

Computation of local degree-of-freedom for tessellation origami with high flexibility

C. C. CHAI*, K. K. CHOONG^a, J. Y. KIM^b

**Graduate Student, Universiti Sains Malaysia, pearlygal_capri@yahoo.co.uk*

^a School of Civil Engineering, Universiti Sains Malaysia, cekkc@usm.my

^b Hyupsung University, South Korea

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Abstract

In the past decades, tessellation origami becomes a design inspiration in architectural and structural engineering. The simulation of the tessellation origami is appear to be beneficial as the form finding and modeling tool for structure such as roof(especially foldable shelter) and facades. At current state, many simulation tools for tessellation origami are focused on one-DOF(degree-of-freedom) tessellation pattern such as the miura-ori and synchronised folding method for more than one-DOF tessellation pattern. This has limited the number of tessellation origami and its corresponding folded configurations that can be study. However, understanding on the folding of tessellation origami which normally has higher degree-of-freedom can provide an insight on how to control the simulation of the folding. Hence, this paper presents the method to compute the local degree-of-freedom of the tessellation pattern by counting the degree-of-freedom from one vertex point to another. This method has produced a map by using the tessellation pattern as the base and using this map, we can further understand about the actuator that can be use to control the folding of the tessellation pattern with different flexibility.

Here, the map is referred as the actuator map and all positive local degree-of-freedom and its location is shown in this map. The counting starts at the self-selected first vertex and the number of actuator line existed on the vertex is equals to the positive local degree-of-freedom at that vertex. For example, figure 1 and 2 show two different actuator maps for crease line pattern 1. Crease line pattern 1 has a single vertex with 6 number of crease lines emanating from that point representing the repetition of the vertex pattern. From the two figures, we can see how the actuator map changed according to how we want to control the fold. The actuator map for crease line pattern 1 has been used to simulate the 5 number of mountain-valley patterns which consisted of the Miura-ori Variation 1, 2, 3, Russo's Optical Illusion and Yoshimura Pattern. The result of the simulation is also showed in this paper. The simulation is carried out with a tool created using the Rhinoceros3D plugin, Grasshopper.

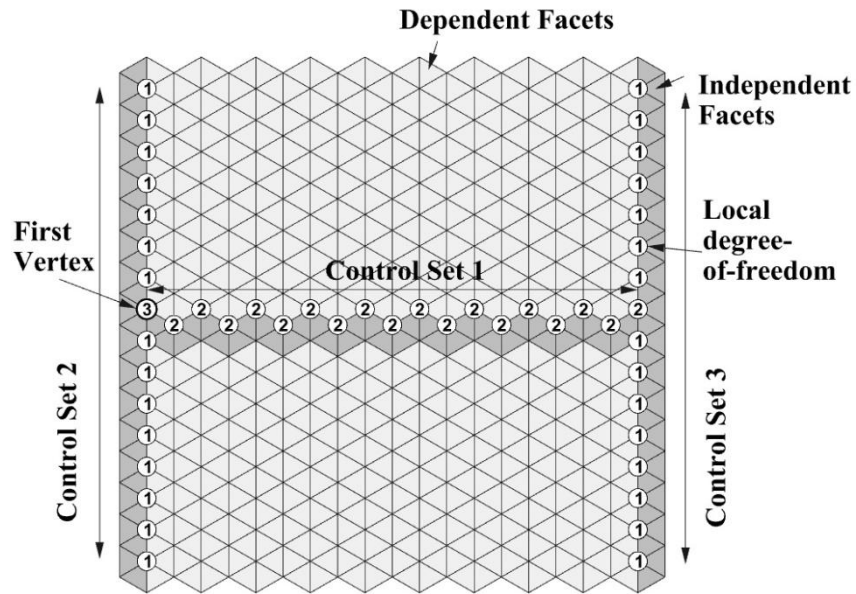


Figure 1. Example of actuator map for Crease Line Pattern 1

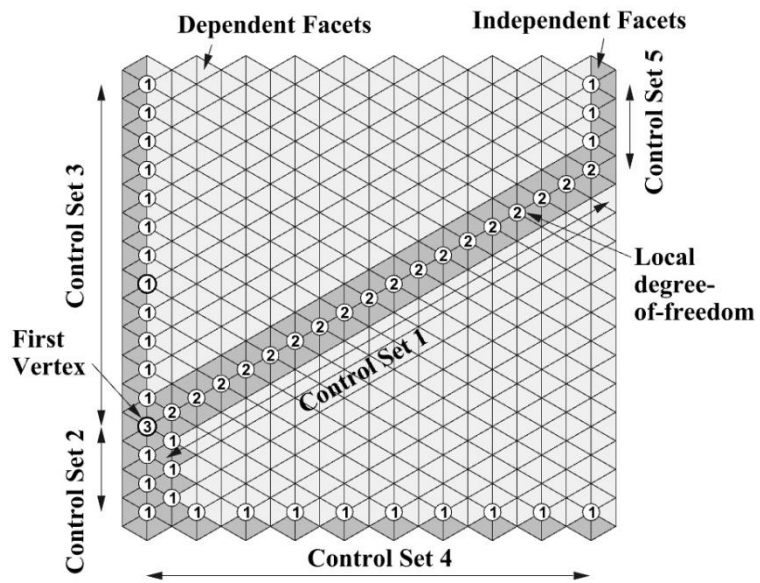


Figure 2. Another example of actuator map for Crease Line Pattern 1