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NOMOGRAPHS FOR ANALYSIS OF POWER CIRCULATION THROUGH CLOSED EPICYCLIC GEAR TRAINS

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تم استخدام النظرية الرصينة لمخططات النوموغراف في تمثيل الآليات الترسيه أولاً ثم في أستبانة اتجاهات جريان القدرة فيها ثانياً . أن السمة الاساسيه لمخططات النوموغراف هي بساطتها. في هذا العمل تم توسعة فضاء الحل لمخططات النوموغراف ليشمل المسلسلات الترسيه العادية. مما أضاف ميزه جديدة للمقاربة المقترحة في بناء مخططات النوموغراف هي: قابليتها لحل مسائل المسلسلات الترسيه الهجينه التي ترتبط فيها المسلسلات الترسيه الكوكبيه مع المسلسلات الترسيه العاديه. يمكن الكشف ببساطه ومباشرةً عن السرع ، العزوم وأتجاهات جريان القدره لآليه ترسيه كوكبيه مغلقه من مخطط نوموغرافي واحد دون تحديد قياس التروس أبتداءً. كذلك تساعد مخططات النوموغراف المصمم بأعتبارها أداة تصميميه على تحوير النظام بسرعه للحصول على النتائج المرجوة. وأخيرا فقد تم أقتراح خوارزميه بسيطه للتأكد من وتخمين وجود قدره راجعه دواره في المنظومة من عدمها.

The well established nomograph theory is used to represent gear mechanisms and then to detect the power flow directions. The main advantage of nomographs is its simplicity. In this work, nomograhs are extended to solve problems of ordinary gear trains. A novel feature of the suggested approach for constructing multi-axis nomograph is the ability to solve problems of mixed gear trains in which ordinary and epicyclic gear trains are connected. From a single nomograph of a closed epicyclic gear mechanism, velocity, torque and power flow directions can be detected simply and directly without specifying the exact size of each gear. A simple algorithm is proposed to estimate if power circulation exists. Nomographs are also utilized as a design tool, allowing the designer to quickly modify the system to obtain desired results.

1. INTRODUCTION

Geared mechanisms have been extensively used as power transmission and torque magnifier devices in machines and vehicles. The power is transmitted from the input to the output links through meshing gear pairs and/or their corresponding carriers. Using nomographs, kinematic relations between input and output links of geared mechanisms are evaluated. Although the tabular and formula methods have been well developed and can solve for almost all planetary gear train problems, such a procedure becomes tedious when gear trains are complex and sometime they are inapplicable when mixed gear trains exist. By virtue of graph theory[1], the concept of fundamental circuits is applied to the kinematic analysis of planetary geared mechanisms[2]. The concept of fundamental circuit is a powerful tool for automated analysis of EGTs. However, the analysis involves the solution of a set of linear equations for all the kinematic variables. It does not provide much insight into mechanics of an EGT.

Chatterjee and Tsai[3] use the concept of fundamental geared entity and apply it to the velocity ratio analysis and power loss problems. However, it is only applicable to analyzing kinematic relations among coaxial links.

Liu and Chen[4] develop the concept of kinematic fractionation and apply it to the motion transmission inside a geared mechanism. It can be regarded as motion transmitted from input to output of a series of kinematic units KUs.

Liu et. al.[5] further reveal the topological structures among fractionated KUs, where two types of structures are identified. However, how the global kinematic relations of geared mechanisms are related to the configurations of KUs is not discussed.

Kahraman et al.[6] propose, based on the concept of fundamental KUs, a methodology for the determination of the velocity ratio for each gearing pairs according to the arrangement of the mechanism and the input and output requirements. For the design of planetary gear trains, Salgado and Del Castillo[7] establish power flow maps by drawing the gearing power and transmission ratio curves. For the analysis and synthesis of parallel axis epicyclic gear trains, Talpasanu et al.[8] develop structure matrices from the spanning tree and joint position of a geared mechanism.