Model Documentation of the Two Mass Floating Bodies

1 Nomenclature

1.1 Nomenclature for Model Equations

m_1	mass of the iron ball
m_2	mass of the brass ball
k_1	geometry constant
k_2	air gap of magnet
k_f	spring constant
g	acceleration of gravity
I	current
s_1	position of the iron ball in x-direction
s_2	position of the brass ball in x-direction
v_1	velocity of the iron ball in x-direction
v_2	velocity of the brass ball in x-direction

1.2 Graphic of the Structure

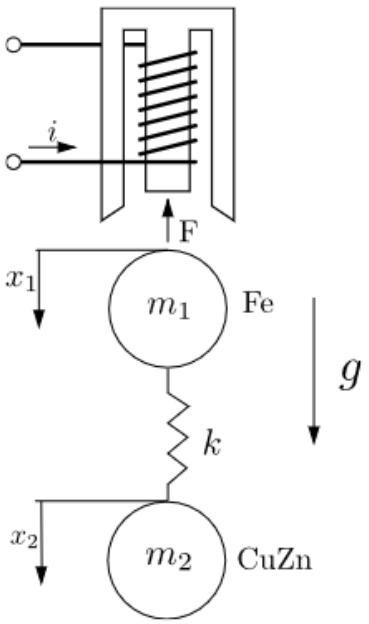

Figure 1: Structure of the Two Mass Floating Bodies Model.
Source: Wang, Xinyu/Erstellung eines Katalogs regelungstechnischer Problemstellungen mit ausführbaren Beispiellösungen

2 Model Equations

State Vector and Input Vector:

$$\underline{x} = (x_1\ x_2\ x_3\ x_4)^T = (s_1\ s_2\ v_1\ v_2)^T$$
$$\underline{u} = u_1 = I$$

System Equations:

$$\dot{x}_1 = x_3 \tag{1a}$$
$$\dot{x}_2 = x_4 \tag{1b}$$
$$\dot{x}_3 = g - \frac{k_f}{m_1}(x_1 - x_2) - k_1 \frac{I}{m_1(x_1 + k_2)^2} \tag{1c}$$
$$\dot{x}_4 = g + \frac{k_f}{m_2}(x_1 - x_2) \tag{1d}$$
$$\tag{1e}$$

Parameters: m_1, m_2, k_1, k_2, k_f, g
Outputs: s_2

2.1 Assumptions

1. Mass of the iron ball is a pointmass.
2. Mass of the brass ball is a pointmass.

2.2 Exemplary parameter values

Parameter Name	Symbol	Value	Unit
mass of the iron ball	m_1	0.05	kg
mass of the brass ball	m_2	0.04	kg
geometry constant	k_1	$4.0 \cdot 10^{-5}$	
air gap of magnet	k_2	0.005	m
spring constant	kf	10	$\frac{N}{m}$
acceleration of gravity	g	9.8	$\frac{m}{s^2}$

3 Derivation and Explanation

The Lagrangian mechanics was used for the solution.

4 Simulation

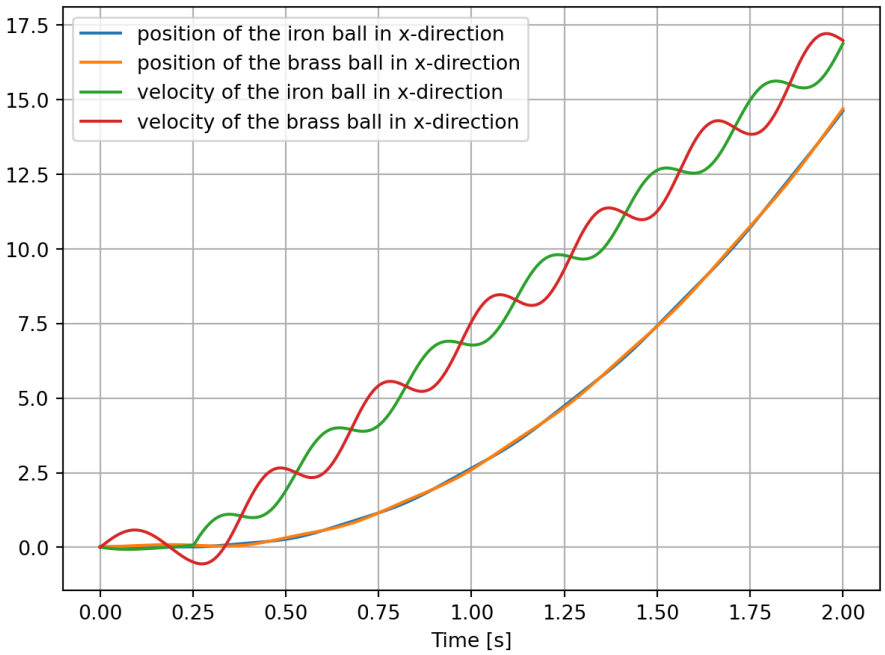

Figure 2: Simulation of the Two Mass Floating Bodies.

References

[1] Wang, Xinyu: *Erstellung eines Katalogs regelungstechnischer Problemstellungen mit ausführbaren Beispiellösungen*, student research project at the Institut für Regelungs- und Steuerungstheorie TU Dresden, 2021.
(not publicly accessible)