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STRUCTURAL ANALYSIS AND SYNTHESIS OF PARALLEL MANIPULATORS

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The paper presents a new way of structural - topological analysis for parallel manipulators, with referring to the calculation of mobility (degree of freedom) of complex mechanisms. A parallel manipulator has a complex topological structure with joints (as kinematical pairs) of various types. For the parallel manipulators we present a new formula for mobility calculation related to the kinematical chain number, considered as identical legs. If we mark with N_l the number of kinematical chains, which are considered as legs for PMp, then the number of independent closed contours is N_l *-1*. It is mentioned that the kinematical chain of a leg can be an open contour (fig. 1) or a complex contour with open and closed contours (fig. 2).

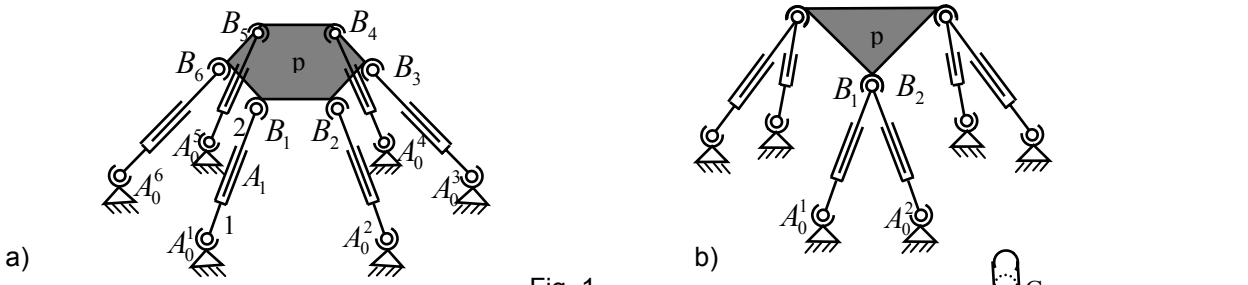

Fig. 1

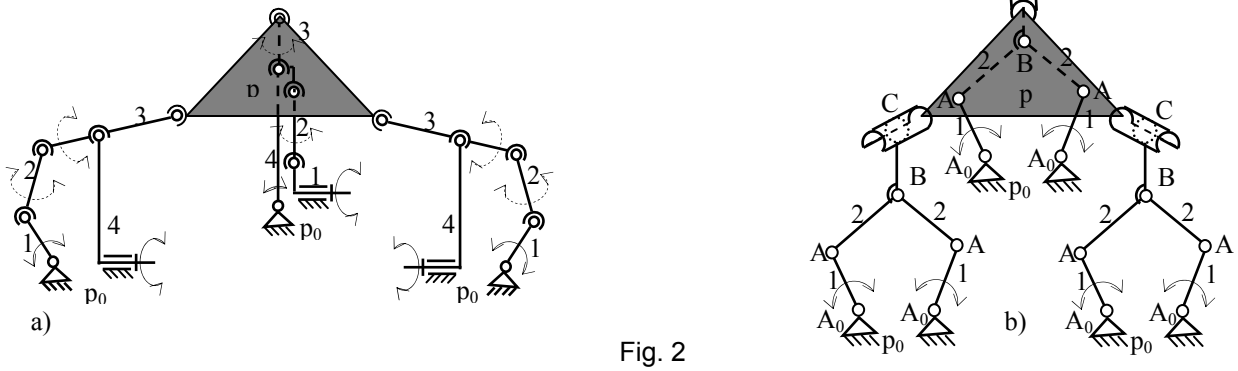

Fig. 2

The general formula of mobility for PMp-s from first category (fig. 1) is writes: $M=(M_0-r_c)\cdot N_l+r_c$, where r_c is the rank of one closed kinematical contour with two legs. For example, for PMp (fig. 1), a leg is composed from two joints of class *m=3* and a joint of class *m=2,* therefore the mobility for them is $M_0=2.1+3.2=8$. The geometrical mobility of this PMp is calculated with previously formula, where r_c*=6* and N_l*=6*: $M=(8-6).6+6=18$. The 18 DOF of PMp are 6 active DOF (provided of 6 actuators, by the 6 sliding motions between elements 1 and 2) and 12 passive DOF (rotations on elements 1 and 2 related to axis A_0B). The general formula of mobility can be written, for PMp-s from the second category (fig. 2), in the following form: $M=\left(\sum_{m=1}^{5}(m\cdot C_m)-(\sum_{i=1}^{n_c}r_i+r_c)\right)\cdot N_l+r_c$, where: $\sum_{m=1}^{5}(m\cdot C_m)$ are the number of a leg joints, r_i is the rank of closed kinematical contour of a leg structure, n_c is the number of closed contours of leg and r_c is the rank of closed contour including the mobile platform. For example, for PMp (fig. 2a), N_l*=3* legs and a leg is composed of a closed contour of spatial pentagon type (with the rank r_1*=6*) and an open contour (r_2*=6*), therefore n_c*=1,* while r_c*=6*. The geometrical mobility of this PMp is : $M=[(1.2+3.4)-(6+6)]\cdot 3+6=12$.

The 12 DOF of PMp are 6 active DOF (circular arrows with continuous line) and 6 passive DOF (circular arrows with dashed line). In the case of PMp from figure 2b N_l*=3* legs and a leg is composed of a closed contour of planar pentagon type (with the rank r_1*=3*) and an open contour (with the rank r_2*=6*), therefore n_c*=1,* while r_c*=6*. The geometrical mobility of this PMp (fig.2b) is: $M=[(1.5+4.1)-(3+6)]\cdot 3+6=6$. All the 6 DOF of this PMp (fig. 2b) are active DOF being represented by the rotations of 6 elements marked with 1 on kinematical scheme.

References

1. Antonescu P., *Mechanism and Machine Science*. Printech Publishing House, Bucharest, 2005.
2. Antonescu O., Antonescu P., *Contributions to topologic structural synthesis of the parallel manipulators.* Conference of Robotics, Iasi, 2006.