Maestría en Ingeniería en Automatización de Procesos Industriales

Model of a single-seat electric vehicle for anti-slip stability control

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1. Introduction

The stability control or ESP is an active safety device, which controls the trajectory that describes a car as shown in figure 1. Generally the ICV (internal combustion vehicles) work with the brakes to correct the deviation of the desired trajectory , so it is required that both the tires and the braking system are in the best possible condition. On the other hand the EV (electric vehicles) having the possibility of using a speed control on each motor, coupled on each rim with traction, is able to maneuver by slowing or accelerating without mechanical wear. [1]

In this paper we present the modeling of the behavior of the single-seat vehicle with rear-wheel drive and incorporating 2 motors on the wheels. And being addressed from the behavior in straight lines and curves to perform an anti-spill stability control.

Trajectories of a vehicle with and without ESP.

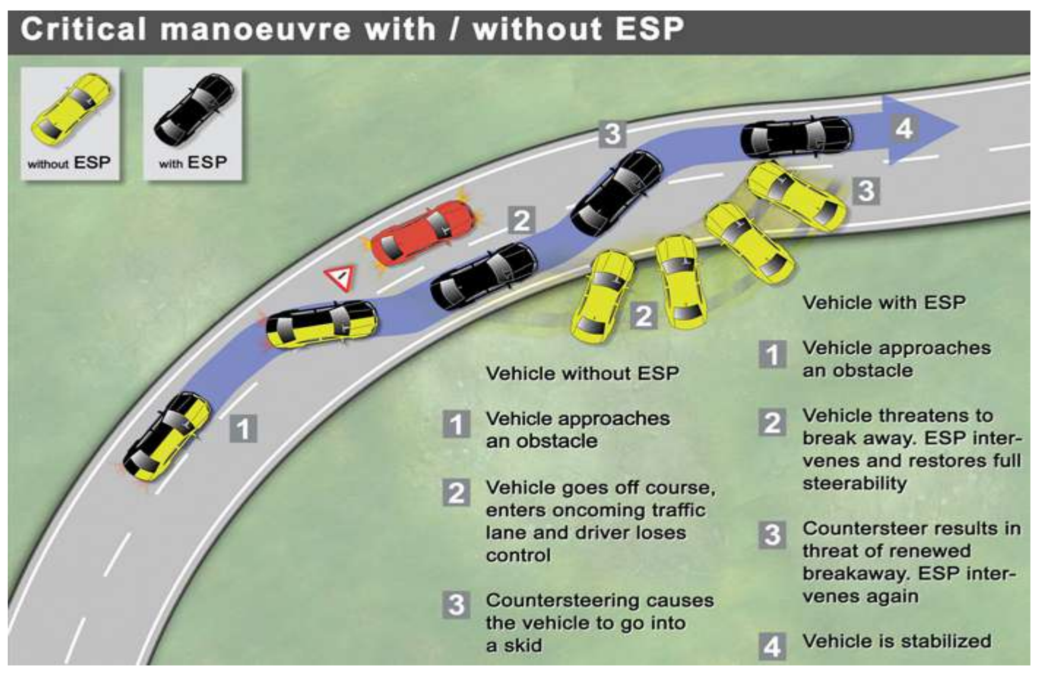

Figure 1. Operation of ESP. [2]

2. Objectives

2.1. General objective

Perform anti-spill stability control for a single-seater vehicle with rear-wheel drive and 2 independent motors coupled in each wheel, to improve its maneuverability in curves and straights.

2.2. Specific objectives

- Model for motor to use and perform speed control.
- Model the dynamics of the electric vehicle.
- Coupling of both models and perform stability control.

3. Methodology

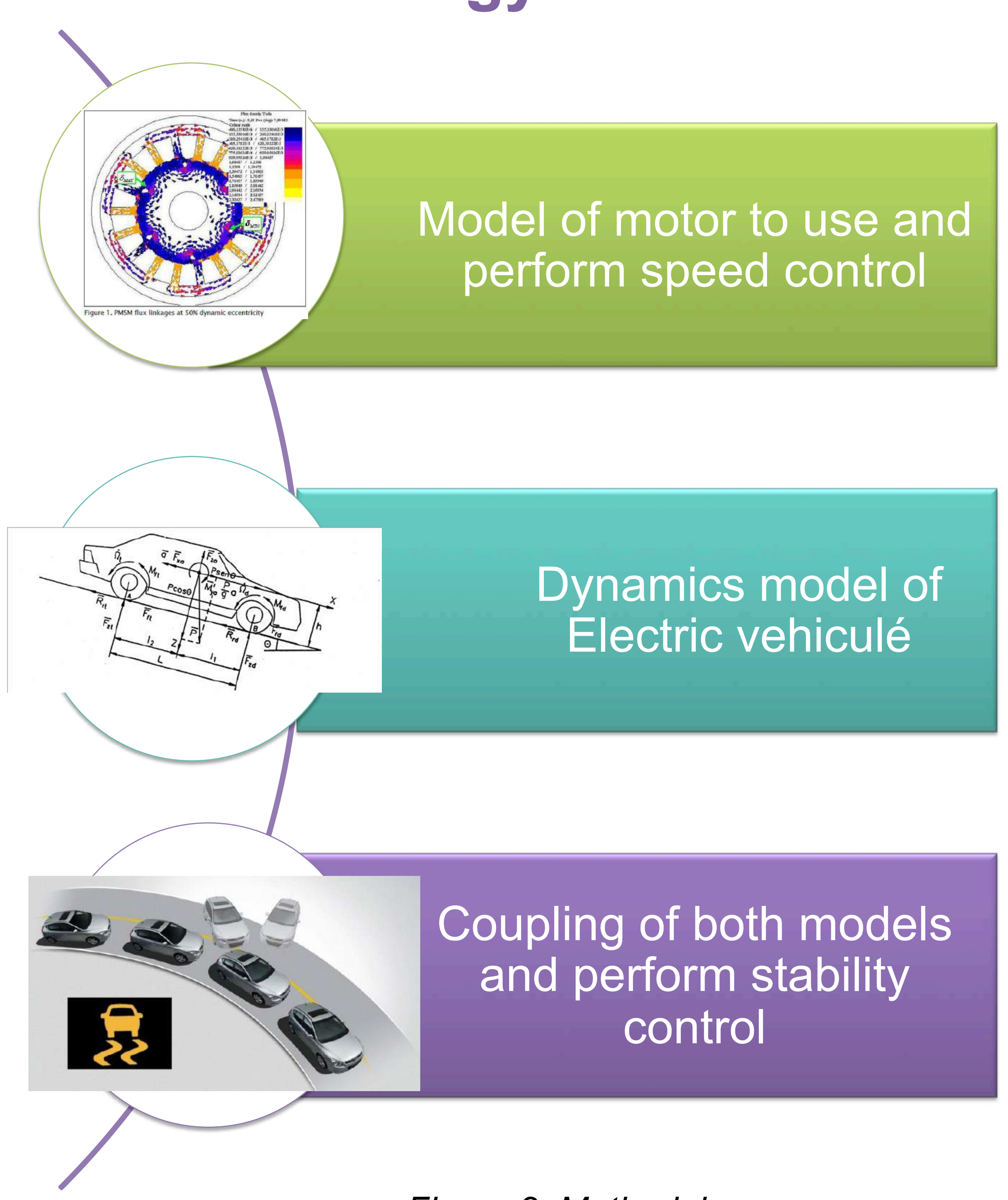

Figure 2. Methodology.

Modeling BLD motor.

The typical model of a PMSM in a two–axis $d-q$ synchronous rotating reference frame is represented by:

$$L_d\frac{di_d}{dt} = \omega L_q i_q P - Ri_d + v_d \qquad (1)$$

$$L_q\frac{di_q}{dt} = -\omega(L_d i_d P + K_m) - Ri_q + v_q \qquad (2)$$

$$\frac{2}{3}J\frac{d\omega}{dt} = K_m i_q - \frac{2}{3}(T_L + B\omega) \qquad (3)$$

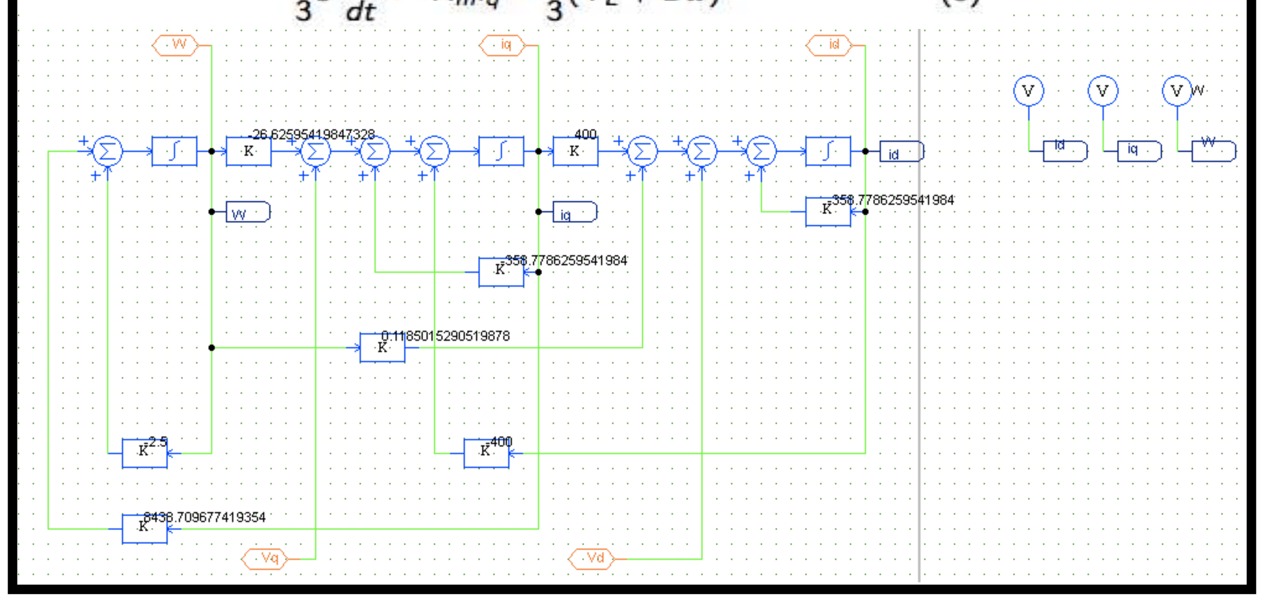

Figure 3. Motor model [3].

Speed control.

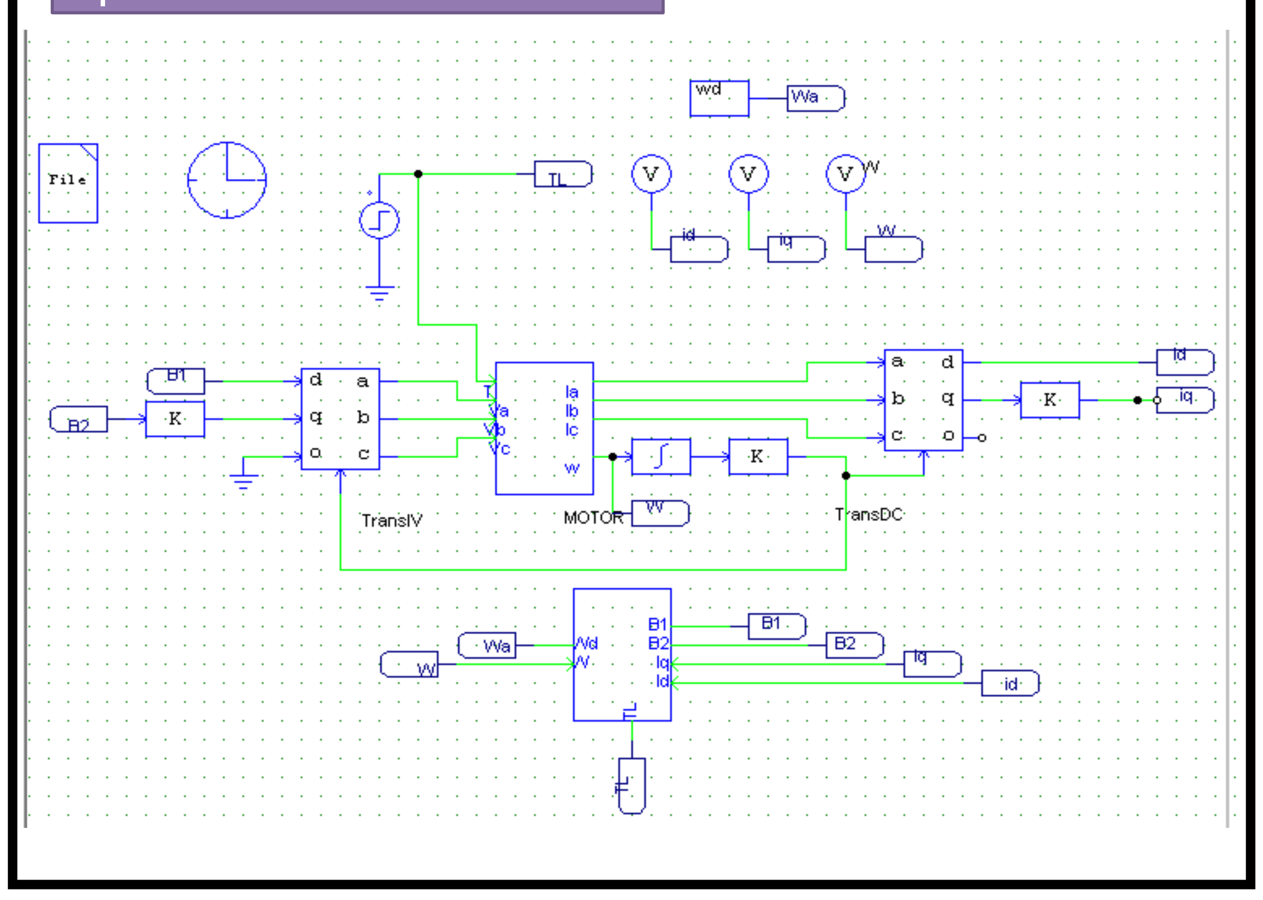

Figure 4. Speed control [4].

Vehicle model in straight lines and curves.

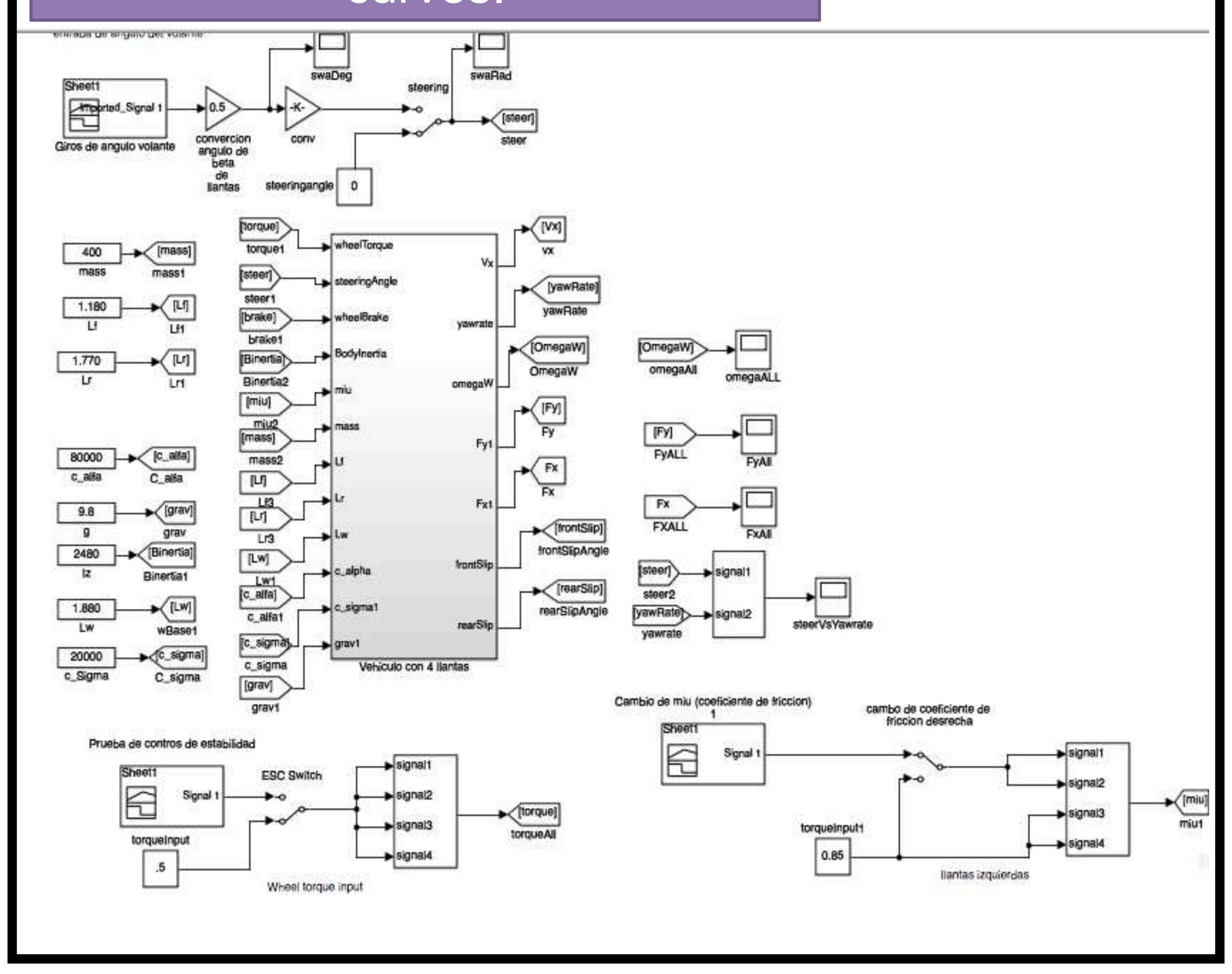

Figure 5. Vehicle Model [5, 6].

Motor and Vehicle Coupling

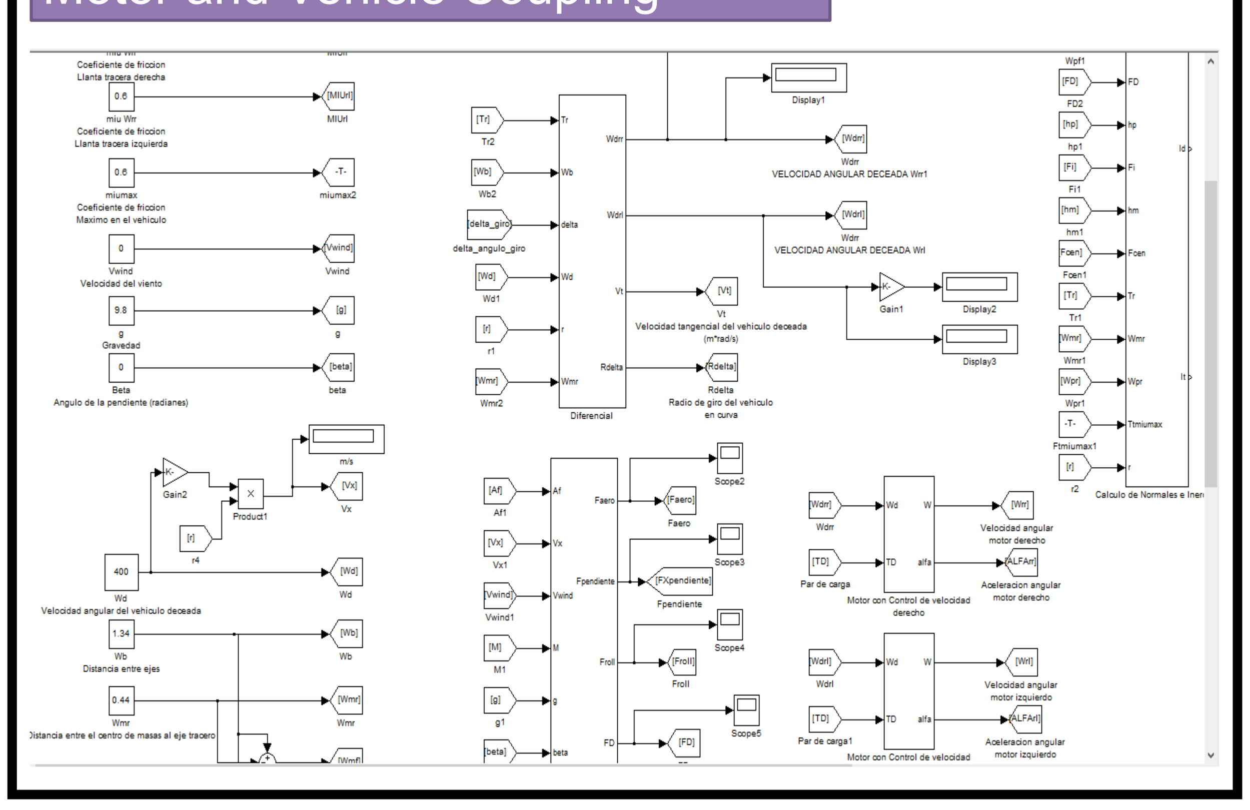

Figure 6. Electromechanical model [5, 6, 7].

4. Results

Speed control simulation.

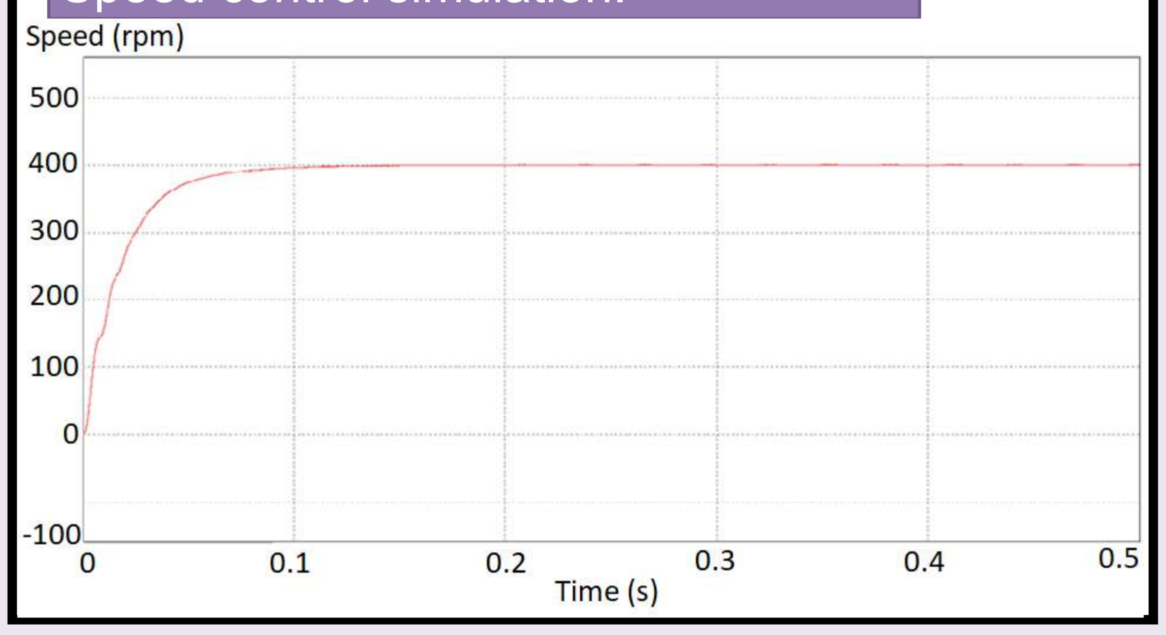

Figure 7. Speed control results.

VE model simulation in a straight line with surface changes.

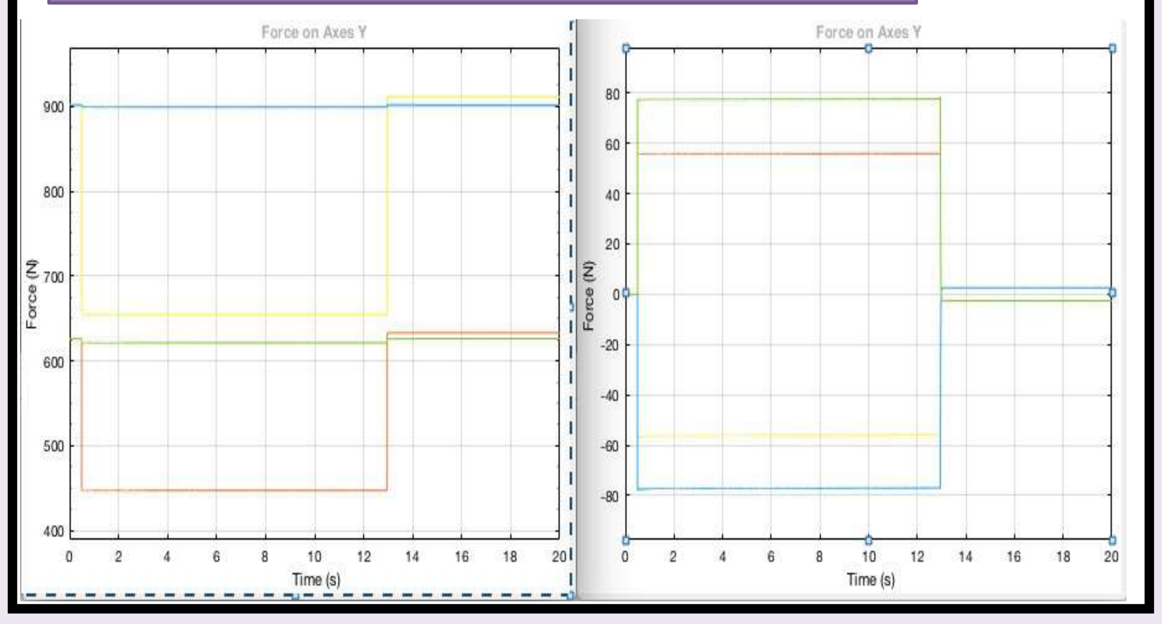

Figure 8. Simulation of the vehicle model on changing surface.

VE model simulation in curves.

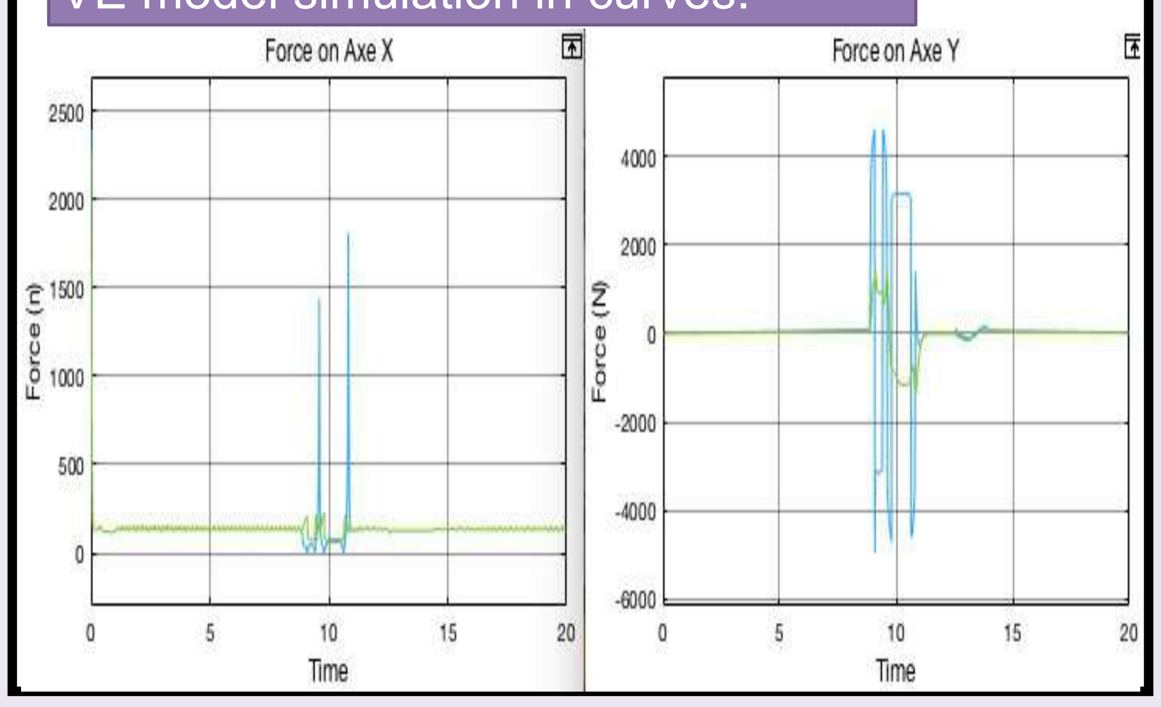

Figure 9. Simulation of the vehicle model in curves.

5. Conclusion

This paper shows the behavior of a single-seater vehicle in straight lines with changes of surfaces and curves, demonstrating the possible deviations that can be had, causing the driver to lose the ability to control the vehicle. And it is proposed the realization of a stability control that allows to recalibrate the speeds of the motors in charge of the traction of the vehicle to correct the real trajectory until it matches the desired trajectory.

Acknowledgements

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