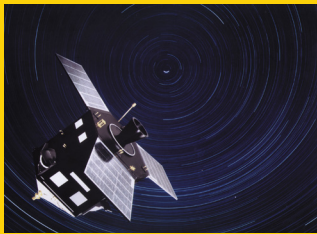


VIRTUAL REALITY UNIVERSE: POCKET PLANETARIUM

The stars in the virtual universe are taken from the catalog of stars observed by the Hipparcos satellite, which was launched by the European Space Agency in 1989 and observed the full sky until 1993. Hipparcos measured the



positions of stars with extreme accuracy, and used the apparent shift in the position of nearby stars relative to the distant background stars as the Earth moves through its orbit (the parallax) to determine the distances to the stars. Our simulation contains the 8,447 brightest stars in the catalog, approximately the set of stars you would be able to see with the naked eye from a very dark location (assuming you could see stars in all directions!).

Hipparcos also measured the colors of stars, as shown in our simulation. The color of a star depends on its temperature: hot stars (which are massive and short-lived) are blue, and cool stars (small and long-lived) are red. Although all stars appear as single points of light in the sky, we have indicated brighter stars with larger sizes.



This star simulation was made with a variety of software packages that handle .obj files, a standard format for representing 3D objects. Using a simple, single object .obj file as a template, we wrote custom Python scripts to generate a full set of .obj files from the Hipparcos star catalog, incorporating the position and brightness (represented by size) of each star. This data was then imported into the Unity application (usually used for video game development), where we applied materials that represent

the star's temperature via its color, and placed the stars into a computer generated space. Unity is a great environment for Oculus viewing experiences.



The soundtrack to the virtual universe was created with Sonic Pi, a free program for Raspberry Pi, Mac OS X, Windows and Linux. Sonic Pi enables the creation of electronic music with simple, Ruby-based computer code, and is a great way to learn basic programming skills while composing music.

Our universe's soundtrack is based entirely on the frequencies of pulsars. The background sound continuing throughout repeats every 1.33 seconds; this is the rotation period of the first pulsar discovered (CP 1919, detected by accident in 1967 by University of Cambridge graduate student Jocelyn Bell). All other tones are the frequencies of the millisecond pulsars used by NANOGrav, the North American Nanohertz Observatory for Gravitational Waves. These pulsars spin hundreds of times each second, corresponding to audio frequencies.

Go to our website for a link to the audio file. You can download the Sonic Pi program used to make it and a basic program to get started on making your own pulsar music!

Scan for more information!



<http://www.cgca.uwm.edu/outreach/maker.html>