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VIRTUAL REALITY SYSTEM TO DETERMINE HUMAN ACTIONS IN A MAZE

The article considers the system of virtual reality to determine human actions in the maze. This system allows you to immerse a person in virtual reality and check how the user navigates in the surrounding space. From the data obtained, it is possible to conclude whether the user is prone to Alzheimer's disease. Possible options for moving the user through the maze, as well as options for collecting information about the movement and user actions are considered. A memory training game in this system is also considered.

Key words: virtual reality, VR, the virtual maze, Alzheimer's disease, Unity

Fig.: 12. Tabl.: 1. Bibl.: 13.

Target setting. Alzheimer's disease progresses greatly and there is a great need to determine whether people are prone to it, as well as to reduce its progression by training memory.

Actual scientific researches and issues analysis. In recent years, virtual reality has begun to be used in medicine. Virtual reality systems already exist to detect Alzheimer's disease in humans. There is a great need to continue to explore this area.

Uninvestigated parts of general matters defining. Existing virtual reality systems for detecting Alzheimer's disease in humans are not sufficiently accessible to a large number of people. Therefore, there is a need to create such a system for mobile virtual reality with the additional ability to train the memory of users.

The research objective. The purpose of this article is to consider the advantages of existing virtual reality systems, to study Alzheimer's disease and its progression, to consider a virtual reality system to determine human actions in the maze, options for movement in this maze, algorithms of these movements. To consider how the system collects data about a user's movements and actions. Moreover, to consider a game in this system that helps to train the memory of users.

In Figure 1 we can see the interaction of the user with virtual reality glasses.

The statement of basic materials. Today, virtual reality is becoming increasingly popular and people use it in various areas of life, such as education, marketing, architecture and design, industry, medicine and many other fields.

There are many virtual reality systems not only for fun, but also to help people in various branches of life.

Fig. 1. Interaction of virtual glasses with a user [1]

Table 1

Comparison table of existing virtual reality systems

Name of the system / Advantage	**Virtual prototyping system**	**The Body VR**	**Sea Quest Hero**	**Other VR systems for detecting Alzheimer's**	**Other VR Maze System (Games)**	**My VR System**
Mass accessibility	-	-	-	-	+	+
Price accessibility	-	+	+	-	+	+
Help for user of system	+	+	+	+	-	+
Help for sick	-	-	+	+	-	+
Simplicity (ease of use)	-	+	-	-	+	+
Entertainment	-	+	+	-	+	+
Memory training	-	-	-	-	-	+
Orientation in space	-	-	+	+	+	+
Full immersion	+	+	-	+	-	-

The table 1 contains existing virtual reality systems to help people in different branches. In this table "Other VR Systems for Alzheimer's Disease Detection", mean other systems for detecting Alzheimer's disease by checking the spatial orientation of the user. Also, such systems include the virtual reality maze created in Germany, which showed that people prone to Alzheimer's disease bad went through the maze unlike healthy people [2]. Because in Alzheimer's disease, that part of the brain that is responsible for spatial orientation is disrupted [3]. There is little information about this maze and it is not accessible enough for a large number of people.

As we can see from the table 1 of comparisons of existing systems that my system:

1. Is widely available, as well as with price available, that is, any user of a smartphone with the Android operating system and with any virtual glasses can try my system.

2. Helps to identify whether a person has problems with memory and orientation in the environment, so whether the user of this system may be predisposed to Alzheimer's disease.

3. To prevent a reduction in the progression of this disease has the ability to train memory.

4. It is easy to use. The user can easily understand its using, because all interaction with interactive objects is by looking, that is, by tilting the head, without using other parts of the body and without moving in real space.

Consideration of Alzheimer's disease. Alzheimer's disease - is the most common cause of dementia in the elderly and senile – it is diagnosed in 50% of patients with dementia. Memory impairment is the first and most significant complaint. [4]

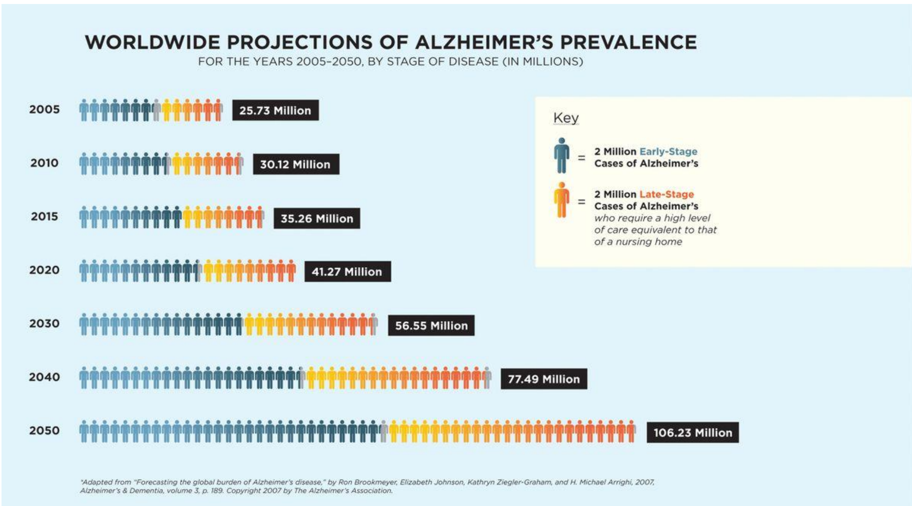

Fig. 2. Worldwide projections of Alzheimer's prevalence. [5]

In figure 2 we can see a graph of statistics about the future epidemic of Alzheimer's disease.

In figure 3 we can also see that the number of patients with Alzheimer's disease will only increase in different countries of the world.

Also this figure shows that dementia mainly affects older people, but the number of cases that start before age 65 is growing rapidly.

So, these graphs show that Alzheimer's disease is progressing rapidly now and will continue to progress in the future. This disease occurs not only in the elderly (over

65 years), but also in younger people. So nowadays, there is a great need to start detecting this disease in people from a young age.

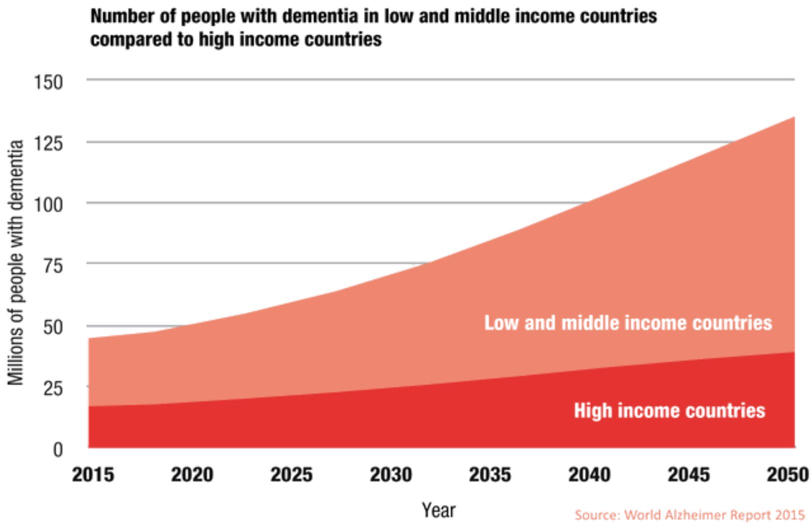

Fig.3. Number of people with dementia in low and middle income countries compared to high income countries. [6]

Some of the main symptoms of Alzheimer's disease are: [4]

- Short-term memory suffers.
- Disturbed spatial orientation.

Fig. 4. Human memory needs constant training with age [7]

In figure 4 we can see that a person's memory is like a puzzle and with age a person can start to lose memory like a piece of a puzzle.

It is very important to keep the memory normal. This requires training the memory systematically, especially for people prone to Alzheimer's disease.

The main view of the created system. Based on the information listed, a virtual reality system was developed to determine human actions in the maze.

In this system, the user is immersed in a virtual space, or rather in a virtual maze, from which he needs to find a way out. With this system we can see how a person moves through the maze, whether he constantly gets into dead ends, whether he moves in the same way, how he behaves in it and whether he can find a way out of it.

Because this system is designed for mobile VR so that it is accessible to as many users as possible, and in virtual reality for mobile devices only the tilt of the head is taken into account, not the movement of a person in real space in this system the user can move in two ways:

1. Looking at the special teleports, which are located on the floor of the virtual maze and act as points for movement. The user needs to look at the teleport to which he plans to move, a special point that acts as a cursor and which is in front of the user's eyes in virtual glasses. After looking at the teleport, the Progress bar is filled (literally one second) and after filling the user is moved to the desired point. Progress bar - is a very important part for the convenience of user interaction between interactive objects, so that if the user accidentally glances can cancel the planned action.

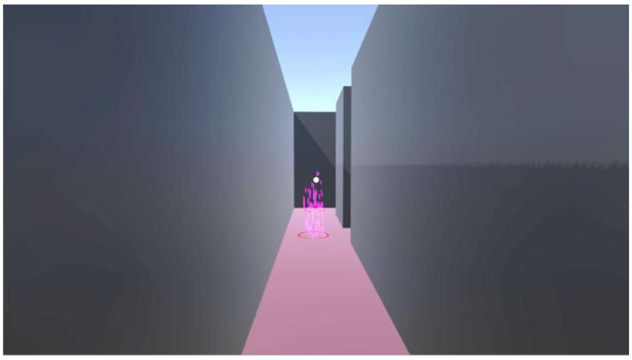

Fig. 5. The first option of moving

In figure 5 we can see the process of moving the first option through a virtual maze. We can see special teleporters that need to be looked at to move.

2. Looking at the four arrows at the bottom of the user. The user needs to look at one of these arrows and he will start moving in the direction of this arrow through the virtual maze. In this case, the process of user movement is smoother and more realistic, because there is no abrupt movement (teleportation) as in the first version of the movement.

In order to see the back of the arrow, the user needs to look back with his head and lower the gaze down and for the movement process itself, user needs to look at the arrow.

Figure number 6 shows the front view of the second version of the movement through a virtual maze.

There is an inscription under the arrow so that the user can easily understand how this option works.

Figure number 7 shows the back view of the second variant of moving through a virtual maze.

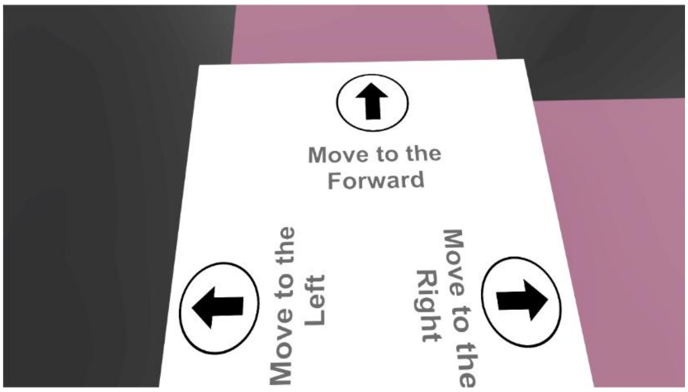

Fig. 6. The second option of moving (front view)

Fig. 7. The second option of moving (back view)

In figure 8 we can see detailed algorithm of the first option of moving through a virtual maze.

1. *timeToFill* - is the time to fill the Progress Bar.
2. *startTime* - is the start time.
3. *overTime* - is the time for which the Progress Bar should be filled from the beginning of time.
4. *progressBarImage.fillAmount* - Amount of the Image (image value) to fill it within [0;1]. [8]
5. *Player.transform.position* - coordinates of the user's position. [9]
6. *new Vector3* (*interectiveObject.position.x*, 1.8, *interectiveObject.position.z*) - creation of a new object to change the coordinates of the user, where:
   - *interectiveObject.position.x* - is the X coordinate value of the interactive object,
   - 1.8 - is the value of the Y coordinate of the interactive object,
   - *interectiveObject.position.z* - is the value of the Z coordinate of the interactive object.

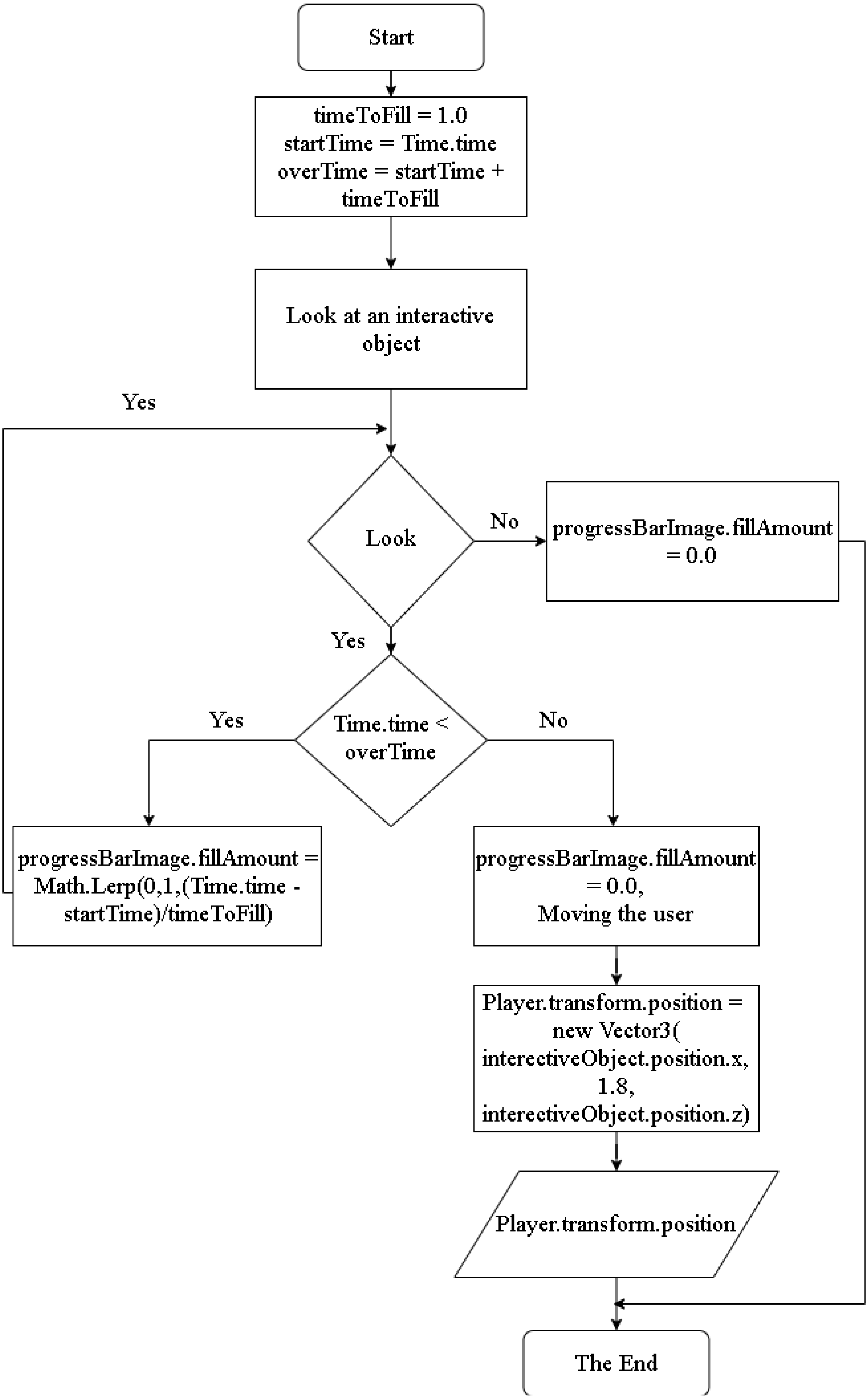

Fig. 8. The algorithm of the first option of movement

The following formula is used to fill in the Progress Bar correctly:

$$fillAmount = Math.Lepr(0{,}1, \frac{Time.time - startTime}{timeToFill})$$

Math.Lepr(float a,float b,float t) - Linearly interpolates between a and b by t. The parameter t is limited by the range [0, 1]. [10]

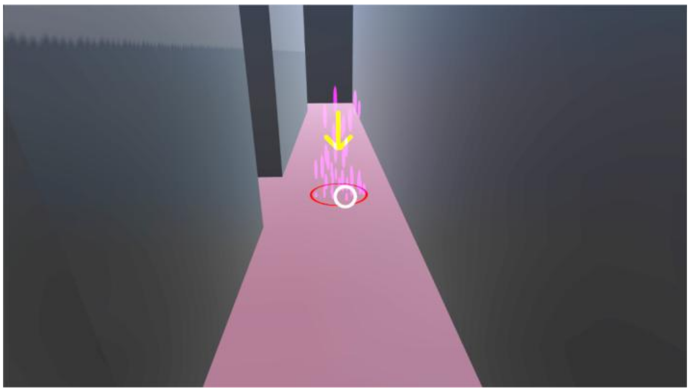

Fig. 9. The process of filling the progress bar (arrow to down)

In figure 9 we can see the process of filling the progress bar. In this case, the arrow that points down acts as a progress bar. After loading an arrow pointing down, the user will be move to the place of the teleport.

In figure 10 we can see algorithm of the second option of moving.

1. Variable *trigger* - a parameter to determine in which direction to move the user.
2. *Player.transform.Translate* (*Vector3 translation* * *Time.deltaTime*) is a method to move the user in the desired direction where: [11]
   - *Vector3 translation* - the direction of movement along a certain axis.
   - *Time.deltaTime* - The completion time in seconds since the last frame. [12]

That is, the movement is in the right direction by one unit per second.

As the user moves through the maze, the system calculates the points at which the person was during the passage of the maze. And above the user's head is constantly a canvas with the result of the points where the user was, this canvas is updated in real time. Canvas is an object in the Unity editor for displaying UI elements such as text, images, buttons, and more [13]. At these points you can understand where the user was during the passage of the virtual maze.

In the first move, these points act as teleport objects. In the second version, I placed objects on the stage that have a collision component. This component is needed in Unity to understand that the user was present. Of course, all of these objects are invisible to the user, so as not to spoil his full immersion in cyberspace. In this case, the result of the points where the user was during the passage of this maze is also displayed.

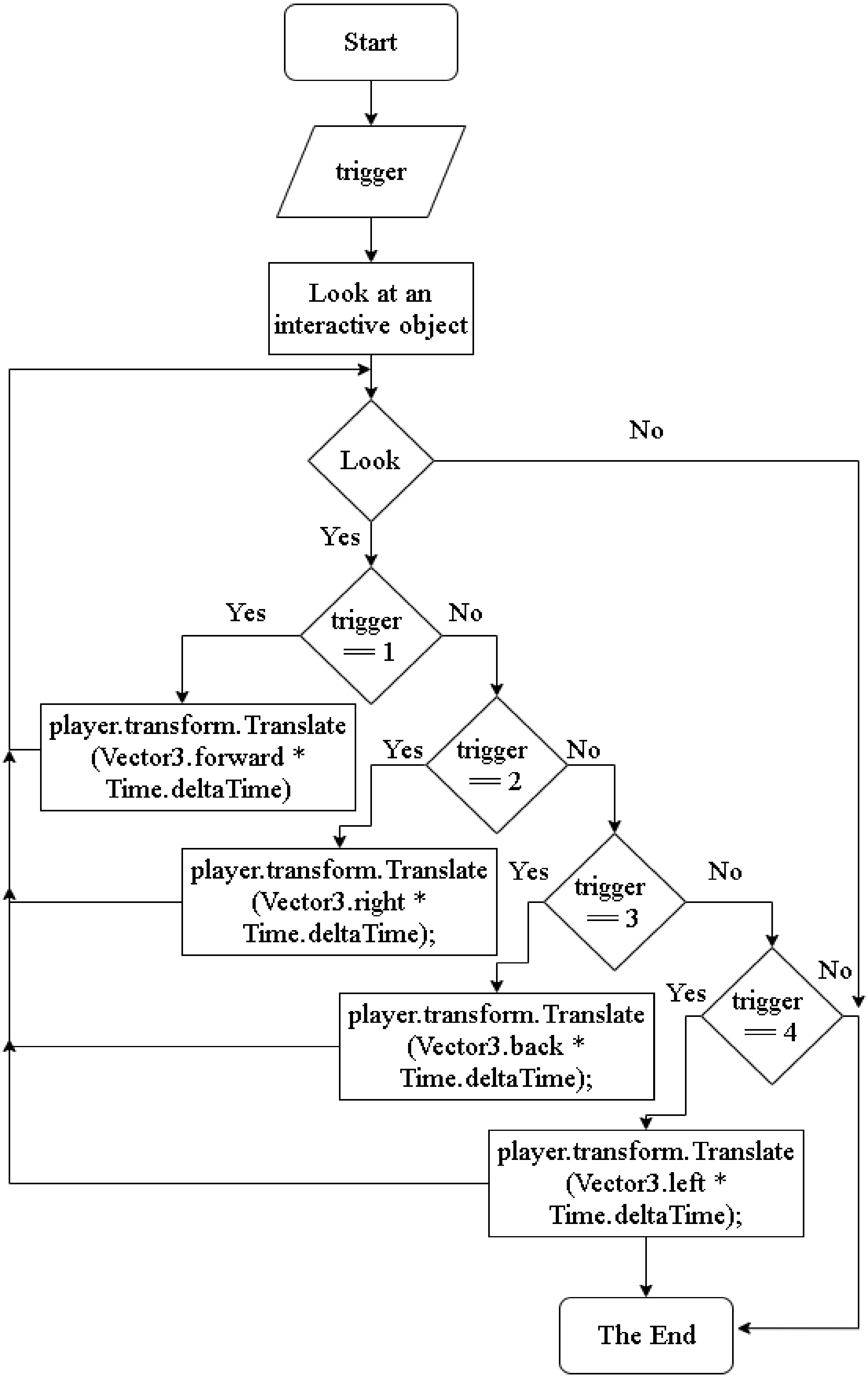

Fig. 10. The algorithm of the second option of movement

I must say that the points give us only information about where the user was during the passage of the maze. But in order to be able to completely see how a person behaved during the passage of the maze in this system there is the possibility of a full video of its passage. That is, you can start a video before passing, and after completing the maze to save this record. This video will be saved in the user's gallery on their mobile device. And after that it can be viewed.

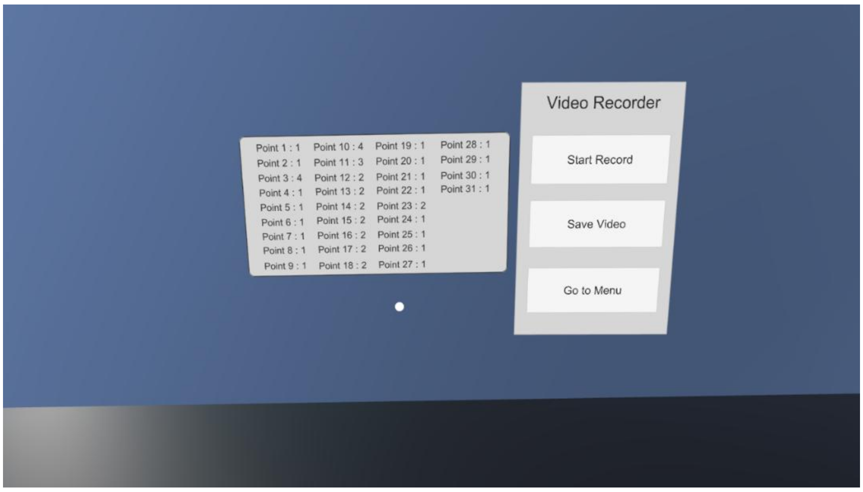

Fig. 11. Canvas of calculate points of movement and canvas of video recorder

In Figure 11, on the left, we can see the canvas of the calculated points of movement, which is updated in real time. On the right is the canvas of the video recorder, with which user can perform video recording and record all own actions.

If the result is involuntary, that is, the person constantly got into dead ends, moved in the same wrong way, it is possible to draw a conclusion that he has problems with memory and orientation in space, and therefore he can have predisposition of Alzheimer's disease.

Because one of the some ways to prevent the progression of this disease is to train the patient's memory [4], so, this system provides the ability to train the user's memory.

To do this, a memory training game has been developed, which consists of several pairs of cards, which are arranged in a shuffle and the user must remember the location of a card during the game, opening one of the cards to find a pair for it. If the second card does not match, they both close and the game continues, if it matches, these cards disappear. The game continues until the user finds all pairs of cards. This system provides three options of this game:

1) 4 cards - this is the simplest version of the game;

2) 8 cards - this is a more complex version of the game, because the user will need to memorize more cards;

3) The last game of 12 cards - is the most difficult version of the game.

If the user, starting from a simple level, will play this game every day and improve their memory, it will be able to move to more complex levels. This game is a very effective tool for training memory.

Fig. 12. Memory training game of 12 cards

In figure 12 we can see game process for training user memory on 12 cards.

As we see, two cards are open, but they are not the same, therefore they will be closed back and the game will continue. As we can see, the game is very bright, so it is useful not only because it trains the user’s memory, but also quite bright, and therefore it will also raise the user's mood.

Conclusion. This article considered the virtual reality system that allows to immerse the user in virtual space, check how he moves through the virtual maze and on the basis of this information to understand whether the user has a predisposition to Alzheimer's disease. Alzheimer's disease was considered, options for movement were considered user and information collection in the system. Considered the memory training game and his game options.

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