

Stewart-Gough Platforms : the potential of 6-DOF parallel mechanisms in architecture and engineering

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Abstract

A Stewart-Gough platform (SGP) is a six degree-of-freedom (DOF) parallel mechanism, initially introduced by Gough and Stewart to animate flight simulator platforms. In common use an SGP consists of a mobile rigid platform, which is connected to a fixed base by six articulated legs in a regular (isosceles) constellation. Each leg is connected to the platforms by universal joints. According to Husty[1] the most interesting question concerning SGPs is to find the pose of the platform frame at given base points, platforms and leg- lengths. This question can be solved by direct kinematics of the SGP and it is used in areas such as robotics, virtual reality or 3D printing.

Recently, the interest in the application of these platforms to other fields, such as construction or architecture (see Filz [2]; Filz and Naicu [3]), has grown, encouraged by their capabilities of generating novel forms in an (seemingly) unlimited design space and huge potential for new functional relationships and visual findings. However, simultaneously, these new forms lead also to new structural requirements regarding functionality, stiffness or, obviously, failure. Thus, both architectural and structural requirements define an iterative process in which geometry becomes the common space where architecture and structural engineering meet.

In this paper, the authors would like to show their preliminary studies about the capability of Stewart-Gough platforms, especially regarding aspects such as mobility, stability or functionality of the configurations that can be generated. Even though path planning that involve storing the entire reachable workspace in memory at high resolutions is not feasible (Au et.al.) due to the six-dimensional workspace, this paper will look into the fundamental principles of how to generate a wide range of constellations for stable configurations. So, the exploration of potentials of this type of structures in architecture and civil engineering will provide the basis for future investigations and applications.



Potentials of Stewart-Gough platforms - from simulation of constellations, to structural model, to kinematic model to the case study of the realized experimental structure of "2Landscapes"

References

- [1] M.L. Husty, "An algorithm for solving the direct kinematics of the general Stewart-Gough platforms", *Mechanism and Machine Theory* 31 (4) (1996) 365–380.
- [2] G. H. Filz, "cut.enoid.tower [kʌt.ənɔɪd.taʊə]" in *TensiNet Symposium 2013: [RE]THINKING Lightweight Structures*, Istanbul, Turkey, May 8-10, 2013.
- [3] G. H. Filz and D. Naicu, "2 Landscapes - interaction of 2 gridshells based on a modified Stewart-Gough principle" in *IASS Working Groups 12 + 18 International Colloquium*, Tokyo, Japan, April 10-13, 2015.