Software Engineering
Lab 5 Report

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MSCV-5

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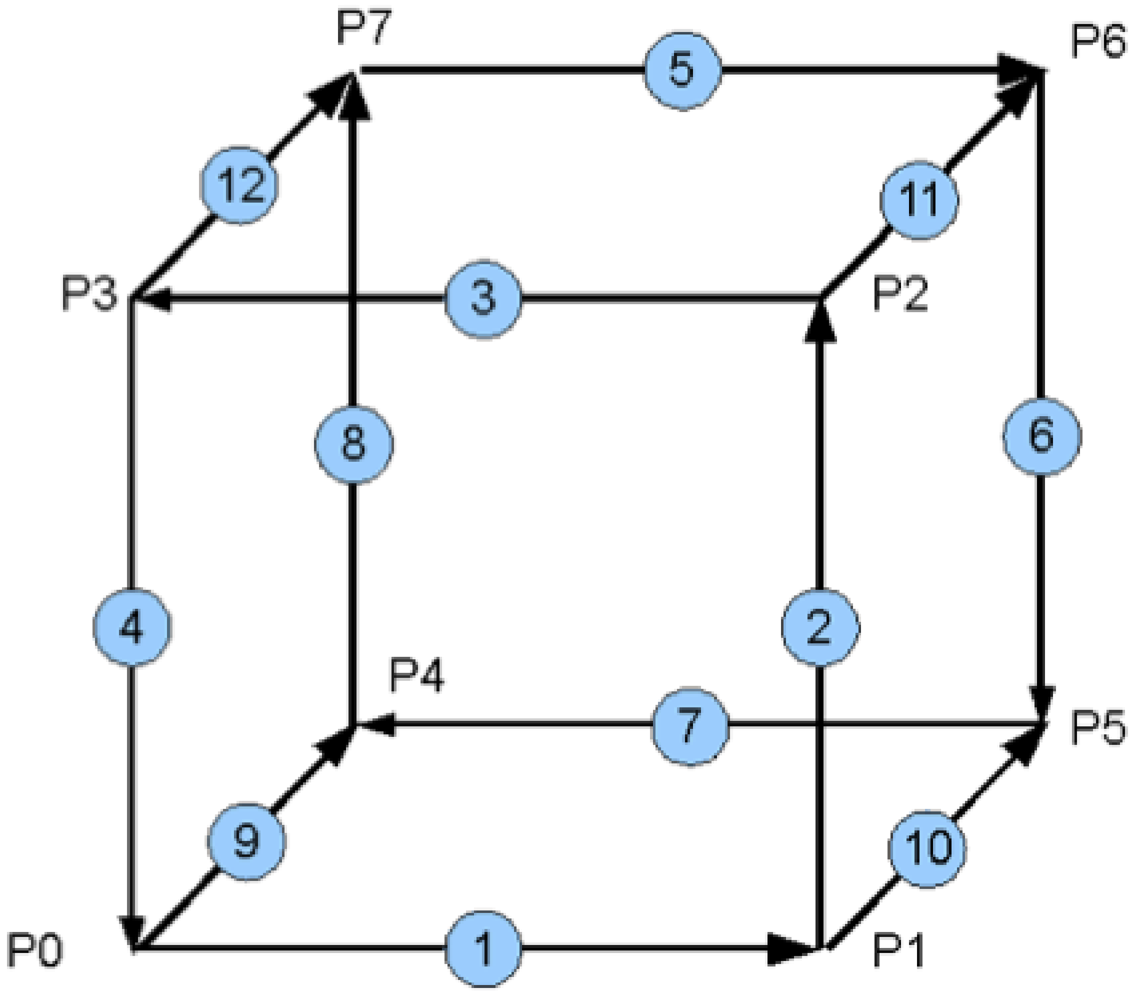
1 Introduction

Representing cubical model with the Baumgart's winged-edge data structure.



2 Edge Table

Edges represented in data structure hold following information;

1. vertices of this edge, P1 and P2
2. its left and right faces, F1 and F2
3. predecessor(Predccw) and successor(Nextccw) when traversing its left face(ccw)
4. predecessor(Predcw) and successor(Nextcw) when traversing its right face(cw)

Here is the Edge Table following representing closed cubic:

Edge Nb	Start Pt	End Pt	Face ccw F1	Face cw F2	Nccw	Pccw	Ncw	Pcw
1	P0	P1	F1	F3	2	4	10	9
2	P1	P2	F1	F4	3	1	11	10
3	P2	P3	F1	F5	4	2	12	11
4	P3	P0	F1	F6	1	3	9	12
5	P7	P6	F2	F5	6	8	11	12
6	P6	P5	F2	F4	7	5	10	11
7	P5	P4	F2	F3	8	6	9	10
8	P4	P7	F2	F6	5	7	12	9
9	P0	P4	F3	F6	7	1	8	4
10	P1	P5	F4	F3	6	2	7	1
11	P2	P6	F5	F4	5	3	6	2
12	P3	P7	F6	F5	8	4	5	3

Table 1: Edge Table

3 Face Table

A faces are represented only with storing start edge, here is the closed cubic representation data for faces:

Face	Point 1	Point 2	Point 3	Point 4	Start Edge
F1	P0	P1	P2	P3	1
F2	P7	P6	P5	P4	5
F3	P0	P4	P5	P1	9
F4	P1	P5	P6	P2	10
F5	P2	P6	P7	P3	11
F6	P3	P7	P4	P0	12

Table 2: Face Table

4 Exercise 1

In this example, we filled the table of edges(Table 1) in lab.

5 Exercise 2

There are 6 class available for representing winged-edge data structure: Point, Edge, Face, ArrayPoint, ArrayEdge, ArrayFace.

- class Point: Representing a 3D point.
- class Edge: Representing edge with 2 points, 2 face ans also 2 previous and 2 next edges in data structure.
- class Face: Representing a face with start edge.
- class ArrayPoint: Collection of points.
- class ArrayEdge: Collection of edges.
- class ArrayFace: Collection of faces.

In header files, there are always #ifndef, #define, and #endif statements for compile time check for multiple file inclusions that protecting including same header files more than once.

In main program, we can add points. edges and faces using menu selection 1, 4 and 10, respectively.

Displaying points, edges and faces can be accomplish by using menu 3, 6, 12, respectively.

Classes are built to handle or keep track of arrays of pointers, by using ¡type¿**.

In order to achieve accomplishment in this lab, it looks like we should implement our function to array class, and call them from the menu.

6 Exercise 3

Implemented 2 functions in ArrayEdge, for menu 7 and 8; and implemented 3 function in ArrayFace to provide menu 9 and 13.

Listing 1: Exercice.h

```

// To class ArrayEdge following public function declarations added
    // "7 : Link segment clockwise - prev and next - (student work here)"
    void linkSegmentsCWCubic(ArrayPoint*);

    // "8 : Link segment counterclockwise - prev and next - (student work here)"
    void linkSegmentsCCWCubic(ArrayPoint*);

// To class ArrayFace-to keep coherence- following public functions declarations added
    // "9 : Link segment to faces (student work here)"
    void linkSegmentsToFacesCubic(ArrayEdge*);

    // 13 : Check if face is closed (student work here)"
    bool isCubicFaceClosed() const;

// and private function for face traversing
  bool isCubicFaceClosedTraversal(Face*, int) const;
```

Listing 2: Exercice.cpp

```

// "7 : Link segment clockwise - prev and next - (student work here)"
void ArrayEdge::linkSegmentsCWCubic(ArrayPoint* pointArray)
{
    if(pointArray->n < 8)
    {
        cerr<<"In Point Array, there is not enough element to represent cube."<<endl;
        return;
    }

    Edge* edge01;
    Edge* edge02;
    Edge* edge03;
    Edge* edge04;
    Edge* edge05;
    Edge* edge06;
    Edge* edge07;
    Edge* edge08;
    Edge* edge09;
    Edge* edge10;
    Edge* edge11;
    Edge* edge12;

    if(this->n < 12)
    {
        edge01 = new Edge(pointArray->GetAt(0), pointArray->GetAt(1));
        edge02 = new Edge(pointArray->GetAt(1), pointArray->GetAt(2));
        edge03 = new Edge(pointArray->GetAt(2), pointArray->GetAt(3));
        edge04 = new Edge(pointArray->GetAt(3), pointArray->GetAt(0));
        edge05 = new Edge(pointArray->GetAt(7), pointArray->GetAt(6));
        edge06 = new Edge(pointArray->GetAt(6), pointArray->GetAt(5));
        edge07 = new Edge(pointArray->GetAt(5), pointArray->GetAt(4));
        edge08 = new Edge(pointArray->GetAt(4), pointArray->GetAt(7));
        edge09 = new Edge(pointArray->GetAt(0), pointArray->GetAt(4));
        edge10 = new Edge(pointArray->GetAt(1), pointArray->GetAt(5));
        edge11 = new Edge(pointArray->GetAt(2), pointArray->GetAt(6));
        edge12 = new Edge(pointArray->GetAt(3), pointArray->GetAt(7));

        this->AddEdge(edge01);
        this->AddEdge(edge02);
        this->AddEdge(edge03);
        this->AddEdge(edge04);
        this->AddEdge(edge05);
        this->AddEdge(edge06);
        this->AddEdge(edge07);
        this->AddEdge(edge08);
        this->AddEdge(edge09);
        this->AddEdge(edge10);
        this->AddEdge(edge11);
        this->AddEdge(edge12);
    }
    else
    {
        edge01 = this->GetAt(0);
        edge02 = this->GetAt(1);
        edge03 = this->GetAt(2);
        edge04 = this->GetAt(3);
        edge05 = this->GetAt(4);
        edge06 = this->GetAt(5);
        edge07 = this->GetAt(6);
        edge08 = this->GetAt(7);
        edge09 = this->GetAt(8);
        edge10 = this->GetAt(9);
        edge11 = this->GetAt(10);
        edge12 = this->GetAt(11);
    }

    edge01->Nextcw  = edge10;
    edge01->Prevcw  = edge09;

    edge02->Nextcw  = edge11;
    edge02->Prevcw  = edge10;

    edge03->Nextcw  = edge12;
    edge03->Prevcw  = edge11;

    edge04->Nextcw  = edge09;
    edge04->Prevcw  = edge12;

    edge05->Nextcw  = edge11;
    edge05->Prevcw  = edge12;

    edge06->Nextcw  = edge10;
    edge06->Prevcw  = edge11;

    edge07->Nextcw  = edge09;
    edge07->Prevcw  = edge10;

    edge08->Nextcw  = edge12;
    edge08->Prevcw  = edge09;

    edge09->Nextcw  = edge08;
    edge09->Prevcw  = edge04;

    edge10->Nextcw  = edge07;
    edge10->Prevcw  = edge01;

    edge11->Nextcw  = edge06;
    edge11->Prevcw  = edge02;

    edge12->Nextcw  = edge05;
    edge12->Prevcw  = edge03;

    return;
}

// "8 : Link segment counterclockwise - prev and next - (student work here)"
void ArrayEdge::linkSegmentsCCWCubic(ArrayPoint* pointArray)
{
    if(pointArray->n < 8)
    {
        cerr<<"In Point Array, there is not enough element to represent cube."<<endl;
        return;
    }

    Edge* edge01;
    Edge* edge02;
    Edge* edge03;
    Edge* edge04;
    Edge* edge05;
    Edge* edge06;
    Edge* edge07;
    Edge* edge08;
    Edge* edge09;
    Edge* edge10;
    Edge* edge11;
    Edge* edge12;

    if(this->n < 12)
    {
        edge01 = new Edge(pointArray->GetAt(0), pointArray->GetAt(1));
        edge02 = new Edge(pointArray->GetAt(1), pointArray->GetAt(2));
        edge03 = new Edge(pointArray->GetAt(2), pointArray->GetAt(3));
        edge04 = new Edge(pointArray->GetAt(3), pointArray->GetAt(0));
        edge05 = new Edge(pointArray->GetAt(7), pointArray->GetAt(6));
        edge06 = new Edge(pointArray->GetAt(6), pointArray->GetAt(5));
        edge07 = new Edge(pointArray->GetAt(5), pointArray->GetAt(4));
        edge08 = new Edge(pointArray->GetAt(4), pointArray->GetAt(7));
        edge09 = new Edge(pointArray->GetAt(0), pointArray->GetAt(4));
        edge10 = new Edge(pointArray->GetAt(1), pointArray->GetAt(5));
        edge11 = new Edge(pointArray->GetAt(2), pointArray->GetAt(6));
        edge12 = new Edge(pointArray->GetAt(3), pointArray->GetAt(7));

        this->AddEdge(edge01);
        this->AddEdge(edge02);
        this->AddEdge(edge03);
        this->AddEdge(edge04);
        this->AddEdge(edge05);
        this->AddEdge(edge06);
        this->AddEdge(edge07);
        this->AddEdge(edge08);
        this->AddEdge(edge09);
        this->AddEdge(edge10);
        this->AddEdge(edge11);
        this->AddEdge(edge12);
    }
    else
    {
        edge01 = this->GetAt(0);
        edge02 = this->GetAt(1);
        edge03 = this->GetAt(2);
        edge04 = this->GetAt(3);
        edge05 = this->GetAt(4);
        edge06 = this->GetAt(5);
        edge07 = this->GetAt(6);
        edge08 = this->GetAt(7);
        edge09 = this->GetAt(8);
        edge10 = this->GetAt(9);
        edge11 = this->GetAt(10);
        edge12 = this->GetAt(11);
    }

    edge01->Nextccw  = edge02;
    edge01->Prevccw  = edge04;

    edge02->Nextccw  = edge03;
    edge02->Prevccw  = edge01;

    edge03->Nextccw  = edge04;
    edge03->Prevccw  = edge02;

    edge04->Nextccw  = edge01;
    edge04->Prevccw  = edge03;

    edge05->Nextccw  = edge06;
    edge05->Prevccw  = edge08;

    edge06->Nextccw  = edge07;
    edge06->Prevccw  = edge05;

    edge07->Nextccw  = edge08;
    edge07->Prevccw  = edge06;

    edge08->Nextccw  = edge05;
    edge08->Prevccw  = edge07;

    edge09->Nextccw  = edge07;
    edge09->Prevccw  = edge01;

    edge10->Nextccw  = edge06;
    edge10->Prevccw  = edge02;

    edge11->Nextccw  = edge05;
    edge11->Prevccw  = edge03;

    edge12->Nextccw  = edge08;
    edge12->Prevccw  = edge04;

    return;
}

// "9 : Link segment to faces (student work here)"
void ArrayFace::linkSegmentsToFacesCubic(ArrayEdge* edgeArray)
{
    if(edgeArray->n < 12)
    {
        cerr<<"In Edge Array, there is not enough edge to represent cube."<<endl;
        return;
    }

    Face *F1;
    Face *F2;
    Face *F3;
    Face *F4;
    Face *F5;
    Face *F6;

    if(this->n < 6)
    {
        F1 = new Face;
        F2 = new Face;
        F3 = new Face;
        F4 = new Face;
        F5 = new Face;
        F6 = new Face;

        this->AddFace(F1);
        this->AddFace(F2);
        this->AddFace(F3);
        this->AddFace(F4);
        this->AddFace(F5);
        this->AddFace(F6);
    }
    else
    {
        F1 = this->GetAt(0);
        F2 = this->GetAt(1);
        F3 = this->GetAt(2);
        F4 = this->GetAt(3);
        F5 = this->GetAt(4);
        F6 = this->GetAt(5);
    }

    Edge* edge01 = edgeArray->GetAt(0);
    Edge* edge02 = edgeArray->GetAt(1);
    Edge* edge03 = edgeArray->GetAt(2);
    Edge* edge04 = edgeArray->GetAt(3);
    Edge* edge05 = edgeArray->GetAt(4);
    Edge* edge06 = edgeArray->GetAt(5);
    Edge* edge07 = edgeArray->GetAt(6);
    Edge* edge08 = edgeArray->GetAt(7);
    Edge* edge09 = edgeArray->GetAt(8);
    Edge* edge10 = edgeArray->GetAt(9);
    Edge* edge11 = edgeArray->GetAt(10);
    Edge* edge12 = edgeArray->GetAt(11);

    edge01->Fccw = F1;
    edge01->Fcw =  F3;

    edge02->Fccw = F1;
    edge02->Fcw =  F4;

    edge03->Fccw = F1;
    edge03->Fcw =  F5;

    edge04->Fccw = F1;
    edge04->Fcw =  F6;

    edge05->Fccw = F2;
    edge05->Fcw =  F5;

    edge06->Fccw = F2;
    edge06->Fcw =  F4;

    edge07->Fccw = F2;
    edge07->Fcw =  F3;

    edge08->Fccw = F2;
    edge08->Fcw =  F6;

    edge09->Fccw = F3;
    edge09->Fcw =  F6;

    edge10->Fccw = F4;
    edge10->Fcw =  F3;

    edge11->Fccw = F5;
    edge11->Fcw =  F4;

    edge12->Fccw = F6;
    edge12->Fcw =  F5;

    F1->Start = edge01;
    F2->Start = edge05;
    F3->Start = edge09;
    F4->Start = edge10;
    F5->Start = edge11;
    F6->Start = edge12;

    return;
}
```

7 Exercise 4

In order to check our cubical is represented closed in our data structure, here are the functions to check it.

Listing 3: Exercice.h

```
    // 13 : Check if face is closed (student work here)"
    bool isCubicFaceClosed() const;
    private:
    bool isCubicFaceClosedTraversal(Face*, int) const;
```

Listing 4: Exercice.cpp

```
// 13 : Check if face is closed (student work here)"
bool ArrayFace::isCubicFaceClosed() const
{
    bool isCubicFaceClosed = true;

    for(int i = 0; i < this->n; i++)
    {
        Face* face = this->GetAt(i);

        bool traversal = this->isCubicFaceClosedTraversal(face, 4);

        if(!traversal)
        {
            isCubicFaceClosed = false;
            break;
        }
    }

    return isCubicFaceClosed;
}

bool ArrayFace::isCubicFaceClosedTraversal(Face* face, int numberOfEdges) const
{
    Edge* temp = face->Start;

    for(int i = 0; i < numberOfEdges; i++)
    {
        if(temp->Fccw == face)
            temp = temp->Nextccw;
        else
            temp = temp->Prevcw;
    }

    if(temp == face->Start)
        return true;
    return false;
}
```

Here are the some function call from main.cpp

Listing 5: main.cpp

```

//------------------------------
//student work here
//------------------------------

            case 7 : {
                //add your code here

            // "7 : Link segment clockwise - prev and next - (student work here)"
            ArrayE.linkSegmentsCWCubic(&ArrayP);


                }break;

//------------------------------
//student work here
//------------------------------

            case 8 : {
                //add your code here

            // "8 : Link segment counterclockwise - prev and next - (student work here)"
            ArrayE.linkSegmentsCCWCubic(&ArrayP);


                }break;

//------------------------------
//student work here
//------------------------------

            case 9 : {
                //add your code here

            // "9 : Link segment to faces (student work here)"
            ArrayF.linkSegmentsToFacesCubic(&ArrayE);

                }break;

            case 13 : {
                //student work here

            // "13 : Check if face is closed (student work here)"
            bool isClosed = ArrayF.isCubicFaceClosed();
            if(isClosed)
                cout<<"Cubic Faces looks closed ^_^ !"<<endl;
            else
                cout<<"Cubic Faces looks like NOT closed :'( !"<<endl;

                }break;
```

8 Results/Lessons Learned

This lab gave us the message not to use winged-edge again, otherwise it's data structure is a pain.