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Research Paper

GENERALIZED METHODOLOGY OF SYNTHESIS OF FOUR BAR MECHANISM

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Different methods are available for synthesis of the four-bar linkage, these includes synthesis for function, path, motion generation with finite precision points. Most mechanism synthesis is followed by using Freudenstein equation with optimized precision points using Chebyshev's polynomials. In some cases the method provides possibilities to find simple solutions of the synthesis tasks. In this paper an approximate kinematic synthesis method is presented with general application to path generation, function generation and rigid-body guidance in planar multibody systems.

Keywords: Four bar mechanism, Synthesis

INTRODUCTION

If numbers of bodies are assemble in such way that the motion of causes constrained and predictable motion to the other it is known as mechanism. Combination of mechanism is known as machines. Machines consist of number of mechanisms in their system for their successful operation and to give desired output. Mechanisms are used for transmitting motion, force, torque, etc. Mechanisms like four bar mechanism, single slider crank mechanism, double slider crank mechanism, etc., are used.

One of the main objects of designing a mechanism is to develop a system that transforms motion in a specific way to provide mechanical advantage. A typical problem in mechanism design is coordinating the input and output motions. A mechanism is designed to produce a specified output as a function of input is called a function generator. A system that transmits forces in a predetermined manner to accomplish specific work may be considered a machine. A mechanism is the heart of a machine. It is a device that transforms one motion, for example the rotation of a driving shaft, into another, such as the rotation of the output shaft or the oscillation of a rocker arm. A mechanism consists of a series of connected moving parts

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which provide the specific motions and forces to do the work for which the machine is designed. A machine is usually driven by a motor which supplies constant speed and power. It is the mechanism which transforms this applied motion into the form demanded to perform the required task. The study of mechanisms is very important.

Any mechanism is synthesized and designed to get desired performance/output in terms of motion, torque, force, displacement, etc. There are various links or dimensions of the mechanism. Any change in one or all link lengths affects on the performance of the mechanism. Software is to be developed for calculating performance.

Kinematic synthesis of mechanism is one of the essential steps of the machine design. According to the duty of machine, several types of mechanisms can be synthesized and largely number of different configurations can be found. After the type of mechanism is determined, the dimensional synthesis has to be performed. Prescribed position synthesis is the most common method for dimensional synthesis and this is the basis of this thesis subject.

The prescribed position synthesis is commonly divided into three parts. These are namely, motion generation, path generation and function generation. Motion generation deals with rotation and translation of a body while it passes from several positions. Path generation deals only translation of a point and function generation is about correlation of input and output motion.

For all these tasks, two curves are obtained which satisfies the prescribed positions namely centre and circle point locus. These loci show the fixed and moving pivots of the suitable mechanism respectively.

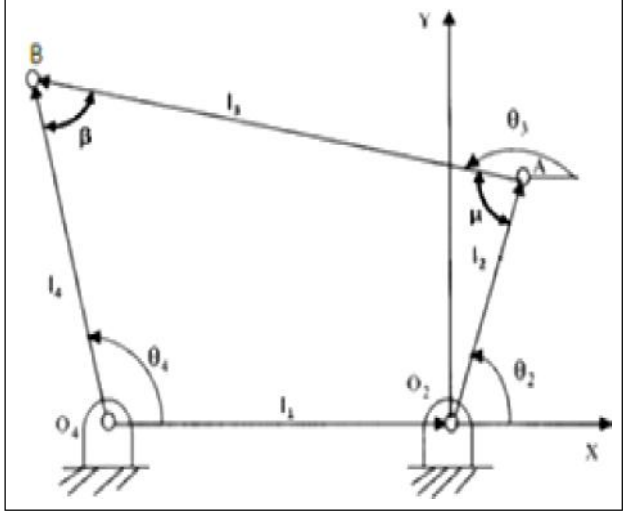
In mechanism synthesis, if the design conditions are suitable, there are an infinite number of solutions and it is engineer's ability to judge and select suitable mechanism type and configuration. Even though various analytical methods have been developed for synthesis of mechanisms, it still depends on trial-error and repetitive tasks which causes loss of time and money.

SYNTHESIS OF MECHANISM

A frequent requirement in design is that of causing an output member to rotate, oscillate or reciprocate according to the specified function of time or function of the input motion, this is called the function generation. When a mechanism is designed to generate a given function or trace a given curve, it is not possible in general to obtain a mathematically exact solution but that the mechanism fits the function or curve at only a finite number of points, the accuracy points. The number of these accuracy points is equal to the number of fixed parameters that may be used in the synthesis. The problem considered here is that of spacing the accuracy points within the interval of function generation to minimize the errors between accuracy points. Given multiple sets of precision points generated by function, the objective is to synthesis a mechanism that can trace each set of precision points. Consider the function $f(x)$ to be approximated in a given interval of variation of x by means of a mechanism which generates function $F(x, D1, D2, ..., Dn)$ where $D1, ..., Dn$, are the values of the n design parameters in the linkage. The

difference between these two functions is the structural error $f(x) - F(x, D1, D2, ..., Dn)$. The general appearance of the structural error when plotted against x.

Figure 1: Four Bar Mechanism



RESEARCH METHODOLOGY

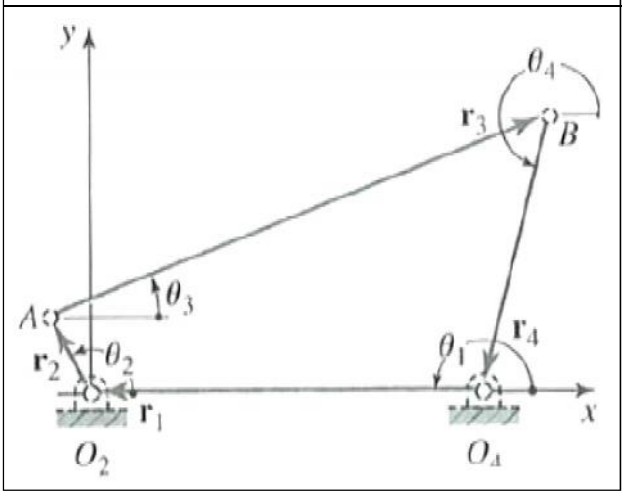
Synthesis of four bar mechanism by Fraudenstein's method.

Synthesis

There are several methods by which synthesis can be carry out as discussed early. Out of which we will go for Fraudenstein's equation because of advantage that all values are being arranged in analytical manner and also calculation are being arranged simple formulation hence will leads towards accuracy as compared to other methods as that of graphical which will leads to an huge error in case of small mistakes.

$k_1\cos\bar{}_1 - k_2\cos\bar{}_1 + k_3$ where, $k_1 = r_1/r_2$. To solve resolving all forces in x-direction and y-direction on adding both we have $\cos\bar{}_1.\cos\bar{}_1 + \sin\bar{}_1.\sin\bar{}_2 = k_1\cos\bar{}_1 - k_2\cos\bar{}_2 + k_3\cos(\bar{}_2 - \bar{}_1) = k_1\cos\bar{}_1 - k_2\cos\bar{}_1 + k_3$, where, $k_1 = r_1/r_2$, $k_2 = r_1/r_4$, $k_3 = r_2^2 - r_3^2 + r_4^2 + r_1^2/r_2.r_4$.

Figure 2: Four Bar Mechanism (Fraudenstein's Equation)



Identification of Problem

Many techniques for the synthesis of four bar mechanism. For available input and output synthesis a four bar mechanism. Many methods are used to synthesis a mechanism but to identify the desirable method of synthesis of four bar mechanism.

Computer Aided Analysis and Synthesis of Linkages

The primary mathematical tool for the analysis of a linkage is known as the kinematics equations of the system. This is a sequence of rigid body transformation along a serial chain within the linkage that locates a floating link relative to the ground frame. Each serial chain within the linkage that connects this floating link to ground provides a set of equations that must be satisfied by the configuration parameters of the system. The result is a set of non-linear equations that define the configuration parameters of the system for a set of values for the input parameters. Fraudenstein's introduced a method to use these equations for the design of a planar four-bar linkage to achieve a specified relation between the input

parameters and the configuration of the linkage.

LITERATURE REVIEW

Literature review is an assignment of previous task done by some authors and collection of information or data from research papers published in journals to progress our task. It is a way through which we can find new ideas, concept. There is lot of literatures published before on the same task; some papers are taken into consideration from which gives the idea of the project is taken.

Beloiu and Gupta showed that in his works, the studies done by Filemon and Waldron fails for finding defects in some cases. Filemon and Waldron's works eliminates the branch defects if the design positions are belong to different modes and the input link is fully rotatable, however, Beloiu and Gupta prove that if the input link is partially rotatable the branch defects cannot be eliminated. They introduced a new approach by combining the previous studies to overcome this problem. The hyperbolic and elliptic boundaries are determined due to the selected output link and input link is determined in the boundaries. About defects of mechanisms.

Chen and Fu have published a new method to determine regions of the canter point curve by using the Grashof inequality, which give the driving cranks of double crank or crank-rocker mechanism when the driven link is selected. The usage of all these approaches becomes very efficient after the developments in the computers due to the nonlinear equations and high number of calculations. In this respect there have been some studies which use mathematical and programming tools and combine the theories mentioned above in computer environment and offer a complete solution.

Martin, Russell and Sodhi presented an algorithm for motion generation in MathCAD for selecting planar four-bar from Burmester curve solutions. The algorithm works in this way; after the Burmester curve solution is given as an input, firstly it calculates all the link lengths of every mechanism solution so, the user can specify the interested region of curve. Secondly, mechanisms are selected which have feasible transmission angles. Thirdly, mechanisms are eliminated which are not desired type according to the Grashof classifications and finally minimum perimeter solution is selected among the other mechanism solutions.

Bourrelle and Chen studied on a program with graphical user interface which solves five position synthesis Burmester problems for RR and RP dyads by MATLAB with considering the mobility of the mechanisms.

Kinzel, Schmiedeler and Pennock studied a new approach called "Geometric Constraint Programming" (GCP) which enables to use sketching mode of CAD programs in order to synthesis mechanisms. This new approach uses geometric constraints and constructions rather than non-linear equations like most of commercial synthesis software. The study based on the motion generation for five finitely separated positions, path generation for nine finitely separated precision points and function generation for four finitely separated positions. The working principle of GCP is can be understood by motion generation for five separated positions problem. In this

problem, five different four-bar mechanisms are drawn separately for every specified separated position. Then, every dimension of linkages of every four-bar is set to equal and corresponding canter points are constraint to be coincident. Moreover, since GCP works on sketch module of CAD program, it is highly parametric that user can visualize every change on parameters.

Talekar and DePauw has developed a function generation synthesize for planar four bar for three, four and five points and spatial four bar (RSSR) for three points on Msc. ADAMS software by using kinematic inversion. It has ability to draw Burmester curve in order to give ability to user to select mechanism according to suitable one.

LITERATURE REVIEW

The literature review indicates that the various method of synthesis, introduces the method using coupler-angle function curve to synthesize a four-bar mechanism. Its precision and speed are high. Methods adopted to synthesize planar linkage-type dwell mechanism. It is convenient to decide the circle path's (or straight line path's) ratio in relation to the whole path, and it is more convenient to select the circle path's radius according to the request of actual linkage's structure. Method can supply initial value for optimization to achieve more accurate path synthesis.

FORMULATION OF PROBLEM

With the related literature review and objective of this concern project, we will find relation between input parameters and corresponding output parameters and formulate relation between them to get required result.

The synthesis of mechanism is done both the way by graphically and mathematically and it will analysis the result which is best suitable for the mechanism for best performance. Also it find the relation between input and output function.

OBJECTIVE

- To determine sensitivity of four bar mechanism.
- To determine the most sensitive link of Four bar Mechanism.
- To optimize set of tolerance to reduce variation in performance of the Four bar Mechanism.
- To minimise manufacturing cost.

CONCLUSION

As per the above description and literature review we concluded that synthesis is done using analytically and graphically. Also software gives the approximate solution to synthesis a four bar mechanism.

FUTURE WORK

- Development of software for synthesis of four bar mechanism.
- Analysis the software and calculated result.

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