

## STEREO PANORAMAS: PROBLEMS AND SOLUTIONS

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### ABSTRACT:

Recent years have seen an increasing interest in the use of panoramic models to document architectural and archeological sites. A stereo-panorama is a new extension to a panoramic model which improves the model by adding the depth dimension to the simple flat panoramic model. In addition to having an impressive view of reality, such a model could allow for three dimensional measurements on the objects. To develop such models a number of questions, however, need to be addressed. The numbers of cameras to use or the way occlusions are tackled are among such questions. In this paper, problems in producing stereo-panoramas and possible solutions to them are discussed. For this, various scenarios were tested. The results of this study showed that using stereo cameras having a very small distance from each other and taking photographs in appropriate lighting conditions can result in high quality stereo-panoramic models.

### 1. INTRODUCTION

Recent years have seen an increasing interest in the use of panoramic models (also called panoramas) to document architectural and archeological sites. A panorama is formed by a series of images taken using a normal camera from its surrounding areas. Once the images are taken, they are stitched together to form a complete 360-degree image which covers the whole area around the camera (Figure 1). The image is then mapped onto the surface of a cylinder, cube, or a sphere on the center of which the viewer is placed. Such a computer model provides a virtual environment in which the user is able to visualize the areas surrounding the camera station in an attractive and realistic way. Panoramic models have many applications in tourism, education and site demonstration (Varshosaz, 1999).



Figure 1. A sample panoramic image

Despite being attractive visualizations, panoramic models suffer from being 2D images, only mapped on a 3D surface to make them seem three dimensional. A stereo-panorama is a new extension to a panoramic model which improves the model by adding real depth to the conventional panoramic models. It is formed by overlaying two single panoramas taken from separate stations covering the same area. They act like a normal stereo model formed in most photogrammetric applications. In addition to having an impressive view of reality, such a model could allow for three dimensional measurements on the objects. To develop such models a number of questions, however, need to be addressed. The numbers of cameras to use or the way occlusions are tackled are among such questions. In this paper, first experiences on the development of stereo-panoramas are

reported. In this regard, various problems occurred when producing stereo-panoramas and possible solutions to them are discussed.

### 2. DEVELOPING STEREO PANORAMAS: FIRST EXPERIENCES

Basically, as a routine operation in photogrammetry, in order to form a stereo model, two overlapping images are required. Therefore, to form a stereo-panorama, the first step was to produce two panoramas from adjacent camera stations. For this, several images from two separate stations which were 1.5m apart were taken and panoramas covering the same area were produced. In order to view the panoramas in stereo, they need to be viewed simultaneously. This could be done using different stereo viewing techniques; one of the simplest ways of stereo viewing is formation of anaglyph images. Anaglyph images are two overlapping images, one of which is represented in red while the other is shown in green or blue. When viewed with a pair of glasses one having red and the other green/blue eyes, the overlapping area can be viewed in stereo. Figure 2 shows the resulting stereo panorama.

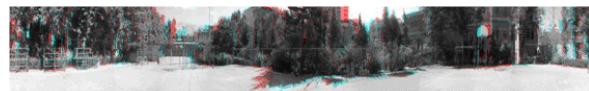


Figure 2. The first stereo panorama produced

Having examined the model, it was realized that due to unlevelling of the cameras, some y parallax was developed, resulting in some difficulties in viewing the model in stereo. It was, therefore, decided to take the panoramas indoors to make sure the cameras remain level during the image acquisition stage. Figure 3 shows the resulting stereo panoramic model.



Figure 3. The stereo panorama model produced indoors on a flat surface

As can be seen in this model, the effect of y parallax is less than that of the previous one. However, at this stage, two additional and more serious problems were observed. The first one was occlusions due to high variations in depth. The biggest problem observed was the co linearity of the camera pointing directions. This meant that the corresponding image canters coincide resulting in an irresolvable x parallax. Consequently, the formation of the stereo model in such situations was impossible.

### 3. DEVELOPING STEREO PANORAMAS USING A STEREO BAR

In order to solve above problems it was decided develop a stereo bar on the two sides of which two cameras of the same brand were placed. Both cameras were pointed at infinity and the lighting conditions were locked in analogous sets. In the first instance the distance between the cameras was around 1m. However, later on it was realized with such a distance excessive object depths produce large occlusions. Various camera bases were tested to evaluate the effect of camera base on occlusions. It was realized that the closer the cameras, the less occlusion effects appearing in the final model. It seemed at last that a 25cm was a reasonable distance which in addition to providing images of sufficient overlaps for stereo viewing, produces images with minimal occlusions. The system acted similar to human eyes. Figure 4 shows a snapshot of the stereo bar cameras used in this project.



Figure 4. The stereo bar used for image acquisition

To form stereo panorama, the stereo bar was first positioned in the site. Then, images of the surrounding areas were taken using the two camera in a step-wise manner until the whole 360 degrees was covered. The results were a set of overlapping image pairs, using each pair of which a stereo model could be formed.

Once the stereo pairs at each step were formed, they were stitched together and a complete stereo panorama was formed (Figure 5).

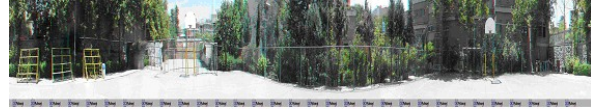


Figure 5. The final stereo panorama

The stereo panoramic model developed, was of much higher quality compared to those previously produced. It included little occlusion, and had a uniform stereo look and feel.

### 4. CONCLUSIONS

This paper presented first experiences on the development of stereo panoramas. It was observed that y parallax and occlusion are immediate problems in the development of such models. It was, however, realized the biggest problem is the co linearity of camera axes, which leads to some x parallax which could not be resolved. To solve these problems, a prototype system was presented which acts the way human eyes do.

The system was tested in a couple of case studies. The results showed that using stereo cameras having a very small distance from each other and taking photographs in appropriate lighting conditions can result in high quality stereo-panoramic models, where the occlusion are also minimized.

### References:

Varshosaz, M., 1999. Visually Realistic Construction of Building Models in Urban Areas. PhD Thesis, University College London, 197 pages.