Implementation of augmented reality to train focus on children with special needs

M F Syahputra¹, P P Sarı², D Arisandi³, D Abdullah⁴, D Napitupulu⁵, M I Setiawan⁶, W Albra⁷, Asnawi⁸ and U Andayani⁹

¹,²,³Department of Information Technology, Faculty of Computer Science and Information Technology, Universitas Sumatera Utara, Medan, Indonesia
⁴Department of Informatics, Universitas Malikussaleh, Aceh, Indonesia
⁵Research Center for Quality System and Testing Technology - Indonesian Institute of Sciences
⁶Department of Civil Engineering, Narotama University, Surabaya, Indonesia
⁷Department of Management, Universitas Malikussaleh, Aceh, Indonesia
⁸Department of Elementary, Teacher Education, Universitas Samudra, Aceh, Indonesia

Abstract. Differences possessed by children with special needs such as differences in mental traits, sensory abilities, social and emotional behavior etc. of normal children causing learning and developmental barriers on children, so that requiring more specific services. Autism is one category of children with special needs who experience delays in responding to the things around him that caused by chaos in the brain work system. The tendency of autistic children who only focus on themselves makes it difficult to concentrate on one thing and easily switch when being talked. Therefore, it takes an application that can help people with autism to be more focused and concentrated so as to reduce barriers in the learning process and its development.

1. Introduction

Every children often experiences obstacles in their learning and development. However, some children with special needs require special attention and treatment from the people around them to overcome these obstacles[1]. Children with special needs or exceptional children are children who differ in mental traits, sensory, physical and neuromuscular abilities, social and emotional behavior, communication skills, or a combination of two or more of them from other normal children.

Autism is one category of children with special needs who experience delays in responding to the things around him that caused by chaos in the brain work system. The tendency of autistic children who only focus on themselves makes it difficult to concentrate on one thing and easily switch when being talked[2]. Therefore, it takes an application that can help people with autism to be more focused and concentrated so as to reduce barriers in the learning process and its development.

In this study, the authors will create a system that can help train the focus of people with autism with augmented reality using leap motion controller. Focus level of the child is seen from the ability of his hands to move the object that is read by leap motion according to the instruction shown to the user. The
use of augmented reality in this system is seen when user seems to hold the object to move it but the fact is the user does not hold the object.

2. Identification of Problems
Due to the frequent occurrence of obstacles in the learning process as well as the development of autism sufferers due to the difficulty of the child's ability to focus and concentration, it is necessary an application that can train focus and concentration for children with autism.

3. Previous research
Research on children with special needs and more autism has been done before as in 2013, Zhen Bai and his colleagues conducted research on autism. In the study Zhen bai made augmented reality with a pretend play model as a treatment process for people with autism. This pretend play-shaped game can demonstrate the communication and social interaction skills of autistic children. Zhen Bai interprets marked beams as a means of transportation and displays them in the form of augmented reality. On the screen will be shown the child is running the train. Whereas in reality, the child is pretending to move the beam as if it were a train. This study received a positive response from parents of people with autism. They really liked the augmented reality in the form of pretend play in helping the healing of his son. And 9 out of 10 users also prefer to play pretend play with augmented reality than non augmented reality [3].

Farhan Luthfi in 2015 conducted research on the use of leap motion on the human anatomy of three-dimensional. Users can study anatomy by moving their hands toward the model. Movement or gesture of the hand captured by leap motion is used as a control system. The hand gestures recognized by the system can change the user's point of view to anatomy, zoom-in / out, and display object names. Based on the results of questionnaires of 4.13 with Likert scale, users feel satisfied and agree this system is very interactive. [4].

In 2015, Gaoxia Zhu also conducted research on autism in the form of games using leap motion. In the game, the user must move the ball into a container that has the same color as the ball. Leap motion is used to read hand movements when moving the ball. Gaoxia measures the development of motor skills of autism sufferers from the accuracy of users moving the ball. Two children who become participant are noticed daily development when using this system. On the first day, the accuracy of moving the ball to the same color is 0%. However one child already has 100% accuracy in adjusting the ball to the same colored container as the ball on day 7. While the other child gets 100% accuracy on the 20th day [5].

Seiji Sugiyama in 2016 conducted research on the use of leap motion controller on augmented reality that is applied to display 3D textbooks. In that study, Seigi created an electronic book model on a web browser. The book can be controlled by hand without touching the surface of the screen or with the help of other control tools such as a mouse. Hand gestures are read by the system via leap motion controller [6].

4. Research methods

4.1. General architecture
In this study consists of several steps, starting from the input process that captures the image and marker, augmented process and leap motion and its output. For more details can be seen in Figure 1.
4.1.1. Input
There are three inputs in this system namely image, marker and hand. The imagery and marker are captured by the camera. The imagery is used as a reality to be combined with a digital object and marker is used as a 3D object marker. While the hand is detected by leap motion controller.

4.1.2. Process
- 3D Object
  The system will display 3D Object from the captured marker of the camera and merged with the image captured by the camera as well. With this marker, 3D objects will be displayed in the form of augmented reality.
- Gesture Detect
  Gesture detect is done to track the movement of the user's hand in real-time. To track the movement of the user's hand done two processes namely scan and position. Scan is the process of detecting the user's hand. While the position is the process of finding the position of the user's hand.
- Direction of 3D Object
  3D objects displayed will show instructions / instructions in the form of audio to help children understand what to do on the system.
- Render
  Rendering is the final process of the whole process. At this point, the system will continue and display a new scene after the instruction in the previous 3D object has been completed by the child.

4.1.3. Output
The system will display a game scene output for game users.

4.2 Introduction of Hand Movement
Leap motion recognizes the user's hand movement by reading the user's hand in the air just above the leap motion controller that has been connected to the computer via USB. Leap motion read movement
will be processed in unity using C# programming language. The movement of hands known by the system is:

- Hand movements such as sweep (swipe gesture) in the direction of x, y and z axis both using the right hand and left hand. However, the object moved/shifted with a gesture swipe in the direction of the z axis will not move according to the settings that the author made on unity.
- Hand gestures like holding objects to move objects more stable.

4.3 Marker Determination
Marker is used as a marker for 3D objects to appearing the form of augmented reality. The marker used on this research is logo of University of Sumatera Utara like figure 2.

![Figure 2. Markers used](image)

5. Result and Discussion
Implementation of the system performed on the patient autism is a game scene that has four levels. The first level is a straight street, the second level is street-shaped turn, third level of branched and level street all four are labyrinths. In this game, the user must collect coins by moving the familiar elliptical object using hands that are moved in the air just above the leap motion as seen in figure 3.

![Figure 3. Scene Game(a),(b),(c)and(d)](image)

5.1 Marker testing
Marker testing is done to determine the farthest distance which the camera can read on the marker. In this research the authors make 3 test parameters for each test distance. While the test distance in this research as much as 6. Testing done 5 times each test distance. To earn a percentage in each description, the number of tests that are successfully divided by total testing (5) then multiplied by 100. Results system testing can be seen in table 1.

Table 1. Marker Test Results

| No | Test range | Number of Tests | Information          |
|----|------------|-----------------|----------------------|
|    |            |                 | Detected  | Stability |
| 1. | 20 cm      | 5               | 100 %     | 100 %     |
| 2. | 40 cm      | 5               | 100 %     | 100 %     |
| 3. | 50 cm      | 5               | 100 %     | 100 %     |
| 4. | 60 cm      | 5               | 100 %     | 100 %     |
| 5. | 65 cm      | 5               | 60 %      | 0 %       |
| 6. | 70 cm      | 5               | 0 %       | -         |

From table 1 information shows that the maximum distance for marker detected and stable is 60 cm. This happens because of the limited focus of the camera in recognizing that marker of 60 cm x 60 cm has reached the maximum limit.

5.2. Testing the detection angle of detection
Detection slope angle is done to determine the degree of maximum marker slope that can be read by camera. As marker distance testing, the detection slope angle testing is also performed 5 times with the number of slope angles tested is 5 corners. To obtain a percentage on accuracy, the number of successful tests divided by total testing (5) is then multiplied by 100. The results of system testing can be seen in table 2.

Table 2. Testing Tilt Angle Marker

| No | The angle of the marker | Number of tests | Accuracy |
|----|-------------------------|-----------------|----------|
| 1. | 0º                      | 5               | 100 %    |
| 2. | 30º                     | 5               | 100 %    |
| 3. | 45º                     | 5               | 100 %    |
| 4. | 60º                     | 5               | 60 %     |
| 5. | 90º                     | 5               | 0 %      |

5.3. Approval’s level of system usage
System testing performed on three autism patients who were accompanied by each expert child therapist. Testing of children can be seen in figure 4.
The authors conducted a survey in the form of questionnaires conducted on respondents to see the level of system use approval. Questionnaires that the authors do in the form Likert scale with four scales of agreement as in table 3.

| Scale of agreement | Value |
|--------------------|-------|
| Strongly agree     | 5     |
| Agree              | 3.75  |
| Less agree         | 2.5   |
| Disagree           | 1.25  |

From the values on the scale can be obtained the average value of each statement by:

\[
\text{Average value} = \frac{\sum (R \times NJ)}{NJM \times R_{\text{total}}} \times 100
\]

Information:
\[R = \text{Respondent}\]
\[NJ = \text{Answer Value}\]
\[NJM = \text{Maximum Answer Value}\]

The system test was performed on three people with autism who were accompanied by each expert therapist (respondent). Based on the manner in which the calculations have been described previously, the average value of each of the statements at the level of system use agreement may be seen in figure 5.
Figure 5. Level of System Use Approval

Based on table 5, the first statement that has an average percentage of 83% indicates that respondents feel strongly agree that the application can train the focus of the child.

6. Conclusion

After doing the implementation and testing phase of the system, then obtained some conclusions found in this study are:

- The system runs well when detecting markers and displaying 3D objects.
- Maximum distance marker detected by camera and 3D object shown with stable is 60 cm.
- The maximum tilt angle of the marker detected by the camera is 45°.
- With an average percentage of 83% on a Likert scale, respondents strongly agree that the app can train the child's focus.

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