Open loop vs closed loop

Open-loop

- An open-loop controller, also called a non-feedback controller, is a type of controller which computes its input into a system using only the current state and its model of the system.

Open-loop

- A characteristic of the open-loop controller is that it does not use feedback to determine if its output has achieved the desired goal of the input. This means that the system does not observe the output of the processes that it is controlling. Consequently, a true open-loop system can not engage in machine learning and also cannot correct any errors that it could make. It also may not compensate for disturbances in the system.

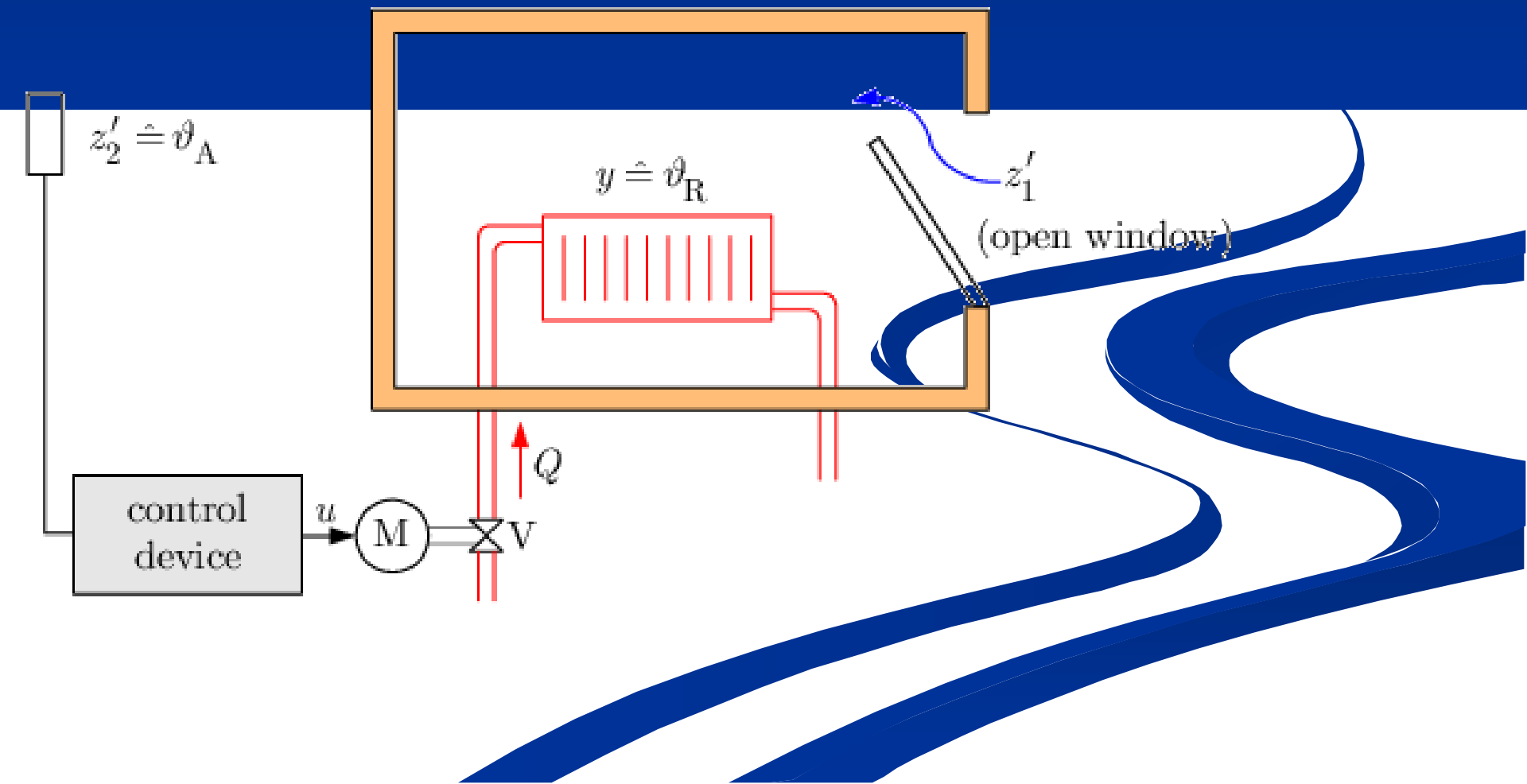
Closed-loop

- Close loop control systems use the open loop systems (as forward path) and feedback from the output to decide the input level to the open loop system. And because the input is decided based on how much away the output is from the desired level, the non idealities in forward path do not degrade the system performance. The accuracy of the output thus depends on the feedback path, which in general can be made very accurate.

Differences

- The terms open-loop control and closed-loop control are often not clearly distinguished. Therefore, the difference between open-loop control and closed-loop control is demonstrated in the following example of a room heating system. In the case of *open-loop control* of the room temperature according to Figure the outdoor temperature will be measured by a temperature sensor and fed into a control device.

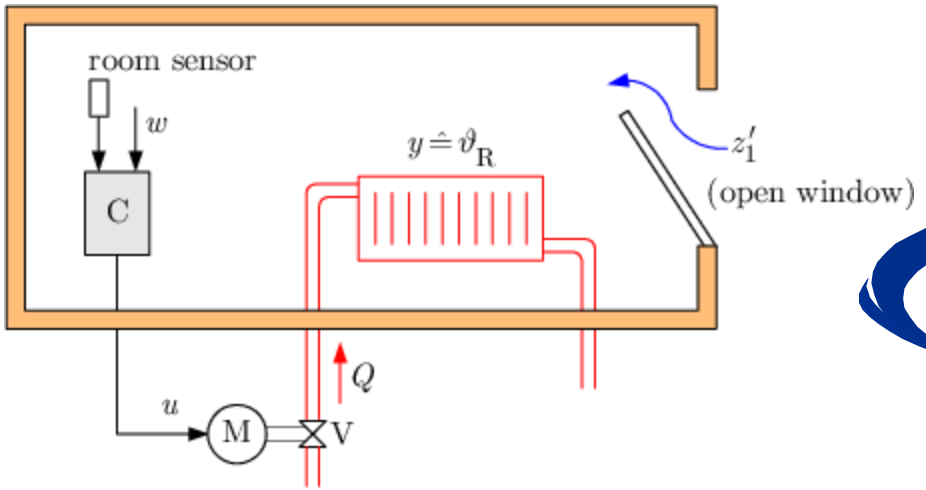
Open-loop


$z_2' \mathrel{\hat{=}} \vartheta_A$
$y \mathrel{\hat{=}} \vartheta_R$
z_1'
(open window)
Q
control device
u
M
V

Closed-loop

- In the case of *closed-loop control* of the room temperature as shown in Figure the room temperature is measured and compared with the set-point value. If the room temperature deviates from the given set-point value, a controller (C) alters the heat flow. All changes of the room temperature, e.g. caused by opening the window or by solar radiation, are detected by the controller and removed.

Closed-loop



The order of events to organise a closed-loop control is characterised by the following steps:

- Measurement of the controlled variable
- Calculation of the control error (comparison of the controlled variable with the set-point value)
- Processing of the control error such that by changing the manipulated variable the control error is reduced or removed

Comparing open-loop control with closed-loop control the following differences are seen:

Closed-loop control

- shows a closed-loop action (closed control loop);
- can counteract against disturbances (negative feedback);
- can become unstable, i.e. the controlled variable does not fade away, but grows (theoretically) to an infinite value.

Open-loop control

- shows an open-loop action (controlled chain);
- can only counteract against disturbances, for which it has been designed; other disturbances cannot be removed;
- cannot become unstable - as long as the controlled object is stable.

Summarising these properties we can define:

- Systems in which the output quantity has no effect upon the process input quantity are called open-loop control systems.
- Systems in which the output has an effect upon the process input quantity in such a manner as to maintain the desired output value are called closed-loop control systems.