NOTIFICATION NO: 580/2025
NOTIFICATION DATE: 11-06-2025

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TOPIC OF RESEARCH: "STRUCTURAL SYNTHESIS OF PLANAR KINEMATIC CHAINS AND THEIR DERIVED MECHANISMS"

FINDINGS

The current study aims to evaluate the feasible types of links in kinematics, based on the specified degrees of freedom and the number of links. The alternative structures are generated for the provided set of links. The 2–F, 9–links, Simple Jointed Kinematic Chain has a total of 203 distinct mechanisms, whereas the 9–links, Multiple Jointed Kinematic Chain has a total of 331 distinct mechanisms.

1 Comprehensive Findings

1.1 Findings Associated with Objective–I

The objective–I was to construct all feasible 40 basic simple jointed kinematic chains and 40 basic multiple jointed kinematic chains from a family of 2–DOF, 9–links, and 11–joints, kinematic chains.

1.2 Findings Associated with Objective–II

Objective–II focused on the modeling of both simple and multiple–jointed kinematic chains, as well as the identification of isomorphism between these kinematic chains. To identify the presence of isomorphism in kinematic chains featuring simple and multiple joints, a direct and efficient mechanism is utilized to derive structural invariants. A total of 40 distinctive simple jointed kinematic chains and 40 distinctive multiple–jointed kinematic chains were derived from the set of 2–DOF, 9–links, and 11–joints, kinematic chains.

1.3 Findings Associated with Objective–III

The goal of Objective–III was to establish the distinct mechanisms within a given family of simple and multiple–jointed kinematic chains. The analysis involves examining the Sum of Squares of Matrices [SS_M] values that are associated with the mechanisms of a kinematic chain consisting of several joints and a simple structure. A total of 203 unique i.e., distinct mechanisms were identified from 40 basic distinct 2–DOF, 9–links, and 11–joints, simple jointed kinematic chains, and 331 distinct mechanisms were identified from 40 basic distinct 2–DOF, 9–links, and 11–joints, multiple jointed kinematic chains.

2. Discussion

2.1 Completion of Objective–I

It is necessary to concentrate the research on improving the generation of simple and multiple–jointed kinematic chains. Therefore, the primary goal of Objective–I was to establish a comprehensive list of all possible 40 basic, 2–DOF, 9–link, 11–joint, simple jointed kinematic chains and 40 basic, 2–DOF, 9–link, 11–joint, multiple jointed kinematic chains generated from the group of kinematic chains featuring simple and multiple joints. The generation of simple and multiple–jointed kinematic chains involve the conversion of ternary and quaternary links (connections) into binary links. The process of converting ternary and quaternary links into binary links results in a physical reduction in the number of joints. To determine the exact or actual number of joints, diagrams are created for both the single and multiple–jointed kinematic chains.

4.3.2 Completion of Objective–II

In a kinematic graph, the vertices represent the links, while the edges represent the joints. The number of edges in the kinematic graph representing the kinematic structure is equivalent to the number of joints in the kinematic chain. However, when simple jointed kinematic chains and multiple–jointed kinematic chains are expressed in terms of their kinematic graph, the number of joints is found to be less than the number of edges. To represent a kinematic chain with a kinematic graph, the edges of the kinematic graph are assigned a weight joint value. The sum of all weighted edges with joint values in the kinematic graph is equal to the number of joints in the kinematic chain. This is the primary condition for representing a kinematic chain with a kinematic graph. A newly developed matrix, called the Cube of the Sum of Joint Values [CSJV] matrix, is derived from the kinematic graph of both simple and multiple jointed kinematic chains. The Sum of Squares of the Matrix [SS_M] for Kinematic Chains is required for obtaining the mechanisms by utilizing the [CSJV] matrix for Simple and Multiple Jointed Kinematic Chains and employing MATLAB software to reach the necessary findings. After calculating the sum of squares of matrices [SS_M] for each kinematic chain for the computation of distinct mechanisms, compare them to identify whether there are any similarities and to identify the presence of isomorphism in the chains. Additionally, analyze the (SS_M) values to identify identical and dissimilar mechanisms. This also encompasses the process of storing the data and subsequently retrieving the information for structural invariants using a computer.

4.3.3 Completion of Objective–III

A total of 203 distinct mechanisms were derived from 40 unique, 2–DOF, 9–links, 11–joints, simple jointed kinematic chains, and a total of 331 distinct mechanisms were derived from 40 different, 2–DOF, 9–links, 11–joints, multiple jointed kinematic chains that were developed from 9–bar basic kinematic chains. The structural invariant, also known as the Sum of the Square of the Matrix [SS_{Mi}], is derived from the [CSJV–i] or [$CSJV_i$] matrix. This structural invariant refers to the distinct identification number or code that represents the characteristic number of the i^{th} mechanism. This technique is utilized to establish structural invariants [CSJV] values of n^{th} mechanisms in both simple as well as multiple–jointed kinematic chains. In this manner, a collection of n^{th} structural invariants is obtained; it is possible that some of these invariants are interchangeable while others are distinct. The same structural invariants are used to represent the structurally equivalent links that correspond to one mechanism, which is a separate mechanism.