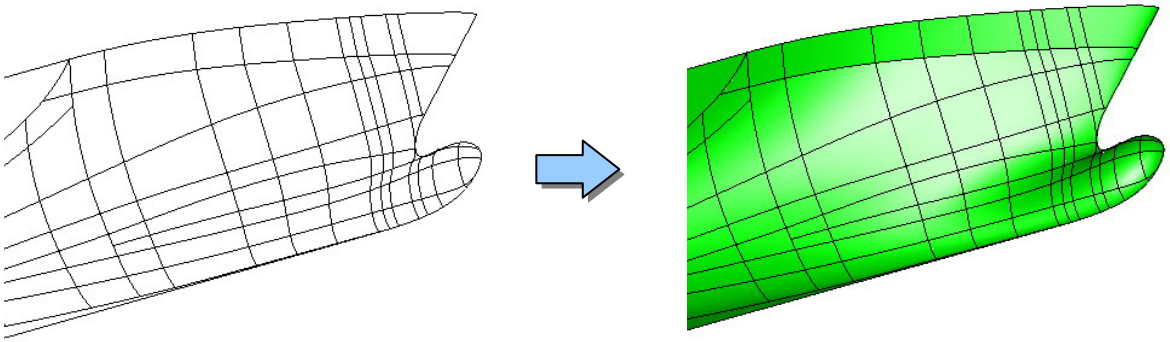
Korea Mathematical Methods for Curves and Surfaces,
Dongseo University, October 26, 2006

Interpolating G^1 Bezier Surfaces over Irregular Curve Networks for Ship Hull Design



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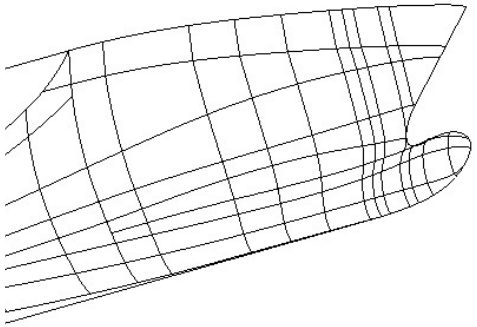
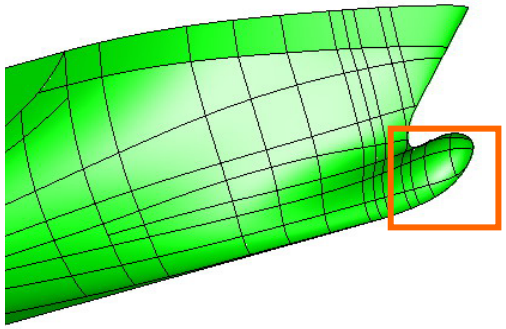
Motivation -> solve a engineering geometric problem

- **Curve network interpolation problems in Ship hull-form design**

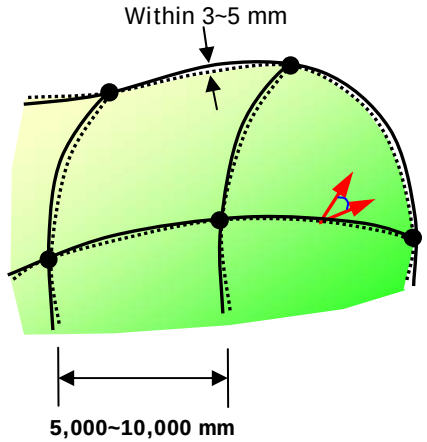
Given :
Curve network of hullform



Find :
smooth hullform surfaces



manufacturing phase
(Bezier, B-spline)



- **Irregular topology**
- Knuckle edges

Value: US$ 100,000,000

Requirements

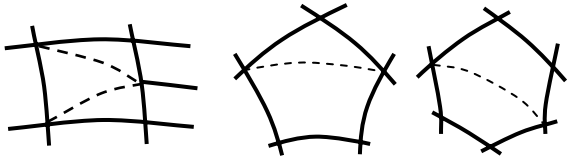
- **Exact Interpolation** of given curve network *or* **Max. distance error** between given curve network and generated surface **< tolerance***
- Smoothness: **exact G^1** Penalty: US$ 20,000,000

→ **Generation of G^1 surface interpolating irregular curve network without modification of given curves**

* Acceptable tolerance in shipbuilding industry is about 3~5 mm for ships of 200~300m length

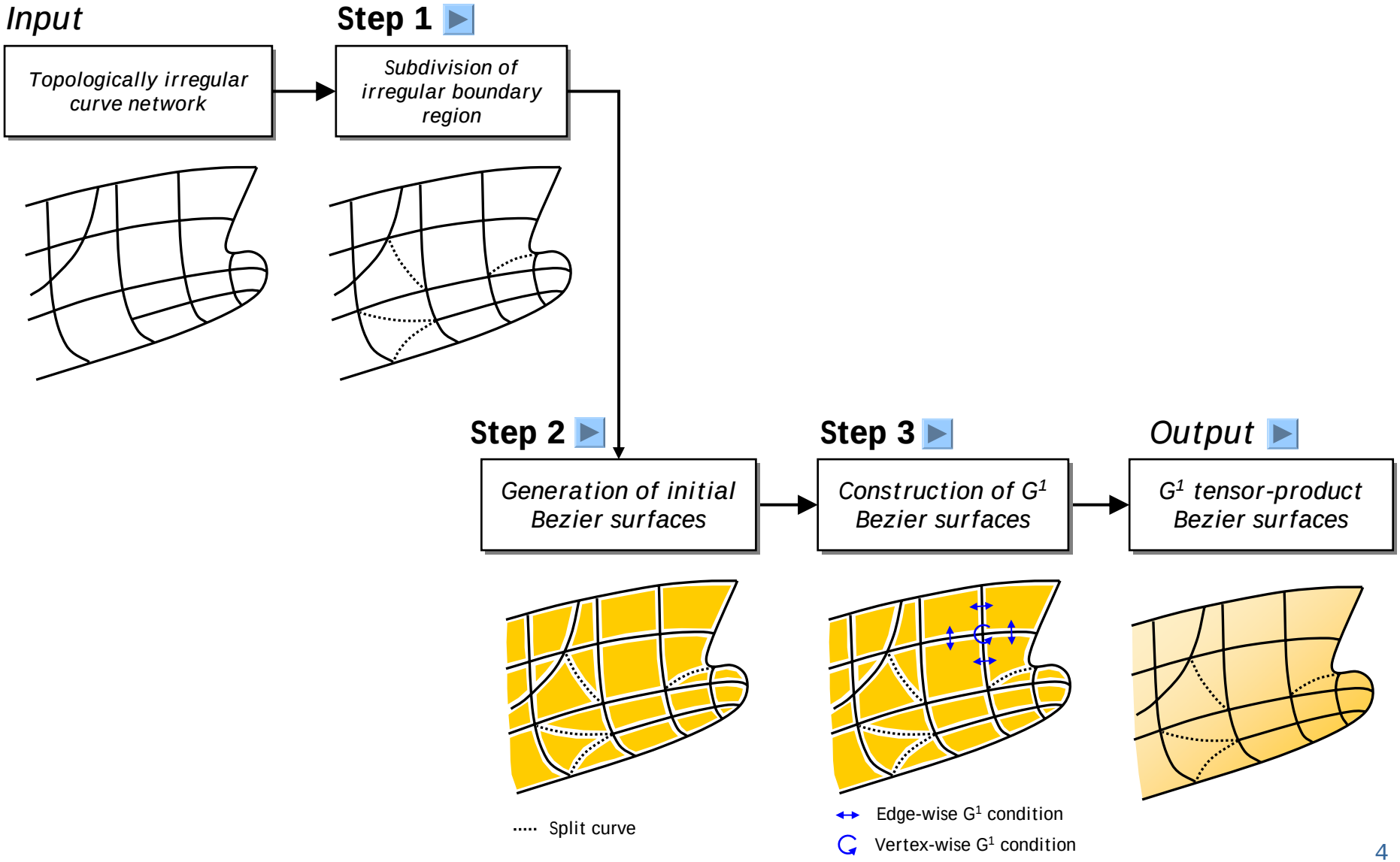
Related Works

	Input curve network			Output surface type	Note
	Topology	Valence	Boundary curve		
G. Farin (1982)	3, 4 sided face	-	**changed**	Bezier surface, Bezier Triangle	Local method
W.Du and J.Schmitt (1990)	4 sided face	N	**changed**	Bezier surface	Local method
J.Peters (1991)	3, 4 sided face	N	**changed**	Bezier surface, Bezier Triangle	Local method
Q.Liu et.al.(1994)	4 sided face	4	**unchanged**	Bezier surface	Global method
X.Shi et. al. (2004)	4 sided face	N	**changed**	B-spline surface	Local method
Our method (CAD 2006. 06)	3, 4 sided face (Support 5, 6 sided face and T-junction by subdivision)	3, 4, 5	**unchanged**	Bezier surface, Bezier Triangle	Local method



* W.Du and J.Schmitt, "On the G^1 continuity of piecewise Bezier surfaces: a review with new results," CAD, 22(9), 1990
* J.Peters,"Smooth interpolation of a mesh of curves" Constructive Approximation, Vol.7, pp.221-246, 1991
* Q.Liu and T.C. Sun,"G^1 interpolation of mesh curves," CAD, 26(4), 1994
* X.Shi, T. Wang and P. Yu, "A practical construction of G^1 smooth biquintic B-spline surfaces over arbitrary topology," CAD, Vol.36, 2004

Outline of proposed G^1 surfaces interpolation method



Conclusions and Future work

- **G^1 surface interpolation of irregular curve network**
  - Based on Farin's G^1 continuity condition,
    G^1 continuity condition with 3 degree of freedoms are proposed
    for G^1 surface interpolation of curve network
  - Analyze singular cases of vertex-wise G^1 condition at the vertex of 3, 4, 5 valence
    → Solutions to avoid singular cases are derived
    without any modification of the given curve network
  - In comparison with Q.Liu's work,
    - We proposed Local interpolation method, while Q.Liu's method are Global interpolation
    - Vertex G^1 on the vertex of 3, 4, 5 valence are analyzed and T-junction, 5-, 6-sided regions are supported
  - Our approach can be applied for any objects which is defined by boundary a curve network for free-form surfaces
- **Future work**
  - Extend proposed algorithm for G^1 Bezier surface interpolation to G^1 B-spline surface interpolation

Thank you for attention