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A Review on Design and Simulation of Four Bar Crank Chain Mechanism

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ABSTRACT: The four-bar mechanism is a fundamental type of mechanical linkage used in various engineering applications. Studying and creating a four-bar system usually has multiple main objectives. Identical Learning about Design and Synthesis, Fabrication and Testing, Kinematics and Dynamics, Optimization, and Application in Real-World Scenarios.

KEYWORDS: Design, Synthesis, Fabrication, Testing, and Optimization.

I. INTRODUCTION

The four-bar mechanism has a rich historical background, dating back to ancient civilizations and evolving through significant contributions over the centuries. Here is an overview of its historical development: Its closed loop structure, formed by four rigid bars joined by pivots, allows rotational motion to be transformed into other forms of mechanical movement. The synthesis of four-bar mechanisms has been thoroughly investigated in the past. Techniques for designing and optimizing these links based on kinematic factors, such as accelerations and angular velocities, are among the key contributions. Resolving vectors into Cartesian components is one noteworthy technique that streamlines and increases the accessibility of design for engineers.

II. RELATED WORK

The concept of four-bar mechanism was done by Shiva Krishna Y, (2022) [1]: This paper presents the design and fabrication of a box transport mechanism to meet the growing demand for intermittent movement of packages in modern industries. Unlike conventional conveyor systems, which offer continuous motion, our mechanism provides a stop-and-move motion using carefully engineered mechanical linkages. This innovative approach introduces flexibility, allowing for on-the-fly alterations to packages or repositioning for various purposes. The prototype design incorporates an electric motor, precision-engineered shafts, and a lightweight yet robust aluminum frame.

Patel Bhautik (2021) [2]: This project aims\or the utilization of kinematic synthesis (type, dimensional and number) to fabricate a working physical model of an eight link transport mechanism. The mechanism to be developed in its simplest form would perform the function of transporting boxes/articles which are being fed onto two rails and are moved ahead one by one. Transport mechanisms generally move material and their application lies in various industries-manufacturing, assembly, packaging etc. In this project we apply the path generation ynthesis and coupler curve synthesis and study to fabricate our model.

Shrikant R. Patel (2013) [3]: The research work on the kinematic and dynamic analysis has been reviewed in this paper. Methodology for different mechanism, kinematic analysis is important to understand the position, velocity and acceleration of each +linkage during the working of mechanism. The essentiality of dynamic analysis is to understand dynamic behavior of each link, during the working of mechanism.

III. METHODOLOGY

Problem Definition: Describe the situation or use case for the four-bar mechanism.

Design Requirements: Establish the design specifications, including the motion characteristics, accuracy, and speed.

Linkage Configuration: Select the proper four-bar linkage setup (double-crank, double-rocker, crank-rocker, etc.).

Dimensional Synthesis: Using methods, ascertain the link lengths and angles required to provide the necessary motion characteristics.

Motion Analysis: Apply kinematic equations to the mechanism's motion analysis to ascertain: Links' location, speed, acceleration, and displacement angles.

Dynamic Analysis: Examine the mechanism's dynamic behaviour while taking into account: Power, energy, Torques and forces.

Fabrication and Assembly: Assemble and fabricate the mechanism while taking tolerance, production methods, and material selection into account.

Verification and Validation: Make sure the finished design satisfies all design specifications and functions as intended by validating and verifying it.

As per grashofs law the sum of shortest and longest links should be lesser than orequal to other two links. On this basis we are planning to design a mechanism and simulate the mechanism in the

IV. EXPERIMENTAL RESULTS

Material Selection: Materials must be durable and have low friction.

Dimensions: Precise dimensions are crucial to ensure smooth operation and desired motion characteristics.

Tolerances: Tight tolerances are necessary to minimize friction and wear.

Cutting and Machining: Components are cut to size and machined to precise dimensions.

Assembly: Frame, Crank, Coupler, and Rocker Arm are assembled with care to ensure alignment and smooth operation.

Testing: The assembled mechanism is tested to verify its functionality and performance.

Materials Used

Frame (Link 1)	:	Mild Steel
Crank (Link 2)	:	Mild Steel
Coupler (Link 3)	:	Mild Steel
Rocker Arm (Link 4)	:	Mild Steel

The different parameters can be found using different equations

The geometry of a four-bar mechanism is defined by the link lengths (a, b, c, and d) and joint angles (θ_1 , θ_2 , θ_3 , and θ_4). The motion of the mechanism is described by the following equations:

- Loop closure equation: $a + b + c + d = 0$
- Grashof's criterion: $(a + b) \leq (c + d)$ or $(a + c) \leq (b + d)$
- Input-output equation: $\theta_4 = 2 \times \arctan((a + b) \times \sin(\theta_1/2) / (c + d))$
- Velocity equations: $\omega_2 = \omega_1 \times (a \times \sin(\theta_1) / b \times \sin(\theta_2))$
- Acceleration equations: $\alpha_2 = \alpha_1 \times (a \times \cos(\theta_1) / b \times \cos(\theta_2))$
- -Position analysis: $x = a \times \cos(\theta_1) + b \times \cos(\theta_2)$, $y = a \times \sin(\theta_1) + b \times \sin(\theta_2)$
- -Coupler curve equations: $x = f(\theta_1)$, $y = f(\theta_1)$

These equations describe the kinematic behavior of the four-bar mechanism, enabling the analysis and design of complex motions. By solving these equations we can find different parameters.

Analysis of Four bar Mechanism by Using Linkage Software:

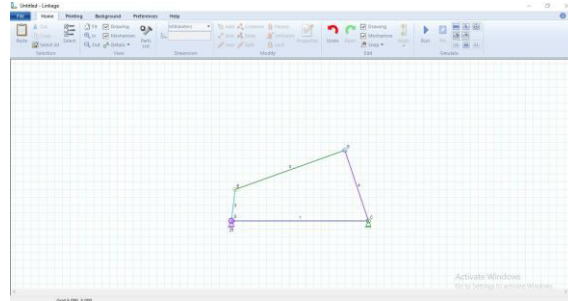


Fig a

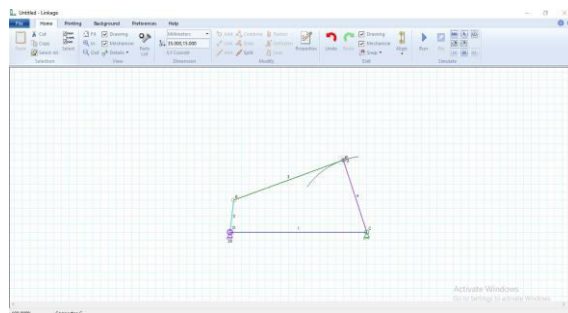


Fig b

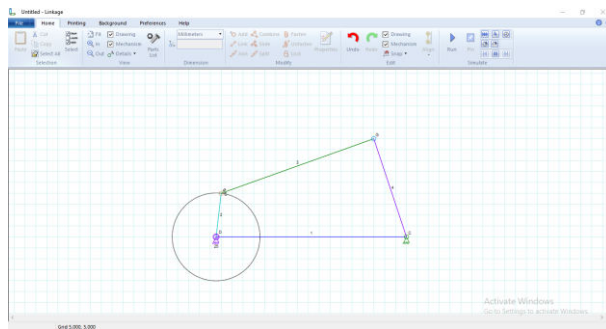


Fig c

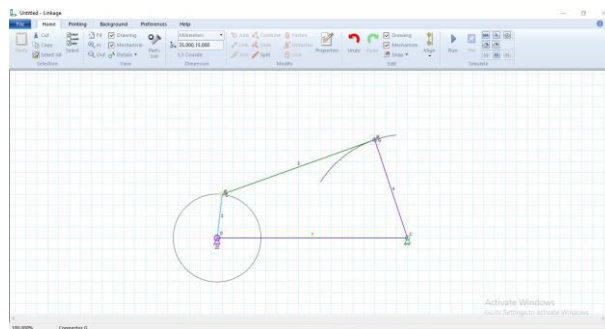


Fig d

Figures shows Analysis of Four bar Mechanism by Using Linkage Software. Figs. a, b, c & d shows Connecting Links, Rocker Arm Motion Path, Crank Motion Path & Complete Motion Bath Of Four Bar Mechanism.

V. DESIGN AND FABRICATION

Materials Used

Frame (Link 1)	: Mild Steel
Crank (Link 2)	: Mild Steel()
Coupler (Link 3)	: Mild Steel()
Rocker Arm (Link 4)	: Mild Steel()

Calculation for grashofs law

Length of link 1	: 300mm
Length of link 2	: 75mm
Length of link 3	: 180mm
Length of link 4	: 190mm

Grashof's criterion: $(a + b) \leq (c + d)$
 $(75+300) \leq (180+190)$

Fabrication Process

Cutting and Machining: Components are cut to size and machined to precisedimensions.

Assembly: Frame, Crank, Coupler, and Rocker Arm are assembled with care to ensurealignment and smooth operation.

Testing: The assembled mechanism is tested to verify its functionality andperformance.



Link 1



Link 2



Link 3



Link 4

VI. CONCLUSION

The significance of the four-bar mechanism in teaching and research is highlighted by its ongoing relevance and instructional usefulness. It is an essential tool in engineering and design because of its capacity to represent and solve complicated motion problems in a clear and simple way. Its status as a foundational component of mechanical systems and a crucial subject in mechanical engineering education and research will be guaranteed by ongoing investigation and innovation.

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