

Kinect sensor controlled game for early diagnosis of visual problems

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ABSTRACT

A serious game was designed for early (preschool-aged) vision-test at home or in kindergartens. It was created with Windows Presentation Foundation framework. This framework is a good choice for developing vision-test game modules, as they can be easily accessed from one main application. The game module is a “Drag and Drop” game, which can be controlled with Kinect v2 sensor. The game is designed to take various objects along the tracks to the suitable finish goal. This type of game will help the user discover visual acuity problems. The game monitors that how long it takes to complete the track with different difficulty settings, while storing the results.

1. INTRODUCTION

Eye exams for children are extremely important, because 5 to 10 percent of preschoolers and 25 percent of school-aged children have vision problems (U.S. Preventive Services Task Force, 2004). The visual acuity test of preschool and primary school children is a big problem. Since they cannot give an answer to the question, whether they can see something clearly? They are not fully familiar with their environment yet, therefore they cannot answer to every question. For testing preschool age children’s vision problems, the ophthalmologist shows a table. Usually a figure, like a capital ‘E’ letter is on this table in Hungary, but the ophthalmologist shows this table in different positions. It means that the capital ‘E’ letter’s opening is in left-, right-, up- or down position. This kind of testing, the Kettesy table (Süveges, 2010), and Snellen Table is used in other countries (Segre, 2015).

Some common eye test used for young children: LEA symbols, Retnoscopy, Rnado dot stereopsis test (Heting, 2015). Furthermore, nowadays there are a lot of smart phone applications. Stanzel and Meyer (Stanzel, 2012) used search engines, developers’ websites and webstores for screening with key words such as “smartphone”, “medical apps” and “eye-test”, after it they made a survey too. The result of their research is that the increasing distribution of Smartphone “apps” in ophthalmology may have the potential to facilitate patient treatment, data management and communication.

The aim of our research is to develop an interactive and attractive game based on new technologies for preschool children. This way, parents and kindergarten teachers could examine children’s vision playfully. The adult persons could realize the children’s visual acuity earlier by using this game, and in such cases they can take specialist’s examination where the ophthalmologist can intervene. Early diagnosis is very important for the untimely therapy.

2. STATE OF THE ART

2.1 *Visus*

In the early 1980s computers became more available in schools for visually impaired children (Blenkhorn, 1986) and a significant number of software systems were developed to support the assessment and training of visual skills (Blenkhorn & Tobin, 1983, Spencer at al., 1987). Although these systems tended to be used somewhat more informally and less systematically than packages such as “Look and Think”, many teachers reported positive experiences with the children. More recently systems have been produced for more modern computer systems. Such systems can be used to support a subset of visual skills, namely: awareness of vision as a sense, localization of visual stimuli, colour vision, tracking and hand-eye co-ordination (Blenkhorn & Evans, 2001).

The number of partially sighted children increases year to year. Several games of different types (action, adventure, exploration...) have already been developed (Sik Lanyi & Lanyi, 2003), (Sik Lanyi et al., 2005). There are also many instruments to be used by partially sighted people, including some solutions (Kobayashi & Watanabe, 2002), but not for very small children.

The *visus*, i.e. how well the person can read the letters of a Snellen Table or other visual acuity test, of children can be improved by early training of their vision. Our programs build on the remaining vision of these children and help them in learning how to fixate on given targets and use their eyes to search for details. This is very important as with proper training the *visus* of the children can be improved considerably. It is probably unnecessary to stress that for any person to be able to live a full life it is very important to have a vision as good as possible. Neither with the best methods of presentation nor with the most sophisticated equipment can one fully compensate for a loss of vision. Thus, it is of great importance to rehabilitate the vision of the children, and this has to be started at a very young age. This will help them to learn more easily in school, to get more information by roaming on the WEB, and finally as an adult to find a job more easily. Later, if these children go to school, they have to use computers and Internet too. Most of the visual impaired users use text-based web browsers, or read online content with a speech-based system. Some people are able to read the screen content only with increased font size.

Before proceeding it is essential to clarify some concepts, which are necessary to understand the meaning of partial sightedness and visual impairment. The term visual impairment is used to describe a slight or serious reduction of sensory function resulting from damage suffered by visual organs. Visual function includes specific perceptive abilities (visual sharpness, field of vision, sensitiveness to contrast, etc) each of which contributes in differing amounts to define the threshold of optimum perceptive functioning. As Khan and Chowdhury stated: "For example, visual sharpness and field of vision are two fundamental parameters, according to which a disability is recognized, in a proportionate measure. Visual sharpness means the ability to "discriminate" in maximum contrast conditions, it is a question of evaluating the individual's ability to perceive the details of an image placed at the centre of his field of vision and in particular an object being looked at, it is measured from a distance and is evaluated with the best correction for each eye. If the eyes are both functioning, there is an improvement of visual sharpness (*visus*) in binocular vision" (Khan & Chowdhury, 2004). The loss of vision is a psychological trauma to the partially sighted, nevertheless, they would like to conduct a lifestyle similar to those with normal vision. To give them a chance of performing similarly to those with normal vision, they have to be helped in developing their skills; they have to be supported in their learning.

2.2 *Kinect for Windows v2*

The main usage areas of Kinect are retail, therapy, healthcare, education and training. Kinect for Windows v2 is a new kind of camera that can see in 3D. It has an RGB camera, depth sensor and multi-array microphone running proprietary software. This software provides full-body 3D motion capture, facial recognition and voice recognition capabilities. Above these it has a traditional video camera and an infra-red (IR) camera too. The new Kinect can recognize that a person is in front of the sensor and what position their body is. Moreover it has a software controllable directional microphone and speech recognition technology, etc. The Kinect for Windows Software Development Kit (SDK) 2.0 enables developers to create applications that support gesture and voice recognition, using Kinect sensor technology on computers running Windows 8, Windows 8.1, Windows Embedded Standard 8, and Windows Embedded Standard 8.1.

3. THE GAME

3.1 *System requirements*

The framework of the game uses a Kinect for Xbox One device and an Adapter for Windows hub for the connection to the Computer. The recommended system requirements are:

- Microsoft Kinect sensor for Xbox One
- Microsoft Windows Adapter hub
- Kinect for Windows SDK 2.0
- Windows 8, 8.1, Windows Embedded 8 or Windows 10 operating system
- 64-bit (x64) processor
- Dual-core 3.1 GHz or faster processor
- 4 GB of RAM
- Dedicated USB 3.0 port
- DirectX 11 compatible video card

In addition to the above recommended system requirements, Microsoft made available an application, which helps to identify that the Kinect v2 meets the requirements of the computer or not. This application is called Kinect Configuration Verifier tool.

3.2 Using the frame-software

3.2.1 Main menu. On the main menu (Figure 1) the user can find the Play-, the Profiles-, the Settings-, History- and Exit options. The main menu is arranged in a horizontal menu, where the user can scroll through items like in the Windows 8 operating system. First, the user has to make the relationship with the system. For this operation the user has to raise his/her hands. It was very important to build natural gestures into the framework of the game, because the users are children.



Figure 1. The main menu.

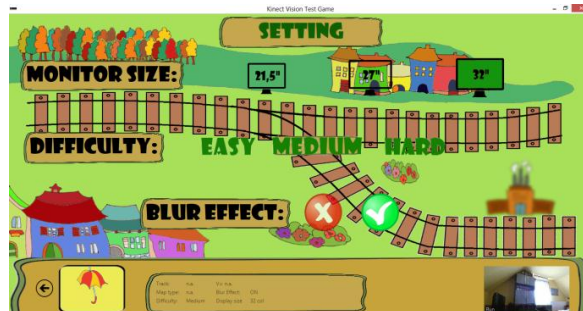


Figure 2. Settings.

3.2.2 Settings menu. Figure 2 shows the settings menu. Here the display size, the level of difficulty is adjustable, and the blur effect feature can be turned on. For this function an example (a track) with an object is visible in the background. Those keys are always available for the user, with the help of which they can make some changes to the settings.

3.3 Using the game

3.3.1 The purpose of the game and using the game. The goal of the game is to put an object (for example a car, a privateer, train) from the left part of the screen to the finish, which is on the right part of the screen. Each track has a good route and a bad route. During the game, the user must choose between the two routes, where he/she moves the vehicle. It depends of course on the visibility of the finish and the routes. The size of the movable objects and the finish is reduced by twenty percent on the next level. So the player will find it more difficult to distinguish the objects.

3.3.2 Controlling the game. The game can be controlled with two input devices: Microsoft Kinect for Xbox One and a traditional mouse. The user can switch between them during the game too. If the user would like to controll the game via Kinect sensor he/she just has to raise his/her hand. In this case it will automatically detect the Kinect and establish a connection between the player and the software. If the gesture was done properly, a hand appears in the center of the screen as a cursor.

After the connection, the player can move the cursor on the display everywhere by moving his/her hands. He/she has to “catch” the vehicle on the left side of the screen and move it on the track to the finish without letting it off. For catching the vehicle the user has to close his/her hand. If the gesure was made properly, the “hand” cursor is closing on the screen as well. For releasing the vehicle the user has to open his/her hand.

3.3.3 Screen of the play. The following elements are on the user interface of the game (Figure 3):

1. Vehicle – the child has to move it to the finish
2. Bad option – if the user draws the vehicle here, it is false results
3. Good solution - if the user drives the vehicle here, this level is succesfull and the user can move on to the next level
4. Kinect v2 color camera screen - to indicate the location of the user
5. Status - displays the status of the sensor Kinect v2.
6. Information - it provides giving information to the parents for example from the applied settings
7. User icon image - the current user ID appears here (kindergarten symbol)
8. Back button - the user can exit from the game

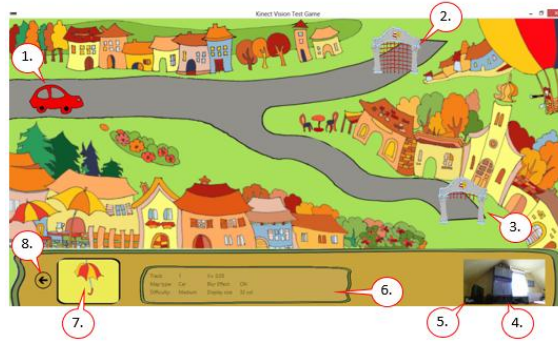


Figure 3. Screenshot of the game.

4. CONCLUSIONS

A Kinect controlled game was developed for early (preschool aged) vision-test. The parents or the pre-schools' teachers can use it at home or in the kindergartens. It was created with Windows Presentation Foundation (WPF) framework. The game has a very user-friendly user interface. The children's task is only catching an object and pushing it to the the final position of a track. The game is designed to take various objects (vehicles) along the tracks to the suitable finish, but the visibility and the size of the objects and background pictures and tracks are changed in each level. This type of game will help the user (parents and pre-school teachers) to discover the children's visual acuity problems. The game monitors the completing time of a level and the difficulty settings too. The results and the settings' data are stored in a database. The game was tested by adult users and children. Our future plan is making ophthalmologist tests and compare the results of the game and the ophthalmologist's tests.

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