MECH 541 Kinematic Synthesis

Mini-project 2: The Synthesis of a Spherical Quick-return Linkage

Statement of Work

Assigned: Monday February 17th, 2014 Due: Friday March 14th, 2014

A quick-return linkage is needed to drive a gripping mechanism intended to lift objects in a production line during a certain time interval T_1, throughout a rotation of 60° of the output link. As the input and the output axes intersect at an angle of 120°—$\alpha_1 = 120°$—a *spherical* four-bar linkage is needed. The output link is then required to return to its original position in a time interval $T_2 = T_1/2$. To this end,

1. Define a set of input-output data pairs $\{\,(\Delta\psi_i,\, \Delta\phi_i)\,\}_1^m$, with $m > 4$. Next, define angles α and β, as part of the design variables, that will produce a set of input-output pairs, namely,

$$\psi_i = \alpha + \Delta\psi_i, \quad \phi_i = \beta + \phi_i, \quad i = 1, \ldots, m$$

2. For α and β varying from 0 to 2π, compute the condition number κ_F of the synthesis matrix $\mathbf{S}(\alpha,\, \beta)$ based on the Frobenius norm. Produce a surface representation of $\kappa_F(\alpha,\, \beta)$

3. Repeat item 2 for the rms value of the structural error obtained upon minimizing the weighted Euclidean norm of the design error.

4. Repeat item 2 for the transmission quality of each linkage.

Estimate visually the optimum values of α and β for minimum κ_F, minimum rms value of the structural error and for the maximum transmission quality. Comment on your results. Is there any correlation among the various optima? What is the influence of m in the foregoing optima? The minimum value that you should assign to m is 5, the maximum needn't exceed 50.

Include plots of the input-output function of the optimum linkage, that clearly show that the given time ratio T_2/T_1 is *reasonably reached*.

Animations of the synthesized linkage are encouraged, although not mandatory.