

# Development of special software for disc brake design

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**Abstract**—Special software for disc brake was developed based on Visual Basic language, in order to design the brake automatically and professionally. The developing principles were easy application, professional design and intelligent operation. Calculating and checking patterns for the main parts of the brake were presented using programming languages. Once the design parameters were input into the software, structural and checking information of the brake components was proposed, which could provide references for the designer. The design and checking report was output with word format, when the analysis data met requirements. The results indicate that the software is easy and efficient to operate.

**Keywords**- disc brake; design software development; Visual Basic language; check; calculate

## I. INTRODUCTION

Automobile is one of the most important and most convenient vehicles in the modern world. Brake system is an important part on the automobile chassis, it is a device to restrict automobile movement. Brake is the most important security component in the vehicle and greatly contributes to the performance of the vehicle<sup>[1]</sup>. Braking ability affects the security of the automobile. People's demand for safety and reliability is getting higher, with the highway speed and traffic density increasing. The automobile should be equipped with reliable brake system so that it could guarantee the safety of personal and automobile<sup>[2]</sup>. So it is important to complete the design of the brakes and the security correction.

Nowadays, people usually use expert system to design brake. In the overall design of the brake, we can use expert system to distribute braking force and chose the model of the brake<sup>[3]</sup>. The expert system can call the parameterized graphics library to select the component model, then it

would call the CAD generates 3D entity model or two-dimensional engineering drawing automatically in the detailed design<sup>[4]</sup>. However, there is a lack of a professional platform on the parameter design, checking and generating design specification of the main parts of a disc brake<sup>[5]</sup>.

For this problem, this article exploits disc brake design system by stereotyping the process of disc brake design and check, realizing disc brake parametric design, integration check, generating document automatically and so on.

## II. DESIGN AND IMPLEMENTATION OF DISC BRAKE DESIGN SYSTEM

The brake design and checking processes involve complex calculations, so we need recalculate and recheck when any parameter is changing. These repetitive behaviors are inefficient and costing a lot of effort and time.

The purposes of the design of disk brake design system in this article are:

- (1) To realize the modeled and parameterization in the design of disc brake.
- (2) To realize the checking automatically about the results of the design and providing the accurate reference data for designer.
- (3) To realize the extracting and processing the results automatically, then, search the template file to replace the corresponding parameters to generate design specification.

### The overall structure of the system

The overall design scheme of this disc brake design system is displayed in figure 1. This system is composed of template file parameterized module, design and checking module and document generation module. The design of

the disc brake is modeled and the parameterization is completed by some corresponding program. When the designer inputs relevant parameters, the program will extract the parameters to do some calculation and check the accuracy of the result. If the result of checking is not meeting the demands of design, it will be required to input relevant parameters again. If the result is meeting the requirement of design, it will be asked to do the next step. The program will search the template files to replace the corresponding parameters to generate particular design specification.

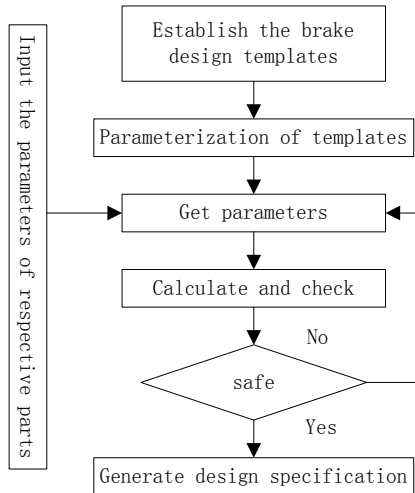


Figure 1. The overall design scheme of this disk brake design system.

### The design and implementation of template file parameterized module

The overall design scheme of template file parameterized is shown in figure 2.

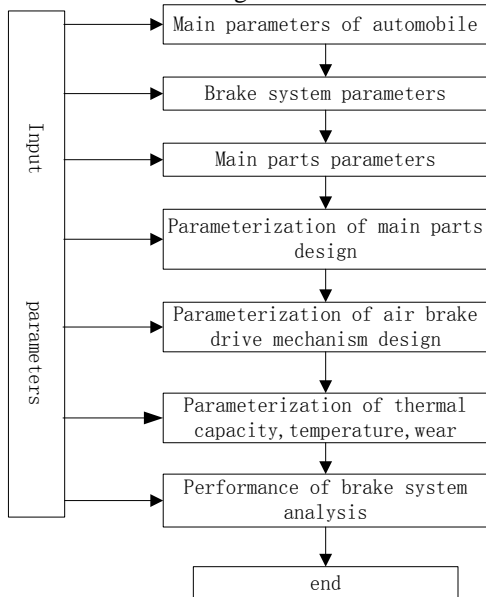


Figure 2. The overall design scheme of template file parameterized.

The design process about the disc brake is to be modeled and need to generate detailed design specification. Extract the relevant parameters which are needed in calculation and checking. The design and check which are needed in the process of the excogitation in this system are

modeled by some programs. It is using unknown variables to indicate these parameters.

The main code is following:

```

... ..
ma1 = TextBox1.Text 'the assignment of the main
                    parameters
mq1 = TextBox2.Text
mh1 = TextBox3.Text
Fu1 = φ * ma1 * (lh1 + φ * hg1) / L 'calculation
                                   modeling
Fu2 = φ * ma1 - Fu1
βr = Fu2 / (Fu1 + Fu2)
Fh1 = Math.Sqrt(Math.Pow(Fq1, 2) + Math.Pow(Ft1, 2)
               - 2 * Fq1 * Ft1 * Math.Cos(103.6))
... ..
  
```

When designers input relevant designing parameters with the software of man-machine interface, the program will extract the parameters and then output the result of calculation automatically.

### The design and implementation of designing and checking module

The designing and checking module is concluding the main components design of the brake, the design of lever, stand and air chamber; the choice of bracket mounting bolt and pillars; the checking of warming and brake performance of disc brake, and so on. As is shown in figure 3 the system main interface.

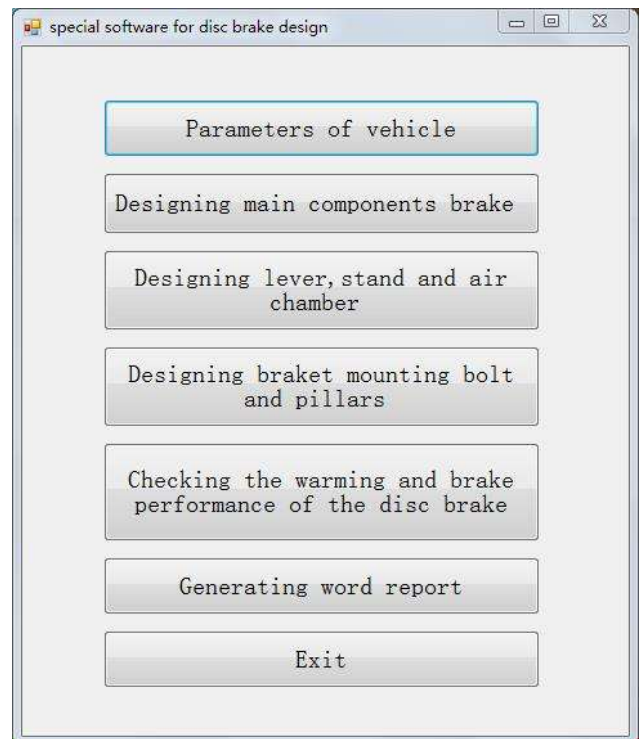


Figure 3. The system main interface



Figure 4. Vehicle parameters

Input the needed parameters through the vehicle parameters interface displayed in figure 4. The system will extract the parameters and assign to corresponding unknown variables, then do some calculation and finally output the results.

Input relevant parameters through the major parts of the brake design interface which is shown in figure 5.



Figure 5. Major parts of the brake design

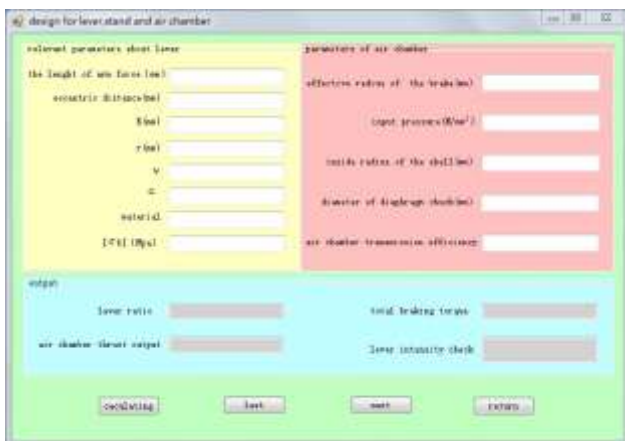


Figure 6. lever, stand and air chamber design

The system will extract the parameters and do some calculation, then output results.

Input relevant parameters through the lever, stand and air chamber design interface in figure 6. The system will extract parameters to calculate, then it will check the result and display the consequence. If the results meet the requirements, it will do the next step. Otherwise it will re-enter the parameters and check the results again. It will not stop until the results meet the design requirements.

Input relevant parameters through the stand erection bolt and guide pin choose interface in figure 7.

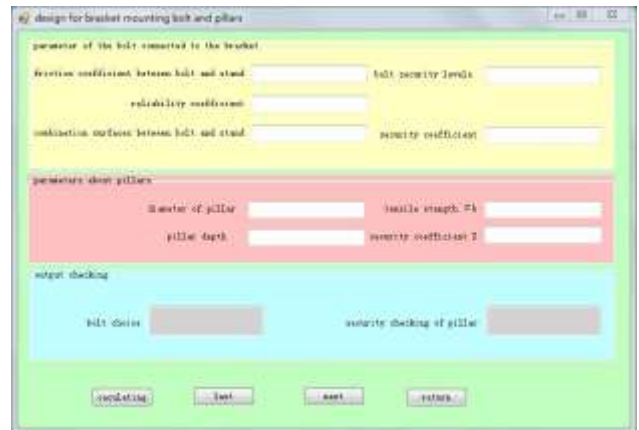


Figure 7. Stand erection and guide pin choose

The system will extract parameters to calculate, and compare results with the standard size. It will choose the right bolt that complied with the design requirement. After that, it will check the safety factor of guide pin and display the check result. If the results meet the requirements, it will do the next step. Otherwise it will re-enter the parameters and check the results again. It will not stop until the results meet the design requirements.

Input relevant parameters through the brake warming and performance check interface in figure 8.



Figure 8. Brake warming and brake performance check

The system will input relevant parameters and check warming and performance of the brake on the bases of the former results. If the results meet the requirements, it will do the next step. Otherwise it will re-enter the parameters and check the results again. It will not stop until the results meet the design requirements.

The main code is following:

```

... ..
jsd = 1.8 * (Mu1max + Mu2max) / (Re * ma2)
                                     'design calculate

t2 = 18 / jsd
e2 = ma2 * 324 * β / (4 * t2 * Am)
e3 = ma2 * 324 * (1 - β) / (4 * t2 * Am)
jsdk = 1.8 * (Mu1maxk + Mu2maxk) / (Re * ma1)
... ..
e2k = Math.Round(e2k, 3)
e3k = Math.Round(e3k, 3)
... ..
TextBox10.Text = Math.Round(f0, 3) 'result output
TextBox11.Text = Math.Round(f0k, 3)
If Math.Max(e2, e3) <= 6 AndAlso Math.Max(e2k,
e3k) <= 6 Then                                     'check
    TextBox9.Text = "dissipative rate of energy is less than
6w/mm2 cut the mustard "
    ElseIf Math.Max(e2, e3) > 6 Then
        TextBox9.Text = " full load dissipation rating is
greater than 6w/mm2,don't meet the requirement "
        Else : TextBox9.Text = " no- load dissipation rating is
greater than 6w/mm2,don't meet the requirement "
    End If
    If f0 <= 2 AndAlso f0k <= 2 Then
        TextBox12.Text = "friction force is less than 2N/mm2
cut the mustard"
        ElseIf f0 > 2 Then
            TextBox12.Text = "full load friction is less than
2N/mm2, don't meet the requirement"
            Else : TextBox12.Text = "no-load friction is less than
2N/mm2, don't meet the requirement "
        End If
        If Sjl <= 21 AndAlso Sjl <= 20 Then
            TextBox6.Text = "brake performance is meet the
requirement "
            ElseIf Sjl > 21 Then
                TextBox6.Text = "full load braking length greater than
21m, don't meet the requirement "
                Else : TextBox6.Text = "no-load braking length
greater than 21m, don't meet the requirement "
            End If
            If Lrn1 <= Lrn AndAlso Lrn2 <= Lrn Then
                TextBox3.Text = "calorific capacity is meet the
requirement "
                ElseIf Lrn1 > Lrn Then
                    TextBox3.Text = "full load calorific greater than " &
Lrn & "don't meet the requirement "
                Else : TextBox3.Text = " no-load calorific greater
than " & Lrn & " don't meet the requirement "
            End If
        End If
    End If
    ... ..

```

### The design and implementation of document generation module

VB.NET can call Word to output report by add COM port. It can stick labels on the parameters which involved in the process of the design. The system will search the

labels in the word template and replace them with the results of calculation and check. Then it will generate detailed design specifications.

The main code is following:

```

... ..
yourform.Label1.Font = New Font("song typeface", 15)
yourform.Label1.Text = ("being generate word
document, please wait ....."
    'replace the data with the output parameters
    filename = "e:\1.docx"
    mWordapp = CreateObject("Word.Application")
    mobjDoc = mWordapp.Documents.Add(filename,
missing, missing, missing)
    mWordapp.Visible = False

    mWordapp.ActiveDocument.Bookmarks.Item("ma1").
Select()
    mWordapp.Selection.TypeText(ma1)
    ... ..
    'save the generated word document then quit.
    mobjDoc.SaveAs("c:\word document.doc")
    mWordapp.Application.Quit(missing, missing, missing)
    yourform.Hide()
    MessageBox.Show("WORD document have been
generated and saved on disc C , the name of the document
is 'word document' ", "hint", MessageBoxButtons.OK)
    mWordapp = Nothing
    mobjDoc = Nothing
    ... ..

```

### III. CONCLUSIONS

(1) The special software development for disc brake design is verified by the design of 24.5 inch disc brake. The results have revealed that the system is right and practical. So we can draw the following conclusions:

(2) The special software development for disc brake design modeled the process of brake design. It also reduced the difficulties in the design process and the load of the designers. It greatly improved working efficiency.

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