

Study on a Novel Method of Building the Parameterized Models

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ABSTRACT *In this paper, a novel method of building the parameterized models is presented. Owing to the limit on the basic function of ADAMS software, after building a mechanism model with ADAMS, the length value of each part can not be changed directly. Sometimes in the need of users the lengths of parts and positions of joints can be changed alternately by inputting some given values in custom dialog box, and thus a dynamic analysis model with new parameters can be obtained. Moreover, it must be guaranteed that when lengths of parts or positions of joints are changed, the relative positions of joints and lengths of parts can be promptly and conveniently displayed in the dialog box. In this thesis, by establishing the position equations of mechanism, creating design variables and custom dialog box, etc, the extended functions described above have been come true, which lengths of parts and positions of joints can be changed easily and a new model is built up automatically.*

1 Introduction

Sometimes, it is needed that the positions of the joints and the lengths of the parts of the mechanism can be easily adjusted after model having been built. We know that it is easy to adjust the positions of the joints with adjusting relative points, but is not easy to get the new lengths (the distance between the two points) of the parts corresponding to adjusted positions of the joints. It is also difficult to adjust the lengths of the parts and get the new corresponding positions of the joints after model having been built.

In order to explain how to solve the problem mentioned above briefly and concisely, joint four-bar linkage mechanism is taken for instance.

2 Building relations between positions of joints and lengths of parts

The mechanism scheme of the four-bar linkage is shown in Figure 1.

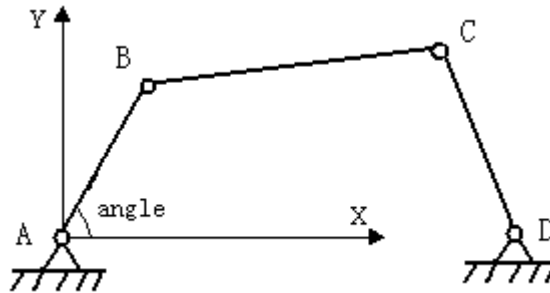


Figure 1. four-bar linkage scheme

Positions of joints B,C and D ($x_B, y_B, x_C, y_C, x_D, y_D$) can be expressed with the lengths of parts ($L_{AB}, L_{BC}, L_{CD}, L_{AD}$), and the rotate angle of driver part (angle) as follow

$$\begin{aligned} \text{Position coordinates of joint B are } & \begin{cases} x_B = x_A + L_{AB} \cos(\text{angle}) \\ y_B = y_A + L_{AB} \sin(\text{angle}) \end{cases} & 1 \\ \text{Position coordinates of joint D are } & \begin{cases} x_D = x_A + L_{AD} \\ y_D = y_A + L_{AD} \end{cases} & 2 \end{aligned}$$

Position coordinates of joint C are

$$x_C = x_B + \frac{L_{BC}^2 - L_{CD}^2 + L_{BD}^2}{2L_{BD}} \cos \theta + \sqrt{L_{BC}^2 - \left(\frac{L_{BC}^2 - L_{CD}^2 + L_{BD}^2}{2L_{BD}} \right)^2} \sin \theta$$

$$y_C = y_B + \frac{L_{BC}^2 - L_{CD}^2 + L_{BD}^2}{2L_{BD}} \sin \theta - \sqrt{L_{BC}^2 - \left(\frac{L_{BC}^2 - L_{CD}^2 + L_{BD}^2}{2L_{BD}} \right)^2} \cos \theta$$

where

$$L_{BD} = \sqrt{(x_B - x_D)^2 + (y_B - y_D)^2} \quad 4$$

$$\theta = \arctg \frac{y_D - y_B}{x_D - x_B} \quad 5$$

Conversely, the lengths of parts (L_{AB} L_{BC} L_{CD} L_{AD}) can be expressed with the positions of joints A,B,C and D ($x_A, y_A, x_B, y_B, x_C, y_C, x_D, y_D$) the lengths of parts (L_{AB} L_{BC} L_{CD} L_{AD}) as follow





$$L_{AB} = \sqrt{(x_A - x_B)^2 + (y_A - y_B)^2} \quad 6$$

$$L_{BC} = \sqrt{(x_B - x_C)^2 + (y_B - y_C)^2} \quad 7$$

$$L_{CD} = \sqrt{(x_C - x_D)^2 + (y_C - y_D)^2} \quad 8$$

$$L_{AD} = \sqrt{(x_A - x_D)^2 + (y_A - y_D)^2} \quad 9$$

3 Building Model

Select the point tool  and create design points Point_A Point_B Point_C Point_D in accordance with the mechanism  scheme as shown in Figure 1. Then select the link tool  to create the links named as Part_AB, Part_BC, and Part_CD. Finally use revolute joint tool  to create joints named as Joint_A, Joint_B, Joint_C, and Joint_D. The mechanism model is shown in Figure 2.

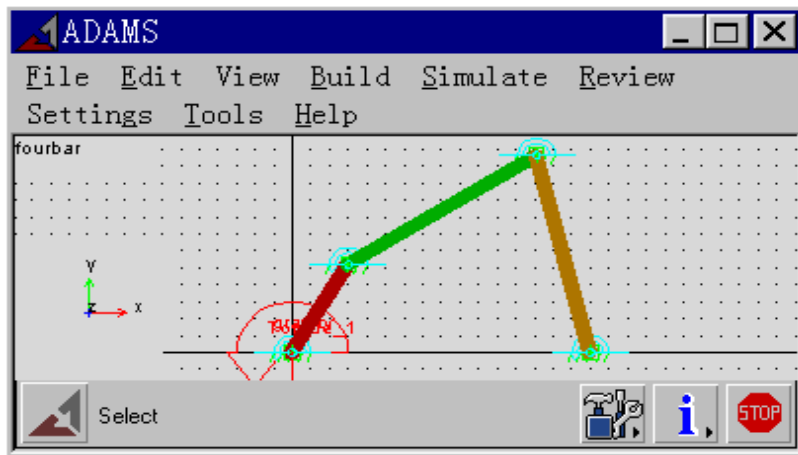


Figure 2. mechanism model

4. Parameterizing Model

Now we can create design variables to represent x and y coordinate values of the positions of the joints and the lengths of the parts. They are `.fourbar.DV_XA`, `.fourbar.DV_YA`, `.fourbar.DV_XB`, `.fourbar.DV_YB`,, and `.fourbar.DV_ab`, `.fourbar.DV_bc`... .. ect. .

The two custom Dialog-Boxes shown in Figure 3. are created to use in adjusting the positions of the joints and the lengths of the parts.

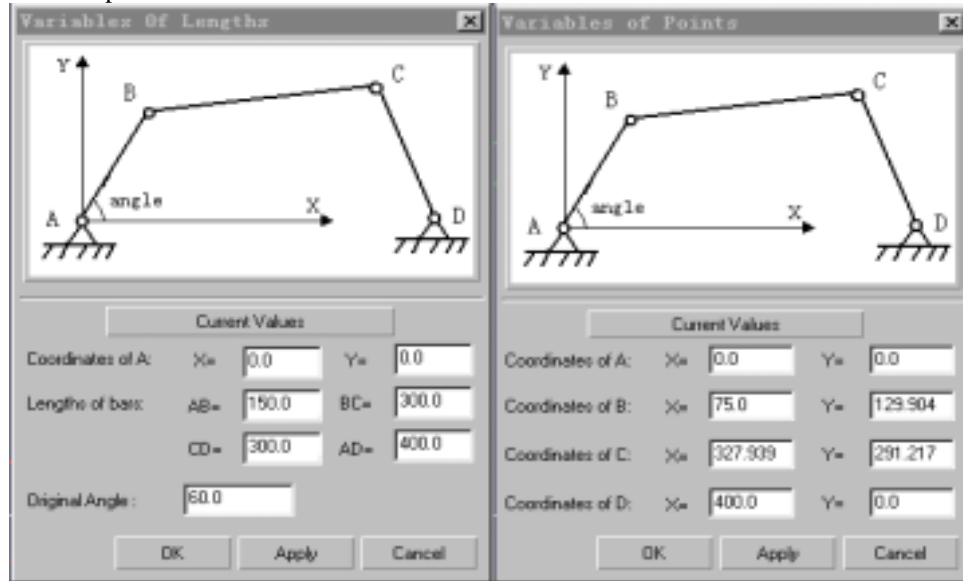


Figure 3. Custom Dialog-Boxes

The each custom Dialog-Box should have two functions, one is to get the current positions of the joints in Variables of Lengths Dialog-Box and the current lengths of the parts in Variables of Points Dialog-Box , an other one is to adjust the values displayed in the text boxes and to calculate the corresponding positions of the joints in Variables of Lengths Dialog-Box by equations through (1) to (5) and the corresponding lengths of the parts in Variables of Points Dialog-Box by equations through (6) to (9). Thus the model can be composed with new positions of joints and new length of the parts conveniently.

In order to explain how to realize the first function mentioned above, The Variables of Points Dialog-Box is taken for example. Whenever the Apply Button in the Variables of Points Dialog-Box is clicked, the commands shown in Figure 4 are executed immediately and the current lengths of the parts are got. And then, a button named Current Values is created in the Variables of Lengths Dialog-Box, and whenever the Current Values button is clicked, the commands shown in Figure 5 are executed immediately and the new lengths of the parts are displayed in the text boxes of Variables of Lengths Dialog-Box. In the same way, the current positions of the joints can also be calculated and displayed in the text boxes of Variables of Points Dialog-Box. The commands used to calculate and display the current positions of the joints are shown in Figure 6 and Figure 7.

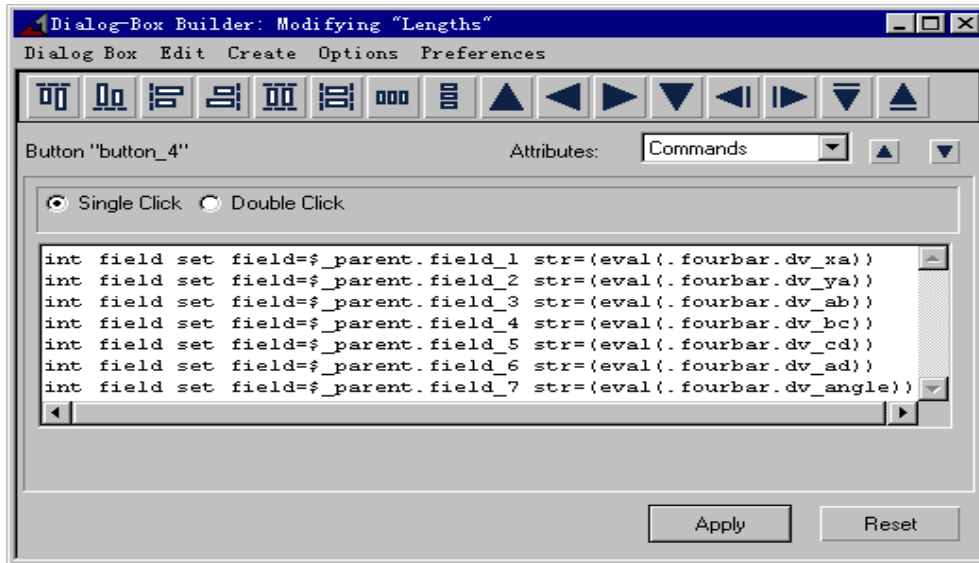


Figure 4. commands used to refresh the lengths of the parts in the text boxes

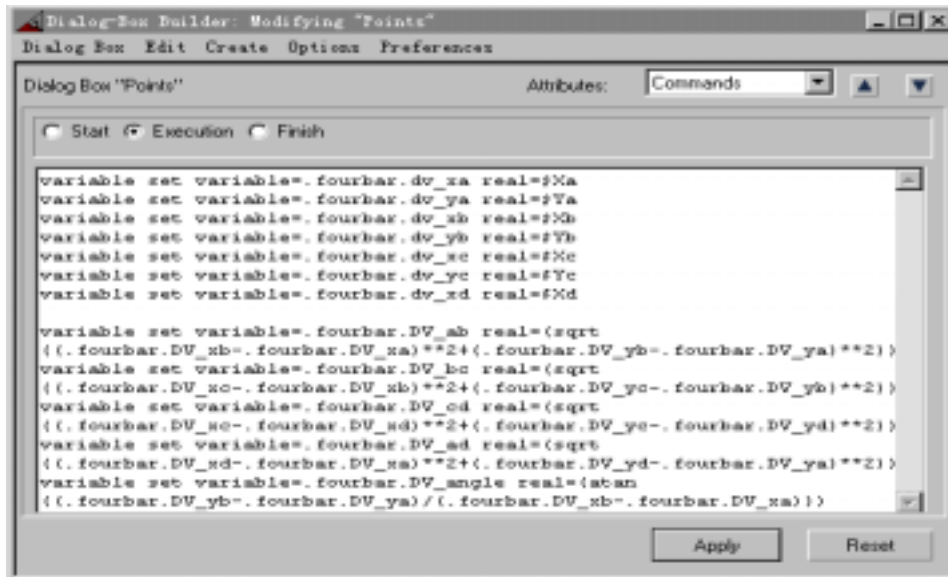
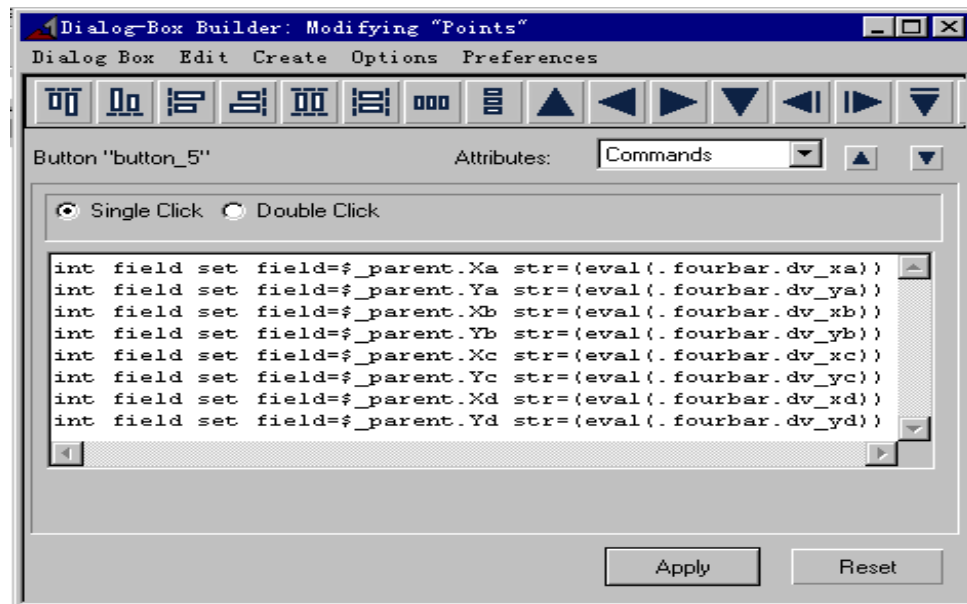
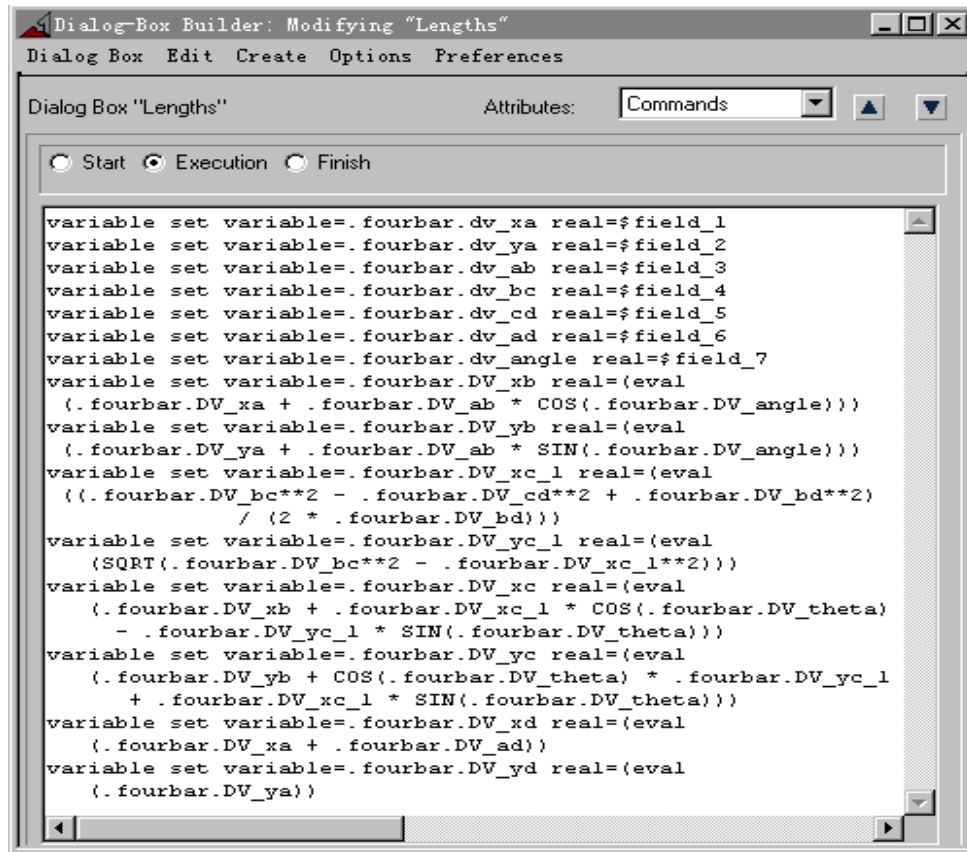


Figure 5. commands used to calculate the new lengths of the parts



5. Example

The model shown in Figure 2 is corresponded to the values in the custom Dialog-Box shown in Figure 3. Now the position of joint B is adjusted from (75,129.904) to (100,90) by inputting (100,90) in the text box corresponding with coordinates of B Label and position of joint C is adjusted from (329.939,291.217) to (300,500) by inputting (300,500) in the text box corresponding with coordinates of C Label Variables of Points Dialog-Box. Clicking the Apply Button, the new lengths of the parts corresponding to the new positions of the joints are calculated, and the model is adjusted as shown in Figure 8.

Click the Current Values Button in the Variables of Lengths Dialog-Box, the new lengths of the parts are displayed in the corresponding text boxes, shown in Figure 9.

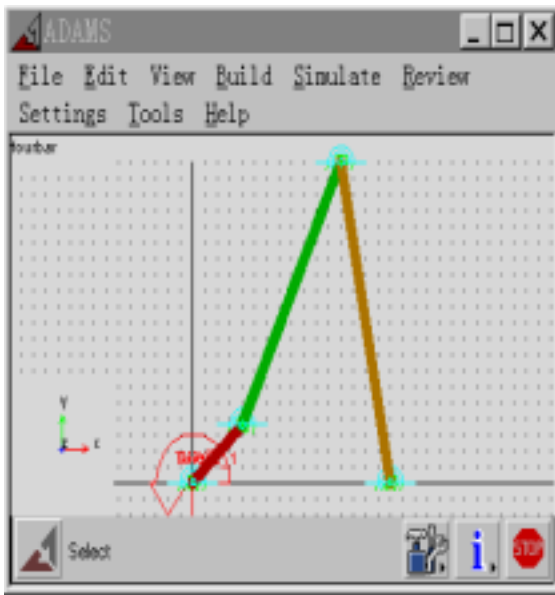


Figure 8. model with new positions of the joints

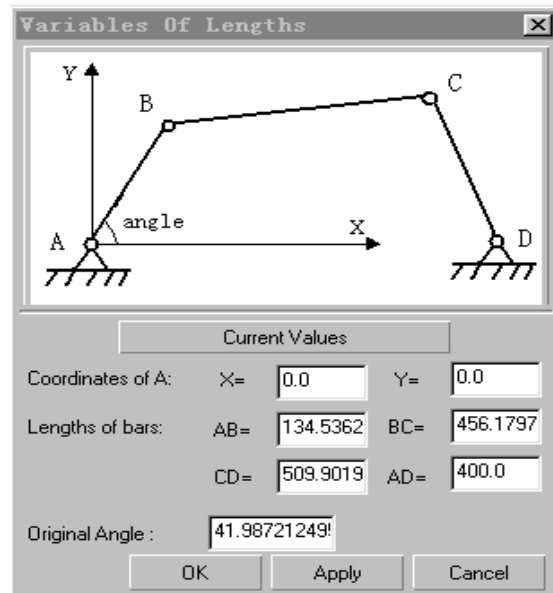


Figure 9. Variables of Lengths Dialog-Box

6. Conclusion

By establishing the position equations of mechanism, and creating design variables, and custom dialog box, etc. , the lengths of parts and positions of joints of the mechanism model can be changed easily and the model with new variables can be built up automatically, so the method mentioned in this paper will be useful to the customs who want to build parameterized model.

Reference

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