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HOW TO IMPROVE WORK IN PLANETARIUM?

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Abstract. Planetariums can provide an immersive environment for scientific education, virtual reality, and entertainment (Shaw 1998). Digital projection into domes, called "full dome projection", can be a technically challenging and expensive exercise, particularly for installation with a modest budget. Here we present an alternative full dome digital projection system, which consists of a single projector and a spherical mirror that scatter the light onto the dome surface. This approach offers many advantages over the fisheye lens alternatives, and results in a similar quality for just a fraction of costs.

1. INTRODUCTION

Historically dome environments have been restricted to large planetariums and have been used primarily for public education in astronomy, showing the positions/motion of planets, stars, and constellations. These planetariums have used a variety of specialized projection hardware such as star projectors, laser projectors, and multiple edge blended slide projectors. In more recent times planetariums have been upgraded to provide full dome digital projection, i.e. a movie is seamlessly projected onto the dome surface. With the success of digital projection in large planetariums, interest has been growing in how to offer the same experience in smaller domes. These smaller domes are typically around 10m in diameter. The difference between these small domes and the large planetariums is largely in the system costs that operators can sustain. Not only that multiple projector systems have high initial costs, but they also have higher requirements in local expertise, and incur significant costs of ownership (Sparacino 2004). The solution was to use a fisheye lens attached generally to a single commodity data projector. The projector and lens are located in the center of the dome, where fisheye frames, generated from movies or real time interactive applications, are projected through the lens, and if created correctly they look undistorted on the dome. Such solutions have the benefit of being easy to manage and do not usually require specialized computer hardware. There are some problematic issues such as resolution, brightness or chromatic aberration, but they are largely a reflection of the price one is prepared to pay for the projector.

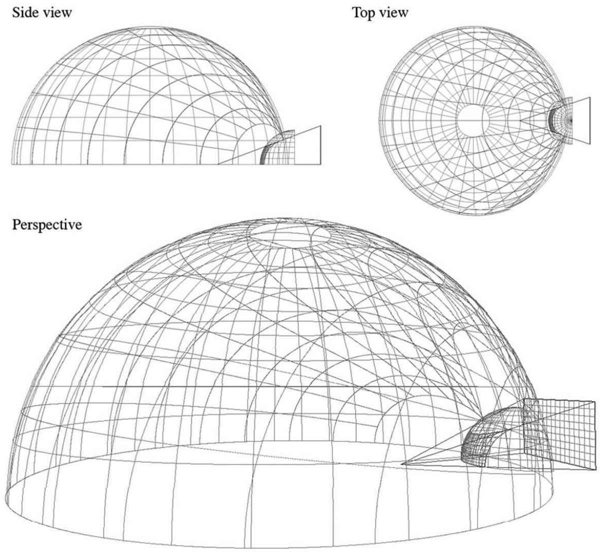

Figure 1: Typical position of the projector, mirror, and dome in a planetarium environment.

2. SPHERICAL MIRROR PROJECTION

The projection system proposed here uses a spherical mirror to distribute light in a wide solid angle instead of a fisheye lens (Fig. 1). It is obvious that a spherical mirror can reflect light from a rectilinear frustum (produced by a commodity data projector) over almost the whole dome surface, but there are a number of options for the projector/mirror placement in relation to the dome.

2. 1. SPHERICAL MIRROR VS. FISHEYE LENS SYSTEM

There are a number of comparisons one can make between a spherical mirror reflection arrangement and a fisheye lens system (Hashimoto and Iwata 2001), here we listed some of them.

(i) It can be advantageous to locate the projection hardware away from the center of the dome since the center is generally the best location for undistorted viewing.

(ii) The projector and optics are separated making it possible to choose projectors based upon the characteristics important for the application at hand, e.g.: brightness, resolution, or contrast ratio. Fisheye lens can typically only fit to a very narrow range of projectors. The coverage on the dome can be controlled by varying the distance between the mirror and the projector or by varying the projector zoom. While it is true that the whole dome surface cannot be totally covered, it is equally not common for fisheye projection to cover the whole dome for pixel efficiency reasons.

(iii) Unlike for the case of the fisheye projector which is located in the center of the dome, in the case of the spherical mirror the path length from the projector to the dome is not constant, resulting in an intensity variation. Fortunately this is straightforward to compute and correct for.

(iv) A common problem with fisheye lens is chromatic distortion at the rim of the fisheye, while no such chromatic distortion occurs with a good quality mirror.

(v) Angular fisheye lens with good optical design is at all positions in focus on the dome surface. When using a spherical mirror there is a variation in path length from the projector to different parts of the dome. The effect of this focusing problem can be minimized by choosing projectors with a good depth of focus.

3. CONCLUSIONS

An alternative dome projection system has been designed and demonstrated to be suitable for small planetarium domes. By comparison to more conventional fisheye solutions, the spherical mirror solution suffers from no serious disadvantages and offers some advantages at a significantly lower cost.

References

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