Kinect controlled game to improve space and depth perception

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ABSTRACT

Space perception is one of the most important skills of human life. Space perception is not a congenital faculty of human beings, but it evolves during the first few years of life. Experts are of the opinion that depth perception can be improved during the first 15-16 years of life. It is essential to perform depth perception in several occupations. We have developed virtual reality game with animations that were used by students to practice space perception tasks and to acquire better space perception. The game is controlled via Kinect sensor.

1. INTRODUCTION

The stereoscopic vision, depth perception is very important ability to navigate in the world. Unfortunately not everybody has these skills, or has only limited stereoscopic vision or depth perception. The number of these people is about 3-5 percent of the population. Professionals use several methods developing these people's spatial perception. This method includes solving visually difficult tasks. These tasks have several variants, nowadays in the form of videogames. The goal of our project was developing a game. Using this game the user can practice with playful tasks and can go through visual tasks. The ordinary repetitive visual tasks sometimes become a bit boring or tiring; therefore our goal was to keep the interest of the user. It was one of the most important points in the developing process to motivate the user (Bavelier et al., 2015), (Indu et al., 2015), (Levi & Li, 2009). The other motivating part is using a new input device, the Kinect sensor. The user can control the game by his/her movements using Kinect sensor without any another input devices. Kinect sensor enables users to control and interact with the computer without need for another game controller, through natural user interface using gestures. The device detects the whole body of the user. It can follow the users' joints. Therefore Kinect as input device is more natural for manipulating 3D object in VR, like manipulating via keys or mouse. Researchers in Nottingham used VR technology for binocular treatment of amblyopia (Waddingham, 2006). Sanchez and his colleagues made a research teaching the blind children to find their way by playing video games. Their result is that the immersive and highly interactive nature of the software greatly engages the blind users to actively explore the virtual environment. This, in turn, generates an accurate sense of a large-scale three-dimensional space and facilitates the learning and transfer of navigation skills to the physical world (Sánchez et al., 2012), (Merabet et al., 2012).

The recent research is a continuation of our previous research, where similar tasks were programmed by VRML. Our future plan is making efficiency tests comparing the efficiency of games, the oldest and the newest one. The new game is implemented in C # .NET.
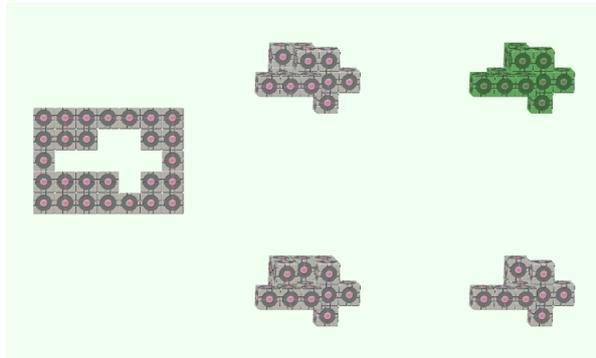
2. THE GAME

The purpose of the software is to make the user able to improve his/her stereopsis via solving visually difficult tasks, presented as games. The software contains 4 games: Rift-, Rotate-, Net- and NetFromCube games.
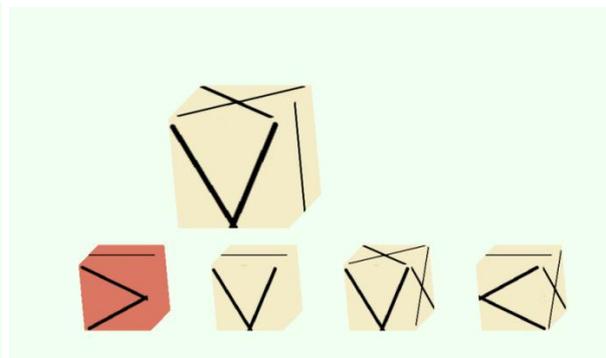
2.1   The Rift game

The game imitates the classic children's game in which a specific shape is pushed through a rift. The program uses cubes to contract shapes. Both the rift and the shapes are built from these cubes. Figure 1 is a screenshot of the "Rift" game. The task is to choose the adequate object from the 4 alternative shapes, which can go through the rift. The user can rotate the shapes, if he/ she doesn't know the right solution at a glance.

2.2   The Rotate game

The game shows a cube on the top half part of the screen. There are 4 other cubes on the down half part of the screen. Of course the user can see only 3 surfaces of a cube, like in the real world. The task is choosing the cube(s) from the 4 cubes, which is/are the same as the cube on the top of the screen. But it can be seen in a rotated position (Figure 2).


Figure 1. *The Rift game….*   **Figure 2.** *The Rotate game.*

The appropriate solutions are the first cube on the left side and fourth cube on the right side (Figure 2). The cube on the left side was rotated with 90 degrees along the positive direction of the z axis. The cube on the right side was rotated with 90 degrees along the negative direction of the z axis.

The user can rotate the cube horizontally by swinging his/her hand to the appropriate direction (Figure 3). These movements rotate the cubes by the y axis. The user can rotate the cube up or down by swinging his/her hands right or left. The user has to keep his/her hand half a second long at the up swinging, and after they can put the cube in the original position. This waiting time distinguishes the two gestures (up or down).
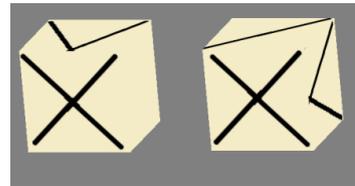

Figure 3. *Swinging movement.*   **Figure 4.** *Rotation along the negative direction of the z axis.*
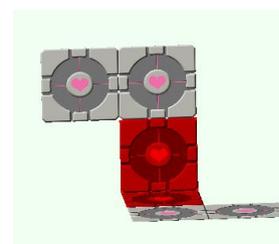
2.3   The Net game

In this task the user has to select net(s) from which he/she can fold a cube. Figure 5 shows a level of the "Net" game. The program includes all the possible nets for the cube and some bad nets too. The program puts the nets randomly onto the screen; of course it contains minimum one right solution. The user can fold the right solution and make a cube.

If the user can't solve the task mentally, he/ she can fold the net. Two sides of a net are highlighted with red colour in the first alternative net in Figure 5. An edge is between these two rectangles. These two rectangles are folding along by the edge between them. The user can select another edge by gestures. These gestures are: up, down, right and left movement of the user's hand.
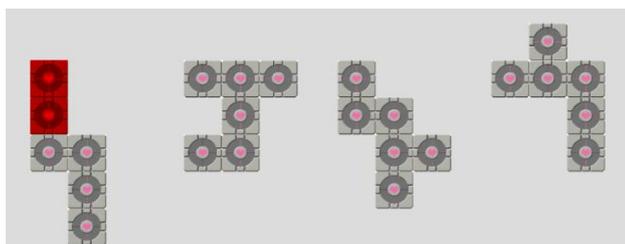
Figure 5. *The Net game.*   **Figure 6.** *A folded net.*

2.4   The NetFromCube game

This game is a combination of the previous two games. The user can watch a cube on the upper part of the screen and 4 alternative nets down. But there are some patterns on the surface of the nets. The user has to select a net or several nets from the alternative nets, fold it/them into a cube to get the basic cube shown above the alternatives (Figure 7).

The right solutions are the right side two nets on Figure 7. It is easy to see, because a line is joining to the upper point of the V shape on both nests. If the user can't see the pattern, he/she can fold the net and after it check the cube by rotating it. These lines on the bad nets are in wrong directions.

The above cube is generated by the program randomly. The program uses some rules. The good and bad nets are made by using these rules. When the program creates the original cube, it places a single non-rotationally symmetric figure at a surface. This figure can be turned to another figure. Such a figure is X and I. The places of these figures are obviously correlating with the non-symmetric figures.

A basis for generating good networks is that the non-symmetric figure, which can be seen from the front viewpoint, is put into different places on the net, and the other sides should be placed accordingly. As it is put in the centre of the upper row or it is on the top of the T shape (Figure 7).
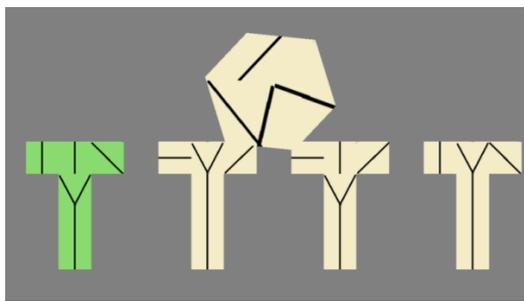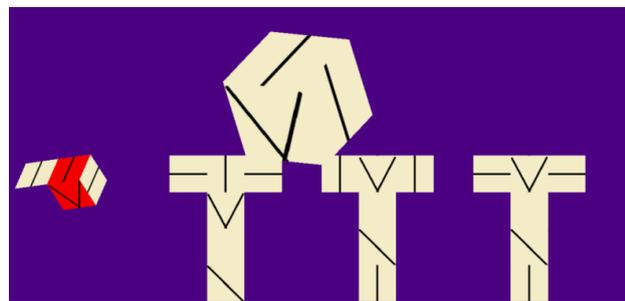

Figure 7. *The NetformCube game.*   **Figure 8.** *Examination of a net.*

The user can examine the alternative nets during the game play (Figure 8). Figure 8 shows that the first net is not the good solution, because after folding the patterns on the surface aren't the same as those of the original cube on the upper part of the screen, as the straight line on the right side of the V shape of the first net is in wrong direction.

2.5   Controlling the games with Kinect

The possible gestures are the following:

1.   Next alternative: right arm parallel to the shoulders, then moving upwards so it will be parallel to the body. The gesture should be done in half of a second by default, this value can be changed in the settings.

2.   Guess/ next alternative: same as above, but with left hand.

3.   In case of rift game, one can inspect the alternative by reaching out with right hand and then moving it.

4.   In case of Cube game one can inspect the cube after guessing:

    i).   Tilt on Y: arm parallel to shoulders, then moving it toward the screen, so it will be perpendicular to the body.

    ii).   Tilt on X:

        I.   Down: arm rested next to the body, then moving it upward to the ceiling then lowering it. Hand must rest for shorter time in the raised position then the given setting, by default half of a second.

        II.   Up: same as above, but hand must rest more as the given value

5.   In case of Netgame: moving among edges: as in the cube rotation game, according to the directions.

6.   Fold edge: raise right foot by 30 cm.

2.6   Adding new side and new language

Program can use textures added by the user. To add new texture, one has to copy that in the textures folder, then adopt the file name in the settings.ini file, with the appropriate symmetry property (halfTurn, quarterTurn, noSymmetry). The program can accept files with bmp extension.

Program can accept new language defined by the user. First, create the text file according to the existing ones with .lan extension, and then adopt the file name in the setting.ini file: add the filename separated by comma to the variable "availablelan".

3. TESTING THE GAME

The testing process was very important both during the development of the parts, functions of the game and after the completion too. It is important that the future users can test the game, not only the developers. The purpose of the testing is not only to find the bags, but to get user evaluation in order to refine the game. Three university students were asked to test the game and fill in a questionnaire based on several criteria.

The results of the questionnaire show that the hardest game is the Net game. It is understandable, because one of the hardest cognitive tasks is to think up if the net is a net of a cube or not. Maybe this complexity makes it less enjoyable than the other games, but the interaction is more interesting (to fold a net), than only turn a cube like in the other games. It could be also motivating. This interaction rounds out the usual interaction possibilities. It makes more spectacular changes with an object compared to the others; therefore it could arouse the users' interest. One question was asked about the accuracy of the gestures. It was valued in a 5 point Likert scale. The average result was 4. It could be a good rate. Only a bit more precisely, a bit finer accuracy is needed for making the game more the enjoyable.

To sum up, the observers evaluated the game with a high score. It means, the software looks like a game and not a teaching application to develop someone's skills, which was one of our main goals.

4. CONCLUSIONS

An easy to use, enjoyable game was completed for the development of space perception. The game is controllable by modern input device, Kinect sensor. It engages the users' attention and motivates them; moreover it makes the game more enjoyable. In this way the user can enjoy the 3D graphics in a playful way and they do not have the feeling that this application is a teaching software.

Our colleagues gave us useful advices to increase the ergonomics of the game. The quality of gestures has improved based on their advices and the result of the questionnaire. We hope that this game can be useful among the other softwares developed for space perception.

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