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Shape Optimization of a 3D Annular Combustor to Eliminate Thermoacoustic Instability[1] STEFANO FALCO, MATTHEW JUNIPER, Univ of Cambridge — Thermoacoustic instabilities, which arise due to the interaction between confined flames and acoustics, are sensitive to small changes in system parameters. Gas turbines are notoriously susceptible to this instability, which often recurs during final engine tests. The instabilities are usually eliminated by inspired trial and error, making small changes to the geometry or adding passive devices. The aim of this project is to identify these small changes systematically. We do this with adjoint-based shape optimization of a 3D finite element Helmholtz solver. We examine the case of a 30kW laboratory-scale combustor (MICCA), which is azimuthally unstable. First, using the Hadamard theorem, we find the eigenvalue shape derivatives in order to identify the most influential regions of the combustor. Then we apply an optimization algorithm based on the shape gradients to stabilize the azimuthal mode. We only apply shape changes that do not break the discrete rotational symmetry of the annular combustor so that the two-fold degenerate azimuthal mode does not unfold. The ability to handle complex 3D geometries makes this tool a strong candidate for the iterative design of thermoacoustically stable combustors.

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