A Literature Review On Optimal Kinematic Synthesis of Four Bar Chain Mechanism

[1]Prof.Govindrao Chavan, [2]Prof.Dinesh Satpute, [3]Mr.Abhishek Sangle

[1] Head of Department, Department of Mechanical Engineering,SOET, Sandip University,Nashik,India
[2] Assistant Professor, Department of Mechanical Engineering, SOET, Sandip University,Nashik,India
[3]M.Tech Design, Department of Mechanical Engineering, SOET, Sandip University,Nashik,India

Abstract : A four Bar mechanism is one which that converts rotary motion into Oscillating Motion of required rotary motion with different rate for its two strokes i.e. working and return stroke. The Working stroke is greater than return stroke and ratio of working to return stroke is called as time ratio. Time Ratio, Stroke Length and Transmission angles are important parameters for mechanism synthesis. The mechanism should work within the desired range of transmission angles. Rational kinematic synthesis of mechanism is the motivation using set of analytical Equations. The Mechanism is optimally synthesized using Powell's Technique of Optimization. In this technique the equations are formed for time ratio and stroke, and this equations are solved by giving the boundary condition of maximum and minimum transmission angles. MATLAB software is used for solving this set of non-linear equation and gives out the optimal results.. The optimal results are compared with the non-optimal results. The simulation is done by preparing a prototype of optimal and non-optimal model in CREO software.

***Keywords*— Four Bar Mechanism, Synthesis, Optimization, Powell's Technique.**

I. INTRODUCTION

The simplest mechanism built by using four elements is called four bar chain mechanism. The links in the mechanism can have any length but they have to follow certain law called Grashof's law. Machines consist of number of mechanisms for their successful operation and to give desired output. Mechanisms such as Inversion of four bar, single slider crank, double slider crank, etc., are used for transmitting motion, force, torque etc. Successful synthesis of mechanisms leads to a successful machine design. Hence this lead to importance of Mechanism Synthesis.

Mechanism Synthesis has been done in various mechanisms. For last few decades Powell's technique of Optimization is been in process for optimal synthesis. This process is good as there is not any implementation of derivatives and Integrative.

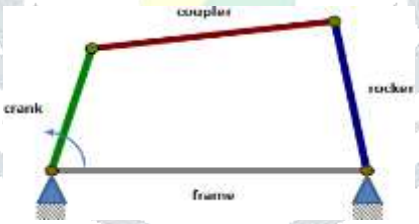

Figure 1: Four Bar Mechanism

It consists of following links.
Link 1: Fixed/Frame
Link 2: Crank
Link 3: Connecting rod.
Link 4: Rocker

This Mechanism is mainly used in Beam Engine, Wipers of Automobile, Coupled wheel of locomotive, pantograph etc.

II. LITERATURE REVIEW

Ali Mohammadzadeh designed and analysed a four bar quick-return mechanism using MATLAB and SIMULINK as the primary software tools The mechanism is analyzed and the synthesized mechanism- using Lagrange's equations and Lagrange's multipliers method for constraint motion- to arrive at the positions, velocities and accelerations of the links[1].
Optima Link, A MATLAB-Based Code for is prepared for Optimum Synthesis and Simulation of Mechanisms. It describes Optimum Synthesis and Simulation of Mechanisms using Matlab based programming codes. The codeaccommodates precision-point synthesis using the complex- number method [2].

Dr. J. M. Prajapati describes optimized kinematic design of a planer mechanism (4-link) based planar manipulator. The author have defined that the performance of the manipulator is maximum for a position interval in addition to a certain position. The relationship between the force and motion according to the mobility index [3]

Girish Kamat et. al. describes the Synthesis and Analysis of Adjustable Planar Four-bar Mechanism. In this paper, the path flexibility of adjustable four-bar linkage is analyzed. The limitation for four-bar linkages to generate continuous paths is that the desired continuous path can only be generated approximately. Length of different links is adjusted to obtain different paths accurately and different paths are generated. Verification of adjustment of links, paths traced and force analysis is carried out on MSC ADAMS 2012 [4].

The first time the optimization in this problem is implemented with two methods. In the first method the length are selected as optimization parameter whereas in the second method precision point's distribution is considered as optimization parameter. They been concluded that precision points as optimization parameters method has produced infinitesimal error, but it could not satisfy dimensional constraints [5]

Methodology for different mechanism, kinematic analysis is important to understand the position, velocity and acceleration of each link during the working of mechanism. The mechanisms are subjected to force and it's effort and due to that dynamic study is required to understand force and its effect on each member and also for the optimization of vibration and mass of mechanism. The graphical and computer aided kinematic and dynamic analysis are described [6].

Galal Ali Hassaan describes Synthesis of Planar - four-bar mechanism for three coupler-positions generation. The author describes a mathematical model for the mechanism position incorporating the 3 coupler positions. The model consists of 8 nonlinear equations considering theTransmission angle of the mechanism in the 3 coupler positions [7].

Galal. A. Hasan synthesized the planar mechanism for inversions for four bar chain, single slider crank and double slider crank chain mechanism. The transmission angles and its limitations are used to synthesize the mechanisms for time ratio and strokes [8].

Ajay A. Dhore et al. describes Synthesis of Four bar mechanism. The synthesis is carried out in two methods. Type Synthesis and Dimensional Synthesis. The tasks carried out in this paper are to Develop CAD Model of profile cutting mechanism [9]

.Retheesh Kumar and Prof. Akash Mohanty, explains Design, Synthesis and Simulation of Four Bar Mechanism for Eliminate the Ploughing Depth Fluctuations In Tractors. In this paper, a four bar mechanism was designed for the particular performance output for a tractor used in farms. [10].

Todor Stoilov Todorov describes Synthesis of Four Bar Mechanisms as Function Generators by Freudenstein - Chebyshev. This paper describes new method for the synthesis of four-bar link for generating a required input-to- output motion. The synthesis method is based on the direct application of Chebyshev's Alternation. The method of Freudenstein - Chebyshev presented here shows that for every structural error which could be presented as generalized polynomial of Chebyshev can be found the best approximation.[11].

Prashim K Kamble et. al. describes the different methods are accessible 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[12]

R. Gurpude et. al. designed a four bar mechanism Design, Synthesis & Simulation of Four Bar Mechanism for Wheels for Climbing. In this paper a mechanism is designed for the desired performance output of the machine & these mechanisms are being used in case of climbing wheels [13].

III. ROADMAP AND METHOD USED IN OPTIMIZATION

Roadmap

- Synthesis of four bar chain mechanism using Analytical Method.
- Synthesis of four bar chain mechanism using Optimized Method in MATLAB.
- Comparison of Results.
- Simulation of four bar chain mechanism using CREO software.
- Performance analysis in CREO software.
- Validation of Results using Conventional Velocity Analysis
- Comparison of Results using Graphs.

Powell's optimization technique is used for the optimal kinematic synthesis of mechanism. This process involves the reduction of unconstrained multivariable. More over this technique is widely used because it does have any implementation of derivatives and integrations.

The mechanism is to be design for satisfying the desired values for strokes, time ratio maximum & minimum transmission angles. For attaining the objectives, following equations are to be solved,

μmin - μmind = 0
μmax - μmaxd = 0
T.R. – T.Rd = 0
S – Sd = 0

IV. CONCLUSION

1) Powell Conjugate direction technique of optimal synthesis can be implemented and can be replaced to conventional method of synthesis so as to avoid the errors upcoming in calculations just by using simple equation coding and dimensions can be obtained.
2) Synthesis Process for several run numbers is completed with analytical and Optimization (Matlab) process for calculations.

V. FUTURE SCOPE

1)Analytical & optimal method calulations are compared to calculate the percent benefits .also experimental model to be made of optimal results
2)Result obtained should be horizontically implemented to compressor.

Acknowledgment

The report is outcome of guidance, moral support and devotion bestowed on me throughout my work. For this I acknowledge and express my profound sense of gratitude and thanks to everybody who have been a source of inspiration during the experimentation. The consistent guidance and support provided by Prof. Govindrao Chavan & Prof.Dinesh Satpute is very thankfully acknowledged and appreciated for the key role played by him in providing me with his precious ideas, suggestions, help and moral support that enabled me in shaping the experimental work.

REFERENCES

[1] Alireza Mohammadzadeh - “Analytical Synthesis and Analysis of Mechanisms using Matlab and Simulink." Grand Valley State University Page 12.242.1 - 12.242.1
[2] Ahmad Smaili et.al "Optima Link: A MATLAB-Based Code for Teaching/Learning Precision-Point and Optimum Synthesis and Simulation of Mechanisms" Int. J. Engng Ed. Vol. 21, No. 5, pp. 874±884, 2005.
[3] Dr. J. M. Prajapati "Kinematic Design Optimization of Planer-link Mechanism based Manipulator" International Journal of Engineering Research & Technology (IJERT) Vol. 3 Issue 2, February - 2014.
[4] Girish Kamat et. al. "Synthesis and Analysis of Adjustable Planar Four-bar Mechanism" International Journal of Advanced Mechanical Engineering for Research India Publications, Volume 4, Number 3 (2014), pp. 263-268.
[5] Yousof Ebneddin Hamidi et. al. "Optimization of Four-bar Steering Mechanism through Artificial Immune System (AIS) Algorithm" 012 12th International Conference on Control, Automation and Systems Oct. 17-21, 2012.
[6] Shrikant R. Patel et. al. "A Review on Kinematic and Dynamic Analysis of Mechanism" International Journal of Engineering Science and Innovative Technology (IJESIT) Volume 2, Issue 2, March 2013
[7] Galal Ali Hassaan "Synthesis of Planar - four-bar mechanism for three coupler-positions generation", Global Journal of advanced Research, Vol-2, Issue-4 Page. 726-734.
[8] Galal Ali Hassaan " Synthesis of Planar Mechanisms, Part II: Specified Stroke, Time Ratio and Transmission Angle" International Journal of Computer Techniques - Volume 2 Issue 3, May - June 2015.
[9] Ajay A. Dhore et al. "Synthesis of Four bar mechanism by freudenstein Equation" International Journal of Engineering Research and Applications, Vol. 2, Issue 5, September- October 2012, page 999-1002.
[10] Retheesh Kumar and Prof.Akash Mohanty," Design, Synthesis And Simulation Of Four Bar Mechanism For Eliminate The Ploughing Depth Fluctuations In Tractors", International Journal of Computer Technology and Electronics Engineering (IJCTEE) Volume 2, Issue 2, April 2012.
[11] Todor Stoilov Todorov "Synthesis of Four Bar Mechanisms as Function Generators by Freudenstein - Chebyshev", Journal of Robotics and Mechanical Engineering Research, Vol: 1, Issue: 1, April 2015.
[12] Prashim K Kamble et. al. "Generalized methods of synthesis of the four-bar linkage" International Journal of Mechanical Engineering and Robotics Research, Vol. 3, No. 1, January 2014.
[13] R. Gurpude et. al. " Design, Synthesis & Simulation of Four Bar Mechanism for Wheels for Climbing", International Journal of Computer Technology and Electronics Engineering (IJCTEE) Volume 2, Issue 2, April 2012.