VB.NET 结合 MATLAB 在沉井姿态控制中的应用

周　龙[1],许明成[2]
(1. 广东置信勘测规划信息工程有限公司　广东　中山　528400;
2. 华冠达工程有限公司　广东　珠海　519000)
DOI:

【摘要】 VB.NET 结合 MATLAB 软件在沉井群姿态监控上,实现了快速化批量化沉井群监测数据处理工作,同时指导一线施工管理人员自助式利用软件实时分析沉井姿态,节省了各环节反应时间,大大提高了施工管理效率,该类做法具备较高的经济效益,值得推广。
【关键词】 沉井;姿态控制;MATLAB;VB.NET

1　引言

MATLAB[1]是美国 MathWorks 公司出品的商业数学软件,用于算法开发、数据可视化、数据分析以及数值计算的高级技术计算语言和交互式环境,主要包括 MATLAB 和 Simulink 两大部分。

VisualBasic.NET[2]是基于微软.NETFramework 之上的面向对象的编程语言。其在调试时是以解释型语言方式运作,而输出为 EXE 程序时是以编译型语言方式运作。

在广东省珠海某建设工程项目中(图 1),有地下空间指地下公共车行通道及其出入口共计 17 处,其中最短 20.40m,最长 304.60m,合计 1605.35m,下沉深度最深 11.15m;基坑支护结构安全等级为二级,重要性系数为 1.0;基坑环境等级为二级,支护结构水平位移控制值 150mm 且不大于 0.005H;长沉井采用分段下沉,分段之间间距 0.3m。

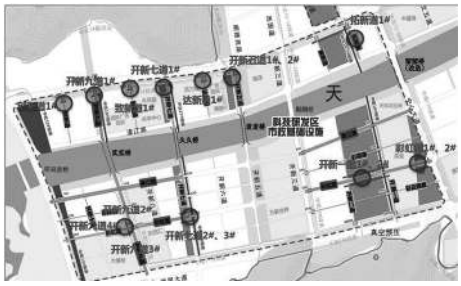

图 1　沉井群分布示意图

该项目淤泥层位埋藏较浅,在工程区内分布厚度大,平均厚度 29.27m,最大厚度 43.00m。在淤泥软土区域或者地质结构不良段施工,极易造成沉井下沉过快、沉井倾斜、沉井偏移、沉井被搁置或悬挂,下沉极慢或不下沉、沉井下沉遇到障碍物等不利情形。为了规避不利情形,通过沉井施工监测,及时的对沉井姿态的掌握,并快速的做出分析和评估以指导现场施工。

该项目沉井施工监测工作存在以下几个难点,一是沉井群分布散乱;二是沉井群数量众多;三是设计图纸要求 2 次/1d,监测频次密集;四是地质条件复杂,为此笔者通过 VB.NET 结合 MATLAB 软件在沉井群姿态的控制上取得了良好的经济效益,为大量沉井群的顺利施工奠定了基础。

2　VB.NET 和 MATLAB 应用于沉井姿态实施过程

2.1　数据准备

对于沉井姿态的控制主要主要靠监测竖向高差和水平偏移来完成,对于竖向高差本项目中要求沉井四角中任何两个角顶中心高差不得超过该两角水平距离的 1%,且不得超过 150mm,沉井顶面中心水平位移不得超过下沉总高度的 1%,下沉总深度<10m 时,不宜大于 150mm。对于这两项姿态参数均可通过布设于沉井顶部的监测点位三维坐标值进行挖掘计算。

由于监测频次较多,数据量大,本文选取沉井第一节下沉前监测数据及下沉后监测数据(表 1)演示

沉井姿态分析判断过程。

表 1　监测数据原始数据表

点名	北(m)	东(m)	高程(m)	北(m)	东(m)	高程(m)
zxd－1	32.110	21.300	3.870	32.058	21.351	0.128
zxd－2	33.400	30.870	3.860	33.313	30.913	0.155
zxd－3	26.530	31.510	3.840	26.449	31.541	0.105
zxd－4	20.840	32.440	3.840	20.761	32.471	0.067
zxd－5	19.540	20.140	3.850	19.507	20.156	0.054
zxd－6	18.160	10.650	3.870	18.144	10.666	0.065
zxd－7	25.060	10.100	3.900	25.055	10.143	0.121
zxd－8	30.820	9.150	3.900	30.800	9.195	0.148
监测时间	2019/8/6			2019/8/22		

2.2　基于 VB.NET 开发沉井姿态控制程序

笔者利用 VB.NET 编写开发出沉井姿态控制程序,通过将沉井下沉控制条件预先设定到程序里,使一般一线施工管理人员在无需进行大量计算的情况下,均可通过监测点坐标值快速的对沉井姿态进行控制,节省了大量的沟通时间,减少了实际施工管理成本,提高了工作效率,其核心代码如下:

```
Public Class Form1
    Private Sub Button4_Click(ByVal sender As System.Object, ByVal e As System.EventArgs) Handles Button4.Click
        Dim filpath As String
        Dim opfil_1 As New OpenFileDialog
        opfil_1.ShowDialog()
        filpath = opfil_1.FileName
        Dim rdtxt As IO.StreamReader = New IO.StreamReader(filpath, System.Text.Encoding.Default)
        Dim str() As String, n As Integer = 1
        Dim arr_len As Long
        Dim dataarr(0)
        Dim cord1() As String
        Dim cord2() As String
        Dim tmpstr1 As String
        Dim tmpstr2 As String
        Dim datearr(0)
        Do Until rdtxt.EndOfStream
            n = n + 1
            ReDim Preserve str(n)
            str(n) = rdtxt.ReadLine
            Debug.WriteLine(str(n))
        Loop
        rdtxt.Close()
        arr_len = UBound(str) - LBound(str) + 1
        读取数据完毕
        Dim m As Long  '返回点数
        Dim k As Long
        m = 0
        k = 0
        For i = 2 To arr_len - 1
            If Len(str(i)) > 10 Then
            dataarr(m) = str(i)
            m = m + 1
            ReDim Preserve dataarr(m)
            End If
            If Len(str(i)) = 10 Then
            datearr(k) = str(i)
            k = k + 1
            ReDim Preserve datearr(k)
            End If
        Next
        For i = 0 To m / 2 - 1 '存坐标对入数组
            ReDim Preserve cord1(m / 2 - 1)
            cord1(i) = dataarr(i)
            tmpstr1 = tmpstr1 & dataarr(i) & Chr(13) + Chr(10)
        Next
        For i = m / 2 To m - 1 '存坐标对入数组
            ReDim Preserve cord2(m / 2 - 1)
```

```
            cord2(i - m / 2) = dataarr(i)
            tmpstr2 = tmpstr2 & dataarr(i) &
Chr(13) + Chr(10)
        Next
        TextBox1.Text = tmpstr1
        TextBox2.Text = tmpstr2
        DateTimePicker1.Value = CDate(datearr
(0))
        DateTimePicker2.Value = CDate(datearr
(1))
        TextBox10.Text = str(2)
        TextBox5.Text = str(3)
        Dim cor1_spit(0 To m / 2 - 1, 0 To 3)'
坐标对变数值
        Dim cor2_spit(0 To m / 2 - 1, 0 To 3)
        Dim arrtmp()
        For i = 0 To m / 2 - 1
            arrtmp = Split(cord1(i), ",")
            cor1_spit(i, 0) = arrtmp(0)
            cor1_spit(i, 1) = arrtmp(1)
            cor1_spit(i, 2) = arrtmp(2)
            cor1_spit(i, 3) = arrtmp(3)
            arrtmp = Split(cord2(i), ",")
            cor2_spit(i, 0) = arrtmp(0)
            cor2_spit(i, 1) = arrtmp(1)
            cor2_spit(i, 2) = arrtmp(2)
            cor2_spit(i, 3) = arrtmp(3)
        Next
        '"计算沉井姿态
        Dim sp()
        ReDim sp(m / 2 - 1)
        For i = 0 To m / 2 - 1
            sp(i) = Math.Sqrt((CDbl(cor1_spit
(i, 1)) - CDbl(cor2_spit(i, 1))) ^ 2 + (CDbl
(cor1_spit(i, 2)) - CDbl(cor2_spit(i, 2))) ^ 2)"
计算水平位移
        Next
        Dim cz()
        ReDim cz(m / 2 - 1)
        For i = 0 To m / 2 - 1
            cz(i) = CDbl(cor2_spit(i, 3)) -
CDbl(cor1_spit(i, 3))"计算垂直位移
        Next
        '计算位移方向角
        Dim jd(0, 1)
        ReDim jd(m / 2 - 1, 1)
        For i = 0 To m / 2 - 1
            jd(i, 0) = cor1_spit(i, 0)
            jd(i, 1) = fwj(cor1_spit(i, 1), cor1
_spit(i, 2), cor2_spit(i, 1), cor2_spit(i, 2))    '
计算水平位移方位角
        Next
        '平均水平位移
        Dim pjsp As Double
        Dim qhsp As Double
        For i = 0 To m / 2 - 1
            qhsp = qhsp + sp(i)
        Next
        pjsp = qhsp / (m / 2)

        '平均垂直位移
        Dim pjcz As Double
        Dim qhcz As Double
        For i = 0 To m / 2 - 1
            qhcz = qhcz + cz(i)
        Next
        pjcz = qhcz / (m / 2)
        ""写下沉监测总结
        Dim yjsp As String
        Dim yjtmp As String
        Dim yjtmp1 As String
        Dim yjcz As String
        Dim yj As String
        Dim jd1 As Double
        Dim fxst As String
        For i = 0 To m / 2 - 1
            "水平位移总结
            jd1 = jd(i, 1)
            fxst = CStr(fxs(jd1))
            If sp(i) > (80 / 1000) Then
            yjtmp = cor1_spit(i, 0) & "点附近
水平位移达到控制值80%,向" & fxst & "位移" &
Math.Round(sp(i) * 1000, 1) & "mm,停止
开挖。"
            ElseIf sp(i) > (50 / 1000) Then
            yjtmp = cor1_spit(i, 0) & "点附近
水平位移达到控制值50%,向" & fxst & "位移" &
Math.Round(sp(i) * 1000, 1) & "mm,谨慎
```

```
开挖。"
            ElseIf sp(i) > (30 / 1000) Then
            yjtmp = corl_spit(i, 0) & "点附近水平位移达到控制值30%,向" & fxst & "位移" & Math.Round(sp(i) * 1000, 1) & "mm,注意开挖。"
            Else
            yjtmp = corl_spit(i, 0) & "点附近水平位移达到控制值小于30%,向" & fxst & "位移" & Math.Round(sp(i) * 1000, 1) & "mm,正常开挖。"
            End If
            yjsp = yjsp & yjtmp & Chr(13) + Chr(10)

            Select Case Math.Abs(cz(i) - pjcz)
            Case Is > (75 / 1000)
                If cz(i) - pjcz > 0 Then
                yjtmp1 = corl_spit(i, 0) & "点附近垂直位移达到控制值100%,下沉值为" & Math.Round(cz(i) * 1000, 1) & "mm,优先开挖。"
                Else
                yjtmp1 = corl_spit(i, 0) & "点附近垂直位移达到控制值100%,下沉值为" & Math.Round(cz(i) * 1000, 1) & "mm,停止开挖。"
                End If
            Case Is > (50 / 1000)
                If cz(i) - pjcz > 0 Then
                yjtmp1 = corl_spit(i, 0) & "点附近垂直位移达到控制值75%,下沉值为" & Math.Round(cz(i) * 1000, 1) & "mm,优先谨慎开挖。"
                Else
                yjtmp1 = corl_spit(i, 0) & "点附近垂直位移达到控制值75%,下沉值为" & Math.Round(cz(i) * 1000, 1) & "mm,建议停止开挖。"
                End If
            Case Is > (25 / 1000)
                If cz(i) - pjcz > 0 Then
                yjtmp1 = corl_spit(i, 0) & "点附近垂直位移达到控制值50%,下沉值为" & Math.Round(cz(i) * 1000, 1) & "mm,优先谨慎开挖。"
                Else
                yjtmp1 = corl_spit(i, 0) & "点附近垂直位移达到控制值50%,下沉值为" & Math.Round(cz(i) * 1000, 1) & "mm,建议停止开挖。"
                End If
            Case Else
                If cz(i) - pjcz >= 0 Then
                yjtmp1 = corl_spit(i, 0) & "点附近垂直位移达到控制值小于50%,下沉值为" & Math.Round(cz(i) * 1000, 1) & "mm,优先谨慎开挖。"
                Else
                yjtmp1 = corl_spit(i, 0) & "点附近垂直位移达到控制值小于50%,下沉值为" & Math.Round(cz(i) * 1000, 1) & "mm,建议停止开挖。"
                End If
            End Select
            yjcz = yjcz & yjtmp1 & Chr(13) + Chr(10)
        Next
        yj = "编号" & str(2) & "沉井下沉姿态监测结论:" & Chr(13) + Chr(10) & yjsp & yjcz
        TextBox11.Text = yj
        ''''计算本环下沉值
        '取初测数组
        Dim arr1() As String
        ReDim arr1(m / 2 - 1)
        For i = 0 To m / 2 - 1
            arr1(i) = corl_spit(i, 3)
        Next
        Dim arr2() As String
        ReDim arr2(m / 2 - 1)
        For i = 0 To m / 2 - 1
            arr2(i) = cor2_spit(i, 3)
        Next
         TextBox8.Text = (pjz(arr1) - pjz(arr2) + TextBox5.Text) & "m"
        '''计算最大水平偏差
        TextBox4.Text = maxnum(sp) & "mm"
        '''计算最大垂直偏差
```

```
        Dim czpc()
        ReDim czpc(m / 2 - 1)
        For i = 0 To m / 2 - 1
            czpc(i) = cz(i) - pjcz
        Next
        TextBox3.Text = maxnum(czpc) & "mm"
        '''计算平均下沉速率
        TextBox6.Text = pjcz / DateDiff("d", datearr(0), datearr(1)) * (-1) * 1000 & "mm/d"
        TextBox5.Text = str(3) & "m"
        MsgBox("沉井姿态分析完毕,请复制监测监测结论。")
        End Sub
        Public Function pjz(ByVal sz() As String)
        Dim wd As Long
        Dim sum As Double
        wd = UBound(sz)
        sum = 0
        For I = 1 To wd
            sum = sum + sz(I)
        Next
        pjz = sum / wd
        End Function
        Public Function maxnum(ByVal a())
        Dim i As Integer
        maxnum = CDbl(a(0))
        For i = 1 To UBound(a)
            If a(i) > maxnum Then maxnum = CDbl(a(i))
        Next
        End Function
        Private Sub TextBox5_TextChanged(ByVal sender As System.Object, ByVal e As System.EventArgs) Handles TextBox5.TextChanged
        End Sub
        Private Sub Button1_Click(ByVal sender As System.Object, ByVal e As System.EventArgs) Handles Button1.Click
        Clipboard.SetText(TextBox11.Text)
        End Sub
        Public Function fwj(ByVal sx As Double, ByVal sy As Double, ByVal ex As Double, ByVal ey As Double) '计算两点方位角(格式为度),点1为测站,点2为前视
        On Error Resume Next
        Dim dX As Double, dY As Double, a_t As Double, pi As Double
        pi = Math.Atan(1) * 4
        dX = ex - sx
        dY = ey - sy + 1.0E-20
        a_t = pi * (1 - Math.Sign(dY) / 2) - Math.Atan(dX / dY)
        a_t = a_t * 180 / pi
        fwj = a_t
        End Function
        Function ddms(ByVal X) '度转换为度分秒
        On Error Resume Next
        Dim ai As Single, bi As Single, ci As Single, ei As Single
        Dim de As Double
        de = Math.Abs(X)
        ai = Int(de)
        bi = (de - ai) * 60
        bi = Int(bi)
        ci = Math.Round(((de - ai) * 60 - bi) * 60, 2)
        If InStr(CStr(ci), ".") = 1 Then
            ei = "0" & CStr(ci)
        Else
            ei = CStr(ci)
        End If
        If X < 0 Then
            ddms = "-" & Format(ai, "000") & "°" & Format(bi, "00") & "′" & Format(ei, "00.00") & "″"
        Else
            ddms = Format(ai, "000") & "°" & Format(bi, "00") & "′" & Format(ei, "00.00") & "″"
        End If
        End Function
        Function fxs(ByVal jds) As String
        If Int(jds) >= 0 And Int(jds) <
```

```
90 Then
            fxs = "东北方向"
        ElseIf Int(jds) >= 90 And Int(jds) <
180 Then
            fxs = "东南方向"
        ElseIf Int(jds) >= 180 And Int(jds) <
270 Then
            fxs = "西南方向"
        ElseIf Int(jds) >= 270 And Int(jds) <
360 Then
            fxs = "西北方向"
            End If
        End Function
    End Class
```

2.3 利用 MATLAB 进行沉井姿态分析

该项目现场施工要求对沉井姿态进行可视化直观且专业化的分析,因此,笔者利用 MATLAB 中 hold on 方法、plot 方法、fill 方法、quiver 方法结合起来对沉井姿态进行可视化分析,生成水平位移矢量云图(图 2),为现场姿态提供快速方便的决策依据。

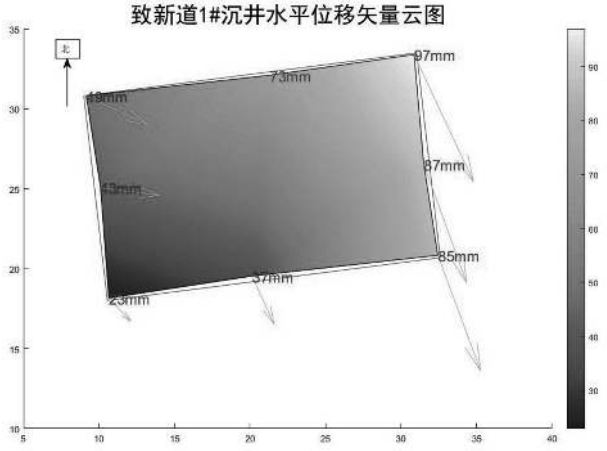

图 2 MATLAB 生成沉井水平位移矢量云图示例

其 MATLAB 过程核心代码如下:

```
[x,y]=meshgrid(13.948:5:37.959,3.838:5:
37.959)
x1=[32.11,33.4,26.53,20.84,19.54,18.16,
25.06,30.82]
y1=[21.3,30.87,31.51,32.44,20.14,10.65,
10.1,09.15]
x2=[30.821,33.502,20.696,18.015,30.821]
y2=[8.997,31.034,32.592,10.554,8.997]
dx=-1*[0.052,0.087,0.081,0.079,0.033,
0.016,0.005,0.020]
dy=-1*[-0.051,-0.043,-0.031,-0.
031,-0.016,-0.016,-0.043,-0.045]
s=1000*[0.073,0.097,0.087,0.085,0.037,
0.023,0.043,0.049]
hold on
plot(y2,x2)
fill(y1,x1,s,'FaceColor','interp')
quiver(y1,x1,dy,dx)
for i=1:8
text(y1(i),x1(i),[num2str(s(i)),'mm'])
end
hold off
```

3 结论

在广东省珠海某建设工程项目中,VB.NET 结合 MATLAB 软件在沉井群姿态监控上,实现了快速批量沉井群监测数据处理工作,指导一线施工管理人员自助式利用软件实时分析沉井姿态,节省各环节反应时间,大大提高了施工效率,产生了较高的经济效益。

【参考文献】

[1] 佚名. MATLAB 程序设计与应用[M]// Matlab 程序设计与应用. 2005.

[2] Petroutsos E. Mastering Visual Basic. NET[M]. 2006.

[3] 朱浩, 王通. 超大陆地沉井信息化施工监控技术[J]. 施工技术, 2018, 47(24):72-77+97.

[4] 彭仪普, 屠名, 程阳. 超大型沉井定位着床及施工过程中的数值模拟[J]. 铁道科学与工程学报, 2015(5):1179-1184.

[5]赵有明, 田欣, 牛亚洲,等. 南京长江第四大桥北锚碇沉井基础施工关键技术[J]. 桥梁建设, 2009, 2009(s1):62-65.