Sphaerica: Interactive Spherical Geometry Software

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Abstract

Sphaerica is a project which is concerned with the studying, using and teaching of spherical geometry. Sphaerica is also computer software which summarizes the results of performed experiments. Thus, in it a new tool is created which can be applied to experiments undertaken in various areas of geometry, physics and art.

Introduction

The aim of this project is to create a tool which can serve as a support for education, in presentations and in experimentation. The process of studying spherical geometry is summarized in the creation of a relevant software. This interactive spherical geometry software can be further used in other projects as an exploratory tool.

The project itself consists of extensive research in small samples in various fields of geometry and art. The presentation serves to introduce the project and demonstrate through examples some of its creative uses.

Further information about the software can be found on the relevant official web page: <http://sphaerica.sourceforge.net> and on the international web page of the software: <http://sourceforge.net/projects/sphaerica/>.

The Software

The software offers numerous tools with which to build constructions on spheres. Beginning with the simple compass and spherical ruler and combining this with less mathematical approaches allows for the creation of more specific and complex designs. The broad selection of tools facilitates the realization of ideas or simple playing around. The capabilities of the software can be extended by composing supplementary Javascript code. This allows for the inclusion of any such design in a web page in the form of an interactive Java applet.

The source code is released under an open source license [1]. It is available to the public at no charge. It can even be modified by adding new features or variations therein to improve its applicability. Or parts of it can be used in one's own personal projects. All of these usages are possible.

Spherical Polyhedron Modelling

Applying tessellations to the surface of the sphere produces spherical polyhedra. These spherical tilings show properties common to usual polyhedra. Furthermore, by using regular and semi-regular tessellations, the formation of Platonic and Archimedean bodies can be induced.

In this project there is an attempt to reconstruct all of the regular and semi-regular polyhedra potentially existing on a sphere. Making them interactive allows for the possibility of changing a parameter or a precondition in order to change the composition. For example, these models can be used to show the gradient to irregular polyhedra. Basic geometrical processes, such as truncation can be modelled this way by using the software.

This method of modelling can be used in both teaching and learning. Constructing on a sphere can expand one's vision and helps one in understanding symmetry. The sphere can be rotated and one can move on it freely. All the calculations and measurements throughout are effected by the computer.

The current status of the project as well as its interactive demonstration are available on the following web page: <http://sphaerica.sourceforge.net/polyhedra/>

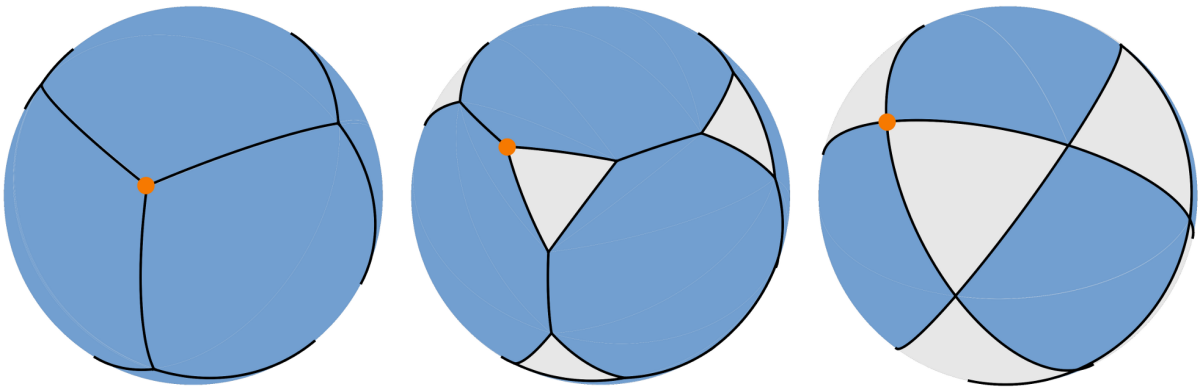

Figure 1: *Truncation modelled with the software*

Elliptic Spidrons

More complex geometrical structures can be implemented by using the software as a new tool. Dániel Erdély's Spidron system [2] offers many possibilities in this field of geometry, also.

All the Spidron shapes can be projected onto the surface of the sphere creating never-before-seen spiral ornaments. Similarly they keep their spidron-property: as the Euclidean spidron's f-angle converges to zero, the elliptic spidron triangle's spherical excess does the same. Designing spidrons on a sphere also reveals interesting features of symmetry. For example, no difference can be discerned between a projection of a spidronized elliptic tetrahedron and an elliptic hornhedron.

Polygons and polyhedra bounded by smooth spiral arms result in more interesting shapes. Partitioning of the plane, sphere or space in this way leads to a new, upcoming geometry. Spidron geometry is based on a

division of the surface and the dissection of volume using logarithmic spiral arms. The system is foldable from a flat circle while its edge remains on the surface of an ellipsoid.

The software offers all the tools needed to design spidrons and even more complicated patterns. It can be used either for prototyping or measurements.

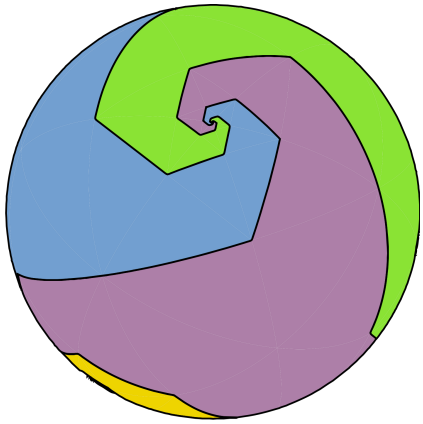

Figure 2: *Four spidrons on a sphere*

Future Work

Continuing the developing of the software and the work on many smaller related topics is what is envisioned for pursuing the project further. It will be necessary to release new versions of the software as often as possible. It will also be important to involve more people in this interesting process. The web appearance is another task which is in progress so that an online knowledge base can be launched, building on results yielded by the project. A community forum where interested users can share their creations or seek help and support is also something worth launching.

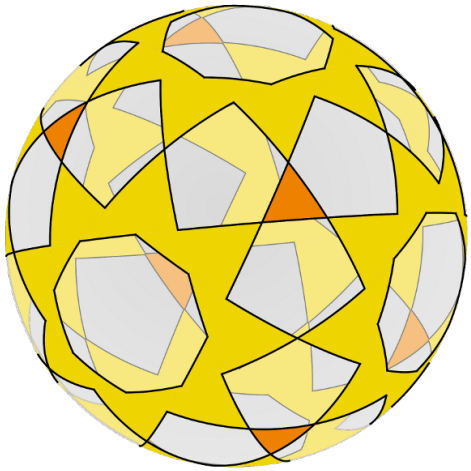

Figure 3: *An octahedral design*

References

[1] In fact, the GNU General Public License offers many opportunities and rights for the users of the software. For more information, visit its official web site: http://www.gnu.org/licenses/gpl.html
[2] D. Erdély, Spidron System, http://spidron.hu/

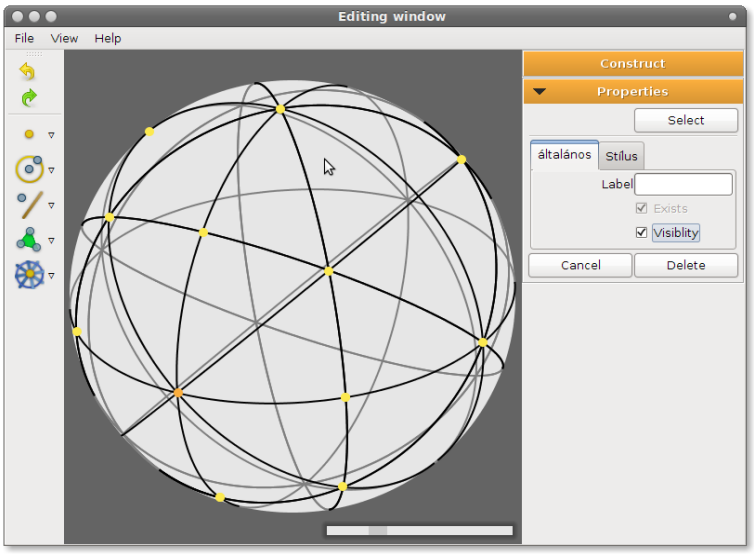

Figure 4: *The software in use*

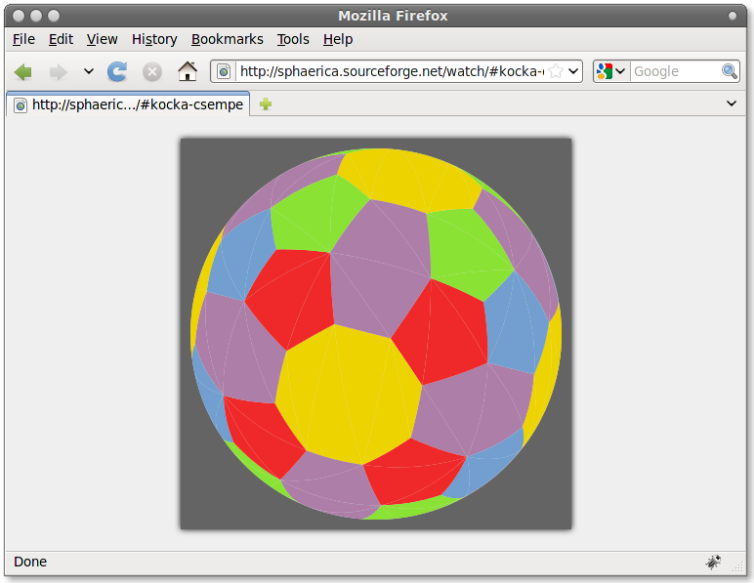

Figure 5: *The final result in a web browser*