Autonomous car model

# State space formulation

Source: ME 597c lecture, Modelling III, p. 22

This will allow prediction of state variables based on control variables, forming the basis of the physics model.

Control and state variables:

: Vehicle speed [m/s]

: Rotation about z-axis, relative to x-axis [rad]

: Angular velocity about z-axis [rad/s]

: Front wheel drive torque [N-m]

: Front wheel drive force [N]

: Steering angle, [rad] (+ve = left, -ve = right)

: Direction of motion for COG [rad]

: Rolling friction force for wheel ; for front wheel, for rear wheel [N]

Model constants – these need to be defined *a priori*, mostly by the design of the car:

: Frontal vehicle area [m2]

: Coefficient of drag

: Length between rear and front wheel axes [m]

: Distance between rear wheel axis and COG [m]

: Vehicle mass [kg]

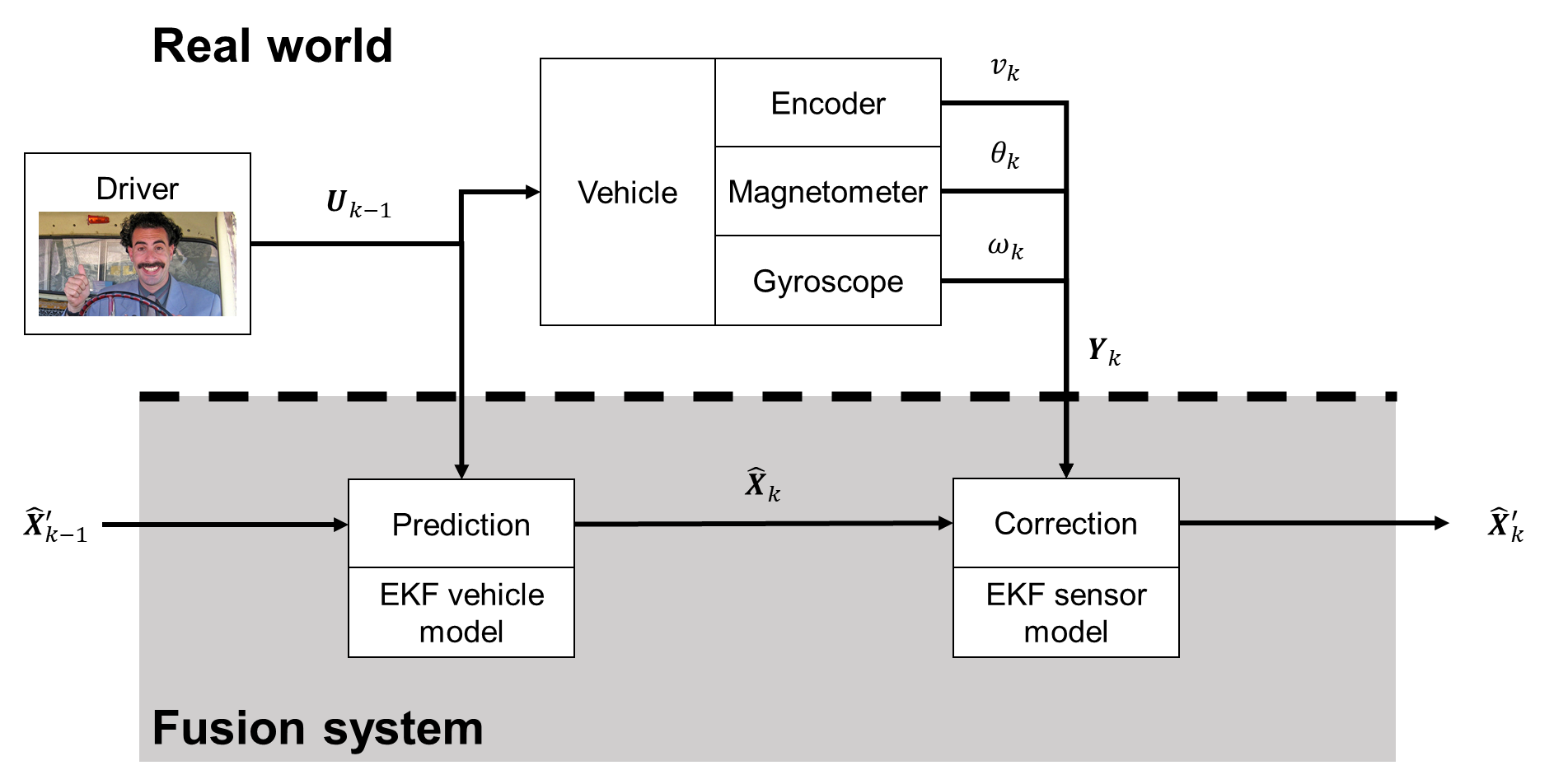
: Axle coefficient of friction for wheel ; for front wheel, for rear wheel

: Wheel radius

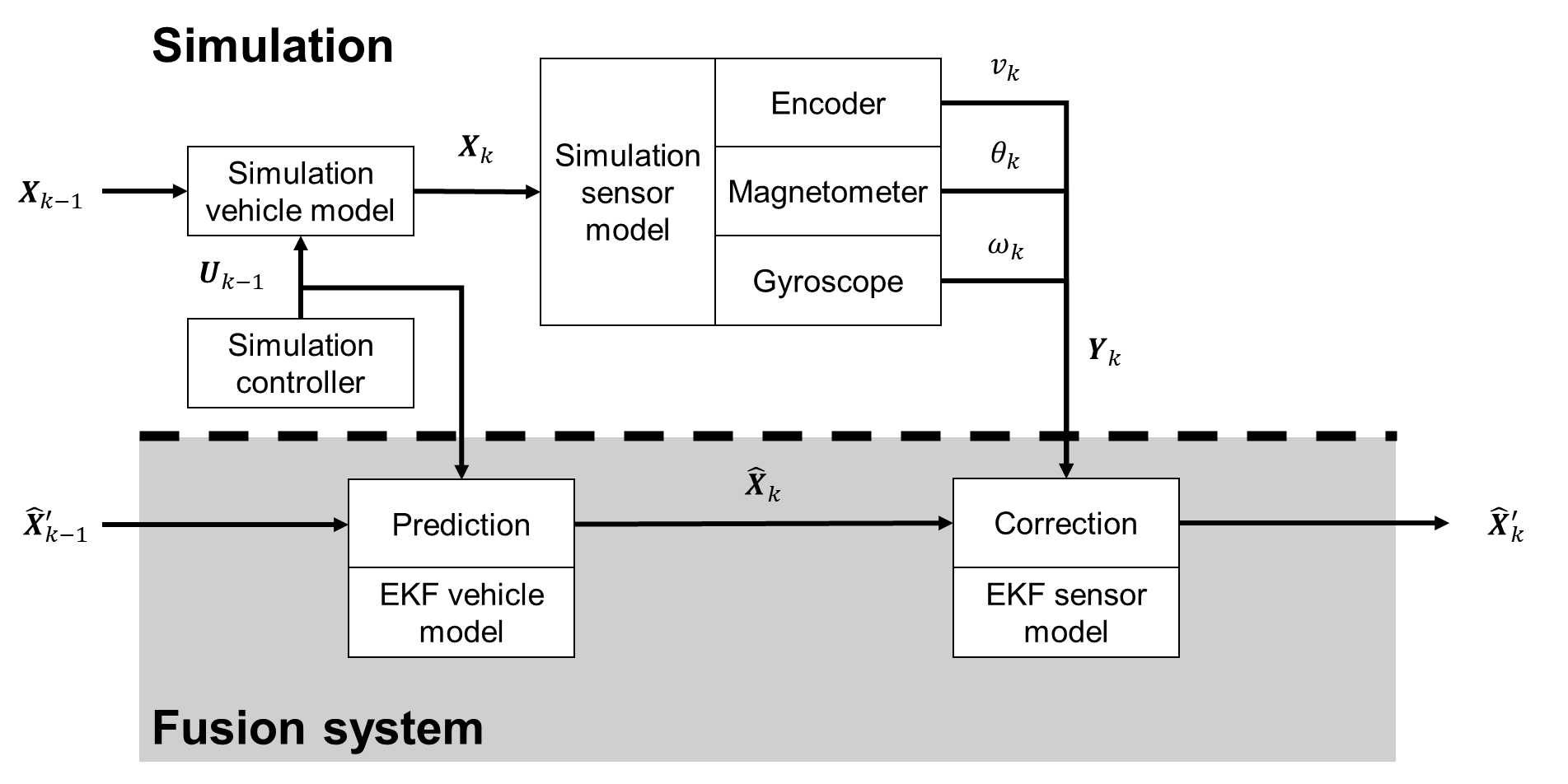
: Acceleration of gravity [m/s2]

# Simulation setup

This is how the system would work in real life:



This is how we test the EKF – by replacing the real world with a high-fidelity simulation, like CARLA:



# EKF formulation

Prediction step:

Correction step:

# Derivation of angular acceleration

My working to derive in the state transition model: