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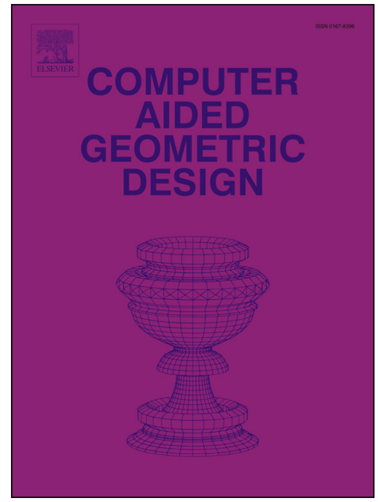


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# Conformal Mesh Parameterization Using Discrete Calabi Flow

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**Abstract**

In this paper, we introduce discrete Calabi flow to the graphics research community and present a novel conformal mesh parameterization algorithm. Calabi energy has a succinct and explicit format. Its corresponding flow is conformal and convergent under certain conditions. Our method is based on the Calabi energy and Calabi flow with solid theoretical and mathematical base. We demonstrate our approach on dozens of models and compare it with other related flow based methods, such as the well-known Ricci flow and conformal equivalence of triangle meshes (CETM). Our experiments show that the performance of our algorithm is comparably the same with other methods. The discrete Calabi flow in our method provides another perspective on conformal flow and conformal parameterization.

## 1 Introduction

In this paper, we present a novel conformal flow-based method for conformal mapping. Our method is based on discrete Calabi energy and Calabi flow [9, 24, 27, 23, 22]. Discrete Calabi flow is inspired by discrete Ricci flow [12, 48, 38, 73], it is also a conformal flow which preserves the angles. Conformal parameterization can keep the shape of the original mesh and is especially useful in all kinds of applications.

Mesh mapping and parameterization are crucial operations in computer graphics modeling. Researchers have designed a lot of different algorithms in the past twenty years. One of the important applications of mesh parameterization is texturing which assigns a 2D image onto a 3D mesh surface, another one is remeshing.

Given a 3D mesh, the parameterization looks for a corresponding 2D flat mesh. The perfect mapping is an isometric one that can only exist on the developable surfaces. Therefore in practice, we try to preserve the area or angle. They are called authalic (area-preserving) mapping, conformal (angle-preserving) mapping, isometric (length-preserving) or some combination of them.

The algorithms proposed in [36, 18] can be designed on the discrete triangle mesh directly. The optimal mapping [14, 45, 47] results from defining and minimizing an energy related to the mesh triangles. Other methodologies are based on the smooth surface mapping theories and then derive their corresponding discrete approximation [38, 34].

Flow-based algorithms do not work on the positions directly, instead they evolve the surface metric into a flat one. The final parametrization is obtained by embedding the surface of the flat metric to the 2D plane. In Figure 1, we show our Calabi flow based conformal parameterization. The angles are preserved very well in several corresponding rendering results. In Figure 2, we exhibit three mesh parameterizations with Calabi flow, Ricci flow and CETM.

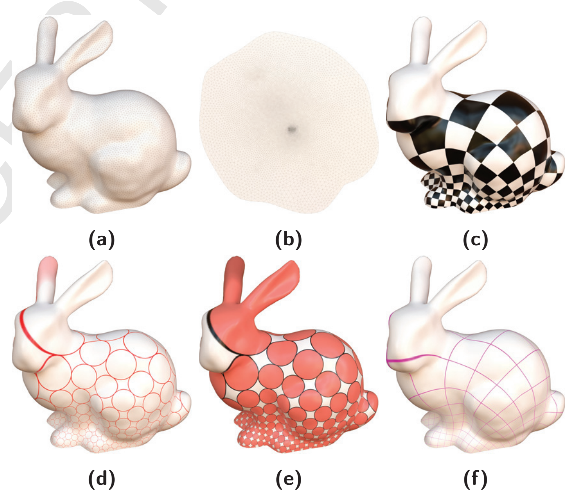


**Figure 1:** (a) the bunny; (b) its parameterization with Calabi flow; (c), (d), (e) rendered with different textures.

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