

Study on Improving the Drawing Efficiency of Schematic Map of Urban Rail Transit Distribution

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Abstract: The drawing of the schematic map of urban rail transit distribution is an indispensable process in urban rail transit design. In the present, the schematic map relies on manual drawing. Because of the large amount of basic data input, tedious updating, and strong repeatability, the outcome of the drawing efficiency is low. In view of the characteristics of the drawing of the wiring schematic diagram, this paper studies how to develop the software for drawing the schematic diagram of rail transit wiring. The friendly interface of software design and the use of One-Key import reduces the manual workload. Drawing wiring schematic diagram in CAD with One-Key will improve the speed and accuracy of data input, and wiring schematic drawing efficiency.

Keywords: Rail transit; Wiring diagram; Cad; Enhance efficiency

1. Introduction

In the process of urban rail transit design, drawing wiring schematic diagram is based on line data, station data, section data and wiring data. This work is characterized by a large amount of input data, heavy workload, strong repeatability, fast update speed, and accuracy check of the data. When drawing the wiring schematic diagram, we should draw the station schematic diagram, wiring schematic diagram, section yard schematic diagram, section yard rail connection, block and other rail transit elements according to the design input data separately, and mark the station name, station mileage, station spacing, starting mileage, ending mileage and other related detailed parameters.

The current drawing method of wiring schematic diagram is that the designer has to manually draw the wiring schematic diagram in CAD based on line data, station data, section yard data and wiring data. Because of the continuous progress of the project, the wiring schematic map needs to be updated continuously, but the current drawing method is inefficient. Therefore, it is necessary to develop a software to improve the efficiency of wiring schematic drawing.

2. Development of Auxiliary Software for Drawing Wiring Sketch

2.1. Software requirement analysis

Aided design software of rail transit wiring sketch drawing is mainly used to meet the demand of new rail transit project whole-stage rail transit wiring sketch drawing. It can intuitively express the relationship between the design parameters of rail transit lines and the components of the wiring schematic diagram. It can also draw, modify, and update the wiring schematic diagram simply, quickly, accurately and efficiently.

From the point of view of system interface, the wiring diagram generation and drawing software need to be connected with the database of the integrated system software for line profile design (Kebaohua software) to meet the requirement of real-time updating of wiring diagram according to the dynamic adjustment of line profile. At the same time, due to the rapid development of new rail transit, new forms of stations and wiring are constantly emerging, so the software must reserve interface for upgrading in order to update the drawing elements in time.

Table 1. Functional requirements table of software for assisted design of wiring schema

Serial number	Function	Explain
1	Generation Function of Circuit Diagram	Drawing the schematic diagram of the whole line according to the type of station, the name of station, the mileage of station and the distance between stations.
2	Connection Line Generation Function	Drawing tie-line schematic diagram according to tie-line type and distance of tie-line design parameters

3	Transfer Line Generation Function	Drawing transfer route schematic diagram according to the name and type of other track transfer lines
4	Segment field diagram generation function	Drawing section field schematic diagram according to section field name and connection type
5	Point and Line Edition of Wiring Schema	Drawing point and line layout of wiring schematic diagram according to station type, station name and station spacing

2.2. Standardization of drawing process of wiring schematic elements

Systematic analysis is used to draw wiring diagram. The first step of standardized wiring sketch drawing is data preparation, and Export the station table from Kebaohua. The second step is data standard edition, which collates the data of the station table, and adds wiring type and design mileage spacing. The third step is to draw the wiring schematic diagram, according to the design input data to draw the line station, wiring and other elements; The final step is to review the wiring schematic layout. As shown in Figure 1.

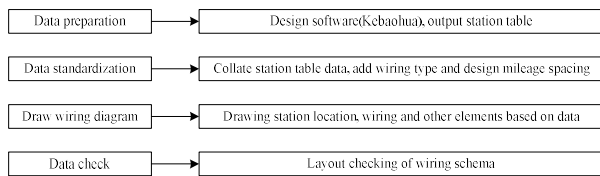


Figure 1. Drawing flow chart of wiring schematic diagram.

2.3. Implementing one-key import function of input data

The original data are processed by Excel standardization and the input data are required by the software. Some core codes are as follows:

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```

public static bool RenderDataTableFromExcel(Stream excelFileStream, bool xls,
    int startRowIndex, int startColIndex, bool haveHeader,
    out DataTable dataTable, string sheetName)
    {
        IWorkbook mWorkbook = xls?(IWorkbook) new
        HSSFWorkbook(excelFileStream)
        :new XSSFWorkbook(excelFileStream);
        var sheet = mWorkbook.GetSheet(sheetName);
        if (sheet==null)
        {
            dataTable = null;
            return false;
        }
        dataTable = new DataTable();
        var headerRow = sheet.GetRow(startRowIndex) as
        IRow;
        if (headerRow == null)
        {
            dataTable=null;
            return false;
        }
    }
    
```

```

    }
    int cellCount = headerRow.LastCellNum;
    for (int i = headerRow.FirstCellNum; i < cellCount; i++)
    {
        string columnName =
        (haveHeader == true) ? header-
        Row.GetCell(i).StringCellValue : "columnName" +
        i.ToString();
        var dataColumn = new DataColumn(columnName);
        dataTable.Columns.Add(dataColumn);
    }
    int rowEnd = sheet.LastRowNum;
    int rowStart = (haveHeader == true) ?
    sheet.FirstRowNum + 1 : sheet.FirstRowNum;
    for (int i = rowStart; i <= rowEnd; i++)
    {
        var row = sheet.GetRow(i) as IRow;
        var dataRow = dataTable.NewRow();
        if (row != null)
        {
            for (int j = row.FirstCellNum; j < cellCount; j++)
            {
                dataRow[j] = ExcelU-
                tils.GetCellDisplayValue(row.GetCell(j), mWorkbook);
            }
            dataTable.Rows.Add(dataRow);
        }
    }
    excelFileStream.Close();
    mWorkbook = null;
    sheet = null;
    return true;
    }
    
```

2.4. One-key drawing of wiring schematic elements

Through the data analysis of the existing wiring schematic elements, the digital expression of each element is obtained. The digitized expression of drawing elements is written into code function by C # language. By identifying the original input data, and using the judgment statement to call the corresponding code to draw the schematic diagram. The function part code is as follows:

```

public static void DrawDBObject(params Entity[] entityArray)
    {
        DocumentLock mDocumentLock = Applica-
        tion.DocumentManager.MdiActiveDocument.LockDocument();
        Document doc = Applica-
        tion.DocumentManager.MdiActiveDocument;
        Database currentDb = doc.Database;
        using (Transaction transaction = cur-
        rentDb.TransactionManager.StartTransaction())
        {
        }
    }
    
```

```

BlockTable currentBt = transaction.GetObject(currentDb.BlockTableId, OpenMode.ForRead) as BlockTable;
BlockTableRecord currentBtRecord = (BlockTableRecord)transaction.GetObject(currentBt[BlockTableRecord.ModelSpace], OpenMode.ForWrite);
foreach (var entity in entityArray)
{
    currentBtRecord.AppendEntity(entity);
    transaction.AddNewlyCreatedDBObject(entity, true);
}
transaction.Commit();
mDocumentLock.Dispose();
Application.UpdateScreen();
}
    
```

3. Application Case

Guangzhou Huangpu District Tram Line 1 is mainly laid along Kailuo Avenue, Xiangxue Avenue, Shuixi Road, Planned Outer Ring Road, the west side of the Second Longitudinal Road of Beijing Normal University, Changling Road and Yongshun Avenue. The whole line is about 14.3 km. There are 20 stations on the whole line, 19 of which have been set up recently (including 2 elevated stations and 17 ground stations), and 1 ground station has been reserved in the future. The main line of Line 1 includes roundabout line, crossing line, parking lot access line and depot access line. There are 20 stations on the whole line and 9 stations with auxiliary lines.

By running "wiring diagram menu" on the software, it activates the drawing software window and waits for the user to input wiring schematic element data in AUTO-CAD 2016. Click on "Open Data" to import wiring schematic element data, as shown in Figure 2. Click on "One Click Drawing Wiring diagram" to Draw wiring diagram, as shown in Figure 3.

序号	站名	站代码	站类型	站址形式	建站形式	站址坐标	站址高程	站址备注
1	起点	D00-000						
2	香雪	D01-001	地下	地下				
3	开泰大道站	D02-002	地面	地面				
4	沙面	D03-003	地面	地面				
5	沙面北站	D04-004	地面	地面				
6	沙面南站	D05-005	地面	地面				
7	沙面东站	D06-006	地面	地面				
8	沙面西站	D07-007	地面	地面				
9	沙面南站	D08-008	地面	地面				
10	沙面北站	D09-009	地面	地面				
11	沙面东站	D10-010	地面	地面				
12	沙面西站	D11-011	地面	地面				
13	沙面南站	D12-012	地面	地面				
14	沙面北站	D13-013	地面	地面				
15	沙面东站	D14-014	地面	地面				
16	沙面西站	D15-015	地面	地面				
17	沙面南站	D16-016	地面	地面				
18	沙面北站	D17-017	地面	地面				

Figure 2. Software interface for wiring diagram.

It takes about half hours to draw the 14.4 km wiring diagram of the whole line with the software. On the other hand, it takes three to six hours to draw the sketch using

the existing manual drawing method. Theresult is shown to improve the efficiency of wiring schematic drawing.

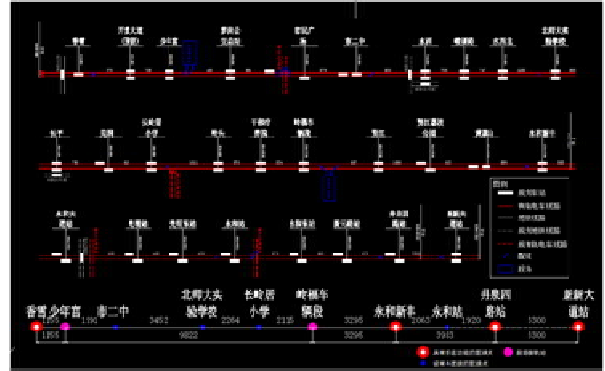


Figure 3. Drawing effect of wiring diagram software.

4. Conclusions

In the process of urban rail transit design, the drawing wiring schematic diagram is based on line data, station data, section data, and wiring data is a very basic work. The characteristics are many input data, heavy workload, strong repeatability, fast update speed, and data accuracy must be verified. Based on Visual Studio 2012 development platform, a wiring schematic drawing aided software is developed by using CSharp language. The software, which utilizes the function of One-Key import of raw data and automatically draws wiring schematic diagram, improves the speed and accuracy of data input, and greatly provides the efficiency of wiring schematic drawing. The software is simple and versatile, so it can be widely used in rail transit design. The idea of compiling the software can also provide some reference for other sketch drawing software development.

5. Acknowledgment

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