LITERATURE REVIEW 2

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Interactive Design of Developable Surfaces
(https://dl.acm.org/citation.cfm?id=2832906)
(Primary Paper)

In both theory and practice, developable surfaces are very important. They are defined such that the surfaces be mapped to a planar domain. The mapping is performed without any stretching or tearing. These shapes are gained by means of thin materials alike sheet metal or paper that do not stretch. Consequently, we be able to say that these developable are very significantly applicable to the manufacturing industry. And not only just in the manufacturing industry, but also these freeform developable occur in the art and architecture designs. These proposals are piecewise-developable. One interesting topic with so many contributions to developable is **origami and paper craft**. It is essential to emphasize that not only smooth developable but also buckled or crumbled surfaces are important in this context. I found this point to be very important. Developable do occur in other places such as in connection with folding maps in augmented reality, 3-Dimensional reconstruction, and mesh segmentation. Despite of having lot of importance, these developable surfaces still present difficulties to today's CAD systems and also the fact that geometric modeling with developable in its full generality is not available, apart from lofting, i.e., defining a developable with its boundary. Undoubtedly, the reason for that is the highly non-linear nature of develop ability. The differential geometry provides users with a detailed mathematical description of developable: Assuming piece-wise curvature continuity, these consist of ruled surfaces with the additional property that the tangent plane along a ruling is constant. For previous work also buckled surfaces have been modeled by triangle meshes. Geometric modeling with continuous developables is an old topic, but contributions might be summarized by the statement that the nonlinear nature of the developability constraint so far pre- vented interactive design. Chu and Se ́quin discuss developability of spline surfaces and derive explicit forms of the developability constraints for surfaces up to degree 3 and use splines for modeling developable surfaces based on the ideas of Liu et .

The authors of this paper depicted the statement of problem as follows: In order for the users to make high quality developable surfaces which can be made available to the industrial design, all the degrees of freedom of composite surfaces have to be modelled whose individual parts enjoy C2 smoothness as well as that are constrained by develop ability. To be precise, it is this task that this paper is mainly concerned with. The authors of this paper propose an approach to develop ability based on splines, which portrays the standard surface representation of CAD (Computer Aided Design). One of the main contributions to this paper is the ability to quickly solve the constraints that show the develop ability of such surfaces as well as other non-linear constraints which are related to isometric deformations, to curved origami, to approximation, and many others. However, having to choose combinatorics is not a limitation when our aim is to explore the possible shapes of composite developables which have exactly those prescribed combinatorics. The paper contributes in interactive modeling of high-quality developable surfaces are performed, combined primal-dual spline representation of developable are used in this paper that involves a normal vector field and it also allows the users to express "develop ability everywhere" by using a finite number of constraints. Hence, the authors say that they can solve for develop ability at interactive speeds. It further contributes in the Curved-folding objects are interactively handled as well as the local and global develop ability are maintained, which gives the user a designed tool for curved origami in the author's perspective And the interactive tool has been extended to handle the design of surfaces which are isometric to a given domain. It is stated that the approximation of reference shapes with developable and piece-wise developable surfaces have been performed in this paper. The approximation's success depends on the above-mentioned vector field.
To conclude, the authors of this paper have presented us with various methods for interactive modeling of piece-wise developable surfaces as well as curved origami which is considered crucial in this paper. The approach discussed in this paper is based on a spline representation of simple developable which is combined with the previous work on solving particular non-linear systems quickly using guided projection. The paper clearly expressed local and global develop ability as well as how to solve certain problems like approximation problems with developable making use of their smooth and 1-Dimensional normal vector field. The method that is discussed in this paper is illustrated taking different examples, some of which correspond to existing work in real-life origami. The method has few limitations such as the need to decide the decomposition combinatorics of a given complex surface before modeling. This is seen mainly when exploring the shapes with a prescribed development, even though a workaround can be used sometimes. However, the authors of this research paper feel that having to choose combinatorics is not a limitation to them when their aim is to explore the possible shapes of composite developable that have those exactly prescribed combinatorics.

For future, the work should be done more on the topics of piece-wise **developable and curved creased sculptures**. The authors of this paper have not touched upon few details such as computation of an optimal decomposition into simple developable and also, they have not considered the topics like continuous unfolding and there is no algorithmic treatment of overlaps in this unfolding which the authors feel that it might actually amount to collision detection in a regularly updated environment. Adding to this, the authors feel that there are certain unsolved problems left out such as how to find the closest curved crease surfaces that can be globally developable as well as can be closest to a target shape that is given to us. This addresses one particular problem of origami tessellation with curved folds. Finally, it is said there is much more potential for extensions in the present method. One is enabling real-time modeling with developable: the authors of this paper propose to study a multi-resolution approach combined with parallelization. There can be more flexibility in modeling by changing few combinatorics, and few more constraints like statics or shading can also be included. Neither have we considered the topic of continuous un- folding, and we have no algorithmic treatment of overlaps in the un- folding (which would amount to collision detection in our regularly updated development).

Geometric Modeling with Conical Meshes and Developable Surfaces
(http://www.yongliangyang.net/docs/quadMesh_sig06.pdf)
(Secondary Paper)

Secondary paper is related to the primary paper in a way that it deals with the geometric modeling of the designs we used/referred in the previous paper. This paper is of the geometric modeling. This paper discusses on how the relation between shape and fabrication in architectural freeform design poses new challenges and requires much more sophistication from the underlying geometry. The concept of conical meshes profoundly satisfies the central requirements for this application: They are quadrilateral meshes with planar faces and hence can be particularly suitable for the design of freeform glass structures. Furthermore, they have a more natural offsetting operation and provide a support structure orthogonal to the mesh. Having said that, they represent fundamental shape characteristics because they are a discrete analogue of the network of principal curvature lines. If we combine this perturbation with subdivision, it yields a powerful new modeling tool for all the types of quad meshes with planar faces and it makes subdivision much attractive for architecture design as well as provides us with an elegant way of modeling the developable surfaces. If we combine this perturbation with subdivision, it yields a powerful new modeling tool for all the types of quad meshes with planar faces and it makes subdivision much attractive for architecture design as well as provides us with an elegant way of modeling the developable surfaces. The study of the quad meshes with planar faces which are called the PQ meshes and henceforth leads the users to interesting geometric results with respect to conical meshes and a discrete counterpart of principal curvature lines that have not been considered previously.

PQ perturbation algorithm has been proposed by the authors of this paper for the purpose of computing a PQ mesh from an given input quadrilateral mesh. As mentioned above, combining the PQ perturbation with a surface subdivision scheme can obtain the users a powerful tool for the purpose of modeling not just conical meshes but also general PQ meshes and circular meshes. When such method is applied to the PQ strips, it leads to an effective and elegant approach for modeling the developable surfaces. To conclude, it has been shown in this paper on how to construct as well as approximate the surfaces with meshes which are composed of planar quadrilaterals. Combining the quad-based subdivision algorithms with an optimization algorithm for the computation of the PQ meshes leads in a powerful modeling tool for the users. The conical meshes that have been introduced in this research work are well-suited for the purpose of designing free-form glass structures in architecture as well as provides the users a simple yet natural offsetting operation and the construction of a support structure from discrete surface normal.