8. Implementation of Augmented Reality in Pretend Play Therapy for Children with Autism Spectrum Disorder

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Abstract. Autism Spectrum Disorder is a pervasive developmental disorder that will affect children in terms of interpersonal communication, social interaction, and imaginative levels in play. Many therapies to help the motor neuron performance is one of them Pretend Play. Pretend Play is a therapy that invites children in playing to demonstrate something else and tell how to use objects that are considered in the child's imagination. However, in the era of highly developed technology, many fields have used the Augmented Reality method as a visualization of various aspects. With this method researchers will present the therapeutic visualization of the block to 3D transportation tool that is useful for strengthening motor nerves and visual strength of the child. The system can run well during marker detection, marker movement, and 3D object display with the accuracy of precision angle and distance between virtual world with real world reach 100% with angle 0° at distance 31 cm and the maximum distance from the marker is 46 cm and the maximum angle is 30°.

1. Introduction

Many children with autism tend to self-stimulatory, such as hand-flapping, wobbling clapping or repetitive vocalizations [2]. ASD is often found by children due to lack of interpersonal communication and social interaction in children.

With the advent of the world of therapy then comes a therapy called Pretend Play. This therapy is one part of therapy in children with autism that is done at an early stage of healing ASD children low level where the behavior of children who are usually done in the real world will be interpreted in the symbolic form. In this therapy there is usually an object or media as a substitution object of an object to increase motor neuron strength and visual strength of children.

A new technology called Augmented Reality (AR) is technology that combines what is in reality and what is generated from computer by enhancing what we see, hear, smell and feel[5]. Augmented reality is implemented as the education media and the information media. Augmented reality is the technology which implements computer vision in its process[6]. As the development of the age of Augmented Reality technology that can combine the virtual world with the real world and is often applied by several aspects. Therefore, researchers use the AR method as a visualization of Pretend Play therapy that substitutes a 3D object into a real beam.

Identifications of Problems

ASD suffers who will find it difficult to focus on therapy because the item has been owned by the child and without being taught the usefulness of the object. As well as the lack of sensory and motor nerve strength in the use of load on the hand is very troublesome children with ASD to perform activities like a normal child. Therefore, a method that can be used to visualize the beam will be substituted as a type of object on Pretend Play therapy.

2. Previous Research

In 2013, Zhen Bai and his colleagues conducted the study using Augmented Reality method by applying target children with ASIS (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. [1]

Samantha also conducts research in 2014 by applying exergame using virtual reality to increase the motivation of children with autism to exercise weight in order to improve the quality of children's health. [2]

Lakshmiprabha in the same year conducted research on children with autism by applying augmented techniques as well as virtual reality on a guessing therapy image in accordance with the instructions given. [3]

2015 Qingguo Xu conducted research using augmented-reality glass platform method for ASD by installing camera and microphone as input used for job interview. [4]

3. Methodology

3.1. General architecture

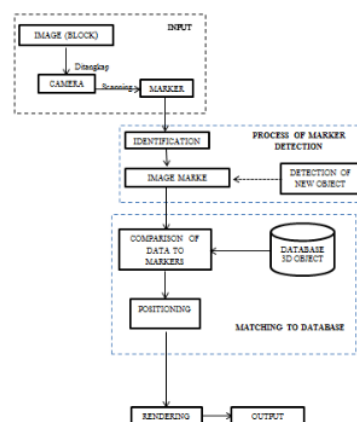In this research consist of several processes namely input, process, and output. As can be seen in Figure 1.

Figure 1. General architecture.

3.1.1. Input

Users use markers in the form of images placed on the block as a medium for viewing cars, trains and boats. The base piece that will display the terrain of a track that will be displayed statically in the form of a different virtual object.

3.1.2. Process

a.   Marker Detection Process

The scanning marker described in the previous section will go through a scanning process to read the new object contained in the marker as a marker given to the therapeutic process performed. Scene used in therapies such as cars, trains and boats. The process of marker scanning process is:

- Identification

  At this point the marker used in the input section will be interpreted by degrees (X, Y, Z) which will produce the correct image marker for scanning.

- Identification of New Object

  This stage is done to read a new object that will be in accordance with the 3D object database after the marker checking step is done.

b.   Matching to Database

At this stage the marker that has been captured by the camera will match it with the existing virtual database. As for the process contained in matching to the database that is,

- Comparison of Data on Markers

  That is a comparison between markers that have been scanned with existing databases to do the laying of the positioning of objects based on markers that have been scanned.

- Positioning

  That is by matching the scale of virtual objects to scale in the real time. And define the appropriate position so that there is a central point contained in the physical object.

c.   Rendering

At this stage will be tracking in the form of hand positioning and marker shift to the central point that has been determined at the positioning stage. And if the information obtained is clear then it will be done rendering that will display the 3D form that has been made.

3.1.3. Output

The final step configures all the objects that have been done during processing to the AR system. And the output that will be displayed on this system is a virtual object in 3D that is combined with real world objects that will be displayed on a screen where there is a centralized sync between the virtual world with the real time and implemented in the form of a game.

3.2. Used data

In this study the data used are images taken in real time with attention to the distance and angle of shooting of the camera used.
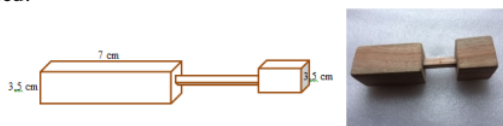

Figure 2. Block size and image block captured camera.

3.3. Marker

Markers are used as 2D markers in the real world that are pasted on the beam to bring up 3D objects. Marker used in this study can be seen in Figure 3

Figure 3. Marker used.
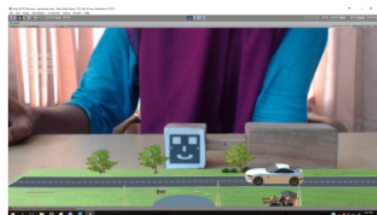
4. Result and discussion

Implementation of the system done by children in the form of a game scene that consists of three scenes. The child's first level uses the beam by means of transportation of the ship, the second level on the train and the last level on the car. In this game the user must pass the track that has been given as shown in Figure 4.

(a)

(b)

(c)

Figure 4. Scene therapy pretend play.

4.1. Marker testing

The test is done in two stages: test based on distance, and angle. From this test can be seen whether the marker can be detected by AR CAMERA well so that it can display 3D objects and the laying of the beam has been in accordance with the given track. Testing is done by opening the application, after the application is open then AR CAMERA will detect the existing marker by pointing the camera at the marker. Marker used is a 2D image with a size of 3.5 cm x 3.5 cm. Here is a marker test based on the distance and angle of the camera. The distance test is performed in order to see the maximum distance marker can be detected and see the most effective distance on marker detection.

Table 1. Testing by distance on markers.

No	Range	Testing	Detected	Not Detected	Accuracy	Explanation
1.	25 cm	5	5	0	80%	Detected, stable, but the 3D object is not on the given track.
2.	31 cm	5	5	0	100%	Detected, stable, but the 3D object is on the given track.

4

No		Testing	Detected	Not Detected	Accuracy	Explanation
3.	36 cm	5	4	1	70%	Detected, not stable, but the 3D object is not on the given track.
4.	46 cm	5	2	3	30%	Difficult to detect, unstable, and incompatible with given track.

Marker testing is done in a room with a marker condition not directly highlighted by the lamp vertically. Through this test the marker can be read well by AR CAMERA when it is precisely at 31 cm so it can produce a 3D object according to the given track. And the value of accuracy is 100%.

The camera tilt angle test is performed to determine the most effective angle in marker detection.

Table 2. Testing by angle.

No	Angle	Testing	Detected	Not Detected	Accuracy	Explanation
1.	0°	5	5	0	100%	Detectable, stable, but the 3D objects right on track.
2.	5°	5	5	0	80%	Detecable, stable, 3D objects right on track.
3.	10°	5	3	2	70%	Detected, less stable, and does not match the given track.
4.	30°	5	2	3	30%	Difficult to be detected, object missing sometimes is not stable, and does not correspond to a given track.

In Table 2 the authors tested 4 angles with different levels of accuracy. The result shows that the object will be stable and in accordance with the test if it is at 0° and 5° with stable results, but at 5° angle the 3D object does not match the given track. But at 10° and 30° angles the given object is unstable and does not match the given track because the marker is not fully visible.

4.1.1. Survey on system
Conducting a survey of the system aims to get more accurate results from making the system. The authors tested to 3 children with special needs of low level with accompanied by different psychologist. The first thing children do is see how to grip the beam, then with the psychologist hearing the beam until the child raises his own initiative to run the beam in accordance with the given track. After that the psychologist filled in a questionnaire filled based on the suitability of the system with children with ASD.

The questionnaire submitted is matched with Likert scale to get the result which can be seen in Table 3.

Table 3. Likert scale on questionnaire.

Approval Scale	Value
Disagree (TS)	1
Less Agree (KS)	2
Agree (S)	3
Strongly Agree (SS)	4

Table 3 is the reference table for the value of each psychologist's answer to the given questionnaire. The questionnaire contains a question of system suitability with the child's motor and visual skills. From the value of the given scale, can be taken the average value based on the questionnaire by summing the

value of each statement divided by the number of respondents (psychologists who fill out the questionnaire). The average value of each statement is described as follows:
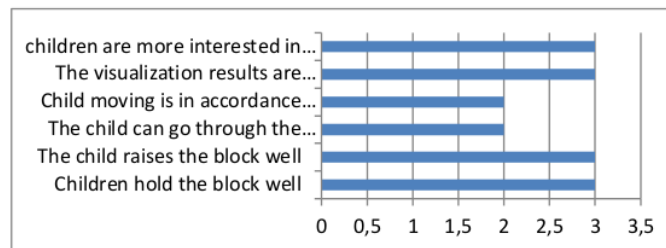

Figure 5. Survey charts in children.

In picture 5 the psychologist gives average value of 3 on the child holding the beam well and the beam well because the beam used is in accordance with the standard usage as media tool for pretend play therapy. While to receive instructions and get through tracks gets value 2 because the child is still confused by the existence of new therapeutic tool. The latter also scored 3 on a convenient visualization result with the child more interested in performing the therapy activities.

5. Conclusion

After doing the stages on the implementation and testing, it will be obtained some conclusions contained in this study are:

- The system can run well during marker detection, marker movement, and 3D object display.
- Accuracy of precision angle and distance between virtual world with real world reach 100% with angle 0° at distance 31 cm.
- The maximum distance from the marker is 46 cm and the maximum angle is 30°.

Based on the value of the Likert scale, respondents agree with the value 3 of the maximum value 4 that the child can lift the load and grasp the beam well.

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