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Abstract

Regular polyhedra are a class of convex polyhedra that have congruent regular polygons as faces and congruent apices (as vertices). Regular polyhedra consist of regular tetrahedron, regular hexahedron, regular octahedron, regular icosahedron, and regular dodecahedron. Regular polyhedra have a long history going back to the book "Elements" written by Euclid. Since then, it has been researched with related to the group theory, the theory of the algebraic equation, and so on.

Polyhedron is solid in 3D, however, its surface consists of connected figures in 2D. There is a way of representation focused on the surface of the polyhedron called "unfolding". A history of unfolding is back to a book written by Dürer in 1525. In this book, polyhedra are represented by the placement of faces according to their adjacency. Since they can be regarded as polygons obtained by cutting edges and open, they are called edge unfolding. An edge unfolding is still an active topic. For example, there is an open problem "whether every convex polyhedron has a non-overlapping edge unfolding". On the other hand, when any place other than edges is admitted to be cut, it is called (general) unfolding. Against the number of edge unfolding is finite for a polyhedron, the number of general unfolding is (uncountable) infinite. Therefore, the relationship between a polyhedron and its unfolding is difficult. Even simple polyhedron like regular polyhedron, there are only a few results except for regular tetrahedron by Akiyama.

In computational geometry, a problem called "folding problem" has been researched. The folding problem asks if a polygon P is unfolding of a polyhedron Q for given P and Q. First, a polynomial-time algorithm was developed in the case that P is a polyomino and Q is a box of integer size. After that, it is extended to a general polygon P.

In this research, we recapture the folding problem as a characterization of an unfolding and organize the previous framework. As a result, we develop polynomial-time algorithms for a case that Q is a regular polyhedron which is extended to a deltahedron, a tetramonohedron, and a box of integer size. A part of this research was published at the 32nd Canadian Conference on Computational Geometry.