SUBJECTIVE TEST DESIGN FOR EVALUATION PRECISION OF STEREOSCOPIC DEPTH PERCEPTION

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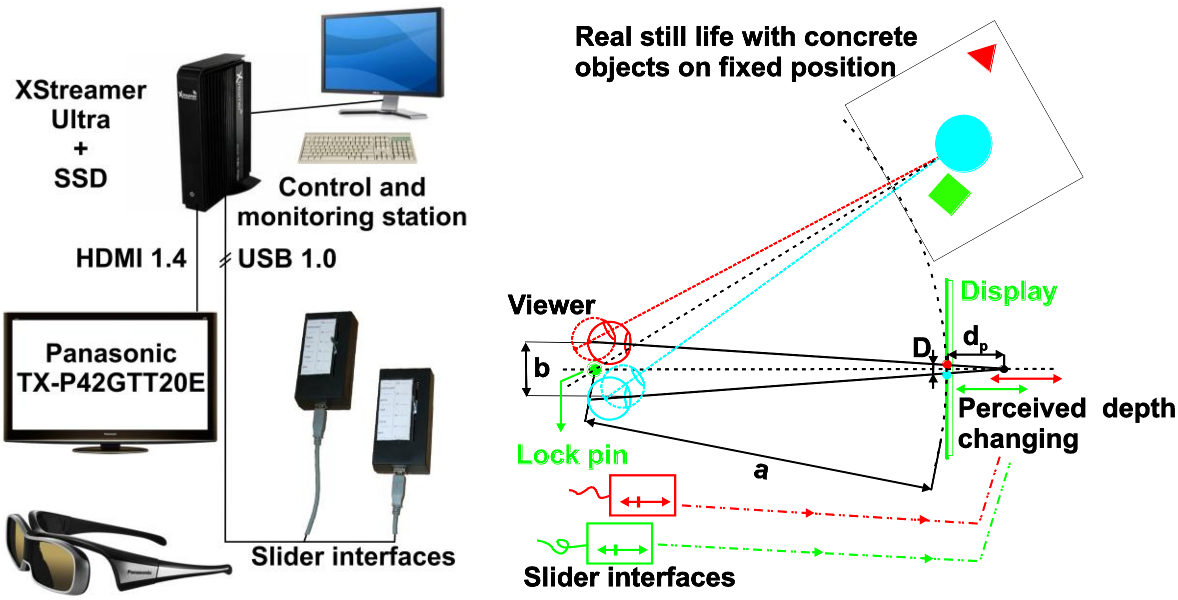
Abstract: This contribution focuses on method and procedure specification of prepared subjective tests. These should be oriented on depth resolution, sensitivity and maximal depth range, which could observer perceive by 3D display. It has been designed even single purpose software in Matlab, provides to the respondents possibility to do the tests autonomously.

Keywords: subjective depth evaluation, depth map, stereoscopic displaying

1. INTRODUCTION

Most promising today's 3D video format with regard to the storage / bandwidth consumption and further rendering in multiview autostereoscopy displays is 2D + Depth. It consists of classical 2D video and depth map, where each pixel represents relative value of z coordinate. This depth coordinate could be scanned during video shooting by active methods like incoherent profilometry or time-of-flight, or in post indirectly from stereo pair or multiview.



a) b)

Figure 1: a) Illustrative scheme of testing facilities.
b) Floor projection of laboratory arrangement.

Each scanning technology can estimate the depth map with specific accuracy and mostly is the depth scale relative and nonlinear. This contribution describes design of subjective test, which should discover how precisely average viewer can differentiate two depth level in contemporary 3D display. The test results can serve to stereoscopic shooting and display technology evaluation.

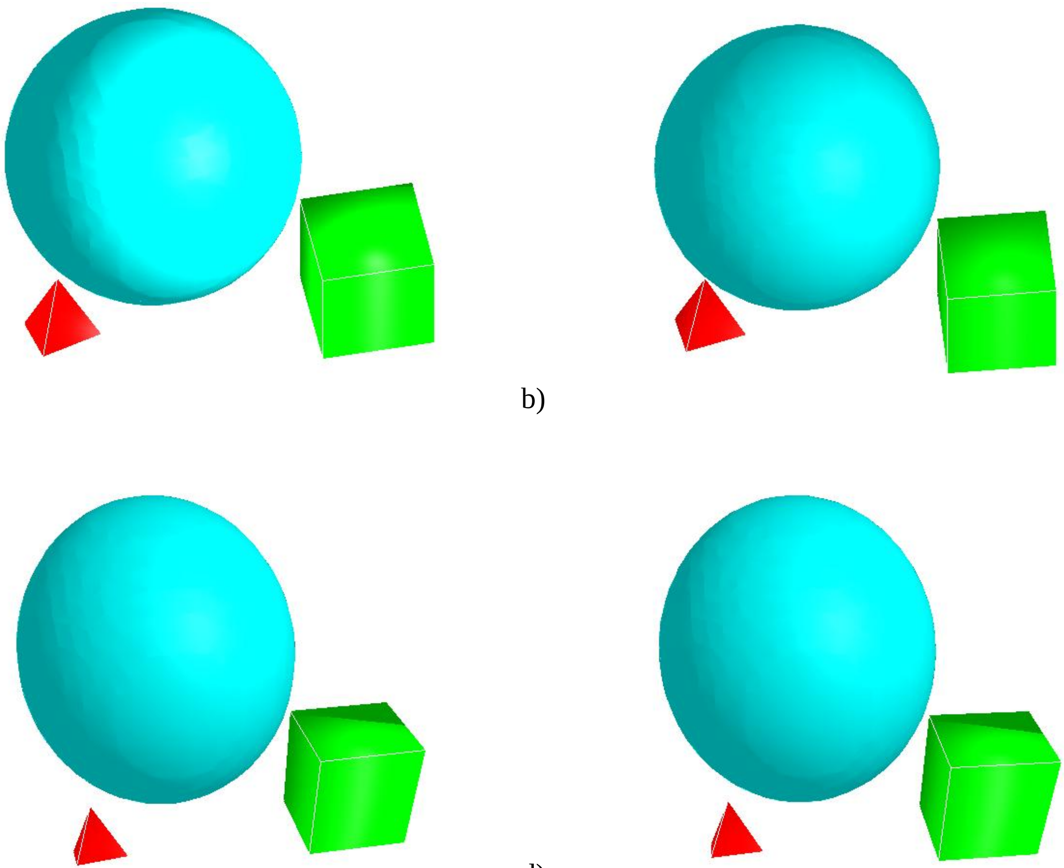
2. DESIGN OF THE TEST

How to realize testing itself? It has been considered three variants. First idea was to design set of stereoscopic images, where one or more from displays object start slowly moving in z coordinate. When viewer recognizes this shift, he should stop the movement and specify which objects and which direction (forwards/backwards) moves. Least specified difference would be than the searched minimum depth sensitivity. The most important disadvantages of this option are obvious. Observer has to remember previous frame to compare it with contemporary, which tested more their visual memory. Then low yield of test is probable cause of bad specified object/direction. The crucial drawback is, that this method in principle does not measure accuracy of depth perceiving nevertheless just a sensitivity of it.

Second possibility assumed that we use two same stereoscopic displays or one 3D data projector, where two separate images of 3D scenes are set. Then one of them would be a reference and the other could respondents modified to be the closest to original. This approach has as well handicaps. Two same displays are needed (or almost with the same technology) or projector. Projector should be with ultra HD (2K or 4K) resolution to provide images of both 3D scenes sufficient resolution. The most important trouble is that observers are asked to reach same scenes. This they can succeed even without stereoscopic glasses or without one eye.

The third assumed possibility, which has been at least chosen, sets as a reference the real still life with concrete geometrical objects in defined positions. (Figure 1b) Respondents are locked by pin in property position (Figure 2), in which they have same viewing angle, same distance and height toward original objects and stereoscopic display. They are asked to shift images of two objects in forward/backward direction. This is realized by software described below, which is controlled among other by slider interfaces (Figure 1a). Mentioned hardware has been originally proposed for subjective image/video quality evaluation.

Figure 2: Lock pin for viewing condition definition.



a) b) c) d)

Figure 3: a) Left image, b) right image of stereoscopic parallel projection. (scenario 2.3.)
c) Left image, d) right image of stereoscopic perspective projection. (scenario 2.4.)

There are four main display scenarios, which differs by the way of combination more perceived information about depth.

2.1. PERSPECTIVE MONOSCOPIC

In this case no binocular disparity occurs. Both eyes see same image and the object distance is evaluated only by monocular cues, such as relative size, occlusion (interposition) and perspective projection. This scenario, which uses same cues as classical 2D display, is used as a blind test and for reference.

2.2. SHIFT OBJECT STEREOSCOPY

This scenario represents stereoscopy imaging, where two same perspective projected images of 3D object is just shifted each other for two eyes view. This scenario models DIBR (Depth Image Based Rendering) using as a source coarse segmented depth map. This scenario should cause cardboard effect, means that objects itself are perceived flat like cardboard, situated in discrete depth levels.

2.3. PARALLEL PROJECTION

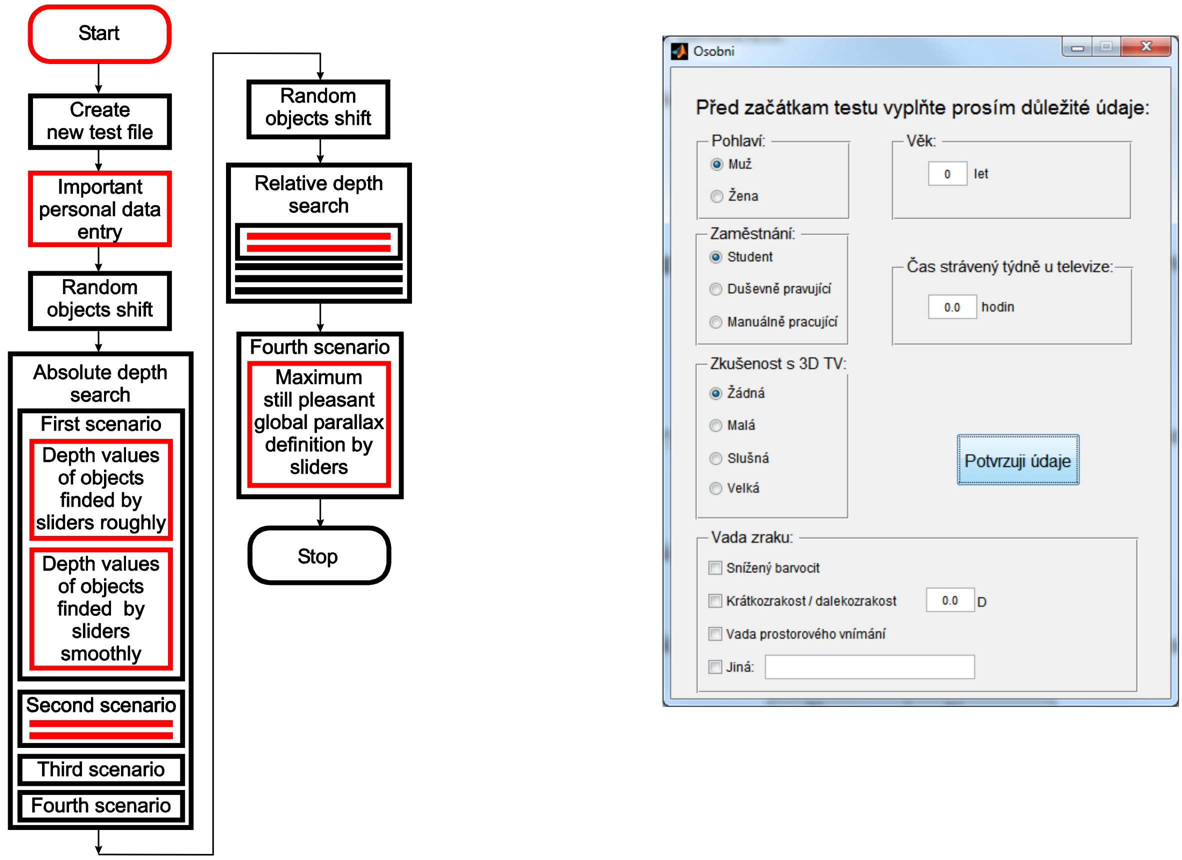
The third instance brings adequate stereoscopic image, where it has been used orthogonal (parallel) projection for transformation from 3D space to two displaying planes. Consequently, this scenario emulates infinite distance of each camera from scene (monocular cue), but defined finite distance of camera stereo pair for stereoscopy (binocular cur). Although it is generally expected, that it should cause

2.4. Perspective projection

The best adjustment combines optimal mutual combination of perspective projection and stereoscopy with same parameters.

3. SOFTWARE FOR NON ASISTED SUBJECTIVE TESTING

We wanted the subjects were able to do the test themselves. So, interactive software has been designed for this purpose. The flowchart shows Figure 4a, where red blocks take information from respondents. Program creates separate file for each test execution, these will be statistically processed and evaluated afterwards.



a) b)

Figure 4: a) Block diagram of created non assisted software.
b) The part of GUI, where important personal data about testing subject are obtained.

4. CONCLUSION AND FUTHER WORK

The paper describes in detail purpose, method and procedure of subjective tests, which we plan, that should quantify depth perception precision on stereoscopic displays.

First we have to organize subjective testing according to the test scheme. It could be problem to reach balanced sample of respondents among students, especially with required adequate gender and age diversity.

Furthermore we plan to do principle same test, but with usage of more complex common objects and their computer 3D models.

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