PanoramaGrid – A Graph Paper Tracing Framework for Sketching 360-degree Immersed Experiences

Frode Eika Sandnes[1,2]

[1]Faculty of Technology, Art and Design
Oslo and Akershus University College of Applied Sciences
P.O. Box 4 St. Olavs plass, 013 Oslo, Norway
+47 67 23 50 03
Frode-Eika.Sandnes@hioa.no

[2]Faculty of Technology
Westerdals Oslo School of Art, Communication and Technology
Postboks 9215 Grønland, 0134 Oslo, Norway

ABSTRACT
A novel framework that allows designers without 3D-modelling experience to draw three-dimensional panoramic sketches by hand with the help of a support lines is proposed. Sketches are viewed with panoramic viewing software, giving observers interactive three-dimensional 360-degree immersed experiences.

CCS Concepts
• Human-centered computing→Interaction design • Interface design prototyping.

Keywords
Sketching; panorama, immersed experiences.

1. INTRODUCTION
Sketching is used within many creative fields such as product design, clothes design and architecture to communicate ideas [1]. Traditional sketches are often rough hand drawings of physical objects, people, and situations that capture the designer's ideas on paper.

Designers often employ three-dimensional modelling software to represent their ideas such that observers can experience their ideas through virtual-reality-like immersed experiences [2]. It has been argued that design tools may hinder creative processes [3]. The operation of design tools require special training, is often time-consuming and difficult. Designers may not be able to express their ideas fully. Moreover, ideas that emerge as a thought in an instance may therefore be lost as the designer is unable to capture these ideas due to the time needed to operate the software. The input of three-dimensional shapes using two-dimensional input devices usually require complex interaction.

A novel framework is therefore proposed for making interactive immersed sketches without specialized modelling software. Sketches are drawn on paper or drawn using standard two-dimensional drawing software. The finished sketches are imported into one of the many panoramic viewing applications.

AVI '16, June 07-10, 2016, Bari, Italy
ACM 978-1-4503-4131-8/16/06.
http://dx.doi.org/10.1145/2909132.2926058

The proposed framework involves sketching directly onto an equirectangular panorama. However, it is challenging to sketch in the equirectangular domain as it is not intuitive how it maps to the real world. For instance, straight horizontal lines are curved in the equirectangular domain, and the spatial relationships are different towards the bottom or top of the panorama (the poles) compared to its middle parts (the equator). The framework therefore provides gridlines, which the designer can trace. Tracing by overlaying existing shapes is common technique for drawing complex shapes, making drawings from photographs, etc. The gridlines allows the designer to determine the correspondence between points in the panorama to points in the real world. The framework encourages drawing by hand, which helps give the sketches their hasty and unfinished brush stroke appearance [4].

2. EQUIRECTANGULAR GRIDS
The observer is defined as being in the origin of a three dimensional Cartesian coordinate system, surrounded by a sphere S with radius R, here arbitrarily set to 1, located at [0, 0, 0]. The observer observes a plane perpendicular to the viewer, that is, a plane with its normal pointing towards the center of the sphere. A rectangular or quadratic grid is defined on the plane. It is the projection of this grid onto the sphere that forms the equirectangular grid that is used in the proposed framework.

The grids used herein are quadratic with N points in the horizontal and vertical directions, respectively. The center of the quadratic grid is the closest point to the center of the sphere. The width of the $N\times N$ grid is defined by the angle a between the normal vector and the vector from the sides of the grid.

The gridline projection is computed by finding the point of intersection $[x', y', z']$ between the viewing sphere S and the line going from the center of the sphere to a grid point $[x, y, z]$ is simply:

$$[x', y', z'] = \frac{R}{\sqrt{x^2 + y^2 + z^2}}[x, y, z]$$

The intersection point $[x', y', z']$ is transformed into geographical spherical coordinates $[X, Y]$ using the following transform

$$X = \tan^{-1}(y', x')$$
$$Y = \sin^{-1}\left(\frac{z'}{R}\right)$$

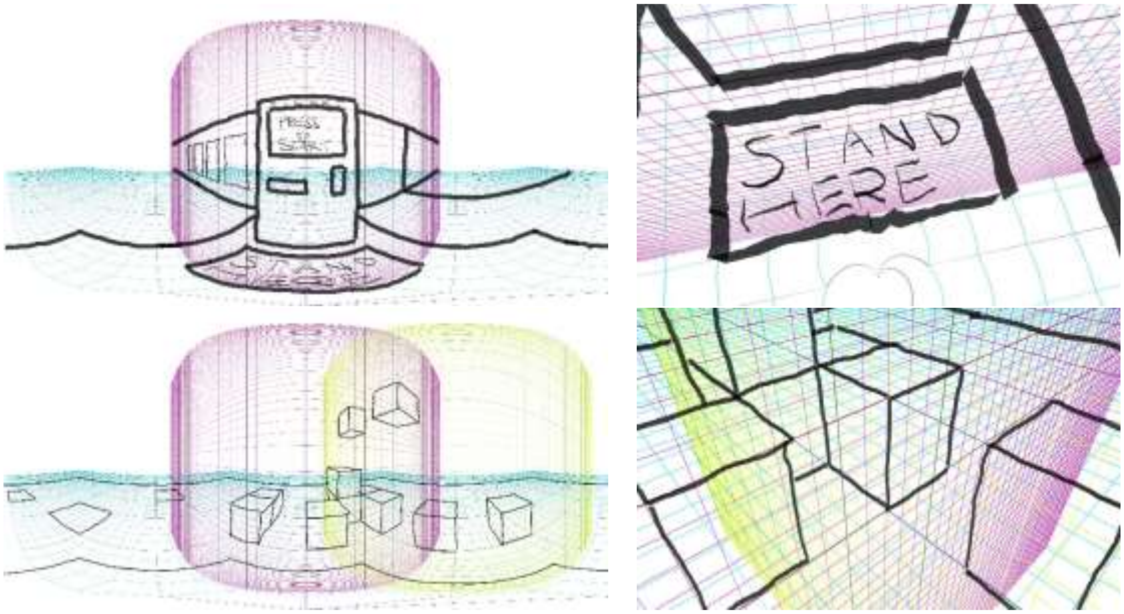

Figure 1. Tracing panorama gridlines (left), rendered views (right).

3. COMBINING GRIDS

The proposed equirectangular graph paper framework uses combinations two basic grids, namely floor and wall grids. The floor grid is used as a ceiling by rotating the grid 180 degrees.

The wall grid can represent any vertical plane. The horizontal position of the grid in the panorama dictate its angle. To represent a room with four walls, four grids are placed on the panorama 90 horizontal degrees apart. A fifth grid can be added to achieve a wrap around and overlap between the leftmost and rightmost grids to make a complete and smooth 360 degree panorama.

4. GRID TRACING

Once the grid composition is configured sketching is simply performed by tracing along the lines of the graph paper. The gridlines can be removed afterwards, or they may be kept to emphasize the unfinished characteristic of the sketch.

The left images in Figure 1 shows examples of how to sketch using the panoramic grids. The first example (top-left) shows a sketch of a vending machine. It is constructed using a floor grid and a wall grid at a horizontal viewing angle of 0 degrees (center). The example rendering (top-right) generated using the panorama software shows the viewer looking down on the mat with the text “stand here”. The wall behind the machine is drawn by tracing horizontal lines from the edge of the vending machines toward the end at the top and bottom of the wall grid. The vending machine itself is sketched by tracing a rectangle such that it appears in front of the wall. Hence, the same wall grid can be used to represent different parallel planes at different distances from the observer by tracing different lines.

The screen, credit card slot and ticket issuing trays are added by tracing smaller rectangles on the grid. To emphasize the floor, a floor mat is sketched by tracing a rectangle on the floor grid in front of the vending machine. In addition, and a surrounding vending machine area is marked by tracing a larger rectangle in such a way that it places the viewer in the middle. When looking around the viewer will get the sensation of standing inside this area.

The second example (bottom) shows a more complex three-dimensional sketch of a scene with cubes. This sketch is obtained using three grids perpendicular to each other (two wall grids 90 degrees apart horizontally, and one floor grid). The respective cubes are then sketched by tracing the lines along the *x*, *y* and *z* directions.

5. SUMMARY

A novel framework for sketching equirectangular panoramas are proposed based on simple floor and wall grids and examples of how to use the framework is given. The angle of the vertical wall grids are directly related to their horizontal position on the panorama. Shapes are created by tracing gridlines. The sketches are viewed using panoramic viewing software that allows the scene to be viewed in any direction from the inside. The framework thus gives designers a simple approach for sketching immersed experience using hand drawings. The grids described herein are made available in the public domain at http://www.cs.hioa.no/~frodes/gridpaper/.

6. REFERENCES

[1] Goldschmidt, G. "The dialectics of sketching." Creativity research journal 4, 2, 123-143.

[2] Israel, J. H., Wiese, E., Mateescu, M., Zöllner, C., and Stark, R. 2009. Investigating three-dimensional sketching for early conceptual design—Results from expert discussions and user studies. Computers & Graphics 33, 4, 462-473.

[3] Black, A. 1990. Visible planning on paper and on screen: The impact of working medium on decision-making by novice graphic designers. Behaviour & Information Technology 9, 4, 283-296.

[4] Sandnes, F. E., and Jian, H.-L. 2012. Sketching with Chinese calligraphy. Interactions 19, 6, 62-66.