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Using Software Technology Analysis of Providing Effective Tolerance on a Link in four bar mechanism considering Joint Tolerances

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ABSTRACT: ***The Four-bar mechanism is a particular four-bar linkage configuration that exhibits both linear and rotational motion simultaneously. The analytical method which can be used to define the various position of crank and respective position of crank and coupler in four bar mechanism is discussed. C programs are provided for kinematic analysis of a crank- crank mechanism containing a coupler point. The program performs position, velocity, and acceleration analysis for a given angle of the crank. The program solves for the unknown coordinates, velocities, and accelerations. Finally the reports of the results are in numerical form. The analysis based on the mathematical model performed with the help of C Programming***

Keywords: *Mechanism, Joint Clearance, Tolerance, Performance Ratio, C# language*.

1. INTRODUCTION

Mechanisms are used in variety of fixed motion generation applications in Engineering. Among that four bar mechanism is most useful mechanism in the present day application for Hydraulic cutting machines and numerous other applications such as robotics, pumps and compressors. It consists of all four turning pairs. It is usually found in Reciprocating Steam engine mechanism. This type of mechanism converts rotary motion into oscillating motion and vice versa.

Graphical velocity analysis is the important phase for the analysis of four bar mechanism. It is the graphical method which requires great drafting skill and it is the only practical way to solve velocity analysis problem.

One can rapidly solved for the velocity of particular point or link in a mechanism for any one input position by drawing the vector diagram. it is very tedious approach if velocities of links of the mechanism for many positions are to be found, because each new position require completely new set of vector diagrams be drawn.
However when it is used as an automobile engine by adding valve mechanism etc., it becomes a machine which converts the available energy (force on the piston) into the desired energy (torque of the Crank shaft). The torque is used to move a vehicle. Reciprocating pumps, Reciprocating compressors and steam engines are other examples of machines derived from the slider crank mechanism

2. BASIC MEHODOLOGY OF ANALYTICAL ANALYSIS

- Identify all the independent closed loops that exist in the mechanism.
- Express all the kinematic dimensions like link lengths, offsets and also the slider displacement by planar vectors.
- Express Loop closed equation through these equations.
- Each such vector in 2D that is a planar linkage is equivalent to two scalar equations that means, if a vector equation is there, that is equivalent to two scalar equations and two unknown quantities can be solved.

3. DIFFERENT STEPS USED

The language used for programming is „C language".
The computer program can be divided into
different stages like
Stage 1: a program to check a class of mechanism

Stage 2: program to sketch the basic mechanism

Stage 3: program to find co-ordinates of velocity Diagram

Stage 4: program to find maximum and minimum performance at an angle ø

Stage 5: program to find set of dimensions for which variation in performance is more than defined acceptable performance in percentage.

4. FLOW CHART OF THE PROGRAMMING

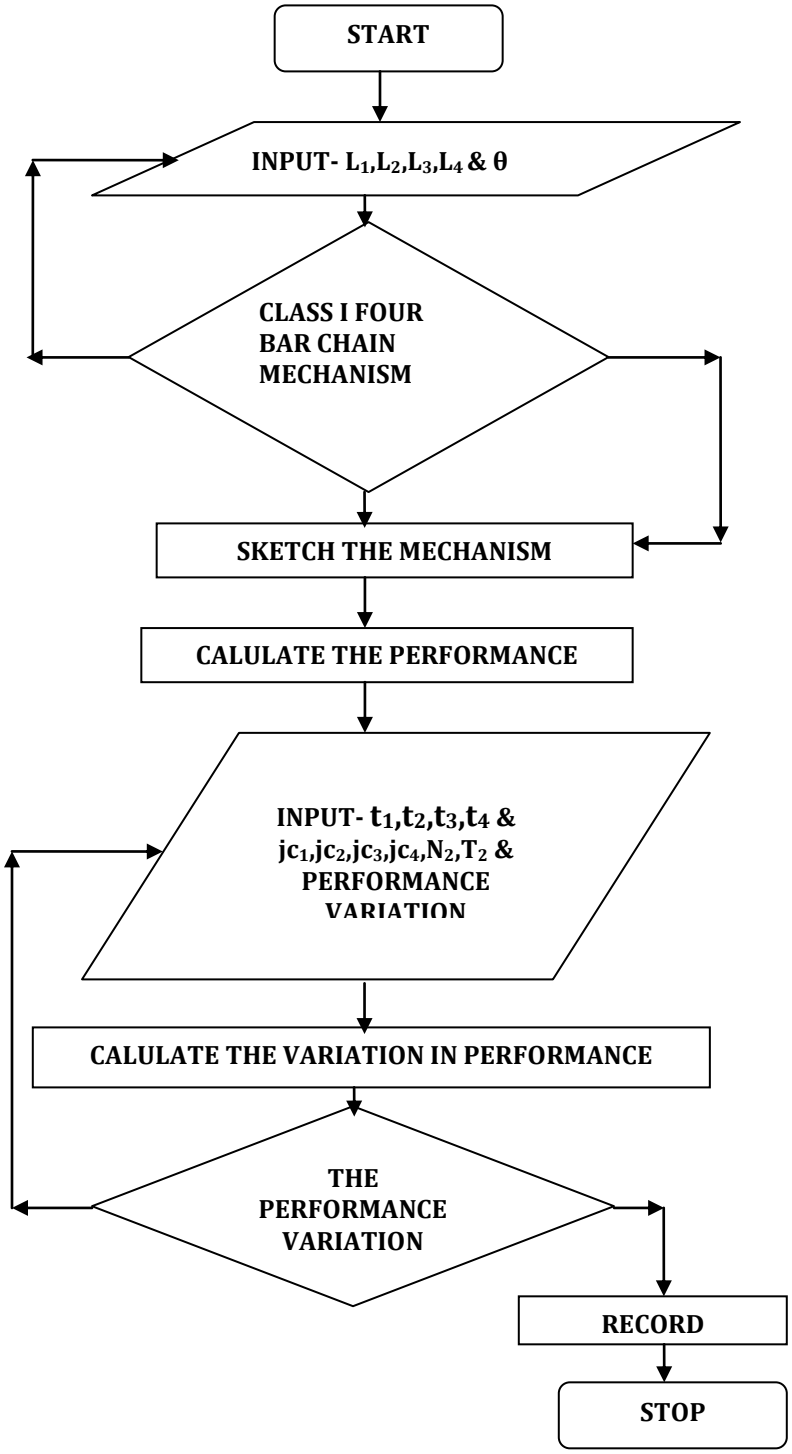

Fig 4.1 Flow Chart Of The C Programming

5. PROCEDURE TO RUN THE SOFTWARE

Various steps involved to run the software are as fallows.

5.1 Performance Ratio Calculator: Image 5.1 shows the Performance Ratio Calculator for the Four Bar chain Mechanism prepared for the program. This Performance Ratio Calculator contains Input Length Box, Input Length Tolerance Box, Check Button, Calculate Button, Input Torque and Input Crank Speed Button, Reset Button, and Progress Bar. It also shows the maximum and minimum performance. Image 5.2 shows Main Home Screen in which Input Length Box and Check Button are active.

5.2 Input Link Lengths: Initially, only link lengths of a mechanism are required. Thus link Length Box and Check Button are active. Check Button is used to check whether mechanism is Class I or not. If the link data shown, it is clear that the mechanism is Class I mechanism. Link data contains the shortest and longest link.

5.3Calculate: The Calculate Button will compute performance of the mechanism in terms of output torque for every 1^0 rotation of the crank. Data required for the calculating the performance of the mechanism is crank angular velocity or cranking speed and input torque. Select the respective button, click on it and enter the respective data. One click on „View Ideal Reading „button shows the performance sheet for all 360^0 rotation of the crank. The performance sheet can be saved in .doc or excel format. Maximum and minimum performance is shown on the screen.

Standard Performance Reading:

Fig 5.1 Standard Performance Reading

Angle	Torque	Angle	Torque
1	-140.15	330	10714.29
2	-148.30	331	-4958.68
3	-155.347	332	-2005.88
4	-162.029	336	-1250
5	-171.626	341	-906.687
6	-182.288	346	-709.119
7	-193.221	346	-582.1
8	-205.577	346	-492.659
9	-219.78	347	-427.046
10	-236.058	348	-376.44
11	-255.129	348	-336.606
12	-277.441	349	-304.183
13	-304.201	349	-277.553
14	-336.464	350	-255.102
15	-376.471	351	-236.046
16	-427.122	352	-219.771
17	-492.712	352	-205.568
18	-582.174	353	-193.213
19	-709.321	354	-182.281
20	-906.865	355	-172.644
21	-1250.31	356	-164.024
22	-2007.49	357	-156.337
23	-4963.6	358	-149.393
24	10691.38	359	-143.164
25	2608.696	360	-137.496

Maximum Performance: 10,714.29
Standard Minimum Performance: -4,963.60

5.4Input length Tolerance & Joint Clearance: Enter values of tolerance on each link length and joint clearance and acceptable performance variation in percentage.

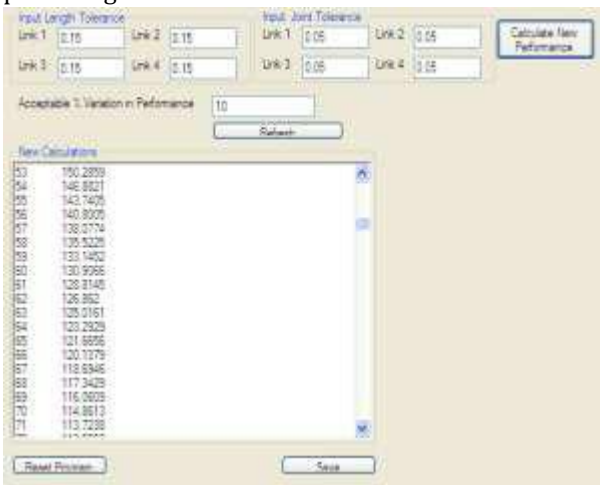

Fig 5.2 New Performance Reading

5.5 Calculate New Performance: After entering the values of tolerance and joint clearance, dimension of respective length will be change. It will change performance of mechanism. One click on „Calculate New Performance" Button start process of calculation and new performance reading is obtained.

5.6 Reset Program: Reset button is used to clear the home screen and all calculations done by the software.

6. RESULT

By considering input angle $\theta=60^0$, The standard performance reading is 131.3198.After entering the values of each link and joint clearance the new performance reading at $\theta=60^0$ is 130.9066 which is shown in fig.3.2. The variation of new performance reading with respect to standard performance reading is less than 10%, so it acceptable.

7. CONCLUSION

The proposed Software technical method is useful in determining performance variation of any planar four bar mechanism cause due to dimensional inaccuracies. Computer software can help in easy workout of possible variation in link dimension.

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