E-ISSN: 2278–179X

JECET; June – August-2013; Vol.2.No.3, 914-917.

Journal of Environmental Science, Computer Science and Engineering & Technology

An International Peer Review E-3 Journal of Sciences and Technology

Available online at www.jecet.org

Engineering & Technology

Research Article

Development of expert system for four Bar Mechanism

R.Saravanan and Magadum Sunil

Mechanical Engineering Department, University Visvesvaraya College of Engineering, Bangalore University, Bangalore. India

Received: 1 August 2013; **Revised:** 16 August 2013; **Accepted:** 27 August 2013

Abstract: In this study, an expert system was developed for a quadricycle four bar mechanism with control of transmission angle. Different types of available synthesis methods are studied and the suitable synthesis procedure is selected for developing the expert system.

Key words: Expert system, four bar mechanism.

INTRODUCTION

Having understood the importance of four bar mechanism in machinery and industry, it becomes imperative to develop an expert system for four bar mechanism, in order to obtain the best suitable possible mechanism, in the direction of desired motion. A mechanism is a device that transforms motion to some desirable pattern and typically develops forces and transmits power. The process of obtaining the suitable mechanism is, in fact, a repeated analysis for a random determined mechanism and finding of the best possible one so that it could meet technological requirements, and it is most often used in dimensional synthesis, which implies determination of elements of the given mechanism [lengths] necessary for creation of the mechanism in the direction of desired motion. Computers play

an important role in all engineering disciplines, including design synthesis and analysis. Synthesis and analytical techniques become too cumbersome to do by hand for finding the best synthesized mechanism for given set of inputs and, of course time consuming. The expert systems can be one of the solutions for this. Expert systems have emerged as useful, deployable systems that are operationally used.

Literature Review: Ngale Haulin *et al*.[1] published a case study of optimal synthesis of a planar four bar mechanism used in hand prosthesis. It is shown that through a comparative study, it is able to select the number of points and the position of each to satisfy the performance criteria. This study permits to confirm that the three position synthesis leads to a null mean quadratic error. Rundgren Brian[2] developed an approach that found an optimized planar four link mechanism that produced a resistance force curve that matched a desired human strength curve. This work furthers the discipline of mechanism design by combining dynamics into existing linkage synthesis methods, resulting in an improved synthesis method that includes both static and dynamic effects. Shrinivas Balli and Satish Chand[3] considered transmission angle to reduce the solution space for the design of five-bar mechanism with variable topology and suggested a method to synthesis a planar five bar mechanism of variable topology. Varbanov *et al*.[4] produced an excellent compilation of expert system for planar mechanisms design. This expert system is developed by including the other classes of planar mechanisms with higher degrees of freedom.

METHODOLOGY

Once the analytical solution procedure is derived for a particular mechanism, it can be quickly solved with the computers. A computer will make the task much more palatable. In this expert system, the kinematic synthesis and analysis module has been integrated. Here, the user provides the ground link dimension along with the desired angle of swing of the output link along with the angles of swing of the input link according to his interest depending upon the space constraints of which the links can rotate. During the synthesis routine of the expert system, the program first selects the initial minimum values of angles of the input link (the three positions of the input link) and calculates the link dimensions of the other three links and is tabulated. For this set of linkage, the minimum and maximum transmission angles are determined and also tabulated. Next step of the expert system is to select the next incremented set of input links and finding the links dimensions and also the minimum and maximum transmission angles and these are tabulated. This process is continued till the last incremented set of input links. Thus, many such sets of linkages with their minimum and maximum transmission angles are obtained and are tabulated. After calculating all the possible linkages within the given set of inputs, the step of selecting the best linkage comes into picture. The best linkage is selected by the program itself depending upon the optimum transmission angle found from the tabulated results after synthesis. There may be cases where the transmission angle is optimum but with improper link proportion which would be difficult when it comes into fabrication of the linkage. So the program selects the linkage which has optimum transmission angle and also with feasible link proportion. It allocates points for each linkage set and selects the linkage with highest points as the best linkage. The kinematic analysis can be performed for the linkage selected.

RESULTS AND DISCUSSIONS

The actual process of solving the synthesis problem was done on a computer. The inputs pertaining to the present problem has been given to the expert system module. The developed expert system is used to obtain the dimensions of the double rocker four bar mechanism.

Input: Fixed link length: R1 = 450mm

Desired angle of swing of the input link: $\Phi = 30$ deg

Range $\Phi = 60$ deg

Desired angle of swing of the output link: $\Psi = 10$ deg

Range $\psi = 110$ deg

Synthesis output: R1 = 450mm; R2 = 131mm; R3 = 524mm; R4 = 209mm

Table 1: Spreadsheet showing the synthesized results

Phi	15	18	21	24	27	30	33	36	39
sl no	0	1	2	3	4	5	6	7	8
r1	450	450	450	450	450	450	450	450	450
r2	131.1085	37.20421	127.2518	174.1863	196.176	203.2815	201.3642	193.9719	183.3149
r3	524.4584	432.1358	395.6858	382.3203	379.9291	383.1725	389.3872	397.1263	405.5571
r4	209.7745	57.4633	195.5399	271.1306	313.0859	335.6308	346.4313	349.8922	348.669
tll	865.3413	526.8033	718.4776	827.6372	889.191	922.0848	937.1827	940.9904	937.541
min ta	85.2543	84.4844	83.68008	82.84324	81.97581	81.07982	80.15729	79.21032	78.24103
max ta	89.96751	89.96751	89.96751	89.96751	89.53337	89.05216	88.52514	87.9537	87.3393
	85.2543	84.4844	83.68008	82.84324	81.97581	81.07982	80.15729	79.21032	78.24103
max of min TA	1	2	3	4	5	6	7	8	9
	15	14	13	12	11	10	9	8	7
	89.96751	89.96751	89.96751	89.96751	89.53337	89.05216	88.52514	87.9537	87.3393
max of max TA	1	2	3	4	5	6	7	8	9
	15	14	13	12	11	10	9	8	7
	10.76265	10.54312	10.29982	10.03319	9.743714	9.431897	9.098265	8.743381	8.367853
Max TA Diff	15	14	13	12	11	10	9	8	7
	1	2	3	4	5	6	7	8	9
	211.1766	171.394	167.6141	165.1899	162.6786	160.298	158.0814	156.0654	155.7229
Max CV TLL	2	1	3	15	14	13	12	11	4
	1	2	3	4	5	6	7	8	9
	47	45	45	45	43	42	41	37	32
Best Synthesises	1	4	5	6	2	3	7	8	9

Table 1 shows the computed result for the above mentioned inputs. The program tabulates all the possible set of linkage within the given range and allot points depending upon its optimum transmission angle and the feasible link proportions. The best synthesis is selected by the program itself which obtains highest points. The first set gets 47 points and fourth set gets 45 points. Therefore the first set of linkage is the first best synthesis and fourth set of linkage is the second best synthesis and thus it has been sorted in descending order.

CONCLUSION

A computational system 'expert system for four bar mechanism' for synthesis and analysis of double rocker four bar mechanism is developed.

ACKNOWLEDGEMENT

We thank Dr.S.Selvarajan for his valuable contribution and constant motivation throughout the duration of this study.

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***Corresponding Author: R.Saravanan;** Mechanical Engineering Department, University Visvesvaraya College of Engineering, Bangalore University, Bangalore.