Control Concepts for a Decentralized Battery Management System

OSTBAYERISCHE TECHNISCHE HOCHSCHULE REGENSBURG
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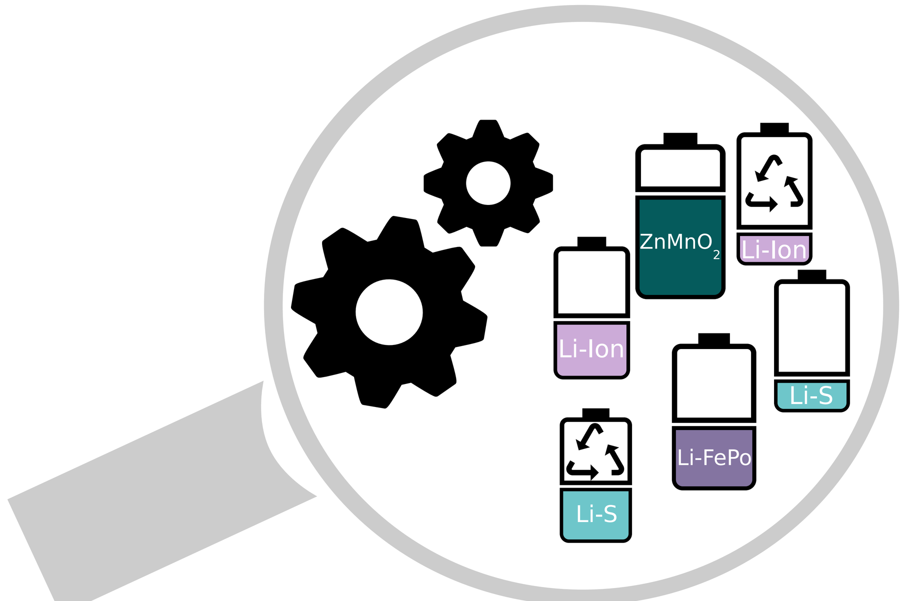
Abstract

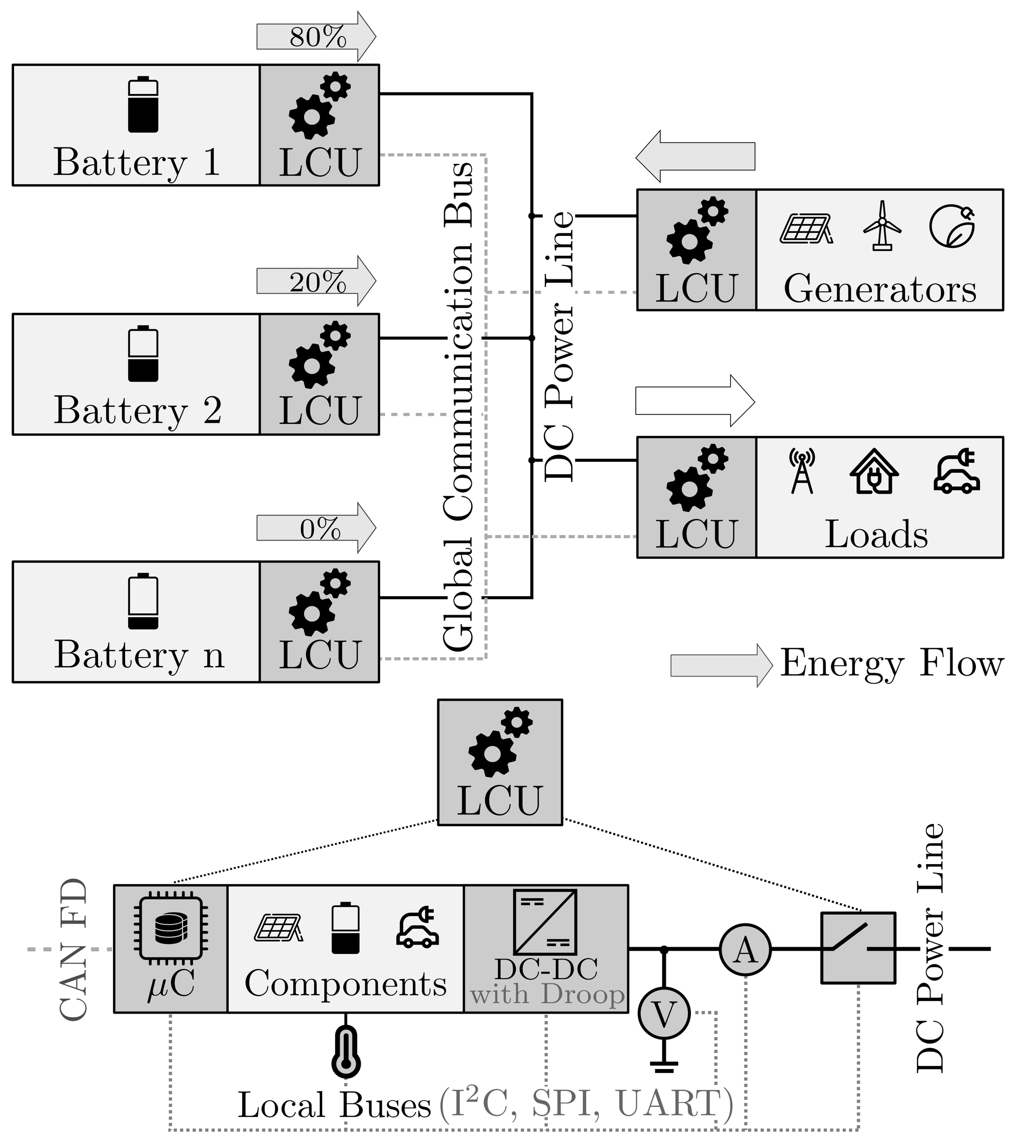
Research Question



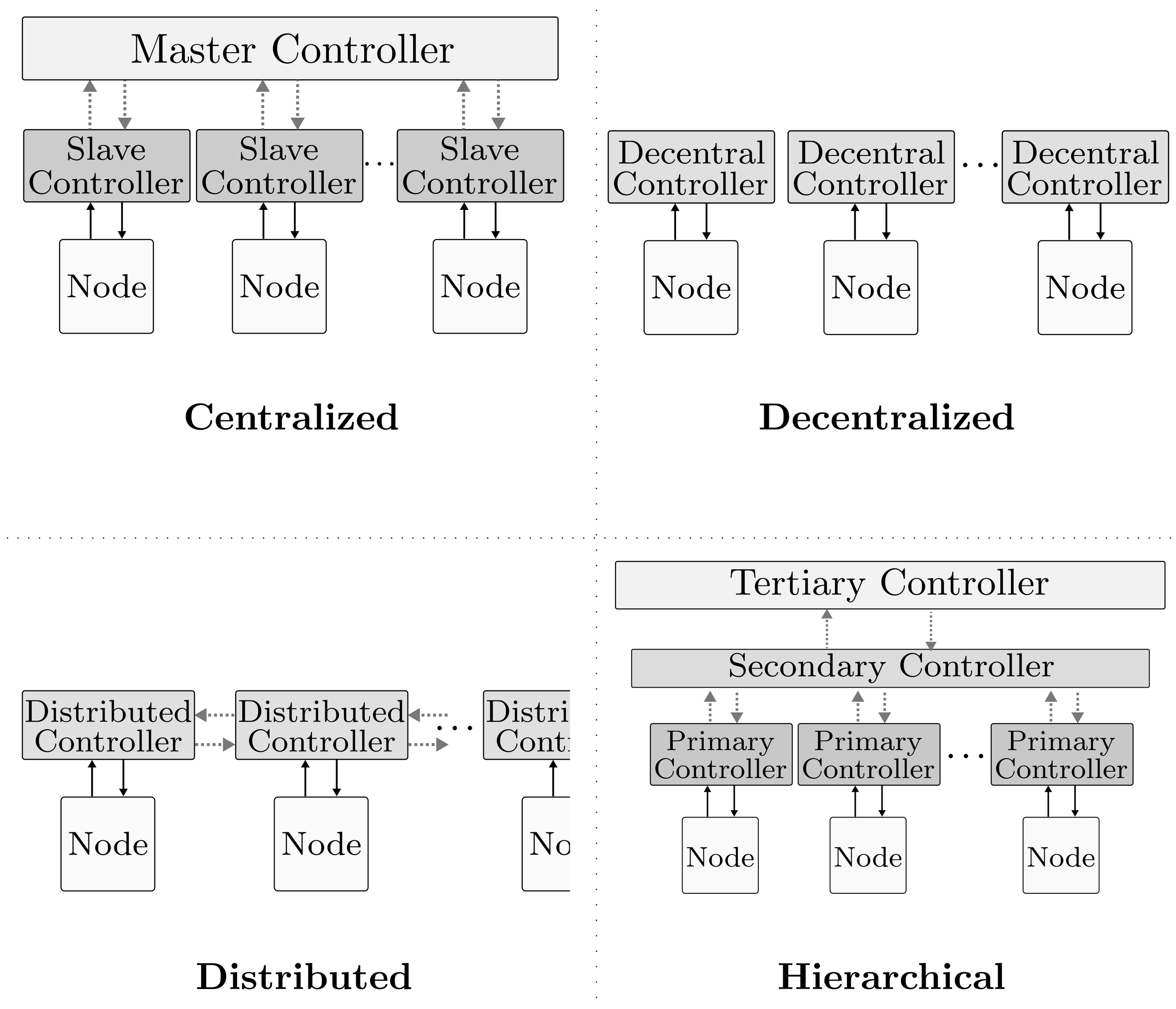
How can a control strategy for a heterogenous battery system achieve the objects of

- Reliability,
- Robustness,
- Scalability,
- Flexibility,
- Availability and
- Optimal battery operation?

Decentralized Battery Management System



Existing Control Strategies

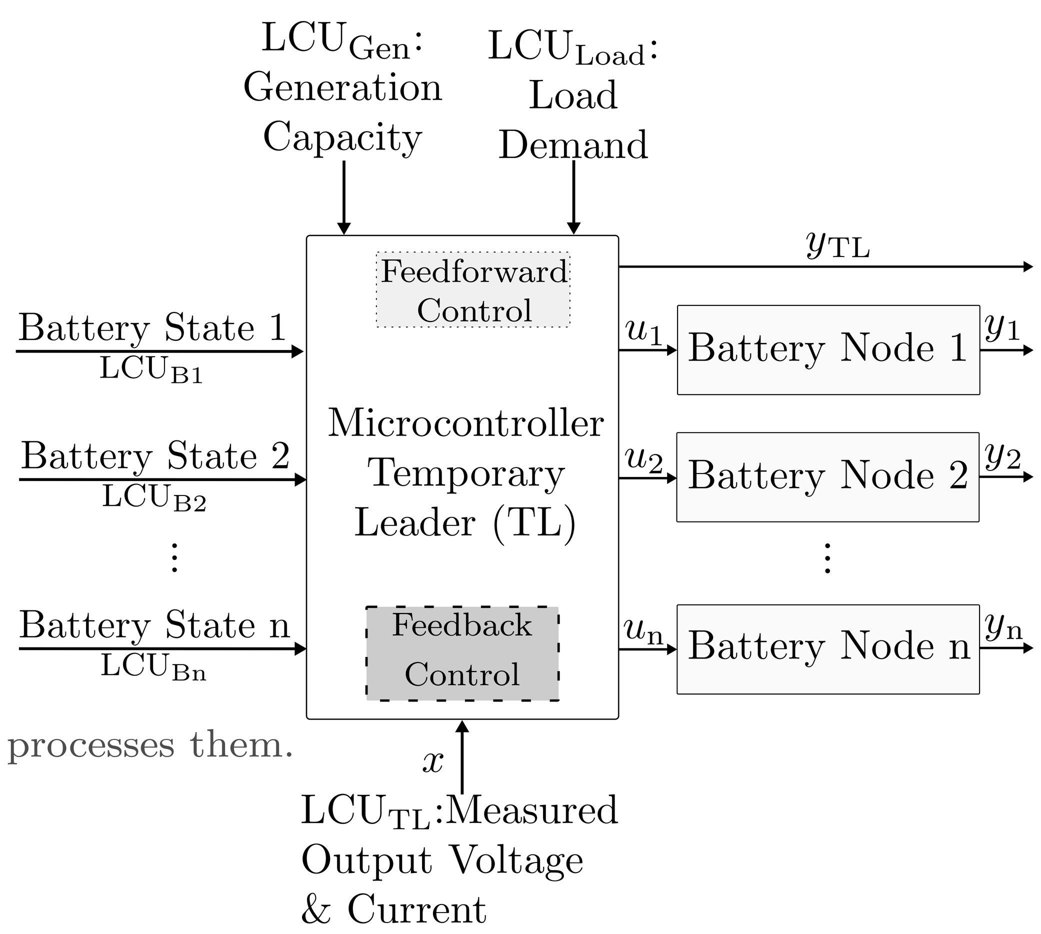


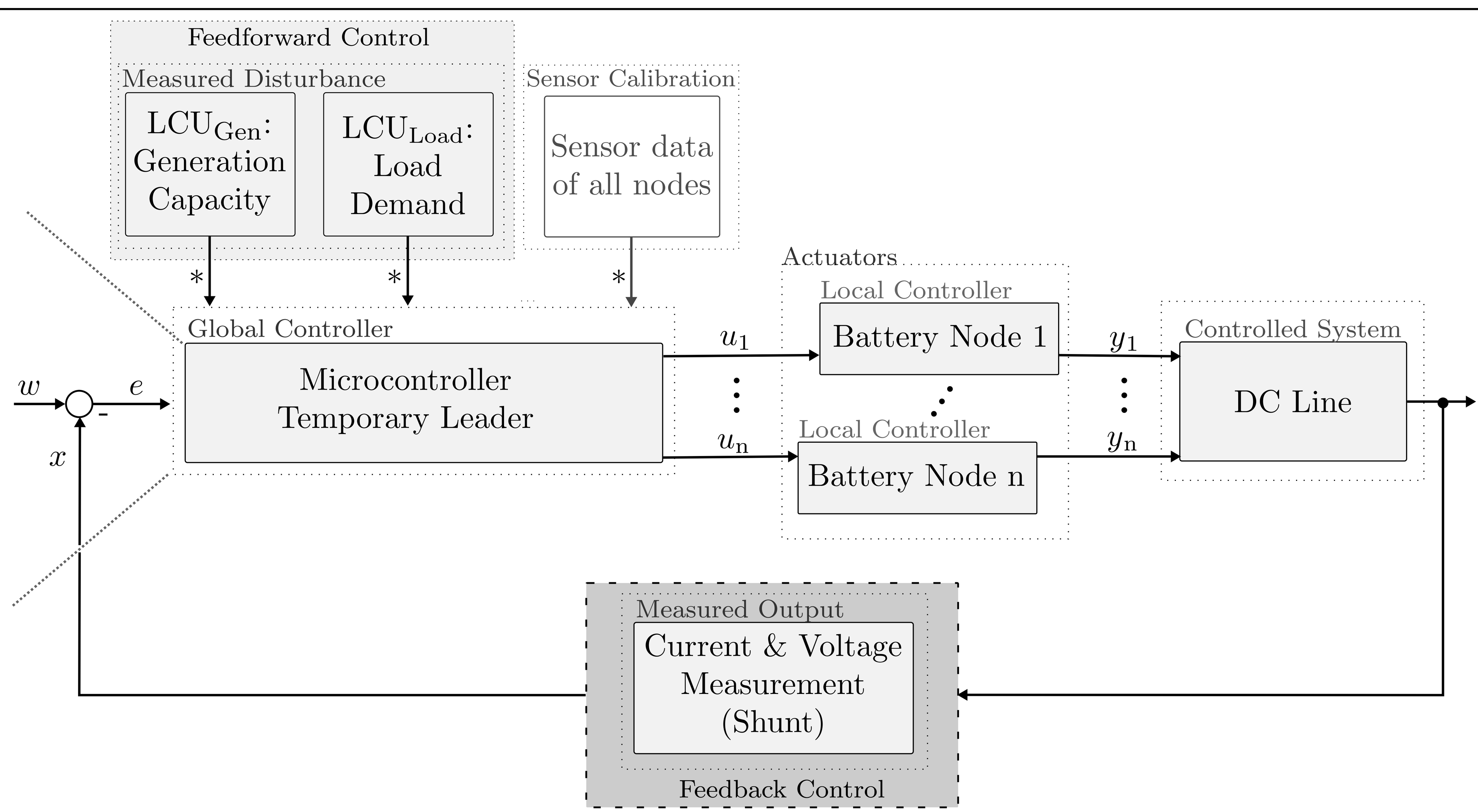
Node: battery, generator, load

Global Control Level

w: setpoint (V_{DC}=24 V)
e: control deviation $w - x$
x: measured output
u: actuating variable (input local controller)
y: control variable

*Data are sent to all LCUs, but only the temporary leader processes them.





Start

Decentralized, Droop-based Control

- Fully decentralized control without global communication
- Increased reliability, robustness and fail-safety
- Droop selection is critical for safe battery operation but difficult to specify
- Inaccurate control: trade-off between voltage control and load distribution

T_1

transition conditions

$T_2 = \overline{T_1}$

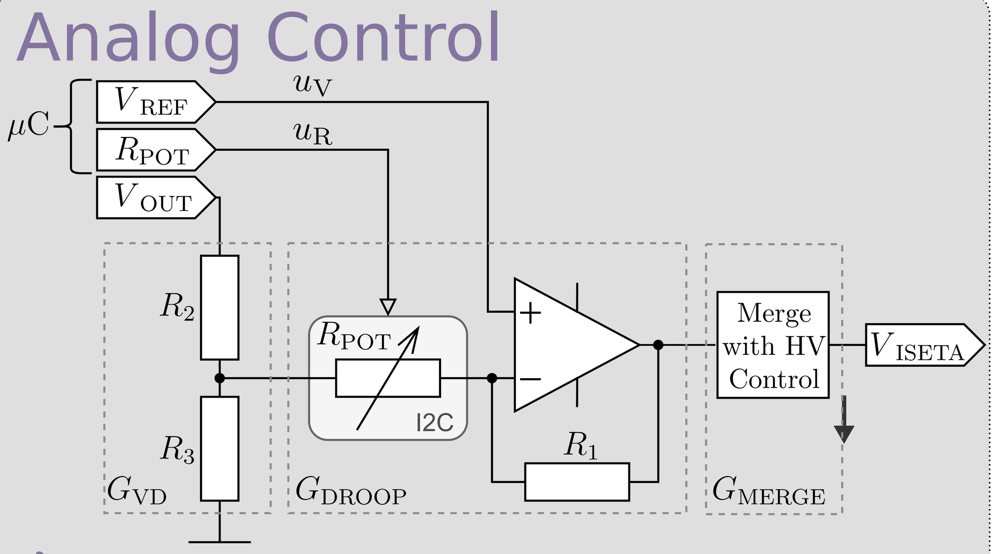
Hierarchical, Communication-based Control

- Accurate, battery-condition-dependent load sharing
- Improved control accuracy by direct setpoint specification and consideration of load and generation power as measured disturbance
- Requires global communication and elected leader
- Higher computing effort and energy consumption of the μCs

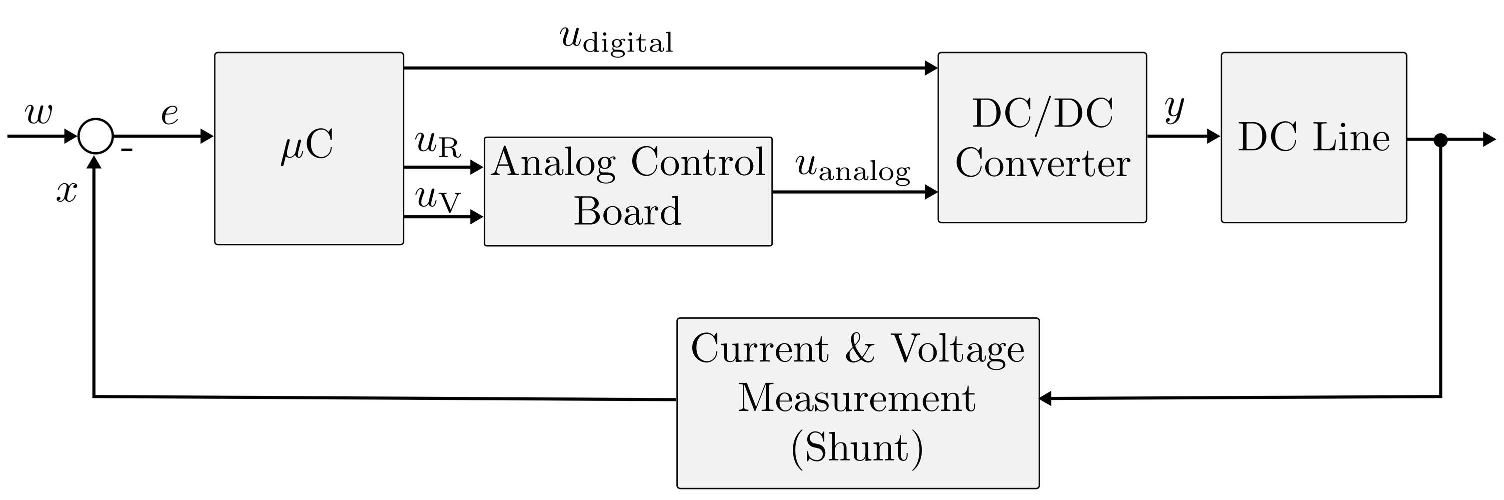
End

Local Control Level

Analog Control

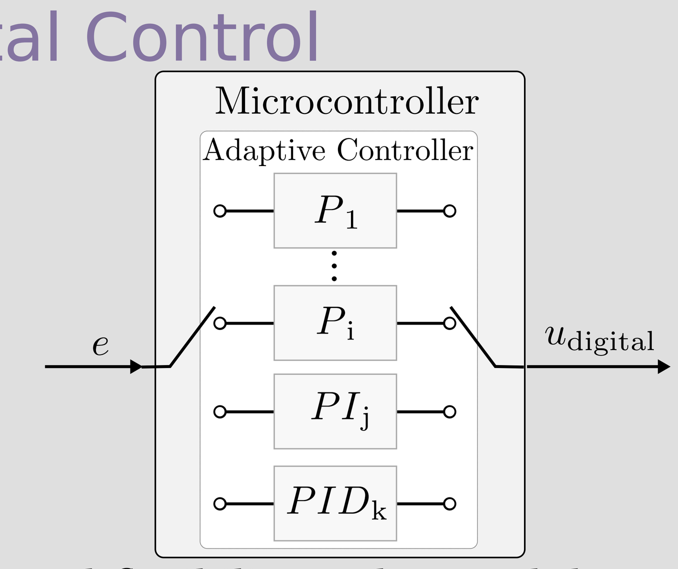


- Increased robustness
- Less computational effort
- Higher power losses due to additional components



w: setpoint (specification of global control level)
e: control deviation
x: measured output
u: actuating variable
y: control variable

Digital Control



- Improved flexibility and control dynamics by adaptive control
- Enhanced precision for setpoint specification
- Complex determination of controller coefficients