**Notation**

Vectors

: State vector approximation

: Corrected state vector approximation

: Control signal

: Sensor output

: Sensor output approximation

Matrices

: Linear system response model matrix

: Linear system control model matrix

: Linear sensor model matrix

: System model Jacobian

: Sensor model Jacobian

: Kalman gain matrix

: State covariance matrix

: Physics covariance matrix

: Sensor covariance matrix

Functions

: Nonlinear system response function

: Nonlinear sensor model function

Scalars

: X position [cm]

: Y position [cm]

: X velocity [cm/s]

: Y velocity [cm/s]

: X acceleration [cm/s2]

: Y acceleration [cm/s2]

: Time step [s]

**KF reference**

Prediction step:

Correction step:

**EKF reference**

Prediction step:

Correction step:

**State definition**

Based on constant-speed block model in X-Y plane. Position in [cm], velocity in [cm/s], acceleration in [cm/s2]. Use linear system model. Use nonlinear inverse fit sensor model because that doesn’t explode off to infinity and doesn’t have a singularity at zero. Multiplied by 100 to convert m/s2 to cm/s2.

Prediction step:

Correction step:

Model parameters ( is guessed, from sensor data):