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Sound synthesis of circular plates by finite differences

Kevin Arcas[a], Antoine Chaigne[a] and Stefan Bilbao[b]
[a]ENSTA, Chemin de la Hunière, 91761 Palaiseau, France
[b]University of Edinburgh, Room 7306B, JCMB, King's Bldgs., Mayfield Rd., EH9 3JZ Edinburgh, UK

This paper shows a method for simulating linear flexural vibrations of circular plates by finite differences (FD) for the purpose of sound synthesis. The vibrations are assumed to follow the Kirchhoff-Love model. In order to solve the continuous problem numerically, the equations are approximated in space and time by FD methods. Two schemes are presented and compared; depending on the coordinate system used for the grid, rectangular and polar, respectively. Cartesian FD are not easily adaptable to circular boundary conditions and generic conservative boundary conditions cannot be found. On the contrary, polar FD allow to find well-adapted conservative boundary conditions. With a polar grid, the distance between consecutive gridpoints decreases from the edge to the center. As a consequence the stability of the algorithm depends on the minimum radius of the grid, where this distance is the smallest. Because of this highly restrictive stability condition, numerical dispersion is high and the high-frequency content of the spectrum is badly reproduced. To avoid this problem an implicit polar FD scheme has been developed which yields simulations with acceptable numerical dispersion. The accuracy of the algorithm is estimated by computing the ratio between numerical and analytic eigenfrequencies in a simple case.