Function Documentation: rhs

Computes the derivatives of the system's state and the control input based on the current state and other system parameters.

Inputs:

currentState (vector): Represents the current state of the system, provided by bike sensors.

- currentState(2): x - X-coordinate.
- currentState(3): y - Y-coordinate.
- currentState(4): phi(ϕ) - Roll angle.
- currentState(5): psi(Ψ) - Yaw angle.
- currentState(6): delta(δ) - Steering angle.
- currentState(7): phi_dot - Roll angular velocity.
- currentState(8): v - Velocity.

p (struct): Contains various system parameters.

- p.g: g - Gravitational acceleration.
- p.l: l - Wheelbase length.
- p.b: b - Distance between the center of mass and the rear axle.
- p.h: h - Height of the center of mass above the ground.

K (vector): Contains control gains, sourced from simulations by the navigation subteam.

- K(1): k1 - Gain for the roll angle.
- K(2): k2 - Gain for the roll angular velocity.
- K(3): k3 - Gain for the steering angle.

delta_offset (scalar): Offset for the steering angle (δ), sourced from simulations by the navigation subteam.

phi_offset (scalar): Offset for the roll angle (ϕ), sourced from simulations by the navigation subteam.

linear (logical): Indicates whether to use a linear or nonlinear model. Note: This variable isn't actively used in the provided code.

Equations:

1. **Control Variable Calculation**:

   $u = k_1(\phi - \phi_{\text{offset}}) + k_2\dot{\phi} + k_3(\delta - \delta_{\text{offset}})$

2. **State Derivative Calculations**:

   a. **Position Derivatives**:

   $\dot{x} = v \cdot \cos(\psi)$

   $\dot{y} = v \cdot \sin(\psi)$

   b. **Orientation Derivatives**:

   $\dot{\phi} = \text{phi\_dot}$

   $\dot{\psi} = \left(\frac{v}{l}\right) \cdot \frac{\tan(\delta)}{\cos(\phi)}$

   c. **Steering Angle Derivative**:

   $\dot{\delta} = u$

   d. **Velocity Derivative**:

   $\dot{v} = 0$

   e. **Roll Angle Acceleration (Nonlinear EOM)**:

   $\ddot{\phi} = \frac{1}{h}\left[g\sin(\phi) - \tan(\delta)\left(\frac{v^2}{l} + \frac{b\dot{v}}{l} + \tan(\phi)\left(\frac{bv\dot{\phi}}{l} - \frac{hv^2\tan(\delta)}{l^2}\right)\right) - \frac{bv\dot{\delta}}{l\cos^2(\delta)}\right]$

Note: I assume the velocity derivative equation(d) is set to 0 as there is no acceleration on the bike. This might need to be adjusted.