Position and Speed Control

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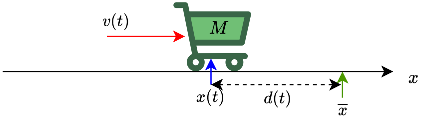
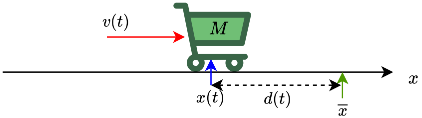
Robotic Systems

Position Control with Speed as Output



- Let us suppose that our cart has an input that is not the force of the traction system, but the **speed** at which we want to travel (let us call it *cart*
- If we want to reach a given position p (starting from 0) we can think to the following control system:
  - When we are **far** from the target, we can travel at a high speed
  - As soon as we **approach the target** we reduce the speed according to the distance (to the target)
  - When we **reach the target** position, our speed must be 0

Position Control with Speed as Output

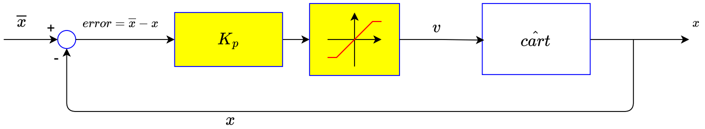


Let's rethink...

- Given that $x(t)$ is our current position and $\overline{x}$ is our target position
- Let's compute the distance to the target $d(t) = \overline{x} - x(t)$
- If $d(t)$ is "high", let's travel at a constant cruise speed v_{cruise}
- As soon as $d(t)$ decreases, we travel at a speed proportional to the distance $v(t) = K\ d(t)$
- When we reach the target, $d(t)$ will be 0 and also $v(t)$, thus the $\hat{cart}$ stops at $\overline{x}$
- If $\overline{x}$ is **overcome**, $d(t)$ will be **negative and also the speed**, thus driving the $\hat{cart}$ towards the target

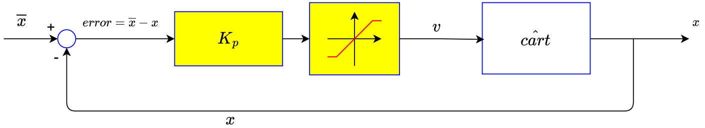
This is a **proportional control with saturation at** v_{cruise}

Position Control with Speed as Output

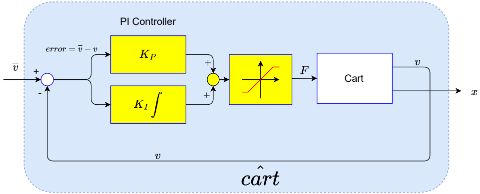


This is a **proportional control with saturation at v_{cruise}**

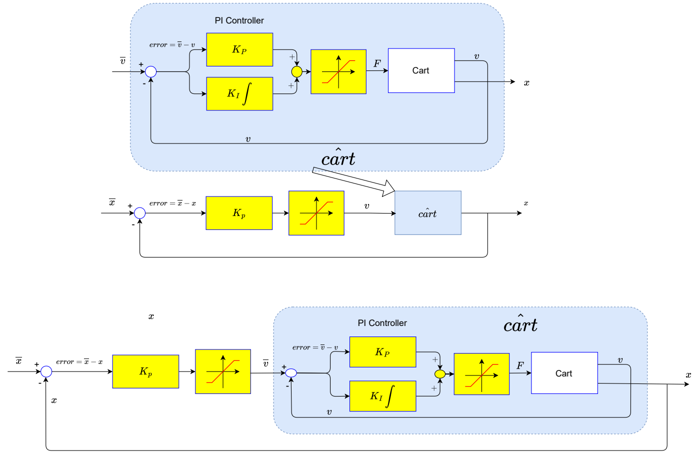
Position Control with Speed as Output



- The matter is that our real cart has **force** *F* as input, not speed
- But we **already solved** the problem of forcing the cart to drive at a given speed!
- Indeed, it has been done by using a speed feedback loop with a PI + saturation controller (see below)
- Thus we can put the schema below inside the schema above in order to obtain the complete position control system



The Final Schema



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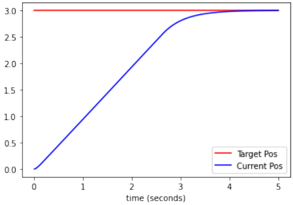
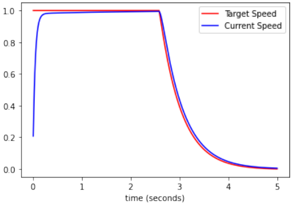
Example

(examples/position_control/cart_position_control.ipynb)

- Let's consider a **cart**, with $M = 1.0$, $B = 0.8$, and $F_{max} = 20\ N$
- Let's implement a position+speed control with $V_{MAX} = 1\ m/s$
- After tuning the parameters, we obtain a good behaviour with:
  - Position: $K_P = 2$
  - Speed: $K_P = 20$, $K_I = 10$





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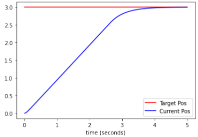
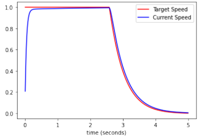
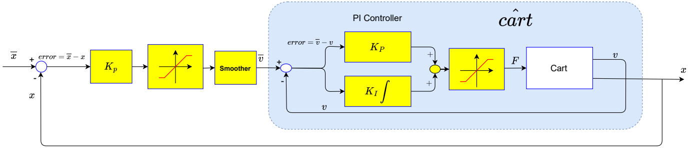




Smoothing and Acceleration

- The speed has a sharp trend at the beginning of motion, this is undesirable
- Indeed, we would like to impose not only a cruise speed, but also an **acceleration**
- A possible solution is to include a **smoother** block, at the output of the position controller to avoid hard changes and transform the (initial) **step** into a **ramp**



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