ON THE USE OF A FREQUENCY DOMAIN METHOD FOR CLASSIFYING THE OSCILLATORY BEHAVIOR IN NONLINEAR CONTROL PROBLEMS

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Abstract: The dynamic behavior close to a non-resonant double Hopf (DH) bifurcation in a simple coupled electrical circuit is analyzed via a frequency-domain technique and numerical continuation methods. A non-resonant DH bifurcation (Kuznetsov, 1998) occurs when two pairs of imaginary eigenvalues of the linearized equations around an equilibrium point cross the imaginary axis when certain distinguished parameters vary. In the neighborhood of this singularity, periodic and quasi-periodic motions (2D and 3D tori) are likely to exist. Approximate expressions of the periodic solutions emerging from Hopf bifurcation curves are computed using the higher order harmonic balance method (Mees and Chua, 1979; Mees, 1981; Moiola and Chen, 1996) while their accuracy and stability have been evaluated through the calculation of the multipliers of the monodromy matrix. Furthermore, the detection of secondary Hopf or torus bifurcations (also called Neimark Sacker bifurcation for maps) close to the analyzed singularity has been obtained. Extending this analysis to the unfolding of DH bifurcation, cyclic fold, period doubling and torus bifurcations have also been detected in that circuit. Furthermore, two fold-flip (FF) bifurcations are computed in the vicinity of the DH bifurcation, and are classified correspondingly. The appearance of FF bifurcations seems to be new connected to the DH bifurcation. The analysis is completed with time simulations, continuation of several limit cycle bifurcations and indication of resonance points. The comparisons of the results obtained with the suggested technique, and with continuation software packages such as LOCBIF and XPP-AUTO have been included for completeness.

References

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