MSc. Music and Acoustic Engineering

Musical Acoustics - A.Y. 2020/2021

HL3 – Modeling Techniques

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January 7, 2021

1 Comments on the FD implementation

1.1 Simulation data

The code contains an implementation of a backward finite difference scheme which is used to simulate a piano string struck with a felt hammer. The string under consideration is tuned to C2 ($f_0 = 52.8221\,\mathrm{Hz}$). We chose a sampling frequency of $f_s = 176.4\,\mathrm{kHz}$ as suggested in ... and it's well above the Nyquist frequency so we don't expect aliasing in the time domain. Other dimensions that are not suggested in the assignment, such as string mass, hammer mass, string length etc. have been taken from ... and can be found listed in Tab. 1 . The string has a linear mass $\mu = M_s/L$ and the tension applied on it at rest has been computed as $T_0 = 4L^2 f_0^2 \mu$ which determines that the speed of sound along the string is $c = \sqrt{T_0/\mu}$. The spatial sampling has been chosen under the limit imposed by the stability condition ...

$$N_{max} = \sqrt{\frac{-1 + \sqrt{1 + 16\epsilon\gamma^2}}{8\epsilon}}$$

where $\gamma = f_s/2f_0$. The number of spatial steps has been set as $N = N_{max} - 1 = 537$ and the relative spatial resolution is $X = 0.0036\,\mathrm{m}$.

string length	L	$1.92\,\mathrm{m}$
string mass	M_s	$35 \times 10^{-3}\,\mathrm{kg}$
string stiffness parameter	ϵ	7.5×10^{-6}
string stiffness coefficient	κ	7.5×10^{-6}
relative striking position	a	0.12
viscous damping coefficient	b_h	$1 \times 10^{-4}\,\mathrm{s}^{-1}$
hammer mass	M_h	$4.9 \times 10^{-3}\,\mathrm{kg}$
hammer stiffness	K	$4 \times 10^{8}\,\mathrm{N\,m}^{-1}$
stiffness exponent	p	2.3
hinge normalized impedance	ζ_l	$10^{20}\,\mathrm{s}^3\mathrm{m}^2/\mathrm{kg}^2$
bridge normalized impedance	ζ_b	$10^{3}\,\mathrm{s}^3\mathrm{m}^2/\mathrm{kg}^2$

Table 1: Values considered in the simulation.