Stepper motor acceleration

Determining angular velocity ω by delay τ

The angular velocity of a stepper motor is defined by the angle per step α and the time delay τ between steps.

The time delay is generally given by

```
delay[ConstDelay_, DelayFactor_] := Function[{n}, ConstDelay + n DelayFactor]
```

```
ω → α/τ
% /. τ → delay[c, d][n]
```

$$\omega \to \frac{\alpha}{\tau}$$

$$\omega \to \frac{\alpha}{c + d\,n}$$

For a constant angular acceleration $\frac{d\omega}{dt}$, we want ω to increase linearly.

```
ω → α/τ
% /. τ → delay[c, d][n]
Ω t == ω /. %
Last[Solve[%, n]]
```

$$\omega \to \frac{\alpha}{\tau}$$

$$\omega \to \frac{\alpha}{c + d\,n}$$

$$t\,\Omega == \frac{\alpha}{c + d\,n}$$

$$\left\{n \to \frac{\alpha - c\,t\,\Omega}{d\,t\,\Omega}\right\}$$

Heuristic for constant acceleration

```
delay → dividend / divisor
ω → α / delay
% /. %%
% //. {dividend → 2000, divisor → Range[dividend / ωmax], ωmax → 20}
N[ω /. % /. α → 1]
ListPlot[%, Frame → True]
```

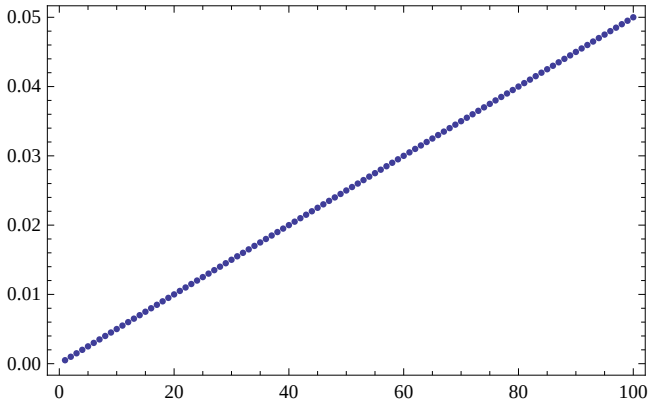
$$\text{delay} \to \frac{\text{dividend}}{\text{divisor}}$$

$$\omega \to \frac{\alpha}{\text{delay}}$$

$$\omega \to \frac{\text{divisor}\,\alpha}{\text{dividend}}$$

$$\omega \to \left\{\frac{\alpha}{2000}, \frac{\alpha}{1000}, \frac{3\alpha}{2000}, \frac{\alpha}{500}, \frac{\alpha}{400}, \frac{3\alpha}{1000}, \frac{7\alpha}{2000}, \frac{\alpha}{250}, \frac{9\alpha}{2000}, \frac{\alpha}{200}, \frac{11\alpha}{2000}, \frac{3\alpha}{500}, \frac{13\alpha}{2000}, \frac{7\alpha}{1000}, \frac{3\alpha}{400},\right.$$
$$\frac{\alpha}{125}, \frac{17\alpha}{2000}, \frac{9\alpha}{1000}, \frac{19\alpha}{2000}, \frac{\alpha}{100}, \frac{21\alpha}{2000}, \frac{11\alpha}{1000}, \frac{23\alpha}{2000}, \frac{3\alpha}{250}, \frac{\alpha}{80}, \frac{13\alpha}{1000}, \frac{27\alpha}{2000}, \frac{7\alpha}{500}, \frac{29\alpha}{2000}, \frac{3\alpha}{200},$$
$$\frac{31\alpha}{2000}, \frac{2\alpha}{125}, \frac{33\alpha}{2000}, \frac{17\alpha}{1000}, \frac{7\alpha}{400}, \frac{9\alpha}{500}, \frac{37\alpha}{2000}, \frac{19\alpha}{1000}, \frac{39\alpha}{2000}, \frac{\alpha}{50}, \frac{41\alpha}{2000}, \frac{21\alpha}{1000}, \frac{43\alpha}{2000}, \frac{11\alpha}{500},$$
$$\frac{9\alpha}{400}, \frac{23\alpha}{1000}, \frac{47\alpha}{2000}, \frac{3\alpha}{125}, \frac{49\alpha}{2000}, \frac{\alpha}{40}, \frac{51\alpha}{2000}, \frac{13\alpha}{500}, \frac{53\alpha}{2000}, \frac{27\alpha}{1000}, \frac{11\alpha}{400}, \frac{7\alpha}{250}, \frac{57\alpha}{2000}, \frac{29\alpha}{1000},$$
$$\frac{59\alpha}{2000}, \frac{3\alpha}{100}, \frac{61\alpha}{2000}, \frac{31\alpha}{1000}, \frac{63\alpha}{2000}, \frac{4\alpha}{125}, \frac{13\alpha}{400}, \frac{33\alpha}{1000}, \frac{67\alpha}{2000}, \frac{17\alpha}{500}, \frac{69\alpha}{2000}, \frac{7\alpha}{200}, \frac{71\alpha}{2000}, \frac{9\alpha}{250},$$
$$\frac{73\alpha}{2000}, \frac{37\alpha}{1000}, \frac{3\alpha}{80}, \frac{19\alpha}{500}, \frac{77\alpha}{2000}, \frac{39\alpha}{1000}, \frac{79\alpha}{2000}, \frac{\alpha}{25}, \frac{81\alpha}{2000}, \frac{41\alpha}{1000}, \frac{83\alpha}{2000}, \frac{21\alpha}{500}, \frac{17\alpha}{400}, \frac{43\alpha}{1000},$$
$$\left.\frac{87\alpha}{2000}, \frac{11\alpha}{250}, \frac{89\alpha}{2000}, \frac{9\alpha}{200}, \frac{91\alpha}{2000}, \frac{23\alpha}{500}, \frac{93\alpha}{2000}, \frac{47\alpha}{1000}, \frac{19\alpha}{400}, \frac{6\alpha}{125}, \frac{97\alpha}{2000}, \frac{49\alpha}{1000}, \frac{99\alpha}{2000}, \frac{\alpha}{20}\right\}$$

```
{0.0005, 0.001, 0.0015, 0.002, 0.0025, 0.003, 0.0035, 0.004, 0.0045, 0.005, 0.0055, 0.006,
 0.0065, 0.007, 0.0075, 0.008, 0.0085, 0.009, 0.0095, 0.01, 0.0105, 0.011, 0.0115,
 0.012, 0.0125, 0.013, 0.0135, 0.014, 0.0145, 0.015, 0.0155, 0.016, 0.0165, 0.017,
 0.0175, 0.018, 0.0185, 0.019, 0.0195, 0.02, 0.0205, 0.021, 0.0215, 0.022, 0.0225,
 0.023, 0.0235, 0.024, 0.0245, 0.025, 0.0255, 0.026, 0.0265, 0.027, 0.0275, 0.028,
 0.0285, 0.029, 0.0295, 0.03, 0.0305, 0.031, 0.0315, 0.032, 0.0325, 0.033, 0.0335,
 0.034, 0.0345, 0.035, 0.0355, 0.036, 0.0365, 0.037, 0.0375, 0.038, 0.0385, 0.039,
 0.0395, 0.04, 0.0405, 0.041, 0.0415, 0.042, 0.0425, 0.043, 0.0435, 0.044, 0.0445,
 0.045, 0.0455, 0.046, 0.0465, 0.047, 0.0475, 0.048, 0.0485, 0.049, 0.0495, 0.05}
```


0.05
0.04
0.03
0.02
0.01
0.00
0
20
40
60
80
100