APPENDIX

Appendix 1. Parameters

Table 1. Two-wheeled vehicle - rider parameters

Parameters	Nomenclature	Values
r_{wf}	radius of the front wheel	$0.35\ m$
r_{wr}	radius of the rear wheel	$0.3\ m$
w	wheel base	$1.02\ m$
a	Trail	$0.08\ m$
l_r	horizontal distance from A	$0.3\ m$
h_r	vertical distance from A	$0.9\ m$
M_r	Mass rear frame	$35\ kg$
M_f	Mass front frame	$4\ kg$
M_{rw}	Mass rear wheel	$3\ kg$
M_{fw}	Mass front wheel	$3\ kg$
I_{rw}	mass moment of inertia rear wheel	$\begin{pmatrix} 0.0603 & 0 & 0 \\ 0 & 0.12 & 0 \\ 0 & 0 & 0.0603 \end{pmatrix} \text{kg}m^2$
I_{Fw}	mass moment of inertia front wheel	$\begin{pmatrix} 0.1405 & 0 & 0 \\ 0 & 0.28 & 0 \\ 0 & 0 & 0{,}1405 \end{pmatrix} \text{kg}m^2$
I_F	mass moment of inertia front fork	$\begin{pmatrix} 0.05892 & 0 & -0.00756 \\ 0 & 0.06 & 0 \\ -0.00756 & 0 & 0.00708 \end{pmatrix} \text{kg}m^2$
I_{rider}	mass moment of inertia of the rider body	$\begin{pmatrix} 4.299 & 0 & 0 \\ 0 & 5.186 & 0 \\ 0 & 0 & 1.413 \end{pmatrix} \text{kg}m^2$
I_{Bike}	mass moment of inertia of the chassis of the bicycle	$\begin{pmatrix} 3.8690 & 0 & 1.3 \\ 0 & 4.667 & 0 \\ 1.3 & 0 & 1.272 \end{pmatrix} \text{kg}m^2$
M_r	mass of rider	$50\ kg$
$k_{\varphi r}$	Stiffness of the upper part of rider	$760\ Nm/rad$

Appendix 2. Matrix coefficients

The coefficients of the linearized equations of motion are:

$$M = \begin{bmatrix} M_{\varphi\varphi} & M_{\varphi\varphi_r} & M_{\varphi\delta} \\ M_{\varphi\varphi_r} & M_{\varphi_r\varphi_r} & M_{\delta\varphi_r} \\ M_{\varphi\delta} & M_{\varphi_r\delta} & M_{\delta\delta} \end{bmatrix}$$

$$M_{\varphi_r\varphi_r} = I_{rxx_r} + m_{ur}h_{ur}^2$$
$$M_{\varphi\varphi_r} = I_{rxx_r} - m_{ur}h_{ur}z_R$$
$$M_{\varphi_r\delta} = -I_{rxz_r} + m_{ur}h_{ur}z_R$$
$$C_1 = \begin{bmatrix} 0 & 0 & C_{1\varphi\delta} \\ 0 & 0 & C_{1\delta\varphi_r} \\ C_{1\delta\varphi} & 0 & C_{1\delta\delta} \end{bmatrix}$$

$$C_{1\delta\varphi_r} = \frac{a}{w} cos\,\varepsilon\, m_{ur}h_{ur} + \frac{cos\,\varepsilon}{w} I_{r\varphi_r z_D}$$
$$I_{r\varphi_r z_D} = -I_{rxz} + m_{ur}s_{hur}x_R$$
$$S_A = m_T \frac{a_T + l_r}{w} c + m_F e_F$$

Mass and center of gravity Distances of the overall system T:

$$z_T = \frac{m_F z_F + m_R z_R + m_{ur}z_{ur}}{m_T}$$
$$a_T = \frac{m_F a_F + m_{ur}a_{ur}}{m_T}$$
$$m_T = m_r + m_{ur} + m_F$$

$$C_0 = \begin{bmatrix} 0 & 0 & 0 \\ 0 & C_{\varphi_r} & 0 \\ 0 & 0 & 0 \end{bmatrix}$$
$$K_0 = \begin{bmatrix} K_{0\varphi\varphi} & -m_{ur}h_{ur}g & K_{0\varphi\delta} \\ -m_{ur}h_{ur}g & c_{\varphi_r} - m_{ur}h_{ur}g & -C_\delta\, sin\,\varepsilon \\ K_{0\delta\varphi} & 0 & K_{0\delta\delta} \end{bmatrix}$$
$$K_2 = \begin{bmatrix} 0 & 0 & K_{2\varphi\delta} \\ 0 & 0 & \frac{cos\,\varepsilon}{w} m_{ur}h_{ur} \\ 0 & 0 & K_{2\delta\delta} \end{bmatrix}$$