

Computer Aided Ship design

-Part II. Hull Form Modeling-

Nonember, 2009

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SDAL

Advanced Ship Design Automation Lab.
<http://asdal.snu.ac.kr>



PA#7 단일 B-Spline 곡면을 이용한 선박 곡 면 표현 프로그램

2009.11.18

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B-Spline Surface Interpolation

- Input Data Format

과제 목표: 입력 받은 점을 지나는 B-Spline Surface를 Interpolation 한다.

Input Data

5 4

10.0 10.0 0.0
10.0 20.0 5.0
10.0 30.0 5.0
10.0 40.0 0.0

20.0 10.0 5.0
20.0 20.0 10.0
20.0 30.0 10.0
20.0 40.0 5.0

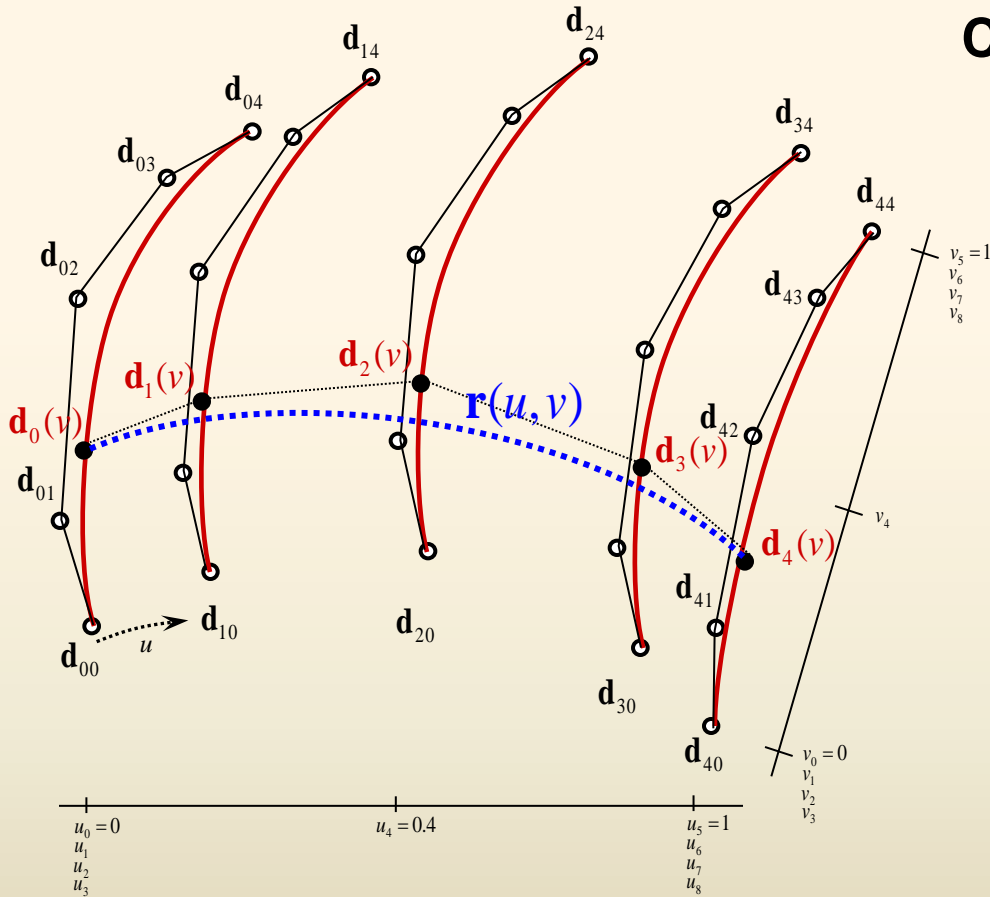
...

→ 입력 받을 점의 u, v 방향 개수

→ 입력 받는 점의 3차원 좌표 (x, y, z)



bicubic B-spline Surface Interpolation



Cox-de Boor Recurrence Formula

$$N_i^n(u) = \frac{u - u_{i-1}}{u_{i+n-1} - u_{i-1}} N_i^{n-1}(u) + \frac{u_{i+n} - u}{u_{i+n} - u_i} N_{i+1}^{n-1}(u)$$

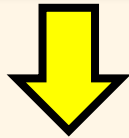
$$N_i^0(u) = \begin{cases} 1 & \text{if } u_{i-1} \leq u < u_i \\ 0 & \text{else} \end{cases}, \quad \sum_{i=0}^{D-1} N_i^n(u) = 1$$

$$\mathbf{r}(u, v) = \begin{bmatrix} N_0^3(u) & N_1^3(u) & N_2^3(u) & N_3^3(u) & N_4^3(u) \end{bmatrix}$$

$$\begin{bmatrix} \mathbf{d}_{00} & \mathbf{d}_{01} & \mathbf{d}_{02} & \mathbf{d}_{03} & \mathbf{d}_{04} \\ \mathbf{d}_{10} & \mathbf{d}_{11} & \mathbf{d}_{12} & \mathbf{d}_{13} & \mathbf{d}_{14} \\ \mathbf{d}_{20} & \mathbf{d}_{21} & \mathbf{d}_{22} & \mathbf{d}_{23} & \mathbf{d}_{24} \\ \mathbf{d}_{30} & \mathbf{d}_{31} & \mathbf{d}_{32} & \mathbf{d}_{33} & \mathbf{d}_{34} \\ \mathbf{d}_{40} & \mathbf{d}_{41} & \mathbf{d}_{42} & \mathbf{d}_{43} & \mathbf{d}_{44} \end{bmatrix} \begin{bmatrix} N_0^3(v) \\ N_1^3(v) \\ N_2^3(v) \\ N_3^3(v) \\ N_4^3(v) \end{bmatrix}$$

Programming Guide (1)

(1) B-spline Surface 생성



(2) u,v 방향 knot 구함

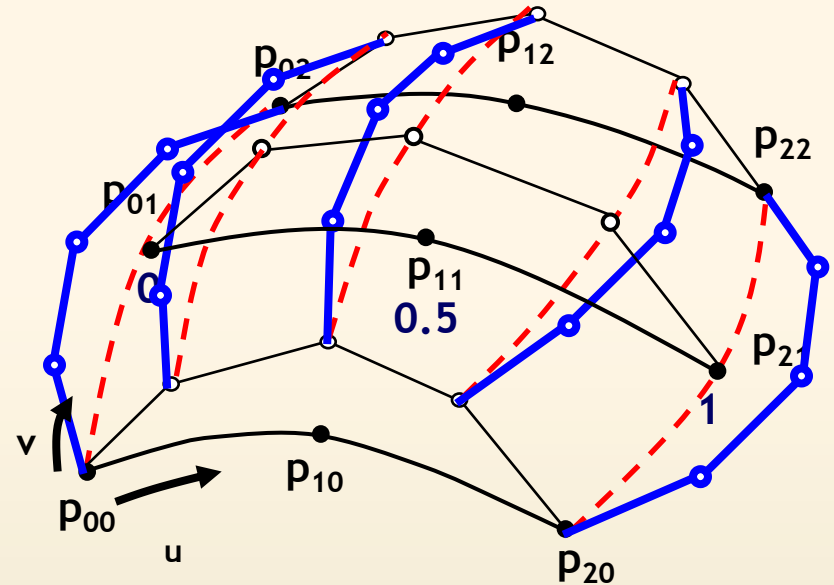
- ① 점 사이의 거리비를 통해 knot 계산
- ② 마지막 knot로 나누어 Normalize 함
- ③ 평균을 구함



(3) u 방향 B-spline 곡선의 Control Point 구함



(4) u방향의 B-spline 곡선의 Control point를 사용하여 v 방향의 B-spline 곡선을 생성하는 Control Point 생성



Programming Guide (2)

Given : 곡면을 지나는 공간상의 점 ($M \times N$ 개)
Find : Cubic B-spline Surface의 Control Points

(Q) 4×3 의 점이 주어졌을 때, u, v 방향 knot 개수와 Control point 개수는?

(A) u 방향 : $4 + 3 \times 2 = 10$ 개
 v 방향 : $3 + 3 \times 2 = 9$ 개
Control Point 개수 : $6 \times 5 = 30$ 개

(Q) $M \times N$ 의 점이 주어졌을 때, u, v 방향 knot 개수와 Control point 개수는?

(A) u 방향 : $M + 3 \times 2 = M + 6$ 개
 v 방향 : $N + 3 \times 2 = N + 9$ 개
Control Point 개수 : $(M+2) \times (N+2)$ 개



Programming Guide (3)

```
#include "Bspline_Curve.h"
#include "Vector.h"

class Bspline_Surface
{
public:
//Constructor & Destroyer
    Bspline_Surface();
    virtual ~Bspline_Surface();

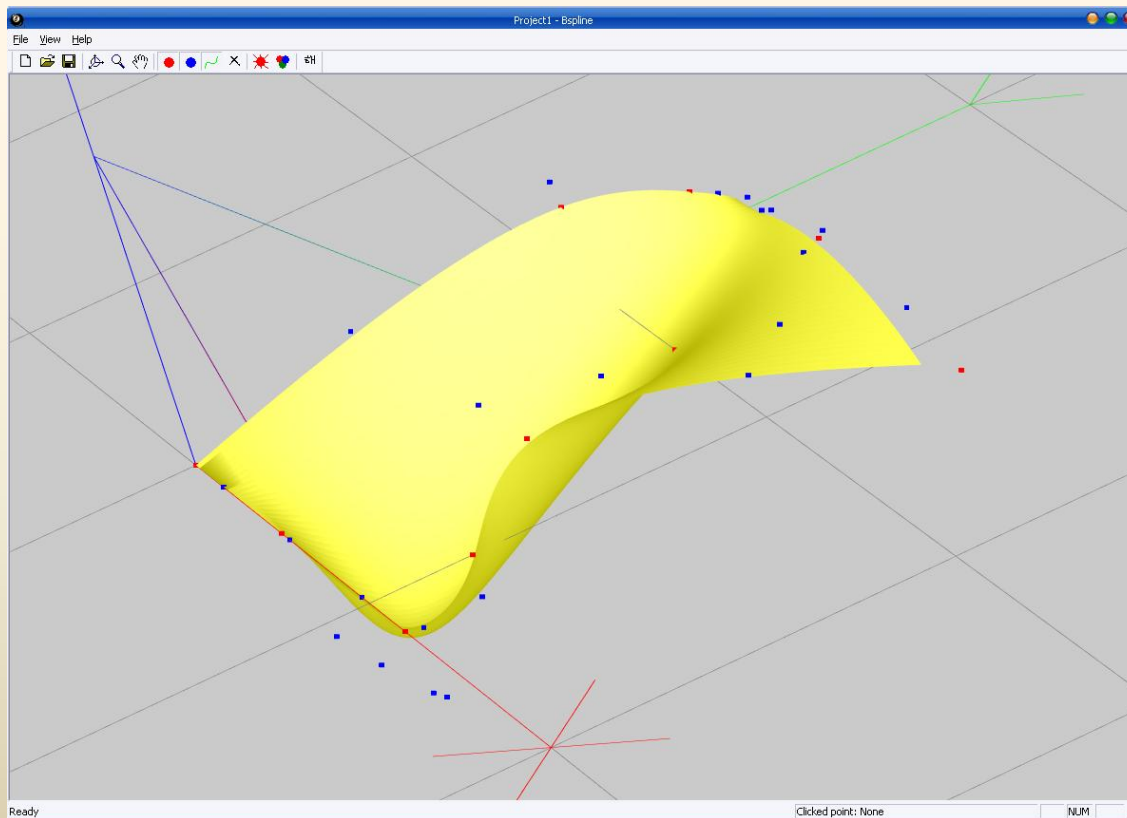
//Member Variables
    int k;
    int m_NumOfColumn;
    int m_NumOfRow;
    int m_Num_u_Knot;
    int m_Num_v_Knot;
    int m_NumOfRowControlPoint;
    int m_NumOfColumnControlPoint;
    Bspline_Curve *bsp;
    double *m_u_knot;
    double *m_v_knot;
    Vector **m_ControlPoint;
```

```
//Member Function
    void set(int _k,int NumOfRow,int NumOfColumn);
    void Interpolation(Vector **inputPoint);
    void Evaluation (double u, double v);
    .....
};
```



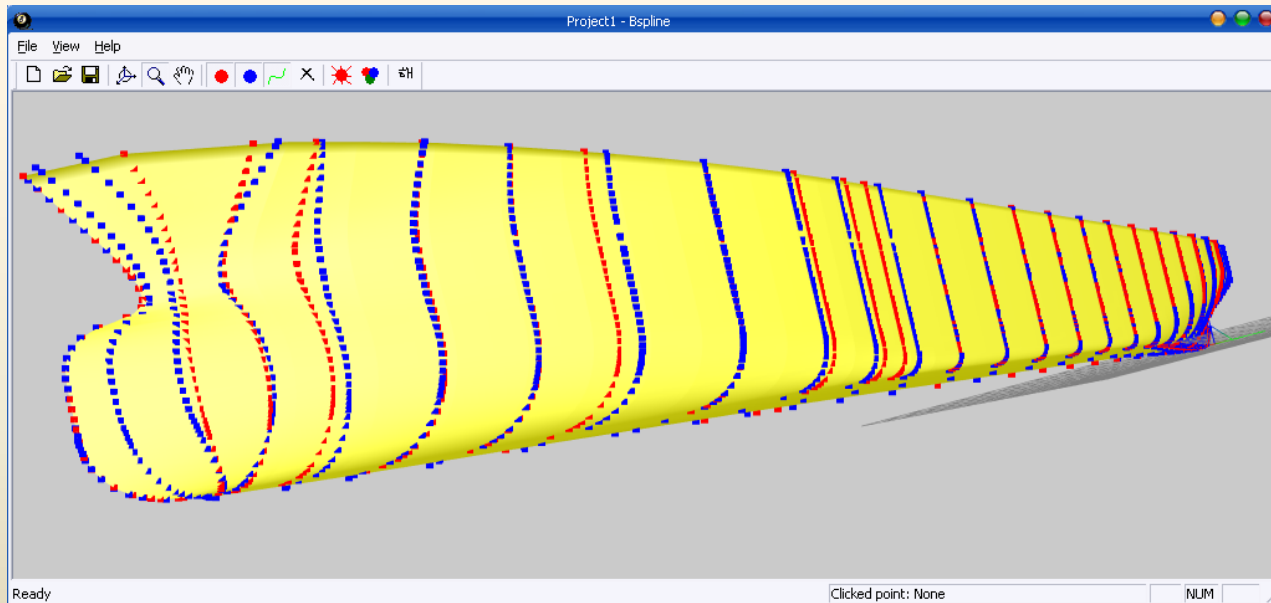
1. Control point와 Point on Curve를 구분하여 표시할 것

예제 곡면



1. Control point와 Point on Curve를 구분하여 표시할 것

300K VLCC 선형



과제

2.Dialog를 통하여 입력점 및 Control Point를 변경할 수 있도록 할 것

