

[PO-A2]Poster Session 2

Symposium A

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**[P2-03]Nonlinear elasticity on Riemannian manifold and its application
to general surface development**

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This study aims to develop a theoretical framework to construct a three-dimensional curved surface from pieces of an elastic sheet which is embedded in two-dimensional Euclidean space. Our formulation is based on the standard nonlinear elasticity within the framework of differential geometry. We first introduce the Riemannian manifolds which equip the metrics, $g[0]$ and $g[t]$, for reference and current configurations. The strain energy density is defined as a quadratic form of Green strain tensor under the assumption that elastic medium is isotropic in the reference configuration $g[0]$. Then, the surface development problem ends up with a variational problem such that to find an embedding mapping which minimizes the strain energy functional. We solve the variational problem numerically using the isogeometric analysis (IGA). To this end, we first derive a weak form equilibrium equation from the first variation of the functional. The embedding mapping is approximated by a linear combination of non-uniform rational B-spline (NURBS) functions with the coefficients ξ_i . Consequently, the equilibrium equation yields a system of nonlinear algebraic equations for ξ_i and which is solved iteratively around a linearized solution by the Newton method. It should be noted here that present method consider in-plane deformation of the elastic sheet exclusively. It implies that two-dimensional isometric deformation, such as out-of-plane bending deformation, produces no strain energy in the medium. In this regards, present method is a fair generalization of conventional surface development method which is frequently used in the paper craft such as origami. Numerical analysis for a one-dimensional system demonstrates that present method converges to an exact solution within a sufficient accuracy.