Retheesh Kumar, Prof.Akash Mohanty / International Journal of Engineering Research and Applications (IJERA) ISSN: 2248-9622 www.ijera.com
Vol. 3, Issue 3, May-Jun 2013, pp.953-956

Design, Synthesis And Simulation Of Four Bar Mechanism For Eliminate The Plowing Depth Fluctuations In Tractors

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Abstract

In this paper, a four bar mechanism was designed for the specified performance output for a tractor. In tractor's plowing is engaged with the assistance of a hydraulic cylinder. Looking on the soil hardness the plowing depth fluctuates that isn't fascinating. To induce the correct plowing depth an Electrical control system is introduced. It consists of hydraulic valve, control unit and also the angular sensor. The control system helps to regulate the plowing depth accurately. The device measures the position of pivot and offers feed back to the system. Thus a sturdy, reliable and safe link mechanism is developed to measure the angular motion of the pivot. The main focus of this paper is to analyze Dimensional synthesis is performed supported Freudenstein's Equation and Chebechev's formula in Matlab and calculate the structural error of linkage mechanism by using Adams. Dimensional synthesis of 4 bar link mechanisms helps the designer to design link mechanisms with correct dimensions and simulation in Adams helps to optimize the link mechanism.

Keywords- *Adams Simulation, Function Generation in Matlab, Structural Error*

1. Introduction

The kinematic structural studies have a very important role within the design and synthesis of mechanisms. The main focus of this paper is to analyze Dimensional synthesis is performed supported Freudenstein's Equation. This paper focuses on presenting the event of a four bar link mechanism that is employed to measure the angular position of pivot. As per the desired task the dimension of links was developed on the idea of dimensional synthesis using Freudenstein's equation and Chebechev's equation. The Adams simulation is dead on the idea of those dimensions. Also, compare these dimensions with existing dimensions used for previous task.

Apart from this linkage mechanism for a similar, we are able to use gear, timing belt and pulley etc. However, these mechanisms aren't reliable and also the producing value is relatively high. The approximate lifetime of the angular sensor is thirty million cycles. Therefore, the mechanism, that is to be coupled to the device, ought to have an honest lifetime while not undergoing any wear and tear, corrosion etc. whereas comparison to gear and timing belt and pulley mechanism the angular sensor can provide additional accuracy because it is coupled to linkage mechanism. Backlash error is that the main complications of mechanisms like spur and bevel gears. Most allowable error of angular sensor is 1%. Slippage error is that the major hindrance in timing belt and pulley, whereas comparison to different mechanisms linkage mechanism offers readings that are additional correct. Advantages to the approach of design of link mechanism can cut back the producing value. Another advantage of linkage mechanism is that the cross load like tangential, radial and axial load functioning on gears together with spur and bevel, timing belt and pulley, intermediate gear are additional comparison to linkage mechanism. Moreover, the weight of the linkage mechanism is negligible. Whereas manufacturing sturdy, reliable and safe link mechanism are the vital goals of this paper. Therefore, the accuracy of the angular sensor is more whereas comparison to gear and belt drive mechanisms.

2. Problem Statement

Angular sensor is employed to measure the angular position of an outsized pivot having diameter of 80 mm. The sensor is placed at a distance of 80 mm from the pivot. This pivot is coupled to the smaller shaft by suggests that of a coupling. The pivot is experiencing explosive jerk or lateral movement. Tractor would like low sensitivity for output voltage once tiller in higher position and wish an outbreak of sensitivity at the time of plowing. The position of the pivot and also the sensor shaft is parallel.

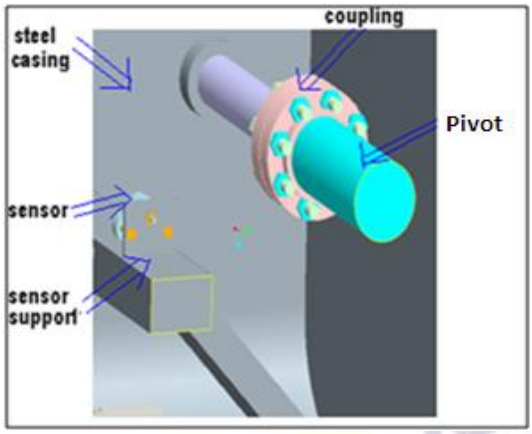

Fig.1 Problem statement

Main complication during this application is that the pivot is in giant in size and an explosive jerk or lateral movement of the pivot. So an innovative four bar linkage mechanism is to be developed. A steel casing is provided to safeguard this from environmental variations.

3. Project Concept

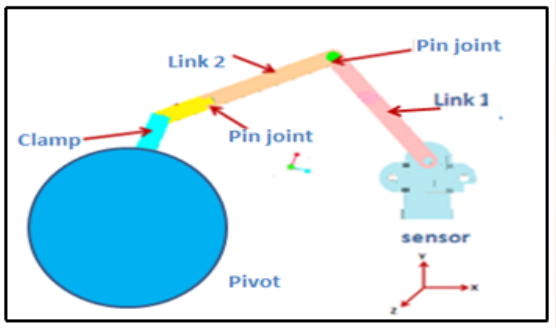

Fig.2 Concept of 4 bar linkage mechanism

A four bar mechanism is developed from Freudenstein's equation by using Matlab. One end of the linkage mechanism is engaged to the angular sensor and different end is coupled to the pivot of 80 mm diameter. The massive pivot can move to and fro at 120 degree and corresponding angle is measured by the angular device. One end of the link mechanism can't be connected on to the pivot as a result of its giant size. To avoid this complication a clamp is mounted to the pivot. Length from the centre of the pivot to the clamp is taken into account joined link; as a result of link mechanism is revolved with relevancy a hard and fast position. Second link accommodates 2 elements. Each elements can moves in x-y plane and live the angular motion of pivot accurately by the device. Moreover, if any explosive jerk happens, the second half can compensate the jerk. This can be attainable as a result of the speed of rotation of pivot is incredibly small.

4. Literature Review

To reduce the human effort the mechanisms and machines are used since ancient time itself. This influenced all aspects of human society throughout the commercial revolution. In easy words, a mechanism is an assemblage of rigid links connected by joints, which permit relative motion between the connected links. The output link is touched with relevancy the input link of mechanism. The Watt's straight-line linkage is that the one amongst the proverbial mechanism was designed by applied scientist employed in the double acting external-combustion engine [1]. Mechanism analysis and design was done diagrammatically within the beginning of nineteenth century. Throughout the time of 1950's computers and algorithms were used for computing a similar. Freudenstien realized the influence of computers for the planning and analysis of mechanisms and machines [2]. Moreover, his analytical approach dead fitted the new computer technologies. Finally design of a four-link mechanism one numerical example is presented [3, 4].

Several investigations are disbursed supported the structural synthesis and analysis of linkages and different mechanisms [5, 6]. Earlier pure intuition and inspection graph theory were the methods utilized for structural synthesis of kinematic chains. Human error is happens all told these studies as a result of visual inspection [7]. This human error is affected in each result and can't be dominated out. Thus absolutely processed technique is developed to eliminate the human error. This helps the designers to get the results quickly. Chebyshev spacing of precision points is performed to scale back the structural error [8]. And additionally the dimensional synthesis of Freudenstein equation can minimize the structural error [9, 10, 11].

A Generalized Performance Sensitivity Synthesis Methodology for Four Bar Mechanisms printed in an exceedingly journal explained the term sensitivity constant. Erdman and Faik outlined and derived the sensitivity constant [12]. This can be a mathematical expression within which tiny variation within the mechanism parameters like link length build modification within the output variable. This parameter helps for analysis of error in four bar link mechanism.

In nowadays, link mechanisms are employed in several devices and kind of gadgets-in automotive fields like steering and braking systems, fluid pumps etc. Medical applications like artificial prosthetic knees, laparoscopic surgical tools, different medical devices, and applications in spacecraft's. Now, these link mechanisms are unified with sensors, electronics and control systems. This results the innovation in micro-electro mechanical systems (MEMS), robotics.

5. Research Methodology

Freudenstein's equation offers additional correct link ratios for the synthesis of linkage mechanism whereas comparison to different strategies. As a result of in Freudenstein's equation all values are organized in analytical manner and formulations are easy. Another vital advantage of Freudenstein's equation is output angle varies with by applying totally different transfer functions.

- Synthesis four bar mechanism by using Freudenstein's method in Matlab.
- Preparation of cad model of four bar mechanism by using similar link ratios from the MATLAB.
- Simulation of four bar mechanism in Adams.

6. Results and Analysis

6.1 Freudenstein's Equation by using Matlab Software

In linkage mechanisms, the path generated by the output link depends on the length of each links. Hence, predictions of the transfer function of linkage mechanisms are difficult. Path generation of output link is calculated with the assistance of Freudenstein's equation. Link ratios are relied on several input parameters. It'll be terribly valuable to be able to quickly compute the link ratios. Thus link ratios are calculated by using Matlab.

Input and output parameters of Freudenstein's equation in matlab as follows:

Initial position of input link, $\varphi 1 = 0°$;
Initial position of output link, $\psi 1 = 60°$;
Range of variation of input link, $\Delta\varphi = 120°$;
Range of variation of output link, $\Delta\Psi = 90°$;
Function, $Y = \exp(X)$
Output in terms of lengths:
Length of the input link, a1 = 56.72 mm;
Length of connecting link, a2 = 64.79 mm;
Length of the output link, a3 = 55.30 mm;
Length of the frame, a4 = 80 mm

The start and final value of X is taken as 1 and 4 respectively. Moreover, by using Chebechev's formula, three precision points are calculated and corresponding input and output angles are obtained. By assumptive vary of input and output, the subsequent result table are going to be obtained.

TABLE 1.Precision Angles

No	Precision Points (X) Values	Function Generator (Y) Values	Input Angle (φ)	Output Angle (ψ)
1	1.20	3.323	8.03	61.04
2	2.50	12.182	60.0	76.41
3	3.799	44.658	111.9	132.7

6.2 Adams Simulation

The link ratios obtained from the Matlab is simulated in Adams. Input angle is touched from zero to 120˚ and corresponding output angle is premeditated. The link ratios obtained from Matlab is important as a result of the path generated by the output link is predicated on the link ratios. The output link generates exponential path suggests that initial stage link can provide low sensitivity and later output link motion can generate high sensitivity. Theoretical and simulation leads to terms of angle are shown within the table below.

TABLE 2.Results In Terms Of Angle

Theoretical results (Matlab)		Simulation results (Adams)	
Input angle (deg)	output angle (deg)	Input angle (deg)	output angle (deg)
6	62.009	6	62.015
18	63.926	18	63.95
30	66.513	30	66.62
42	70.006	42	70.07
54	74.720	54	74.75
66	81.084	66	80.98
78	89.675	78	89.39
90	101.270	90	100.94
102	116.923	102	116.72
114	138.052	114	138.39
120	151.246	120	151.78

6.3 Structural Error Analysis

Structural error is outlined because the distinction between the actual mathematical function and performance created by the synthesized linkage .Value of function is obtained from Matlab and values of synthesized linkage are collected from Adams simulation. The results from Adams simulation is thus near the values got from Matlab. This result's acceptable as a result of structural error is a smaller amount than 1%.The output link of synthesized four bar link mechanism follows the similar graph of actual function. The percentage error is shown within the table below.

TABLE 3.Results In Terms Of X and Y Values

Theoretical results(Matlab)		Simulation results (Adams)		
X value	Y value	X value	Y value	Structural error
1.15	3.158	1.15	3.1617	-0.11
1.3	3.669	1.3	3.6777	-0.22
1.6	4.953	1.6	4.9922	-0.79
1.9	6.685	1.9	6.7275	-0.62
2.2	9.025	2.2	9.051	-0.28
2.5	12.182	2.5	12.17	0.10
2.8	16.444	2.8	16.338	0.64
3.1	22.197	3.1	22	0.89
3.4	29.964	3.4	29.789	0.58
3.7	40.447	3.7	40.403	0.10
4	54.598	4	54.914	-0.57

6.4 Plot of actual and Approximate Results

The X and Y values of each prescribed function and performance of synthesized linkage is premeditated as shown in Fig. 3.

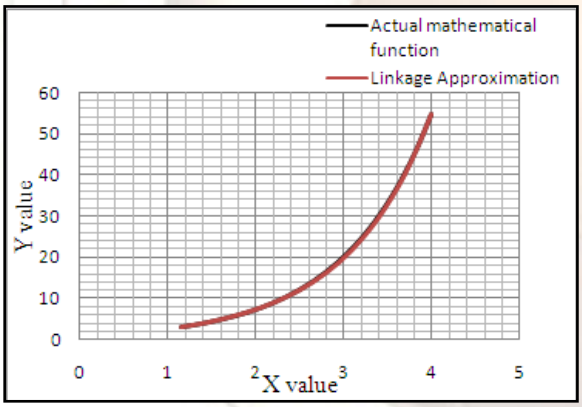

Fig.3 Precise and approximate behavior of y =exp(X) over the vary of 1≤x≤4

7. Conclusion

This project investigates the design, synthesis and simulation four bar mechanism to eliminate the plowing depth fluctuation in tractors. The projected four bar linkage mechanism can eliminate the plowing depth fluctuations. The output link generates exponential path suggests that initial stage link can provide low sensitivity and later output link motion can generate high sensitivity. Percentage error obtained from Adams is suitable in vary.

References

[1] D. Sangamesh and G.K. Ananthasuresh, James Watt and his Linkages, *Resonance, 14(6)*, 2009, 530–543.

[2] F. Freudenstein, *Design of Four-link Mechanisms, PhD Thesis*, Columbia University, USA, 1954.

[3] F. Freudenstien, An Analytical Approach to the Design of Four-Link Mechanisms, *ASME Trans,76(3)*, 1954, 483–492.

[4] F. Freudenstien, Approximate Synthesis of Four-Bar Linkages, *ASME Trans, 77(8)*, 1955, 853–861.

[5] T.S. Mruthyunjaya, A Computerised Methodology for Structural Synthesis of Kinematic Chains: Part 1 -Formulation, *Mechanism and Machine Theory, 19(6)*, 1984, 487-495.

[6] T.S. Mruthyunjaya, Structural Synthesis by Transformation of Binary Chains, *Mechanism and Machine Theory, 14*, 221-231.

[7] G.N. Sandor and A.G. Erdman ,*Advanced Mechanism Design*, I and II, Prentice – Hall, 1988.

[8] J.E. Shigley and J.U. John, *Theory of machines and mechanisms*, International Student Edition

[9] R.L. Williams II and C.F. Reinholtz, Proof of Grashof's Law Using Polynomial Discriminants, *Journal of Mechanisms, Transmission, and Automation in design,108*,1986, 562-564.

[10] I.W. Long and W. Shiau-huei, A Note on Freudenstein's Theorem, *Mechanism and Machine Theory, 33(1/2)*, 1998, 139-149.

[11] G. Gogu, Mobility of Mechanisms: A Critical Review, *Mechanism and Machine Theory, 40(9)*, 2005, 1068–1098.

[12] Kwun and T. Lon, Mobility Criteria of Single-Loop N-Bar Linkages, *Journal of Mechanisms, Transmission, and Automation in design,111*, 1989,504-505.