Solving the Forward Displacement Problem for Stewart-Gough Platforms

In this project you will
(1) study the formulation of an application as a polynomial system;
(2) apply homotopy methods and coefficient-parameter polynomial continuation;
(3) combine working with Maple and `phc`.

In Lecture 9 we discussed coefficient-parameter polynomial continuation, using the application described by Charles W. Wampler: **Forward displacement analysis of general six-in-parallel SPS (Stewart) platform manipulators using soma coordinates.** *Mech. Mach. Theory*, 31(3):331–337, 1996. Via UIC's library system, you can download this paper electronically.

From the course web site, also download a Maple worksheet. This Maple worksheet generates a polynomial system which is suitable for a numerical homotopy solver.

At `http://www.math.uic.edu/~jan/download.html` you can download executable versions for the program `phc`, for various machines and operating systems.

1. Assignment One: Solve the System

Use `phc -b` (in blackbox mode) to solve the system generated by the Maple worksheet.

1. Interpret and describe the results of the computations.
2. Generate multiple instances of the problem and solve these systems.
   Do you always see the same number of solutions?

2. Assignment Two: Coefficient-Parameter Homotopies

The polynomial system in the worksheet is the general Stewart-Gough platform with six legs attached at random positions at base and end platform. When the joints at base and/or end plate coincide, the number of solutions is expected to drop.

1. Extend the Maple worksheet to generate the polynomial system with a special Stewart-Gough platform for which there are only three different joints at base and end platform. This so-called 3-3 platform is displayed on a picture in the lecture note.
2. Use `phc -p`, to solve this specific instance, taking a general system as start system.

3. Assignment Three: Reformulate the Problem as in the Proof

To show that the problem can have at most 40 solutions, the proof in the paper of Charles Wampler rewrites the system into one for which a multihomogeneous Bézout bound equals 80.

1. Extend the Maple worksheet so it generates the system as in the proof.
2. Apply `phc -b` to the generated system to verify.

4. The deadline is Monday 26 February 2007 at 9AM

You are allowed to work in pairs (i.e.: groups of two). If you are not so familiar with Maple, team up with some one who knows Maple well. Every pair should hand in one report with the two names of its authors (not two identical reports).

The report should be structured along the assignments, i.e.: the first section contains the answers of Assignment One, followed by the answers of Assignment Two, etc.

You may use Maple output in your answers, but the complete print out of your Maple worksheet must remain an *appendix* to your report.

Feel free to come to my office for help.