

Types of self-motions of planar Stewart Gough platforms

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With this talk, which is based on reference [1], we want to continue the series of contributions about self-motions of Stewart Gough platforms given by KARGER [2, 3] in the previous conferences on geometry – theory and applications, held in Vorau 2007 and Plzen 2009.

We show that the self-motions of the general planar Stewart Gough platforms can be characterized in the complex extension of the Euclidean 3-space by the movement of three platform points in planes orthogonal to the planar base (3-point Darboux motion; cf. [4]) and a simultaneous sliding of three planes orthogonal to the planar platform through points of the base (3-plane Mannheim motion; cf. [4]). Based on this consideration, we can prove that all one-parametric self-motions of a general planar Stewart Gough platform can be classified into two types (type I DM and type II DM, where DM abbreviates Darboux Mannheim).

We also present a way on how the set of equations yielding a type II DM self-motion can be computed explicitly. Based on these equations, which are of great simplicity seen in the context of self-motions, we are also able to compute first results for this class of self-motions (cf. [5]). These results raise the hope of giving a complete classification of type II DM self-motions in the future, which would be an important step in solving the famous Borel Bricard problem [3, 6, 7, 8, 9]. The work towards this goal is in progress.

We close the talk by presenting a geometric interpretation of a large set of already known type II DM self-motions (cf. [2, 10]), which also simplifies their computation considerably.

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References

- [1] NAWRATIL, G.: Types of self-motions of planar Stewart Gough platforms, under review.
- [2] KARGER, A.: Self-motions of Stewart-Gough platforms, Computer Aided Geometric Design, Special Issue: Classical Techniques for Applied Geometry (B. Jüttler, O. Röschel, E. Zagar eds.) **25** (9) 775–783 (2008).
- [3] KARGER, A.: Parallel manipulators and Borel-Bricard problem, Computer Aided Geometric Design, Special Issue: Advances in Applied Geometry (B. Jüttler, M. Lavicka, O. Röschel eds.) **27** (8) 669–680 (2010).
- [4] BOTTEMA, O., ROTH, B.: Theoretical kinematics, Dover Publications (1990).
- [5] NAWRATIL, G.: Basic result on type II DM self-motions of planar Stewart Gough platforms, In Proc. of 1st Workshop on Mechanisms, Transmissions and Applications, Timisoara October 6–8 2011, Romania, Springer (2011) to appear.
- [6] BOREL, E.: Mémoire sur les déplacements à trajectoires sphériques, Mém. présentées par divers savants, Paris(2), 33, 1–128 (1908).
- [7] BRICARD, R.: Mémoire sur les déplacements à trajectoires sphériques, Journ. École Polyt.(2), 11, 1–96 (1906).
- [8] HUSTY, M.: E. Borel’s and R. Bricard’s Papers on Displacements with Spherical Paths and their Relevance to Self-Motions of Parallel Manipulators, Int. Symp. on History of Machines and Mechanisms (M. Ceccarelli ed.), 163–172, Kluwer (2000).
- [9] VOGLER, H.: Bemerkungen zu einem Satz von W. Blaschke und zur Methode von Borel-Bricard, Grazer Mathematische Berichte **352** 1–16 (2008).
- [10] KARGER, A.: New Self-Motions of Parallel Manipulators, Advances in Robot Kinematics: Analysis and Design (J. Lenarcic, P. Wenger eds.), 275–282, Springer (2008).