

Chainmail algorithm

With simple voxelization

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목차

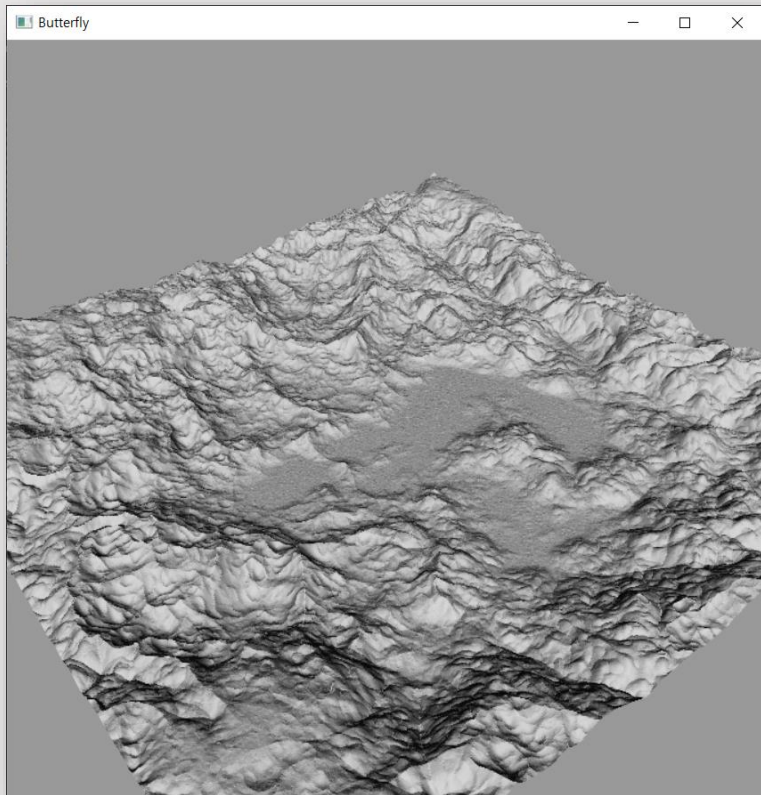
1 Voxelization

3 시연 영상

2 Chainmail

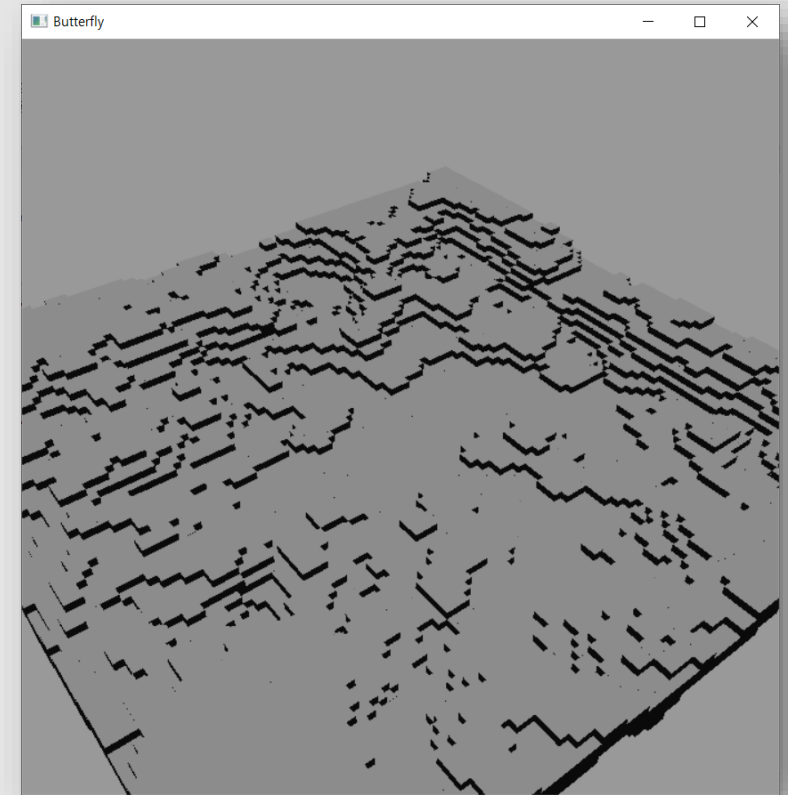
4 아쉬운 점

Voxelization



Before
Vertex : 1002001

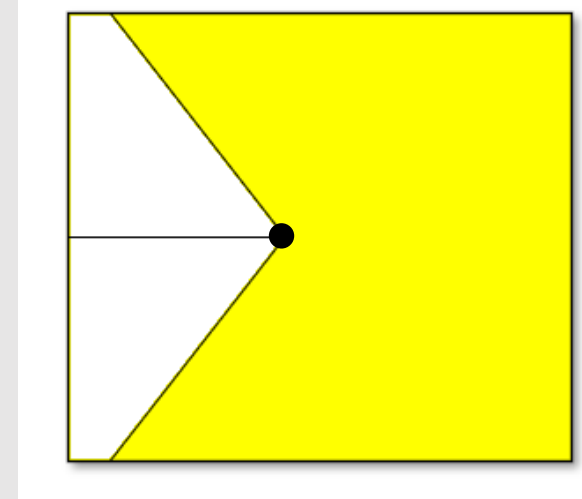
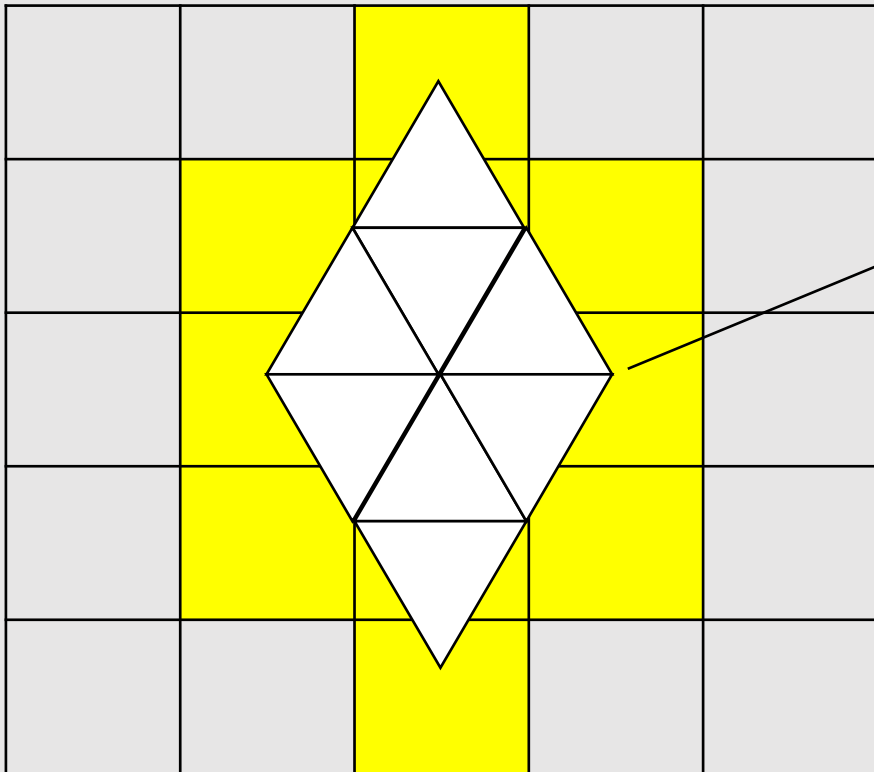
Voxelization
256x256



After
Vertex(Voxel) : 12792

Voxelization

algorithm

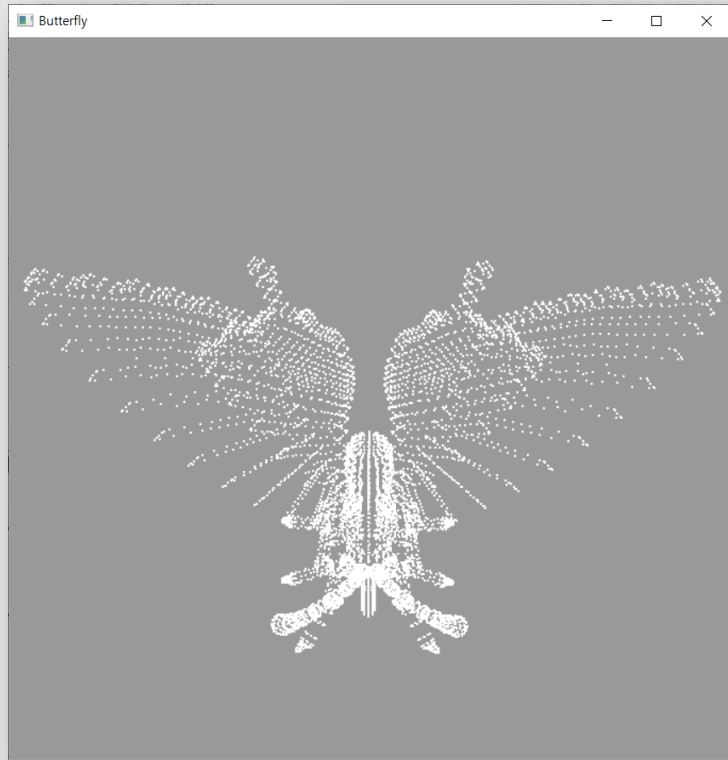


```
double grid_coord_calc(double n, double size, double max, double min) {  
    size += -1;  
    double p = n * 2 - (size - 1); // -size + size  
    p /= (size - 1); // -1 ~ 1  
    p *= (max + abs(min)) / 2; // max, min normalize range  
    p += (max - abs(min)) / 2; // -min ~ max  
    return p;  
}
```

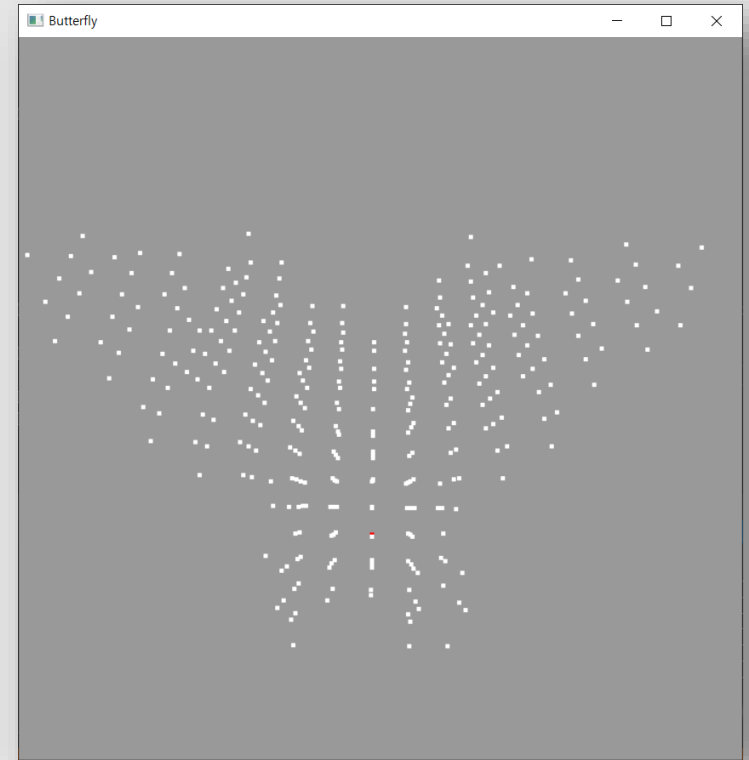
3D mesh와 Voxel grid

Voxelization

algorithm



3D mesh vertex



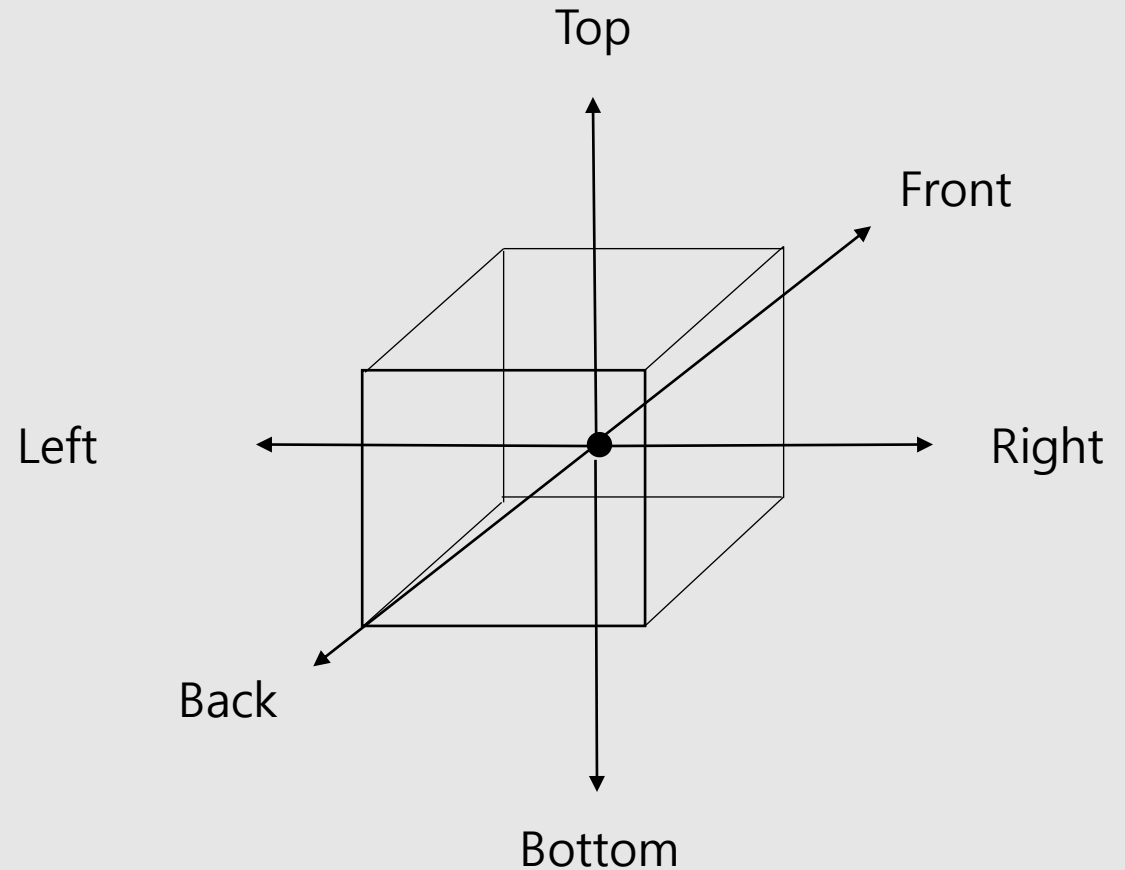
3D voxel vertex

Voxelization

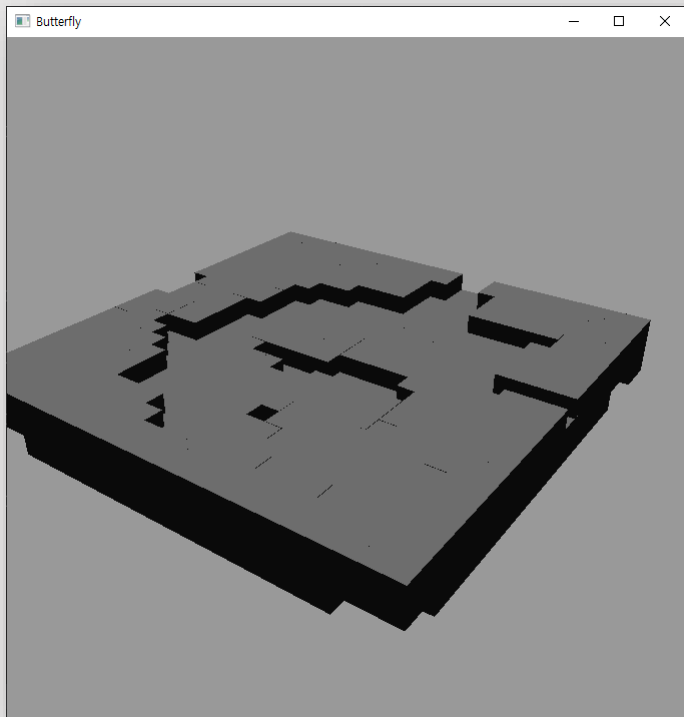
Build adjacency

class Voxel

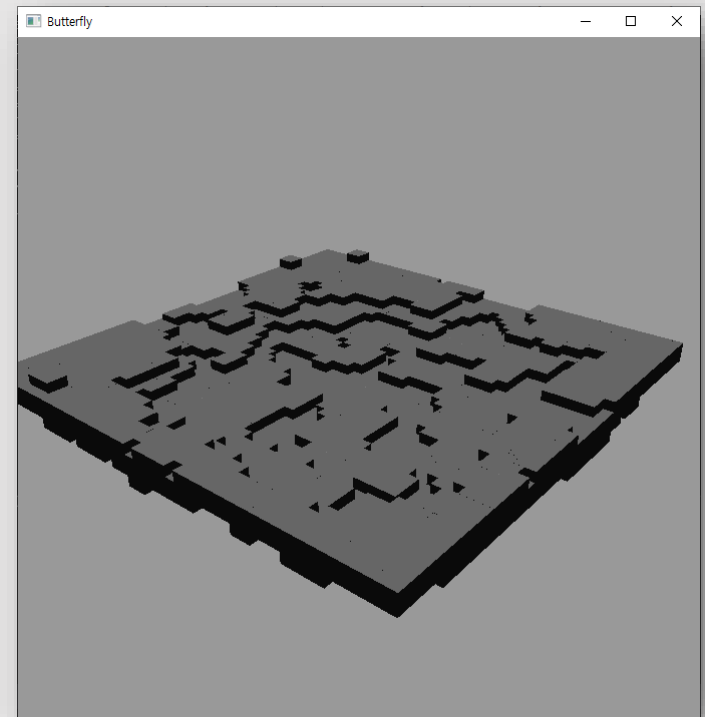
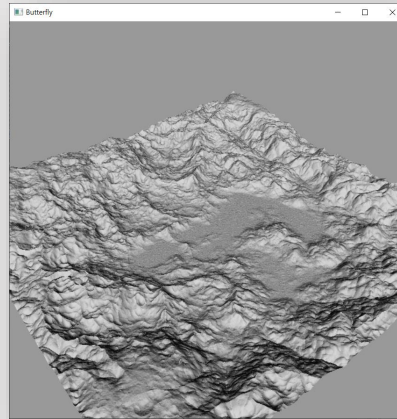
```
public: // Neighbor voxels
    Voxel* left = nullptr;
    Voxel* right = nullptr;
    Voxel* top = nullptr;
    Voxel* bottom = nullptr;
    Voxel* front = nullptr;
    Voxel* back = nullptr;
```



Voxelization

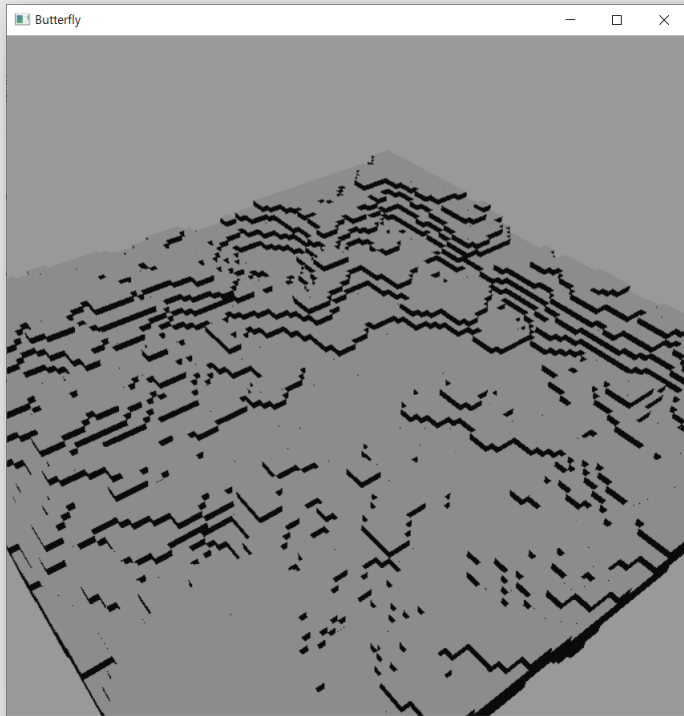


Size : 64

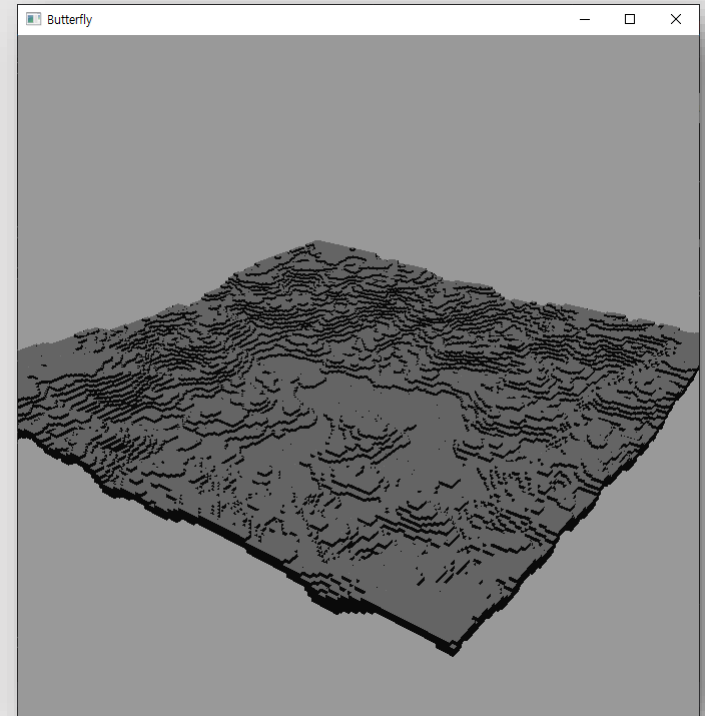
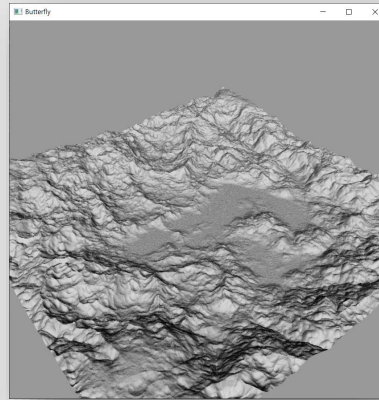


Size : 128

Voxelization

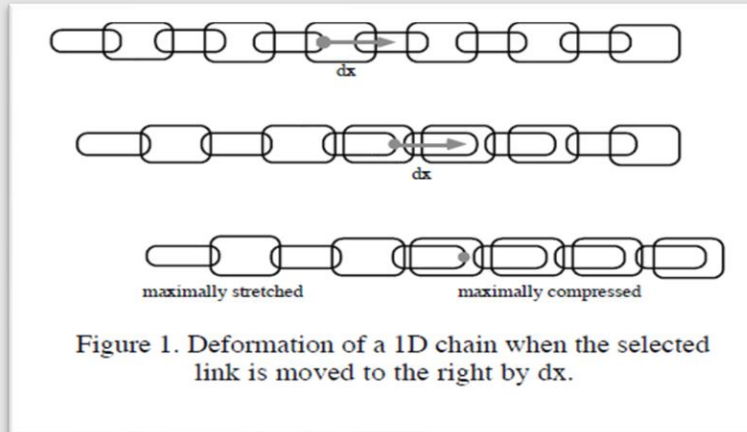


Size : 256



Size : 512

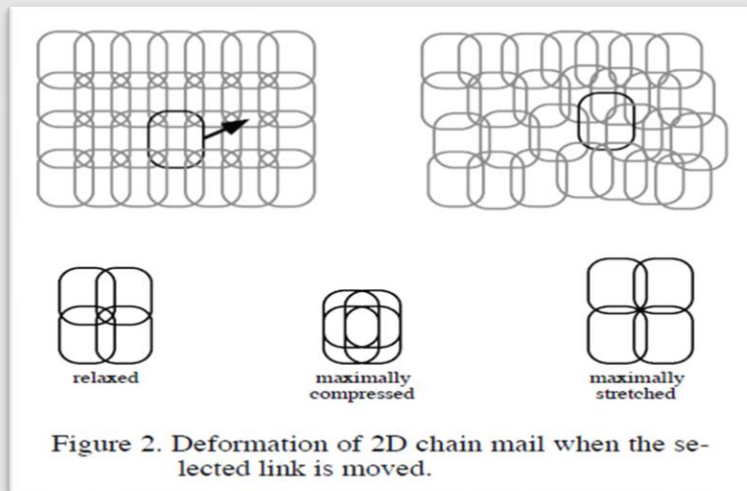
Chainmail algorithm



1D



Looks like chainmail!



2D

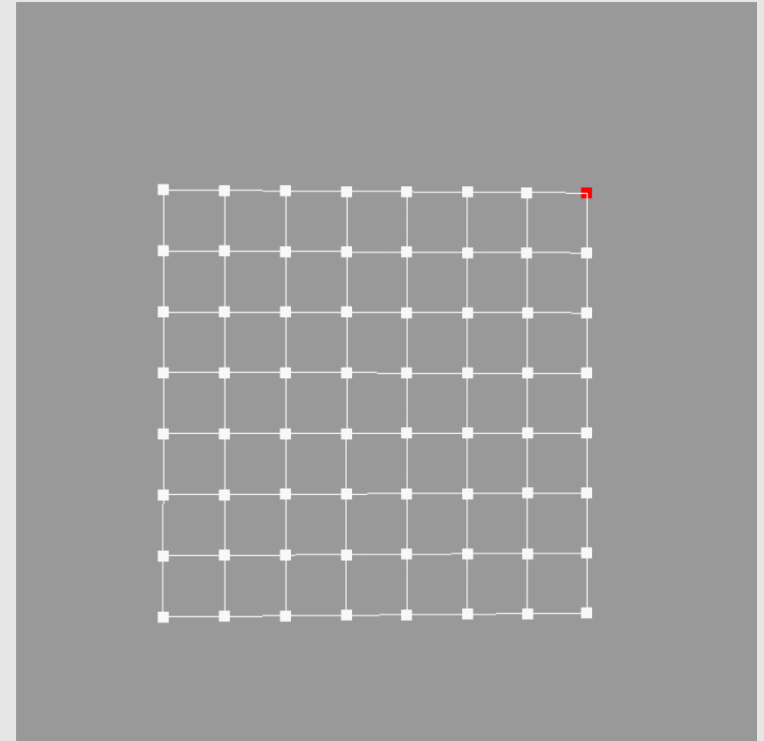
S.F. Gibson, "3D Chainmail: A Fast Algorithm for Deforming Volumetric Objects," Proceeding of Symposium on Interactive 3D Graphics, 1997

Chainmail algorithm

propagate

```
if (x - xleft) < minDx, x = xleft + minDx;  
else if (x - xleft) > maxDx, x = xleft + maxDx;  
  
if (y - yleft) < - maxHorixDy, y = yleft - maxHorixDy;  
else if (y - yleft) > maxHorixDy, y = yleft + maxHorixDy;
```

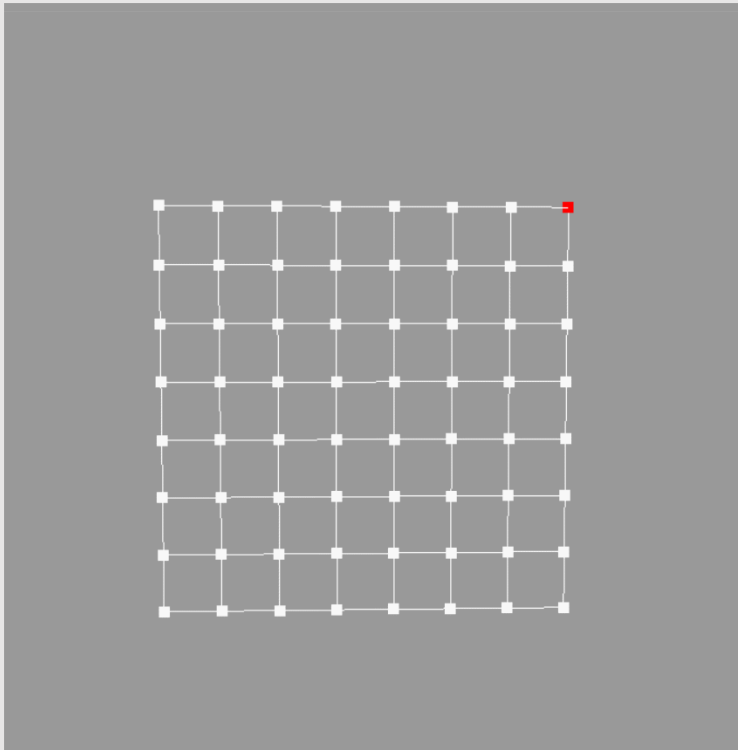
Right direction



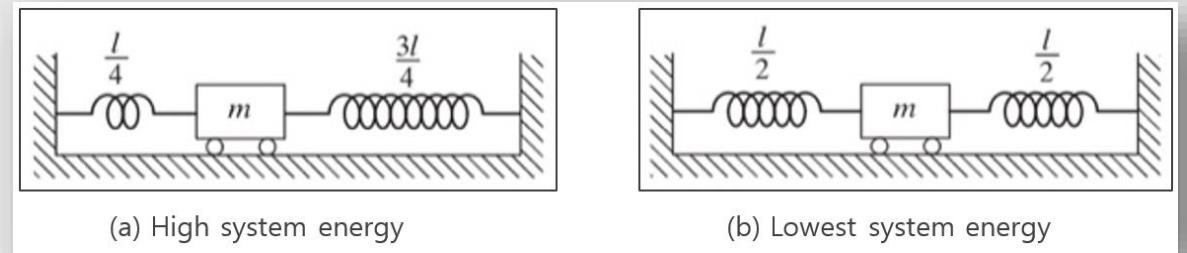
2D Chainmail

Chainmail algorithm

Elastic relaxation



2D Chainmail

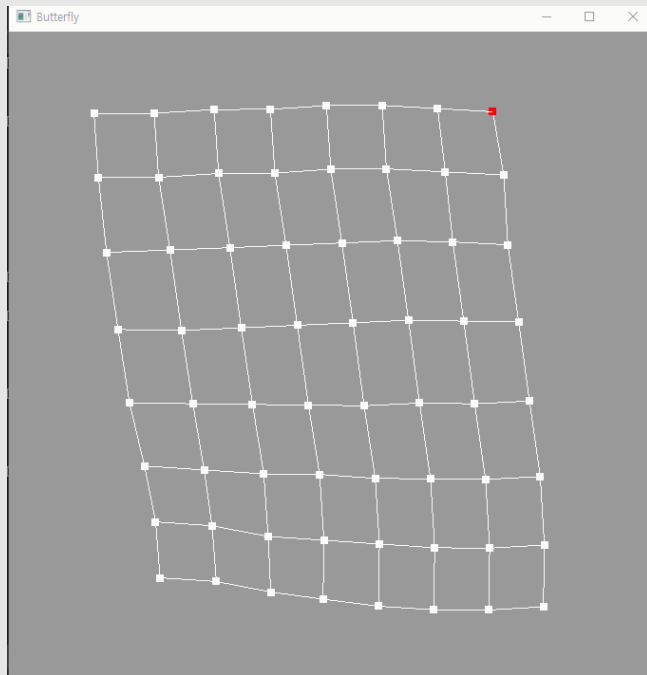


$$(x, y, z)_{opt} = \left(\frac{1}{N} \sum_{neighbors} (x_n - \Delta x_n)_*, \quad \frac{1}{N} \sum_{neighbors} (y_n - \Delta y_n)_* \right), \quad \Delta x_n = \begin{cases} -\Delta x & : n = left \\ +\Delta x & : n = right \\ 0 & : \text{all other neighbors} \end{cases}$$
$$\Delta y_n = \begin{cases} -\Delta y & : n = bottom \\ +\Delta y & : n = top \\ 0 & : \text{all other neighbors} \end{cases}$$

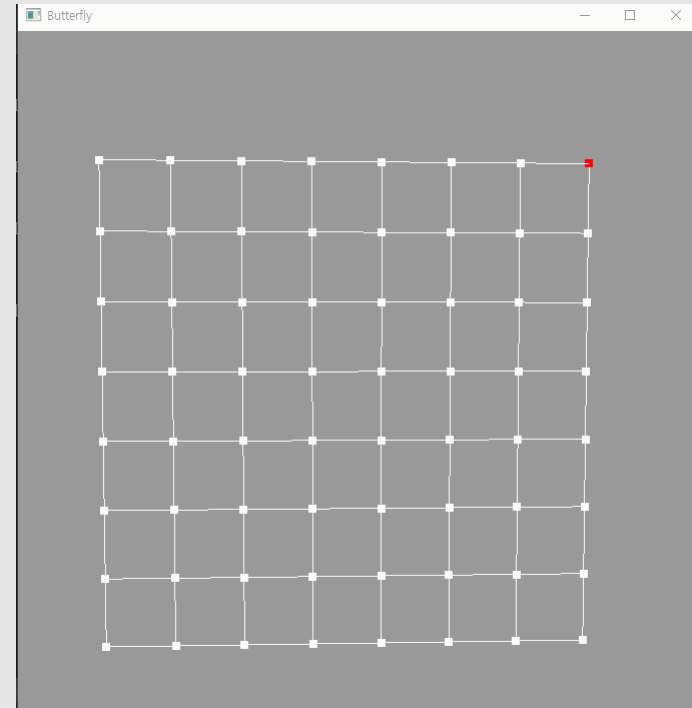
Relaxing algorithm

Chainmail algorithm

Elastic relaxation



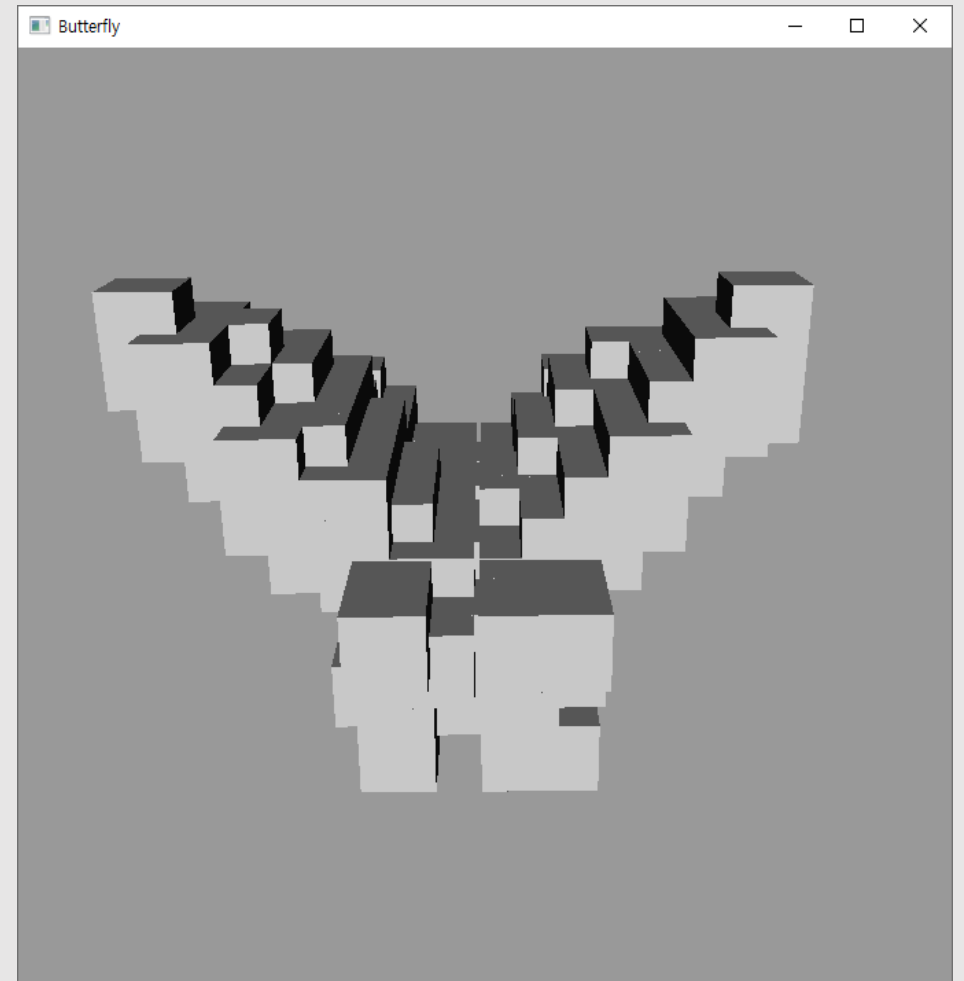
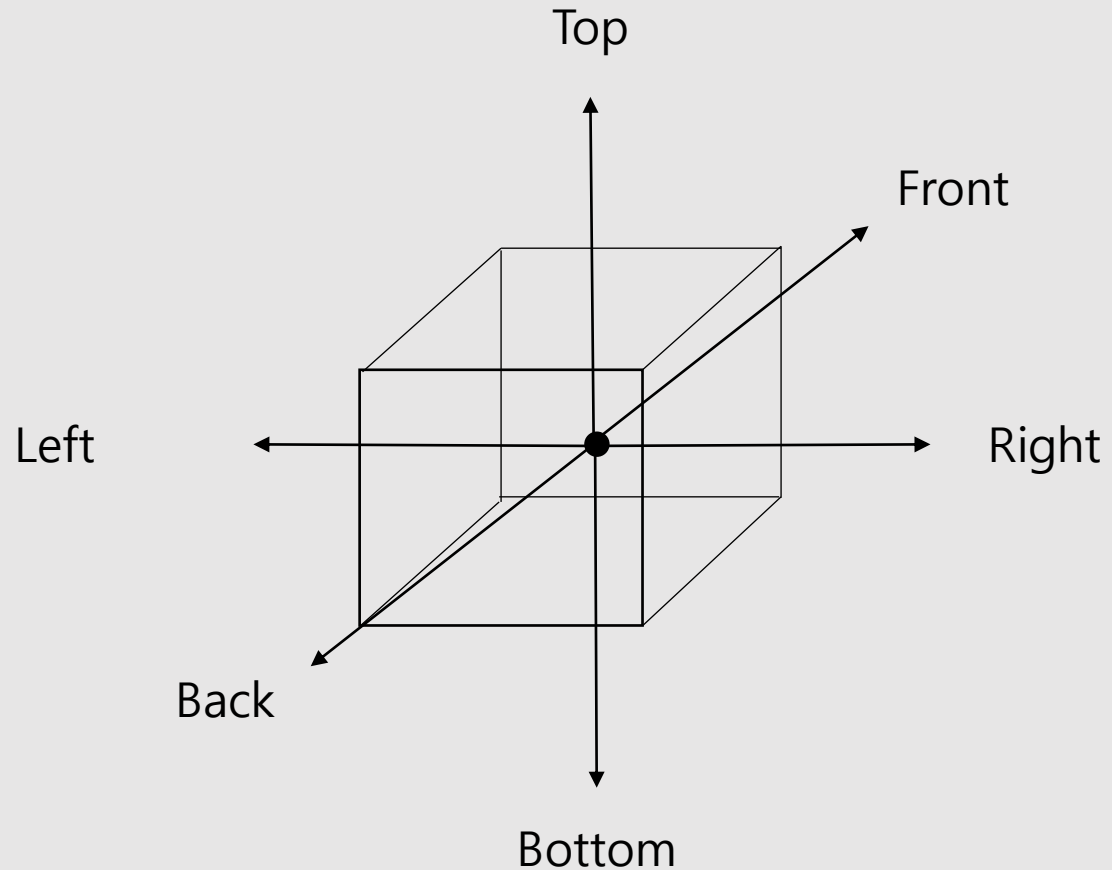
$k = 0.1$



$k = 0.005$

Chainmail algorithm

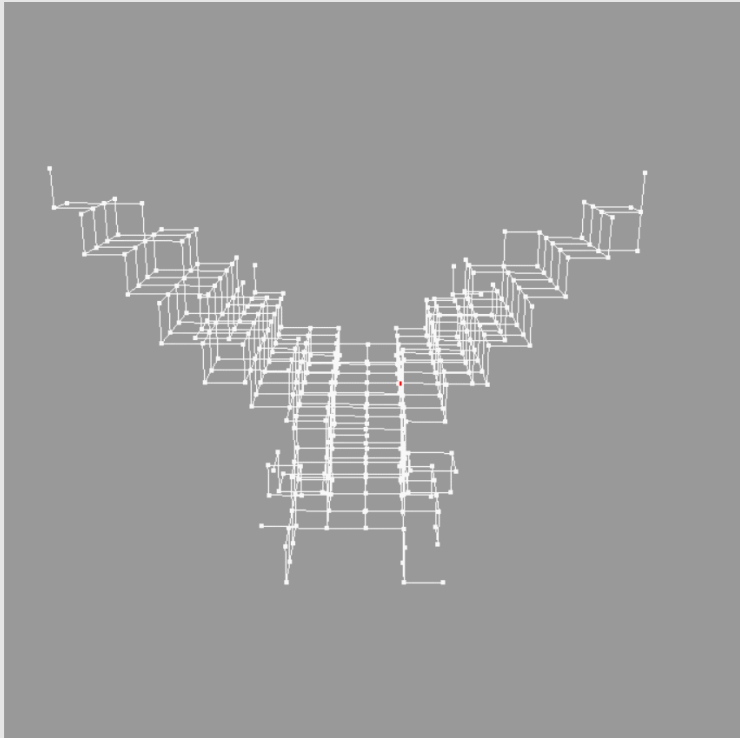
3D Voxel Structure



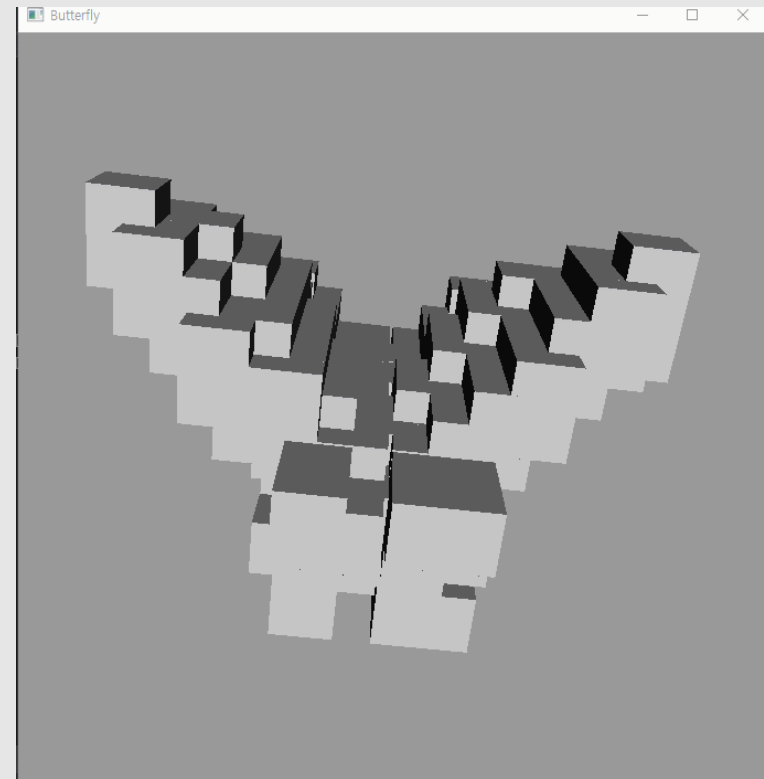
Build adjacency

Chainmail algorithm

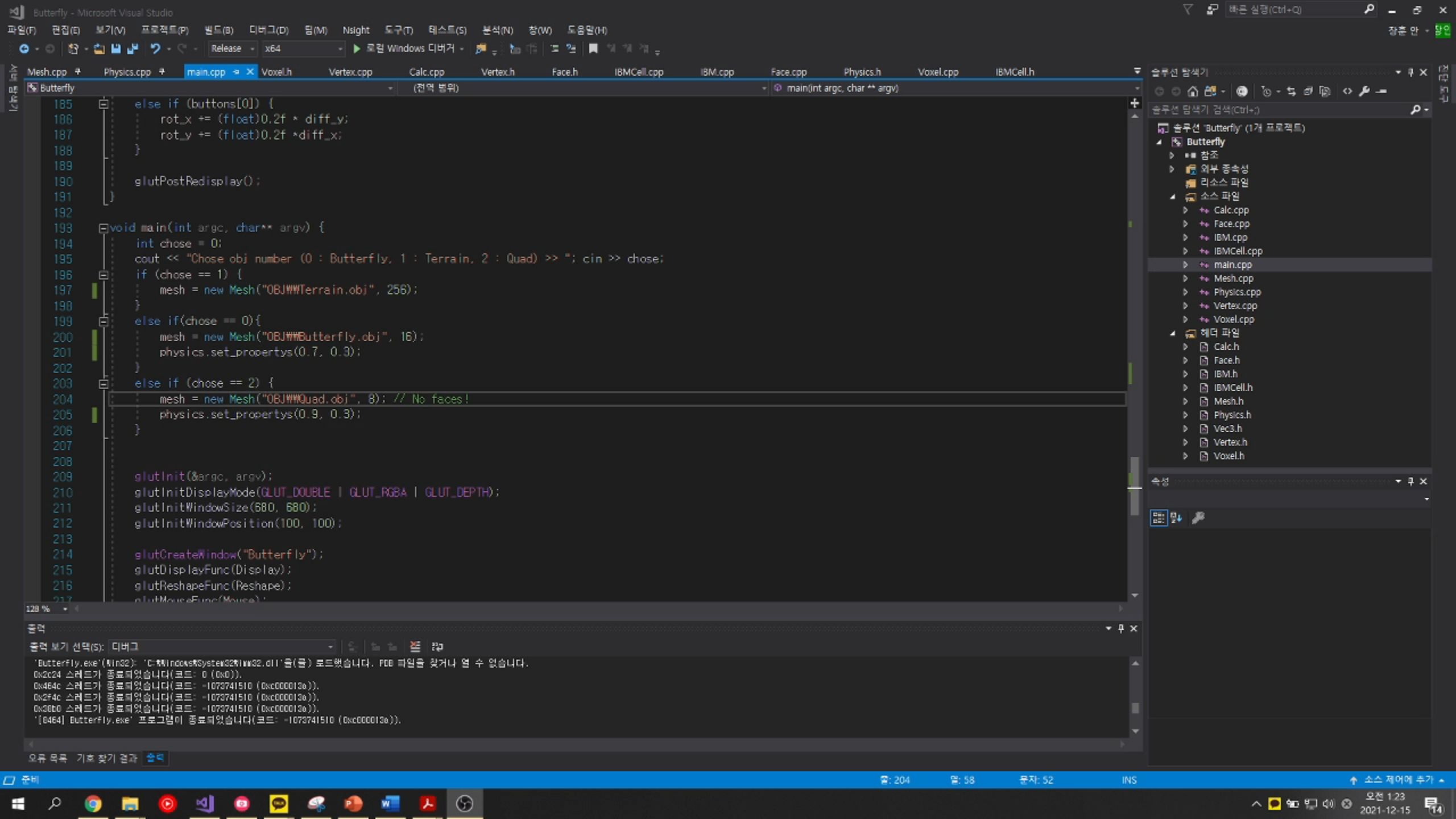
3D Voxel Structure



Draw wire

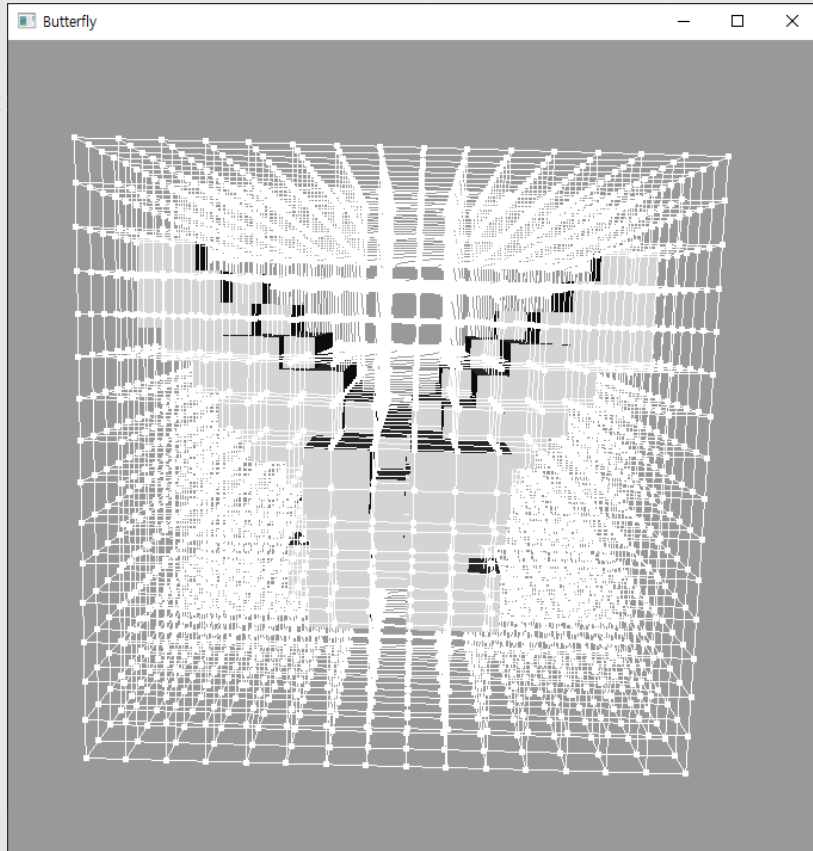


Draw voxel



아쉬운 점

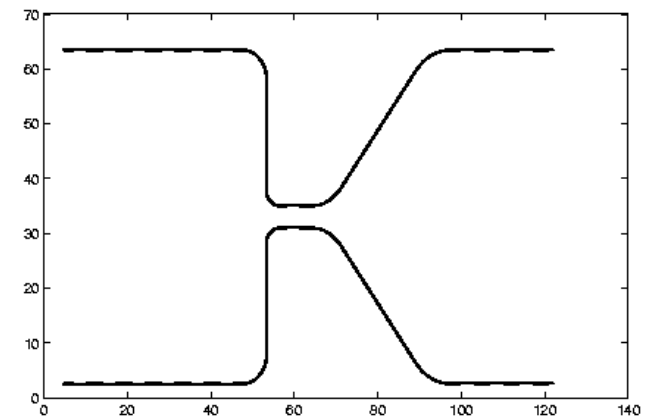
Immersed boundary method



IBM grid coordination

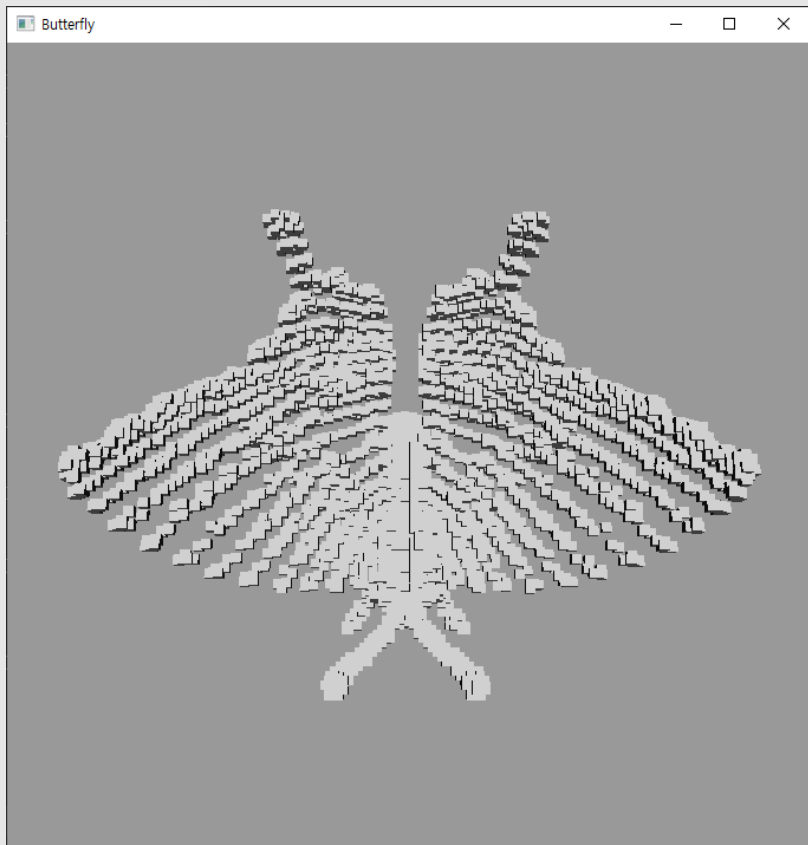
$$\frac{\partial u_i}{\partial t} + \frac{\partial u_j u_i}{\partial x_j} = -\frac{\partial p}{\partial x_i} + \frac{1}{\text{Re}} \frac{\partial^2 u_i}{\partial x_j \partial x_j} + f_i$$
$$\frac{\partial u_i}{\partial x_i} - q = 0$$

IBM governing equation

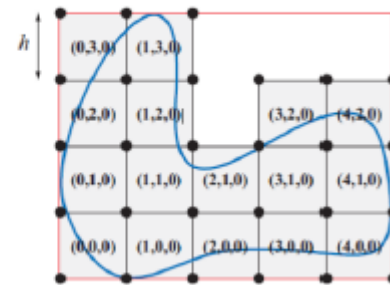
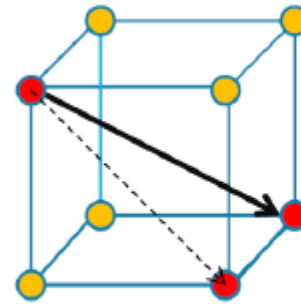


Vocal fold simulation

아쉬운 점



Size : 128



감사합니다!

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