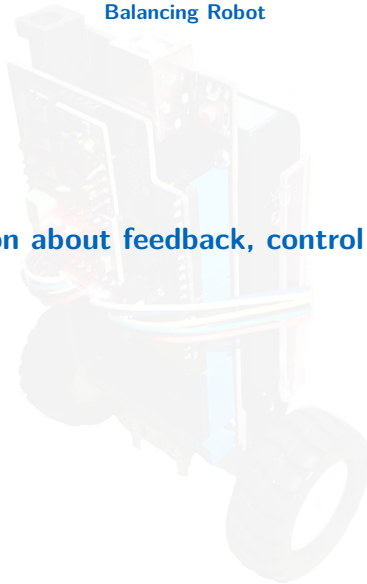


Balancing Robot

2. Introduction about feedback, control and modelling



Introduction

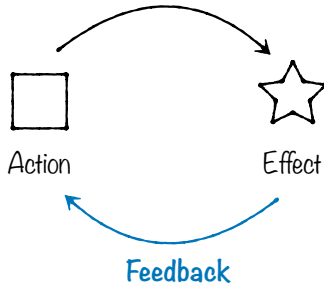
Before we proceed further with the project, we need to understand some useful concepts:

- ▶ What is **feedback**?
- ▶ What is **control**?
- ▶ What is **mathematical modelling**?



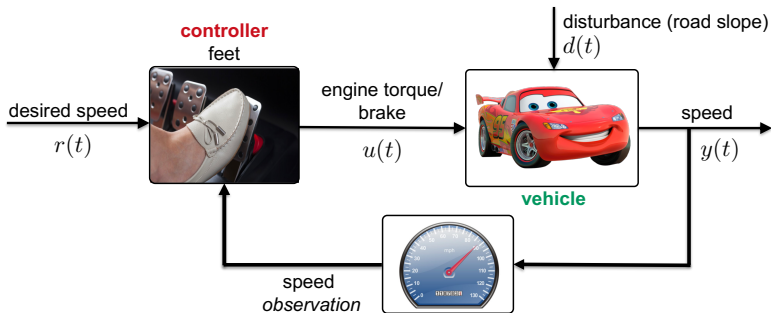
Feedback

- ▶ **Feedback** occurs when outputs of a system are routed back as inputs as part of a chain of *cause-and-effect* that forms a circuit or loop.



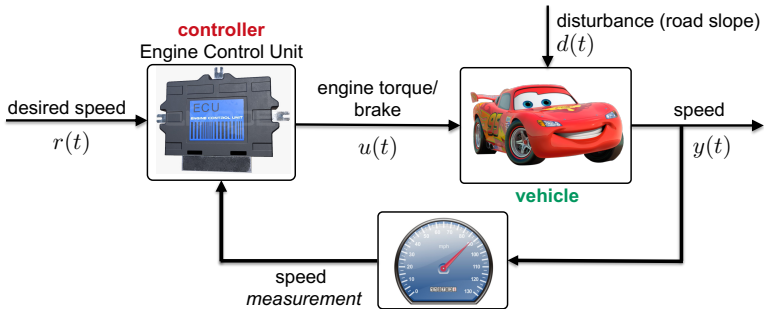
- ▶ By using properties of feedback, we can change the behavior of a system to meet the needs of an application, e.g., systems can be made
 - ▶ **stable**
 - ▶ **responsive** or
 - ▶ **held constant**

Control your car's speed



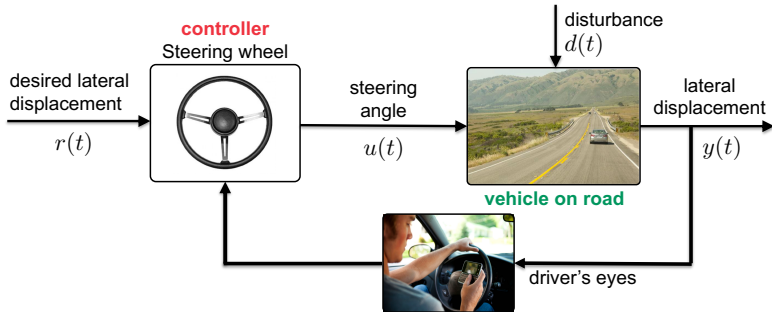
- ▶ The vehicle speed must be controlled in order to reach and maintain the desired speed $r(t)$...
- ▶ ... in spite of changes of the road slope and the desired speed

Automatic cruise control



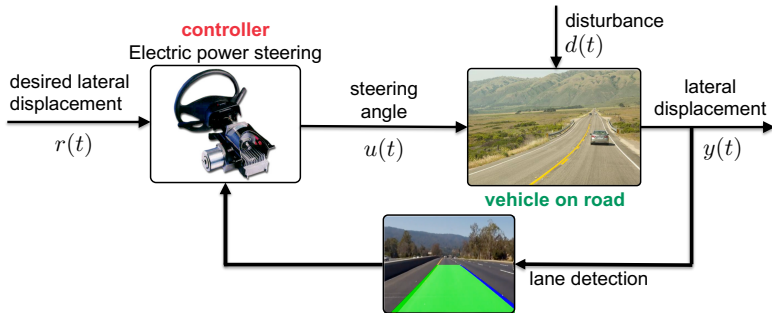
- ▶ The vehicle speed must be controlled in order to reach and maintain the desired speed $r(t)$...
- ▶ ... in spite of changes of the road slope and the desired speed

Keeping within the lane



- ▶ The steering wheel must be controlled in order to reach and maintain the desired lateral displacement $r(t)$ within the lane ...
- ▶ ... in spite of changes of the road curvature and of $r(t)$

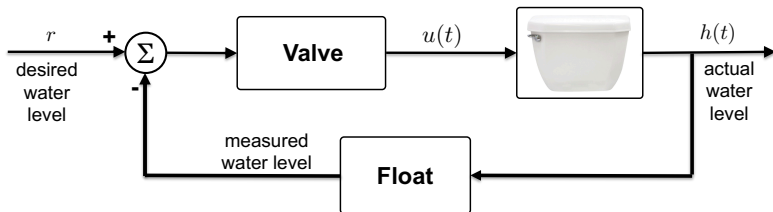
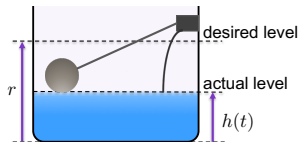
Automatic lane maintenance



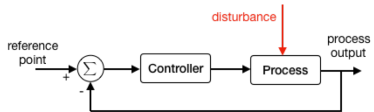
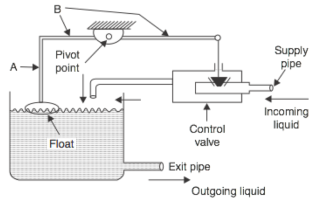
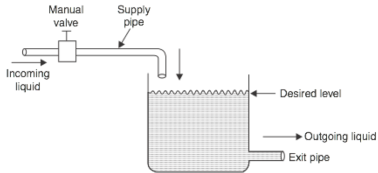
- ▶ The steering wheel must be controlled in order to reach and maintain the desired lateral displacement $r(t)$ within the lane ...
- ▶ ... in spite of changes of the road curvature and of $r(t)$

An every day control system: the flushing toilet

- ▶ After a toilet is flushed, the water tank must be refilled to a desired level r
- ▶ This is done with a simple control system using a valve controlled by a floating ball



Feedback vs No Feedback



Mathematical Modelling

- ▶ A mathematical model helps us **make predictions** about the behavior of a system and to study the **effects of different components**
- ▶ Why do we *need* to predict?
 - ▶ What happens if ... ?
 - ▶ What happens next?
 - ▶ What happens there?
- ▶ Why do we *need* to study the effects of different components?
 - ▶ It could be a controller that you want to have specific properties
 - ▶ It could be a new component you added/would like to add on a system
e.g., nuclear reactor, car, ...

