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Synthesis of Four bar mechanism by freudenstein Equation

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ABSTRACT

We present a method to enumerate and codify the solutions of type synthesis of linkage mechanisms with rotoidal and prismatic joints. The essence of mechanism synthesis is to find the mechanism for a given motion. Type Synthesis is the first stage of conceptual design of mechanisms, where the number, type and connectivity of links and joints are determined. It is followed by the Dimensional Synthesis stage, where the link lengths and pivot positions are computed to fulfill a given kinematic task. The latter and the subsequent stages of detailing design are very costly. Therefore, the aim is to propose all "non-isomorphic topologies" without repetitions satisfying structural requirements.

Keywords: Four Bar Mechanism, Synthesis,

I. INTRODUCTION

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.

Freudenstein 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. Another approach to planar four-bar linkage design was introduced by L. Burmester, and is called Burmester theory.

In this project, we will use what we have learned in studying rigid body kinematics to do a complete kinematic analysis of a mechanism designed to cut out wing or airfoil profiles. Mechanisms like the one we will analyze are called **four bar linkages** (the ground is considered to be the fourth bar) and have been used since the beginning of the industrial revolution in machinery of all types. You will see during this project how complex even simple looking mechanisms can be to analyze. In addition, you will see how complex we can make the path traced out by different parts of the mechanism.

For synthesis of mechanisms following method

1 Function generation.
2 Path generation.
3 Body guidance.
4 Fraudensteins equation

It is time consuming to carry on the analysis, mathematical or graphical to simulate a mechanism. Software is required to be developed for the same purpose.

To design the basic mechanisms for finding different positions, synthesis that mechanism simulates it by taking or exist dimensions, a CAD model is to be developed.

II. Project Concept

Figure 1 shows a diagram (drawn approximately to scale) of the mechanism we will analyze in this project.

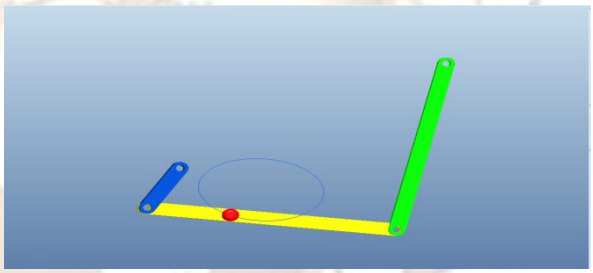
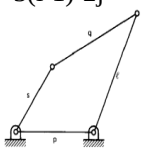


Figure1. The mechanism we will analyze in this project

The red circle at point in the mechanism shown above is the laser cutting device. The center of the device is the point at which the cutting occurs. The motor at drives the link at a constant angular velocity $\acute{\omega}_0$ (omega sub zero). The angles shown define the position of the mechanism at any given time.

III. DEGREE OF FREEDOM

1)Kutzbach criterion:
n=3(l-1)-2j-h
2)Grublers criterion
n=3(l-1)-2j



Where
l: number of links

j: joints
h: number of higher pair:

IV. Project Objectives

To understand the working principle of the profile cutting mechanism. Position and displacement analysis - position of a point, graphical and complex- algebra method for displacement. Rotational and translation displacement. Velocity analysis - relative motion, linear and angular velocity,Computer Aided analysis of profile Cutting mechanisms e.g. velocity, acceleration, transmission function, transmission angle, translation, force- and torque moment detection

1) To Develop CAD Model of profile cutting mechanism.
2) To Perform Kinematic Analysis of profile cutting mechanism.
3) To solve real time practical problems related to profile cutting mechanism

V. 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 are lot of literatures published before on the same task; only two papers are taken into consideration from which idea of the project is taken.

A.G. Erdman and S. Faik [1] (1999) in his paper titled "A Generalised Performance Sensitivity Synthesis Methodology For Four Bar Mechanisms" published in a journal " Mechanism and Machine Theory" explained the term sensitivity coefficient The idea of sensitivity coefficient is defined and derived by Erdman and Faik. According to them, sensitivity coefficient is a mathematical expression which represents the change in output variable because of small change in the mechanism parameters like link length. The relationship for sensitivity coefficient is a very useful tool for analysis of errors in the given four bar chain. The relationship between the sensitivity to sensitivity of link lengths and the location of the moving pivot of four bar link mechanisms is investigated for the particular objectives of three and four positions synthesis maps with iso-sensitivity curves plotted in design solution space allows the designer to synthesis a planer mechanisms with desired sensitivity values or to optimize sensitivity from a set of acceptable design solutions.

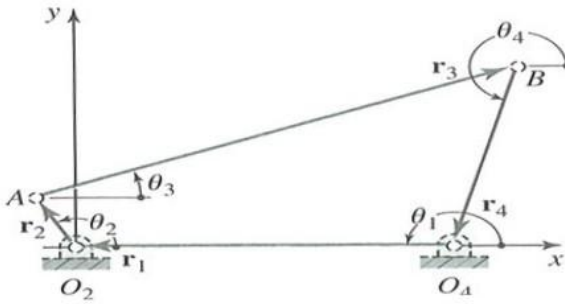
Behman Motakef Imani [2] through his paper titled "Tolerance Analysis of Flexible Kinematic Mechanism Using DLM Method" in a journal "Mechanism and Machine Theory" explained effect of tolerances on the performance of assembly. The paper proposes that by decreasing the tolerance limits of those manufacturing variables that have the highest contribution in the assembly specification, number of rejects could be decreased significantly.

He also mentioned about variations in manufacturing processes. He explained the fact that due to unwanted variations in manufacturing processes, all parts produced in industry are not manufactured with nominal or exact dimensions. Therefore for each part dimension, a tolerance limit is prescribed. Also for all assemblies, a limit of variation is prescribed for a specified parameter of the assembly which is referred to as the assembly specification, and it could be the position of a point, a gap or geometry tolerance of a feature in the assembly. As a matter of fact, the performance of the assembly is measured by accuracy of the assembly specification which is a function of associated part tolerances. If the assembly specification has limits of variation in two or more directions, the correlation between these variations also impresses the limit of variation. He used the direct linearization method (DLM) to determine the bivariate distribution of the assembly specification, in terms of part tolerances. The mechanism consider in his paper consists of flexible parts and is subjected to external loading. The extra variations of each part dimensions due to its flexibilities will impose new variations for the assembly specification. The influence of loading on variation of the assembly specification is modelled by the finite elements method (FEM) using CALFEM toolbox of MATLAB software. First, the valid domains of DLM are recognized by means of Monte Carlo simulation and then, the percent contribution of each manufacturing variable in assembly specification is determined by DLM method. The simulation results in his paper confirm that after loading the mechanism, mass production rejects are remarkably increased. The paper proposes that by decreasing the tolerance limits of those manufacturing variables that have the highest contribution in the assembly specification, the number of rejects could be decreased significantly.

VI. RESEARCH METHODOLOGY

a) Synthesis of four bar mechanism by fraudensteins method.
b) Preparation of cad model of synthesized four bar mechanism.

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 .



s θ1 - k2cos θ1 + k3
Where, k1= r1/ r2,

To solve resolving all forcces in x-direction & y-direction on adding both we have
cos θ1.cos θ1 +sinθ1.sin θ2 = k1cosθ1 - k2cos θ2 +k3
cos(θ2 - θ1) = k1co s θ1 - k2cos θ1 + k3
Where, k1= r1/ r2,k2= r1/ r4, k3= r22 - r32 + r42 + r12 / r2.r4

VII. 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.

VIII. 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.
Freudenstein 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. Another approach to planar four-bar linkage design was introduced by L. Burmester, and is called Burmester theory.

IX. Result and Analysis

Structural Error Analysis:

The function generator linkage was synthesized using only three points along the range, hence it is bound to have some structural error (theoretical difference between the function produced by the linkage and the original mathematical function). To find the structural error we need an EXACT model of the linkage, and a means to acquire accurate measurements of angles Θ2 and Θ4.

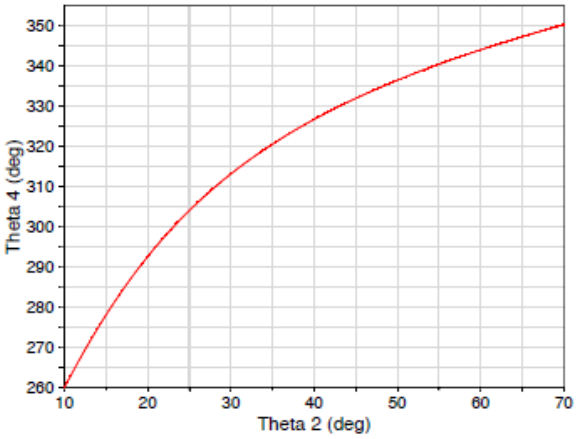


Figure 6: Plot of actual linkage θ_4 *vs* θ_2.

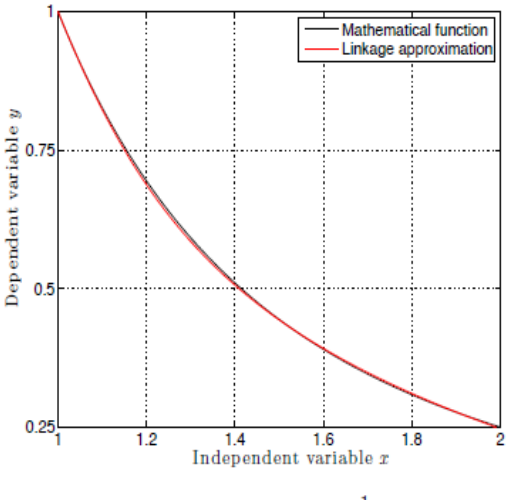
Path Generation Error:

In path synthesis problems, this part is the sum squares which computes the position error of the distance between each calculated precision point (Pxi, Pyi) and the desired points (Pxdi,Pydi) which are the target points indicated by the designer. This is written as:

$$f(X) = \sum_{i=1}^{N} [(Pxd_i - Px_i)^2 + (Pyd_i - Py_i)^2]$$

where X is set of variables to be obtained by minimizing this function. Some authors have also considered additional objective functions such as the deviation of minimum and maximum transmission angles μmin and μmax from 90°, for all the set of initial solutions considered.

Plot of Exact and Approximate Results.



% error = (y-ya)/y x 100

References

1) J.A .Carbrea. A. Simon & M.Prado, Optimal synthesis of mechanism with GA, Mechanism & Machine Theory, Vol.37, pp 1165-1177, 2002.
2) E.C.Kinzel,J.P.Schniedeler &G.R.Pennock, Kinetic synthesis for finitely separated positive any geometric coordinate programming, J. Machine design, Trans.ASME, Vol.128,pp.1070-1079,2006
3) A.Smaili and N.Diab, Optimum synthesis of hybrid-task mechanisms using ant-gradient search method, Mechanism & Machine theory, Vol. 42, pp.115-130,2007