statement to the eighth states that if the social story application can be used as a medium of learning for children with autism, social story application helps mentors in the process of learning, this application can provide appropriate learning in the pre-academic stage curriculum, the arrangement of content on the application in accordance with the therapy, the use of colors and images in the application in accordance with the therapy, the display game interesting, the game is interactive and easy to play and children are enthusiastic with this game, where the average percentage of this statement is 75%. In the ninth statement, two respondents chose to agree and one respondent chose less agree if the game on this system to make children interested in doing the process of learning, where the average percentage of the statement is 67%. As for the tenth and eleventh statements, one respondent chose to agree and two other respondents chose less agree that the audio in this game is clear to be heard and the audio in this game can be understood its meaning, where the average percentage of this statement is 58%.
6. Conclusions
Some conclusion based on testing of the augmented reality social story therapy system for children with Autism Spectrum Disorder (ASD), are: Accuracy rate is higher when the number of therapy more. The more the amount of therapy can result more accurate the healing of children with ASD. NMarker distance and marker type changes as well as scenes given on visualization will increase the accuracy level when the therapy is done. Applications can run well when detecting markers, hand interaction using leap motion controller and displaying 3D objects. Based on the Likert scale with an average percentage of 71.18%, respondents agree that the system can support visualizing social story therapy for children with Autism Spectrum Disorder (ASD) in interpreting and understanding the surrounding social situations.

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