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Multi Phase Synthesis of Planar Six Bar Mechanism with Rocker as Output Link

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Abstract

Now a day mechanical mechanisms are shows a crucial role in all domains. The ability of planar six bar mechanism, to generate various kinds of motion, can be greatly enhanced if it is made adjustable. In this paper, desired function is generated by adjusting the coupler length of a six bar mechanism. The adjustment is achieved by dividing the six bar mechanism into two phases namely phase - I and phase - II. The present work attempts to develop a procedure to compute the precision points using Chebychev spacing and then utilize them in obtaining the dimensions of the desired mechanism from Fruedenstein's methods.

Keywords: *Planar six bar mechanism, Adjustable link, fruedesteins method, synthesis procedure, Chebychiv spacing.*

1. Introduction

This paper focuses on synthesis technique for six bar mechanism, having adjustable coupler length with maintaining some tolerance of +0.5 and -0.5 for adjustable link. Within that tolerance both phase design variations should obey the sine function. A technique to synthesis a six bar adjustable function generation operating in two phases to produce two specified functions is presented here. By choosing design variable we can satisfy the exact relationship of input and output angles. With an example the synthesis procedure is described.

Mechanism which compose some connected rigid members are exclusively used in the area mechanism engineering for motion and energy transfer from one or more input members to one or more output members. Many of investigators are investigated on adjustable mechanisms. GORDON R. PENNOCK [1] AND ALI ISRAR [1] presented paper on the "kinematics of an adjustable six bar linkage" where the rotation of the input crank is converted into the oscillation of the output link. The paper shows that how to determine the angle of oscillation of the output link for a specified position of the fixed pivot and investigates the extreme position of the output link corresponding to the extreme position of a point on the coupler link. ELONG ZHOU [2] presented paper on "synthesis of adjustable function generation linkages using the optimal pivot adjustment". In this desired functions can be generated precisely by adjustable four bar linkages. A revolute joint is used to adjust the fixed pivot location of the driven link. The synthesis model is established based on the optimal adjustment. The effectiveness of the proposed synthesis approach is verified. D. P. NAIK [3] and C.AMARNATH [3], presented a paper entitled "Synthesis of Adjustable Four bar Function Generators through five bar loop closure equation". In this presented a technique to synthesize a four bar adjustable function generator operating in two phases to produce two specified functions is presented here and is based on five bar linkage theory. A maximum of three precision points for each function have been selected in the illustrative example. The adjustment is attained by rotating one link of the five bar about its ground pivot and holding it fixed. H. ZHOU [4] and K. L. TING [4] Presents an analyzation technique for the path flexibility of adjustable slider crank linkages. The optimal synthesis model is set based on the positional structural error of the slider guider introduced, which can effectively reflect overall difference between the desired and generated paths avoid the difficulty of selecting corresponding comparison points on the two paths and can be calculated conveniently. A genetic algorithm is employed to seek the global optimal solution. The results of an optimal synthesis example verify the effectiveness of the proposed method. V.B.MATH [5] and S.G.SARAGANACHARI [5] and C.M.VEERENDRAKUMAR [5] and SYED ABBAS ALI [5] presented paper on "Synthesis of adjustable planar four bar mechanism for function generation". It is usually tiresome for us to synthesize mechanism because of the limitation of the maximum precision points. In general, we could not synthesize "exactly" our necessity or desired linkage mechanism. This present work is an attempt to synthesize an adjustable link mechanism to overcome this imperfection, also, presents a synthesis procedure making use of

Chebychev spacing method. The choices of design variables have the freedom of desired necessary computing time is also reduced for changing the adjustable link.

2. Six bar linkage

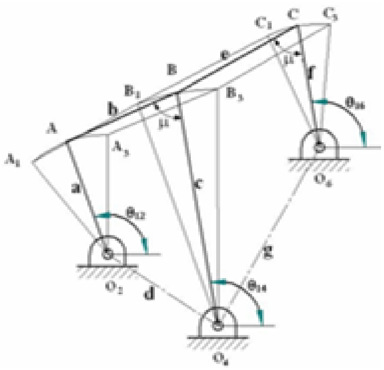

Figure-1 Six bar linkage

The “figure-1” shown is the six bar mechanism; this mechanism is most likely used in industrial applications. In the “figure (1)”‘d’ and ‘g’ are ground links, and a,b,c,e and f are connected together. When input link ‘a’ is rotates about 360 degree, both links (c and f) are oscillates with some degree. When consider phase1 a,b,c,d links, theta12 (θ12) is the input angle and theta14 (θ14) is the output angle. And if g,c,e,f links are considered theta14 (θ14) is the input angle and theta16 (θ16) is the output angle.

3. Examples

Phase-1

3.1 Planar four bar mechanism

Function Generation:

$y = \sin(x), \quad 0^0 \le x \le 90^0, \quad 0 \le y \le 1,$

Initial angle $\phi_0 = 97^0, \psi_0 = 60^0$, $\phi_f = 217^0$, $\psi_f = 120^0$ and $\Delta\phi = 120^0, \Delta\psi = 60^0$

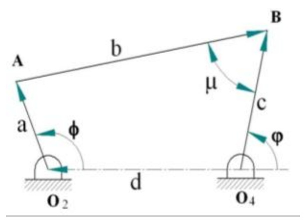

Figure-2 Four bar linkage of 1st phase.
Link lengths are,

a = 29.0 mm, b = 75.6 mm, c = 38.0 mm, d = 52.5 mm.

By using chebychev’s method, utilize three positions synthesis from the input and output angles for calculation. The link lengths are calculated by fruedenstein, s method. Design variables are obtained with reference to sin function and the design variables (Δb) are between +0.5 and -0.5. And the equation is given by,

$$\Delta b = -b + \sqrt{\left(a^2 + 2acK_3 + c^2 + d^2\right)} \quad (1)$$

Where,

$$B = -2\sin\theta_2$$
$$\alpha = -K_1 + (1 - K_2)\cos\theta_2$$
$$\beta = K_1 - (1 + K_2)\cos\theta_2$$

$$K_1 = \frac{d}{a}, \quad K_2 = \frac{d}{c}, \qquad K_3 = \frac{\beta + \alpha\tan^2\left(\frac{\theta_4}{2}\right) + B\tan\left(\frac{\theta_4}{2}\right)}{1 + \tan^2\left(\frac{\theta_4}{2}\right)}$$

The equation (1) is exact synthesis form of planar four bar mechanism by adjusting the length of coupler link ‘b’ in “figure-2”. The variation of Δb is function of link length and input and output relationship. So it will be different any sets of link length and input-output relationship. The curve in “figure-3” and “figure-5” are also continuous and differentiable.

Hence, the variation velocity of length of the adjustable link. Using above relations, the design variables are calculated.

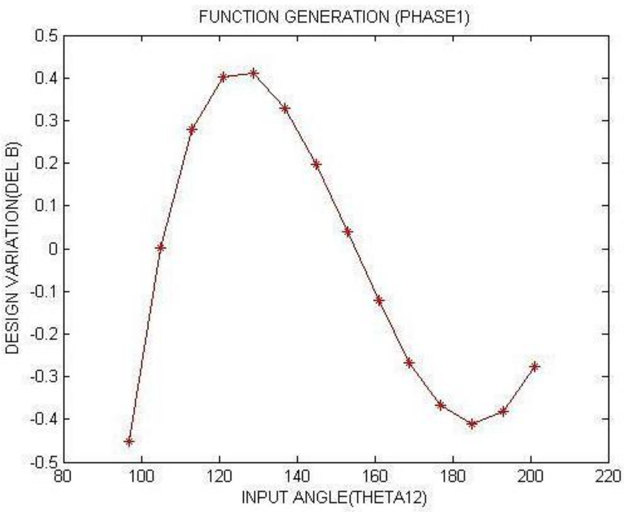

Figure-3 Input angles (θ_{12}) **v/s** design variables (Δb)

Table-1 The design variation variables Δb against input angles are tabulated below.

Input angles (theta12)	Design variation (del b)
97	-0.4525
105	0.0022
113	0.2792
121	0.4019

129	0.4104
137	0.3282
145	0.1986
153	0.0387
161	-0.1221
169	-0.2676
177	-0.3675
185	-0.4104
193	-0.3828
201	-0.2754

And the resulting graph is shown in below.

For 2nd phase

y=sin(x),
Initial angle $\phi_0 = 60^0, \psi_0 = 50^0$, ϕ_f =120^0,
ψ_f =60^0 and $\Delta\phi = 60^0, \Delta\psi = 60^0$

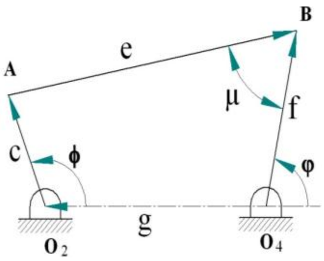

Figure-4 Four bar linkage of 2nd phase.

Link lengths are,

g = 85.5 mm, c = 38 mm, e = 274 mm,
f = 255.9 mm.

Considering the design variables, derive the response of Δb and Δe corresponding to given curve y = sin(x) as in equation (1). The synthesis procedure is same as phase-1, to calculate design variation variables for phase-2 four bar mechanism. The output angles (theta16) are computed by solid edge software and both phases of bar mechanisms synthesis procedure are programmed in MATLAB software. And the resulting values are tabulated below.

Table-2 The design variation variables Δe against input angles are

Input angles (theta14)	Design variation (del e)
60	-0.0076
66.27	0.0108
72.47	0.0137
78.54	0.0114
84.4	0.0042
90	-0.0059
95.26	-0.0122
100.14	-0.0138
104.58	-0.0127
108.54	-0.0090
111.96	-0.0043
114.81	0.0018
117.06	0.0070
118.688	0.0101

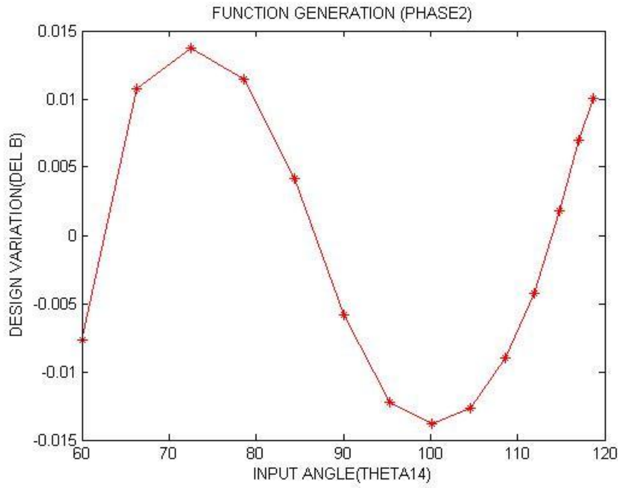

Figure-5 Input angles (θ_{14}) v/s design variables (Δe)

Conclusion

In this present work, analytical equations and programmed method is developed in MATLAB to synthesis of six bar mechanism for function, path and motion generation. The method comprises of two phases consisting of a four bar linkage in each phase. The resulting six bar mechanism satisfies the input and output relation between crank and follower oscillation. The chebychev method and fruedestein's equations are used to obtain the links length.

The output angles for phase-2 are calculated or taken by solid edge software. Both phases of design variables are varying within +0.5 and -0.5.Hence both phases of functions are satisfied the required curves and follows the sin function. In any design constant variables, it always controllable and customer shall satisfy with input and output relationship.

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Nomenclature

a, b, c,d- Four bar mechanism for 1st phase
g,c,e,f- Four bar mechanism for 2nd phase
φ - Input swing angle
θ12 and θ14- Input and output angles for 1st phase
θ14 and θ16- Input and output angles for 2nd phase
ψ Output swing angle