实验：空间直角坐标和大地坐标的转换

一、实验目的：

- 掌握空间直角坐标和大地坐标概念
- 理解空间直角坐标和大地坐标的转换关系

二、实验工具：

- 计算机
- VS2010 版本以上

三、实验步骤：

1、 利用下列公式进行转换。

WGS84 坐标系参数：地球椭球长半轴 a=6378137，扁率 f=1:298.257=（a-b）/a，卯酉曲率半径 N 和偏心率 e 的公式在（2-4）公式的下面。通过扁率求短半轴 b，再求第一偏心率 e。

$$\left.\begin{aligned} X &= (N+H)\cos B\cos L \\ Y &= (N+H)\cos B\sin L \\ Z &= \left[\left(N(1-e^2)+H\right)\sin B\right] \end{aligned}\right\} \qquad (2-3)$$

$$\left.\begin{aligned} L &= \arctan(Y/X) \\ B &= \arctan\left\{Z(N+H)/[\sqrt{X^2+Y^2}\,(N(1-e^2)+H)]\right\} \\ H &= Z/\sin B - N(1-e^2) \end{aligned}\right\} \qquad (2-4)$$

式中，$N = a/\sqrt{1-e^2\sin^2 B}$，$N$为该点的卯酉圈半径；

$e^2 = (a^2-b^2)/a^2$，$a,e$分别为该大地坐标系对应椭球的长半径和第一扁心率。

2、 求纬度 B 时，用迭代，高程 H 先假定为 0。

3、在进行空间直角坐标转换大地坐标时，注意反正切的取值范围。以下为参考界面及实验数据：


图 1：大地坐标转成空间直角坐标


图 2：空间直角坐标转成大地坐标

参考代码如下：

```
using System;
using System.Collections.Generic;
using System.ComponentModel;
using System.Data;
```

```
using System.Drawing;
using System.Linq;
using System.Text;
using System.Windows.Forms;

namespace CoordinateTransformation
{
    public partial class Form1 : Form
    {
        double Lon, Lat, H;
        double LonDeg, LatDeg, LonMin, LatMin, LonSec, LatSec;
        string TxtB1, TxtB2, TxtB3,TxtB4,TxtB5,TxtB6;

        double a, b, f, e2, N;                                          //椭球参数定义及计算

        double X, Y, Z;

        public Form1()
        {
            InitializeComponent();
        }

        private void Form1_Load(object sender, EventArgs e)
        {
            comboBox1.SelectedIndex = 0;
        }

        private void button1_Click(object sender, EventArgs e)
        {

            a = 6378245;
            double temp1, temp2;
            temp1 = 1;
            temp2 = 298.3;
            f = temp1 / temp2;                                                  //分别是长
半轴，短半轴，扁率，第一偏心率和卯酉曲率半径
            int cmbB_N = comboBox1.SelectedIndex + 1;
            switch (cmbB_N)
            {
                case 1:
                    a = 6378245;
                    temp1 = 1;
                    temp2 = 298.3;
                    f = temp1 / temp2;
```

```
                    break ;
                case 2:
                    a = 6378140;
                    temp1 = 1;
                    temp2 = 298.257;
                    f = temp1 / temp2;
                    break;
                case 3:
                    a = 6378137;
                    temp1 = 1;
                    temp2 = 298.2572;
                    f = temp1 / temp2;
                    break;
                case 4:
                    a = 6378137;
                    temp1 = 1;
                    temp2 = 298.2572;
                    f = temp1 / temp2;
                    break;

            }


            if (textBox1.Text == string.Empty || textBox2.Text == string.Empty || textBox3.Text ==
string.Empty)
            {
                MessageBox.Show("大地经度、纬度和高程不能为空");

            }
            else
            {
                TxtB1 = textBox1.Text;
                TxtB2 = textBox2.Text;
                TxtB3 = textBox3.Text;
                LonDeg = Math.Truncate(double.Parse (TxtB1)) ;

               LonMin = Convert.ToInt16( TxtB1.Substring(TxtB1.IndexOf(".") + 1, 2));
               LonSec = Convert.ToInt16(TxtB1.Substring(TxtB1.IndexOf(".") +3, 2));

                Lon = LonDeg + LonMin / 60 + LonSec / 3600;
                Lon = double.Parse(TxtB1 );

                LatDeg = Math.Truncate(Convert.ToDouble(TxtB2));
```

```
            LatMin = Convert.ToInt16(TxtB2.Substring(TxtB2.IndexOf(".") + 1, 2));
            LatSec = Convert.ToInt16(TxtB2.Substring(TxtB2.IndexOf(".") + 3, 2));

            Lat = LatDeg + LatMin / 60 + LatSec / 3600;

            Lat = double.Parse(TxtB2);

            b = a - a * f;
            e2 = (Math.Pow(a, 2) - Math.Pow(b, 2)) / Math.Pow(a, 2);
            N = a / Math.Sqrt(1 - e2 * Math.Pow(Math.Sin(Lat * Math.PI / 180), 2));       //计算N


            H = double.Parse (TxtB3);


            X=(N+H )*Math.Cos(Lat*Math.PI /180)*Math.Cos(Lon*Math.PI /180);
            Y=(N+H )*Math.Cos(Lat*Math.PI /180)*Math.Sin(Lon*Math.PI /180);
            Z = (N*(1-e2)+H)*Math.Sin (Lat*Math .PI /180);
            textBox4.Text = X.ToString();
            textBox5.Text = Y.ToString();
            textBox6.Text = Z .ToString() ;

        }
}

private void button2_Click(object sender, EventArgs e)
{
        TxtB4 = textBox4.Text;
        TxtB5 = textBox5.Text;
        TxtB6 = textBox6.Text;
        X =double.Parse(TxtB4);
        Y = double.Parse(TxtB5);
        Z = double.Parse(TxtB6);
        if (Math.Abs ( X) <= 0.000001)
        {
            if (Y > 0.000001)
            {
                Lon = Math.PI /2;

            }
            if (Y < -0.000001)
            {
                Lon = Math.PI *3/2;
            }
```

```
        if (Math.Abs(Y) <= 0.000001)
        {
            Lon = 0;
        }
        return;
    }
    Lon = Math.Atan(Math.Abs( Y/X));
    if(X>0.000001 )
    {
        if (Y <- 0.000001)
        {
            Lon = 2*Math.PI    - Lon;

        }
    }
    if (X < -0.000001)
    {
        if (Y > 0.000001)
        {
            Lon = Math .PI    - Lon;
        }
        if(Y<-0.000001)
        {
            Lon = Math.PI    + Lon;
        }
        if (Math.Abs(Y) <= 0.0000001)
            Lon = Math.PI;
    }


    double H1;
    H = 0;

    do
    {
        H1 = H;
        Lat = Math.Atan(Z * (N + H1) / (Math.Sqrt(Math.Pow(X, 2) + Math.Pow(Y, 2)) * (N *
(1 - e2) + H1)));
        H = Z / Math.Sin(Lat) - N * (1 - e2);
    } while (Math.Abs(H - H1) <= 0.00000001);

    Lon = Lon/Math.PI    * 180;
    Lat = Lat / Math.PI * 180;
```

```
            LonDeg = Math.Truncate(Lon);
            LatDeg = Math.Truncate(Lat);

            double LonMinF, LatMinF, LonSecF, LatSecF;

            LonMinF = (Lon - LonDeg)*60;
            LonMin = Math.Truncate(LonMinF);
            LonSecF = (LonMinF - LonMin)*60;
            LonSec = Math.Truncate(LonSecF);

            LatMinF = (Lat - LatDeg) * 60;
            LatMin = Math.Truncate(LatMinF);
            LatSecF = (LatMinF - LatMin)*60;
            LatSec = Math.Truncate(LatSecF);

            string LonStr,LatStr;
            LonStr = LonDeg.ToString()+ "." + LonMin.ToString() + LonSec.ToString();
            LatStr = LatDeg.ToString() + "." + LatMin.ToString() + LatSec.ToString();




            textBox1.Text = LonStr;
            textBox2.Text = LatStr;
            textBox3.Text = H.ToString();


        }

    }
}
```