Problems which involves eigenvectors

Ninoslav Truhar
Department of Mathematics, University of Osijek,
ntruhar@mathos.hr

September 20, 2021

We consider two problems which in a some way involve eigenvectors and eigenspaces of Hermitian matrices.

As the first problem, we consider the damping optimization problem for systems defined by the vector differential equation $M\ddot{x}+C\dot{x}+Kx = 0$, where $M, C, K \in \mathbb{R}^{n\times n}$ are mass, damping and stiffness matrices, respectively.

We present a novel approach for simultaneous optimization of positions and damping viscosities. The position optimization is based on a heuristic for defining a feasible set of possible optimal positions that are local minimizers for the one-dimensional damping acting on only one danger (or dominant) frequency. For this case, we also present a quality analysis for the trace function $f(v) = \mathrm{trace}(X(v))$, which allows us to approximate the trace function as a rational function.

As the second problem we consider the eigenvector-dependent nonlinear eigenvalue problem (NEPv) $H(V)V = V\Lambda$, where $H(V) \in \mathbb{C}^{n\times n}$ is an Hermitian matrix-valued function of $V \in \mathbb{C}^{n\times k}$ with orthonormal columns, i.e., $V^HV = I_k$, $k \leq n$ (usually $k \ll n$). We present the conditions on existence and uniqueness for the solvability of NEPv using the well known results of the relative perturbation theory. All results are illustrated with a set of numerical examples.

Presented results are joint work with:

Ivica Nakić; Department of Mathematics, University of Zagreb, Croatia; nakic@math.hr and
Ren-Cang Li; Department of Mathematics, University of Texas at Arlington; rcli@uta.edu.