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The Celestial E-Sphere

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Introduction

The Celestial E-Sphere originally came from an idea from Dr. Bob Lambourne who expressed a desire for a Celestial Sphere that you could see from outside, rather like the desk-top spheres that you can buy. There was some discussion about the possibility of modifying the open source of Stellarium, a very popular planetarium package, but this was perceived as probably being very complex. The final impetus came when using the Sky Maps tool of the Sloan Digital Sky Survey website, shown below.

This showed a celestial sphere from the outside. Although the functionality was very limited, you couldn't 'go inside' the sphere for example, the aesthetic appeal of seeing the heavens presented in this form was evident.
**Initial Version**
The program is written in C++ using the OpenGL graphics library. Data for 30,000 stars was read into an array from the HYG database (The Astronomy Nexus. [http://astronexus.com/node/34](http://astronexus.com/node/34)). The stars’ positions were plotted using simple spherical geometry. They are modeled using a single star texture mapped to the relevant size depending on apparent magnitude. They are coloured according to their spectral type. The textured stars are ‘bill-boarded’ that is their two dimensional image always faces the camera so as to appear three dimensional.

It was evident from very early in the development that the sphere presented a very striking animation that was aesthetically pleasing whilst being of obvious educational value. In particular the animation is very smooth, commonly running at 60 frames per second on a reasonably good machine equipped with a graphics card.

**Additional development**
Features were added that corresponded to a typical planetarium demonstration (I actually based these on Roger O’Brian’s presentation at the Mallorca Observatory’s planetarium in September 2007). These include:

- constellations and their boundaries;
- ecliptic;
- labelling of solstices;
- north and south celestial poles;
- labelling of coordinates;
- projection of equator onto celestial sphere;
- Sun, Moon and planets with ephemeris calculations;
- horizon for anywhere on Earth;
- altitude of some stars;
- motion of Sun and planets.
**User Feedback**

The first outing for the Celestial E-Sphere was at Astrofest in February 2007. Scores of attendees asked about the program making very admiring comments. Several of followed up since and asked for copies. In all cases where there has been feedback it has been very positive.

Some of the lecturers and tutors at the OU expressed interest in using it for teaching on some of the Astronomy courses including S282. This further influenced the features that have been included. In particular, after implementing several hardwired tours complete with audio it was realised that what would be more effective would be a general macro recording and playback facility that the tutors could use themselves. This facility allows the user to capture any interactive sequence that can then be replayed. A soundtrack can be added to this. Thus it is possible to create self-running tutorials.
The application has been demonstrated to the staff at the National Space Centre in Leicester. They have expressed a desire to use it projected onto a stage using the Pepper’s Ghost principle which will make the sphere look like it is hanging in space. This is to form part of their section which is targeted at 16-18 year old students of Physics.

The application has also been presented at several CETL conferences and at a Physics and Astronomy departmental meeting. In all cases it has met with considerable enthusiasm.

**Conclusion**

The Celestial E-Sphere certainly has a high ‘wow factor’ whilst being of huge educational value. Concepts such as the Sun crossing from the South to the North hemisphere at the spring equinox can be appreciated with an immediacy that is lacking from normal static descriptions and schematics.

The provision of a macro-record and playback facility allows anyone to design tutorials using the E-Sphere. We are looking forward to the evaluation of such material now that this has been added.