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**Dome Project**

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# Dome Project

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**Abstract**

This report describes the details of the project *DomeView*, developed by Digitok Co., Visgraf Lab - IMPA and Brazilian Astronomic Museum (MAST) with CNPq financial support. This project develop a full camera model based on OpenGl pinhole model, able to capture and to display non-trivial panoramas, such as spherical and cilindrical ones.

**Resumo**

Este relatório descreve os detalhes técnicos do projeto *DomeView*, desenvolvido por Digitok Co., Visgraf Lab - IMPA e Museu Brasileiro de Astronomia (MAST) com suporte finaceiro do CNPq. Nele, foi desenvolvido um modelo completo de câmera baseado no modelo de câmera pinhole do OpenGl, capaz de capturar e exibir panoramas digitais não-triviais, como por exemplo, mapas esféricos ou cilíndricos.

## 1 Introduction

The actual graphic paradigm is based on a pinhole model camera. Briefly, this model describes, a light-proof box with a small hole in one side. Light from a scene passes through this single point and projects an inverted image on the opposite side of the box. Cameras using small apertures, and the human eye in bright light both act like a pinhole camera (Figure 1).

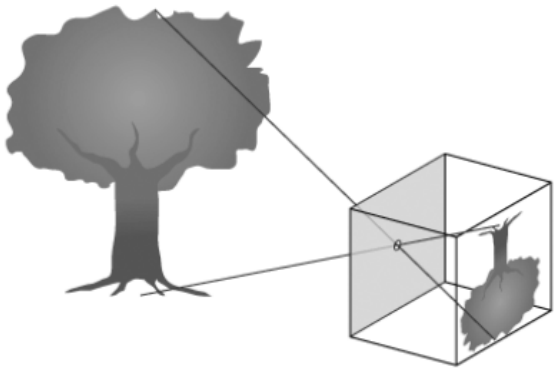

Figure 1: Pinhole camera model.

This schema has many advantages: is a simple and succeeded model. The biggest example is the standard specification OpenGL for writing 2D and 3D computer applications. The OpenGL was developed based on the pinhole model and, nowadays, is widely used in many graphics aplicattions such as CAD, virtual reality, scientific visualization, information visualization, flight simulation and games. Also, it is supported in all current graphics cards and on different platforms.

Today, some important research groups are studing possible new ways for capture and display images. One of the objectives is doing photo/movie projections in non-trivial geometric screens. They are searching for immersive environments, that seems to be the next step in large movie industry.

Thus, we intend, in this project, develop a tool that unites the portability and all consolidated techniques of OpenGL with this new projection context, creating a new paradigm for general camera model. The goal is to create a technology that is in line between the two paradigms: be portable, in terms of support, and be adaptable for different models of capture and display.

One application of this technique is in astronomical sciences. In this science field, simulations are often necessary. Astronomical simulations normally envolves spherical projections once these models describes movements in the sky space, specially for planetarium projections. Once the current model envolves a single pinhole camera, the current solution uses multiple cameras, where the quantity depends on the size of the projection screen.

Specifically, this solution has bourn of a problem preseted by Brazilian Astronomic Museum (MAST), an institution for support educational astronomical programs. They have several projects and among them, there is the *Planetário Itinerante* (in english, *Traveler Planetarium*). In this project are used inflatable domes, a semi-sphere with six meters of diameter called *Small Planetarium*.

There are many others small planetariums in Brazil but almost of them works with non-digital projections yet. However, the digital projection has many practical advantages: is a way to modernize the equipment of projection and to make easier and independent the creation of didactic material. Thus, changing the current technology is more than a modernization issue. It is also a question of effective impacts on the way of conducting this type of project.

# 2 Illumination Field

- Descricao do modelo de iluminacao usual do OpenGl e seu campo de iluminação.

## 2.1 About light and illumination field

- Transmission
- Local Illumination
- Illumination Mechanisms: Light Transport and Bidirectional Transport Function
- Local Illumination Models: Pure Diffuse (Lambert's law), Specular(Phong Approximation) and Transmitted
- Light Sources and Types

## 2.2 About openGL illumination model

The OpenGL illumination model approximates the light through the usual decomposition of 3 channels: red, green and blue. According to this model, the illumination is the result of 4 components:

- ambient: illumination uniform and from all directions, with an estimative of multiple diffuse reflection;
- diffuse: represents the light coming from a given direction and reflected as equal in all directions. Thus, this component does not vary with the position of the observer;
- specular: light coming from a specific direction, which tends to be reflected on the surface in a preferred direction;
- emission: the materials may also have an illumination component corresponding to the emission of light from the object itself.

With the exception of this last component, these characteristics can be defined for light sources and for materials. To specify these components for the light source, means to indicate the intensity of each component in the light emitted by the source. For materials, the definition of illumination components represents the behavior of these materials under the lighting set.

# 3 Camera Model

The camera model used in this software is based on multiple OpenGl camera, where each one is a pinhole camera directed for a determined direction.

- Thin Lens Model and Pinhole Camera Model
- Projections
- OpenGL
- New paradigm proposed for a camera model

## 3.1 Capture

Describe the model of four pinhole cameras forming a cube (ou half cube) and the sphere inside the half cube.

## 3.2 Display

Describe the display mode: the relation between the steps, that can be interpretated as a map composition, where each map is a deformation starting in the fisheye image creted in the capture model. Write about the inverse problem used and point out the positive and negative topics in each approuch.

## 3.3 Texture and Mesh Format

Describe the use of texture in deformeted image and its importance in process od map composite. Describe the mesh format. (Maybe this topic could be condensate in the two prior topics as part of each step).