AJAX WEB SCRIPTING APPLIED TO INTERACTIVE STEREOSCOPIC IMAGING

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ABSTRACT:

Creating the illusion of depth in images was first invented 1838 by Sir Charles Wheatstone. It is today still a great experience to view high quality large format images with depth perception, exceptionally of virtual objects like reconstructions of the past or building projects.

High quality presentation of computer graphics is provided by projection onto a transparent screen surface from behind. Image separation can be easily performed by polarisation filters in front of the projection lenses. It is necessary that the beholders carry polarized glasses. Interactive viewing in this context means, that the observer is able to select image pairs from the database, can zoom in and out, select the display details and sets the zero parallax to an arbitrary position. The selection must be simultaneously transferred to the second image of the stereoscopic pair.

While each data projector is driven by its own computer, a PDA (personal digital assistant) is recommended to receive the instructions from the presenter or viewer. That network configuration requires amongst other software tools Bluetooth, to connect the PDA to a local computer network, and ActiveSync, to hold a continuous connection between the PDA and the host computer. Furthermore a Web server with PHP (hypertext pre processor) extension is running. Web browsers are acting as clients on both computers and the PDA as well.

The challenge is now to write an application software that provides an interface on the PDA to set the adjustments and pushes the image information to the graphic cards of the host and the slave computer. To minimize the effort in software development, open source software components are largely applied to this system. We take advantages from Mozilla Firefox Web browser and Apache Web server.

This paper introduces the application of AJAX (asynchronous JavaScript and XML) Web scripting in connectivity with PHP and delineates the infrastructure of network components connected to a working presentation environment, that serves a screen surface of about 100 inch diagonal. High quality stereoscopic colour images are presented at daylight conditions also, due to the BlackScreen RP technology.

1. CALCULATION AND VIEWING OF STEREOSCOPIC IMAGES

1.1 Stereoscopic Viewing

Perception of natural stereoscopic vision originates in overlapping the field of visions of the human eyes. Due to the eye distance and the spatial dimension of objects the retinas receive slightly different information. Varying distances between corresponding points in the left and right image are named as disparities (or deviation). In photogrammetric terms it is called parallax. Observing spatial sceneries with one eye only disables perception of depth. In that case, depth sense is detected only by experience.

Artificial stereoscopic vision requires two images taken from different observation positions and a separtion during viewing. The complete process exists of image generation, projection and viewing. Focussing image generation to calculation of computer generated graphics, is a simple procedure. Setting two camera positions with parallel directions, the same field of view and a distance between the cameras delivers the different perspectives. The distance between the cameras, named basis, can be calculated by a simple formula.

1.2 Calculation of Stereoscopic Image Pairs

Condition for undisturbed spatial impression are identical image content, missing of vertical parallaxes and the limitation of a depth area. The latter is given, if the maximum parallax in the image is not greater as 1/30 of the image width. Taking photographic image formats as a sample, that value amounts dev = 1.2 mm for a 35 mm image and 2 mm in case of a medium format camera. The predefined stereoscopic window, given by the nearest point (near) and the most farthest point (far) from the viewer, together with the focal length (f) gives us the basis (b) as follows:

```
b = dev * (near*far)/(far-near) * 1/f
```

A computer perspective should be calculated for a projection with 1024 x 768 px and will be projected with enlargement but viewed from farer distance. It is common in graphics software to define the field of view according to 35 mm camera formats. Therefore 1.0 < dev < 1.2 is a usable amount. The stereoscopic window covers in the here presented example 5 m to 60 m. A focal length of 25 mm is used. The basis calculates as

```
b = 1.2[mm] * (5[m]*60[m])/(60[m] -
     5[m])/25[mm] = 262 [mm]
```

A JavaScript for calculating the stereo basis can be found on *www.imagefact.de/p3da/sterobasis.html.*

The most easiest way defining the camera position is graphically. Construct a line from the camera position to the target position in your drawing. Construct the other camera position by offset of that line, applying the calculated amount *b*. Use a separate camera layer to switch off the positions when not used.
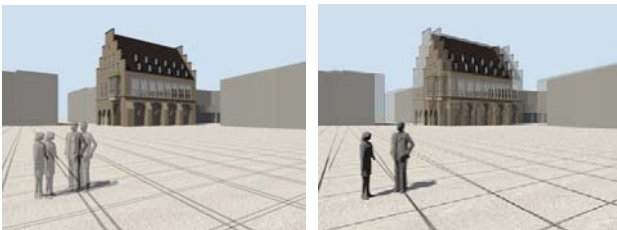

Figure 1: Overlapping of image pairs, alternating the zero parallax

Depth position of the stereoscopic window relative to the projection surface can be influenced by movement oft the images one another. Positioning the zero parallax into the centre of the stereoscopic window minimizes the parallaxes. Extension of 3D impression can be reached by setting near objects in front of the projection surface. More conservative is the positioning of the stereoscopic window complete behind the viewing plane.

Disaggregation will occur if the parallax exceeds 1/30 of the image width. Background images are in general not recommended, since they can not have parallaxes. The generated images should complain with the final resolution, since later resampling influences the stereoscopic quality.

1.3 Image Separation

Image separation can be provided by filter techniques, spatial separation or time separation. The latter is used in active stereoscopic systems, where projection of the image pair and receiving of images must be synchronised. Shutter glasses are working according to this principle, left and right image are positioned at the same location but changing time based. Spatial separation is known from the children toy view master or used in head mounted displays. Each eye receives its own image from another position. From the filtering separation techniques polarization with linear filters is widely spread. Anaglyph filtering is suitable for everyone and stands for a cheap solution.

1.3.1 Linear polarisation: Natural light is generated by in arbitrary directions swinging electrons, therefore it is not polarized. Light is a transversal wave. The vectors of the electric and magnetic field are always perpendicular to the direction of the movement. The polarisation of light describes a property of the electrical field vector. If that vector always points to the same direction in one plane, the beam is linear polarized. Two images, projected with 90 degree different polarisation direction and viewed with the according filters perform stereoscopic viewing.

Use of linear polarizers is most common for passive stereoscopic presentation. Projection light is polarized in angles of 45 und 135 degree by filters. Colour reproduction is very good. Due to the not entire image separation a light ghost image is detectable. Loss of light is only 60 %. The projection requires a special surface as a silver screen. The viewers head position should be parallel to the projection direction.

1.3.2 Circular polarisation: If light is composed of two plane waves of equal amplitude by differing in phase by 90°, then the light is said to be circularly polarized. Circular polarisation is not so common as linear polarisation. It is possible that the user inclines his head against the projection direction. The other conditions respond to linear polarisation.

1.3.3 INFITEC Filters: Daimler-Chrysler developed a system for professional 3D reproduction. INFITEC is distributing this system, which is working by wavelength multiplex imaging. Image separation is perfect. Loss of light is high, therefore bright projectors are needed. The system is suitable for mobile systems and viewing in small groups.

1.3.4 Anaglyph Images: Anaglyph images are known as real anaglyphs in red-blue or red-green, grayscale anaglyphs or with red-cyan filters as colour anaglyphs. An optimized colour method which is implemented in PHP back-end software one can access from *www.imagefact.de/p3da* was presented by *http://www.3dtv.at.*

With the colour values of the left half image r1, g1, b1 and the right half image r2, g2, b2 the colour values of the anaglyph ra, ga, ba are calculated as follows:

$$\begin{pmatrix} r_a \\ g_a \\ b_a \end{pmatrix} = \begin{pmatrix} 0 & 0,7 & 0,3 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix} \cdot \begin{pmatrix} r_1 \\ g_1 \\ b_1 \end{pmatrix} + \begin{pmatrix} 0 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix} \cdot \begin{pmatrix} r_2 \\ g_2 \\ b_2 \end{pmatrix}$$

2. PRESENTATION ENVIRONMENT

A GeoWall is a low cost interactive 3D stereoscopic projection system. It consists of a computer with a dual-output graphics card, two projectors in a rack to hold them, polarizing filters, projection surface and a pair of cheap polarized glasses for each user (figure 2 and 3). GeoWalls are examples of passive stereoscopic viewing systems. Instead of a complete immersive experience for one user, there is a partial immersive experience for multiple users. This makes it suitable for classrooms, group presentations, and interactive museum shows.

In the present case, the projection surface is not a silver screen. It is named as black screen and designed for back projection. The projection surface emulates by its thickness off approx. 5

cm a dark room. Light from the back should be avoided. But daylight in front of the screen does not affect the quality of the presentation.

With interactive stereoscopic viewing it is assumed, that the user can select pre calculated image pairs from the database, defines the centre of the image, the scale and the zero parallax.. For a convenient presentation a PDA as a system driver software is connected to the network.

Figure 2: Viewing stereo images with polfilters

Figure 3: GeoWall. Projector rack and back projection screen

3. NETWORK CONFIGURATION

3.1 Hardware

Extending the GeoWall configuration for a network environment requires in the here described set up a router, a Bluetooth-Stick and a PDA personal digital assistant.

Figure 4: Belkin Bluetooth USB adapter

Bluetooth is a technology for data transmission via wireless radio in a frequency around 2,4 GHz. This frequency range is worldwide license free usable. Bluetooth technology was developed for the cable free connection of mobile devices. But it is suited as well to connect devices in stationary use like printers.

Bluetooh technology is available in devices including Bluetooth functions as mobile phones, as add-on adapters to extend the functionality of a device and as modular components or chip sets. In the given case we use a Bluetooth USB-stick class one with a transmission distance of 100 m and 730 kBits data transfer rate.

Bluetooth was developed since 1994 in Sweden at Ericsson. The name points to a Danish king who unified 960 the Scandinavien countries, Harald Baltand, engl. Bluetooth.

3.2 Software

Microsoft ActiveSync is a software to synchronize Windows-CE-PDAs or smartphones with a PC. Changes, taken at the PDA or PC will be updated on the opposite device to guarantee even the same data balance.

Condition for a data interchange between desktop and pocket PC is an installed Internet Explorer and Microsoft Outlook. Communication is carried out via USB, Bluetooth or infrared port. Further the network configuration requires a XAMPP environment with Web server and PHP extension.

In the described environment an application software will be installed, that uses AJAX elements and a PHP back-end for displaying image pairs. Concepts for a local network handling and running from the Web will be compared. Presentation is carried out on a GeoWall with image separation by polarisation and anaglyph filtering.
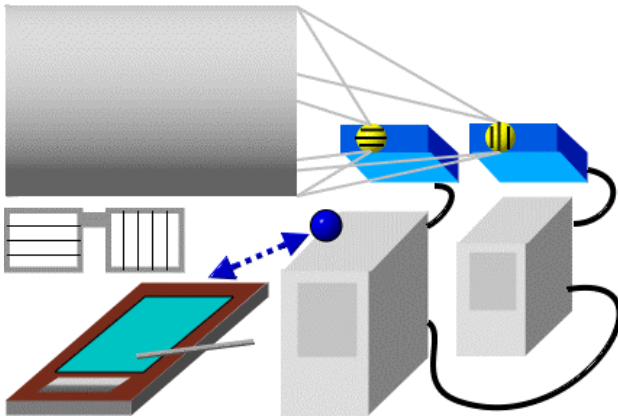
Figure 5: System configuration with two graphic cards

4. APPLICATION SOFTWARE

4.1 AJAX

Ajax is not a new technology, it incorporates several technologies like XHTML and CSS, the Document Object Model DOM, JavaScript, XML and XSLT and the XML HttpRequest Object. The acronym stands for Asynchronous JavaScript and XML. Ajax Web applications act as desktop applications. Popular application examples are Google Maps or Google Suggest. Ajax enables the programmer to manipulate elements of the DOM tree via the XMLHttpRequest object without downloading the complete document from the server. A browser client sends an HTTP request to the Web server. The server works out the request and sends back HTML and CSS data that is rendered by the Web browser. In case of Ajax, a JavaScript function is called that sends a XMLHttpRequest. The server answers with XML data that is transported to the browser integrated Ajax engine. The Ajax engine manipulates the DOM elements of the document by means of the transferred XML data.

We try to figure out the described procedure by focussing to a part of our software application. The user interface of the stereoscopic viewer consist of an image browser and an image navigation part. The image browser displays thumbnails of the stereoscopic image pairs, due to the regulations to the filenames. Filenames must have suffixes, _qqr for the right image and _qql for the left image. Browsing through the server sided subdirectories works in a section with the id *browser*. The div tag defines another section named *navigation*. In the first step , the browser renders as shown in figure . The navigation section is still empty. The HTML code reads as follows:

```
<script type="text/javascript">
function createRequestObject(){
   var ro;
   var browser=navigator.appName;
   if(browser == "Microsoft Internet
Explorer"){
     ro= new ActiveXObject
("Microsoft.XMLHTTP");
   }
   else {
     ro = new XMLHttpRequest();
   }
   return ro;
}
// XMLHttpRequest-Objekt initialise
```

```
var http = createRequestObject();
// request to back-end
function sndReq(action){
   http.open('get', 'x3d.php?bild='
+action);
   http.onreadystatechange =
handleResponse;
   http.send(null);
}
// evaluate answer from back-end
function handleResponse(){
  if(http.readyState == 4) {
  var response = http.responseText;
document.getElementById("navi").innerHTML =
response;
}
}
</script>

<!-- in HTML-Code -->

<div id ="thumbs"></div>
<div id ="navi"></div>
```
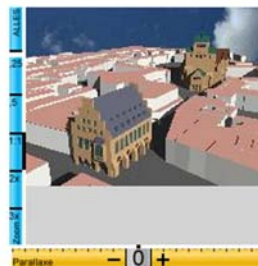

Figure 6: AJAX front end software

Clicking into an image thumbnail calls a JavaScript function. In this function an XMLHttpRequest object is generated. The server loads the requested data, that is transferred to the Ajax engine. The Ajax engine manipulates the content of the *div* section identified by id *navigation*. The user can operate in that area and finally calls the back-end to process the server sided image files as requested. The image file browser area will not be affected by loading the navigation information as shown in figure 6

```
<script language="javascript">
function GrafikAnzeigen(GrafikURL, Breite,
Hoehe, bildtitel)
{
Fensteroptionen="toolbar=0,scrollbars=0,loc
ation=0,statusbar=0,menubar=0,resizable=0";
Grafikfenster=window.open("", "",
Fensteroptionen + ',width=' + Breite +
',height=' + Hoehe);
```

```
Grafikfenster.focus();
Grafikfenster.document.open();
with(Grafikfenster)
{
document.write("<html><head>");
document.write("<title>" +bildtitel
+"</title>");
document.write("</head>");
document.write("<body leftmargin=\"0\"
marginheight=\"0\" marginwidth=\"0\"
topmargin=\"0\">");
document.write("<img border=\"0\"
onclick=\"window.close();\" src=\""+
GrafikURL +"\" title=\"Zum auf
dasFotoklicken\">");
document.write("</body></html>");
            }
}
</script>
```

4.2 PHP Back-end Stereoscopic Viewer

P3D-SC (single computer) is a stereoscopic image pair viewer applied to GeoWalls and anaglyph image separation. The software is written in PHP and benefits from AJAX scripting.

As mentioned above, a Geowall consist of two data projectors connected to a NVIDIA graphics card with two separate outputs. The desktop properties are set to horizontal span. One projector displays the left image of a stereo pair, the other is connected to the right image. The images are high end renderings with very high resolution.

Naming convention for the files is as follows: The left and right image must have the same name with a suffix qql or qqr. Preferred File formats are jpg or png. Files with the suffix qqt are image thumbnails and qqx are text files containing some image parameter. Those files are automatically generated by the first access through the file browser.

Running the software in a local area environment needs a client server environment, which is given for example by XAMPP. Start your Web server, open a Web browser and type in *http://localhost/p3da/index.php*. Take care of the set up of your application directory. By default it is *htdocs*. The image browser displays all the subdirectories in the *p3da* directory, which acts as a root directory for our application. Clicking a directory name results in displaying thumbnails and generating the files qqt, qqx.

A second click into a thumbnail displays a navigation area for that image. You can choose a centre point for the view and a zoom factor. Click into the blue bar on the left and in the image. The selected parameter are displayed in a separate window, here it is possible to change the values by altering the text fields

In this part of the software we take advantages from AJAX scripting. The thumbnail area and the parameter settings are running in two different containers. If you select another image, only the navigation part is loaded by sending a request via an XMLHttpRequest object.
If the parameter setting fits to your needs, click display images. The displayed image size is half the size of the graphic resolution or the maximum resolution of the data projectors. Both images are calculated from the high resolution source images.

Consider you have selected a centre point in the lower right corner of the source image by clicking a point of interest (image position 1920,1010) Your zoom factor is set to 1. The window size for displaying one image is 1024x768. In this case the area from 1408 – 2432 in x and 626 –1394 of the source image will be projected onto your screen. If the zoom factor is less than 1, the displayed area will be enlarged resulting in a larger image scale.

The left image is positioned at 0,0 the right image at 1025,0. But it is possible to move both images by dragging the mouse. You can adjust the parallax values in this way. The vertical and horizontal shift, shown in the display parameters are not used in case of linear polarizing.Behind the images another window gives control about the image parameters.

Click into an image closes the window. Changing the window size is only possible by setting the parameter inside the software. It has to be mentioned, that the zoom factor *all* may distorts the images due to different aspect ratios of the window size and the image resolution.
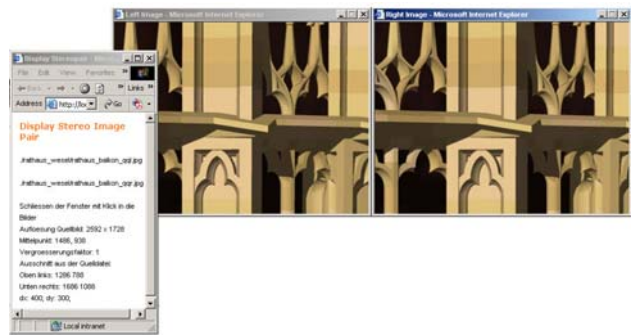

Figure 7: Stereo image pair displayed with a NVIDIA card

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http://www.3dtv.at/Knowhow/AnaglyphComparison_de.aspx

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http/geowall.geo.lsa.umich.edu/intro.html