MATLAB

PID Controller

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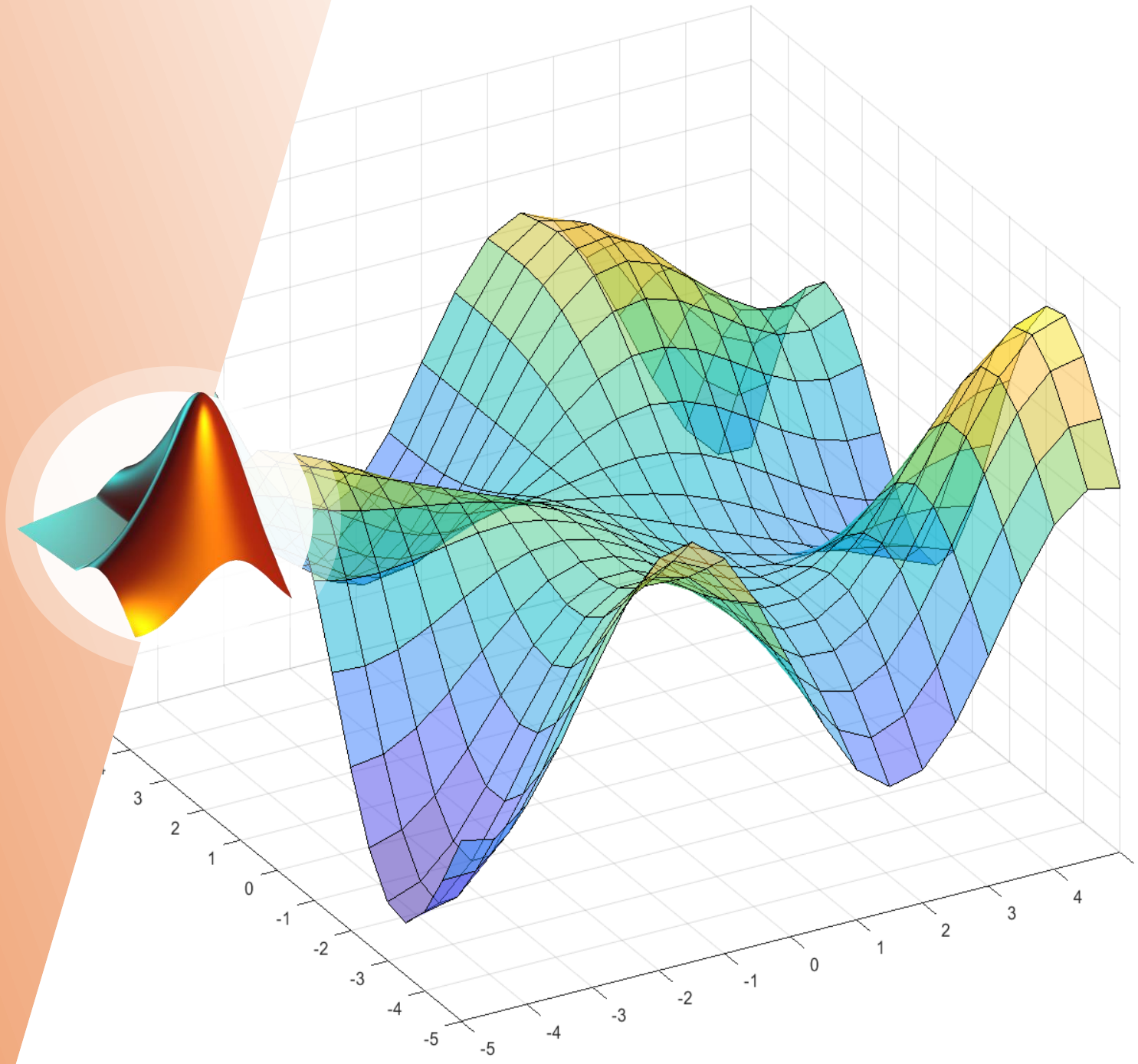
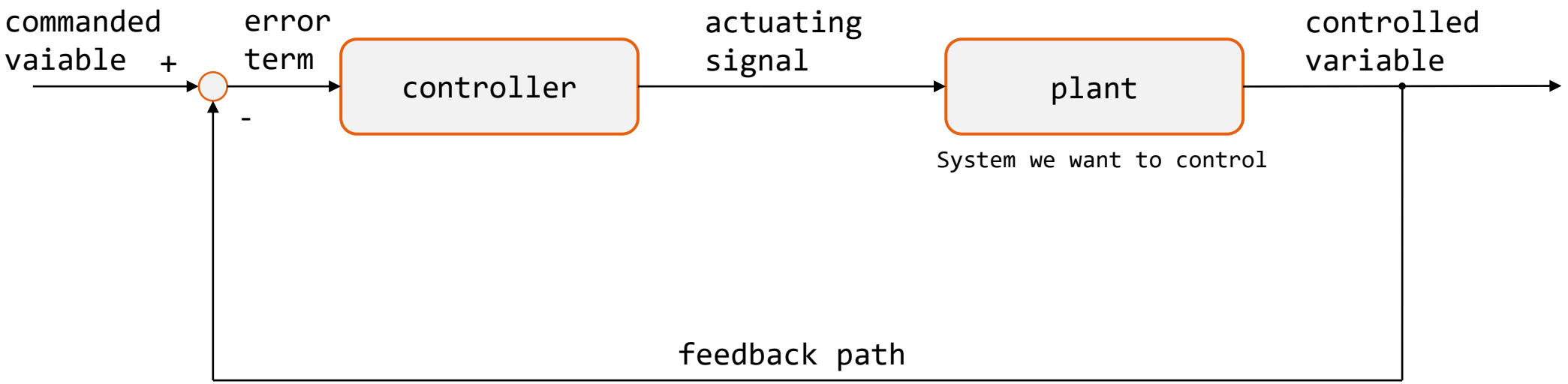
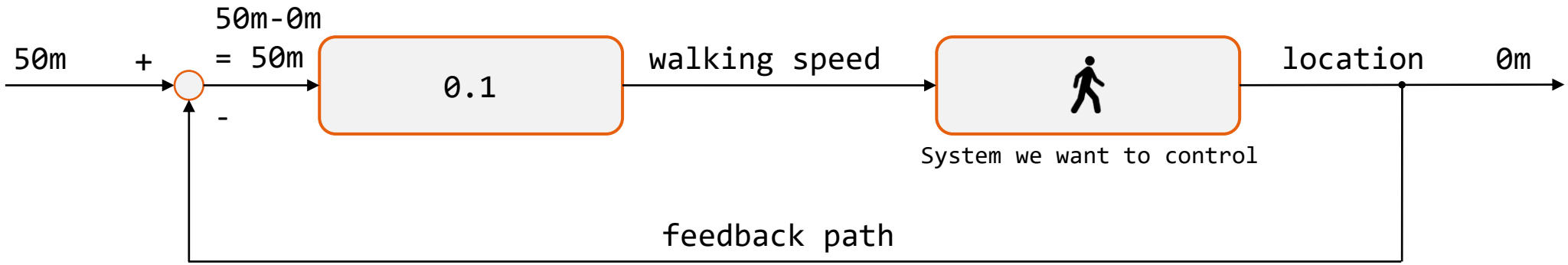
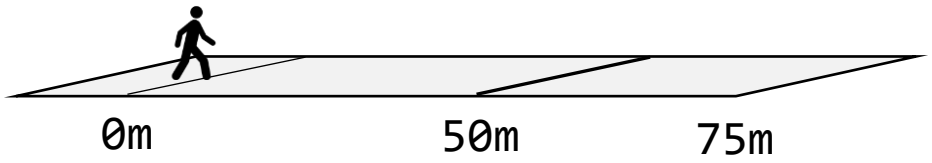
Slides based on Brian Douglas about PID
https://bit.ly/2Po5vMU

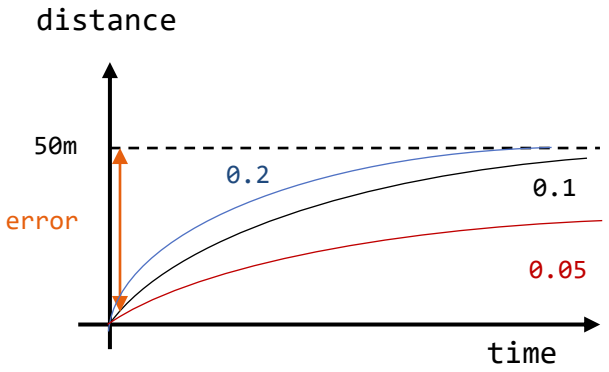
DHBW Stuttgart

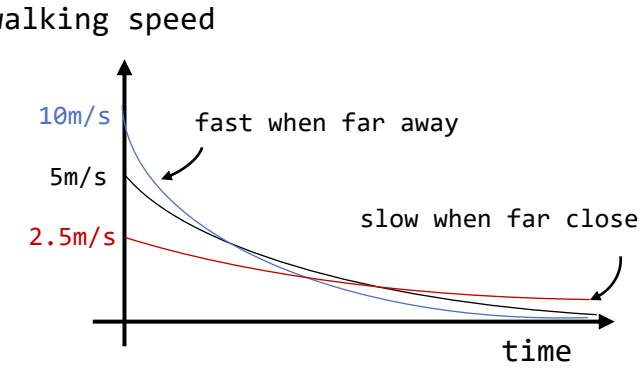


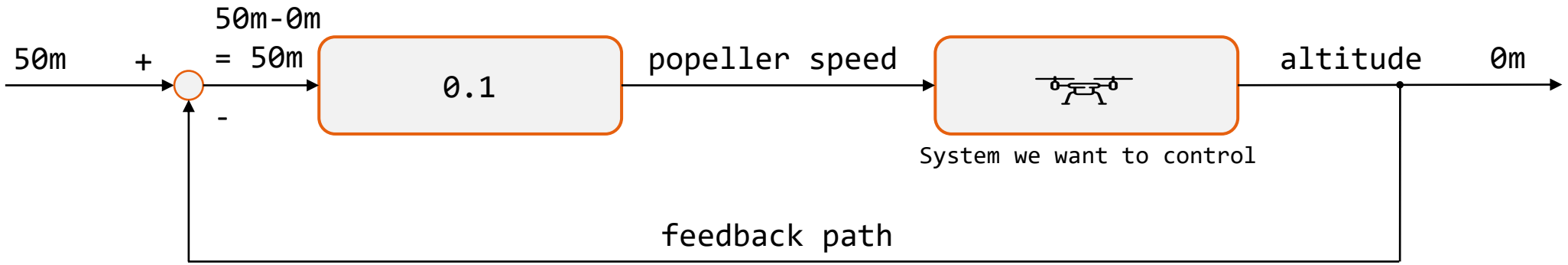

commanded
vaiable
+
-
error
term
controller
actuating
signal
plant
controlled
variable
System we want to control
feedback path

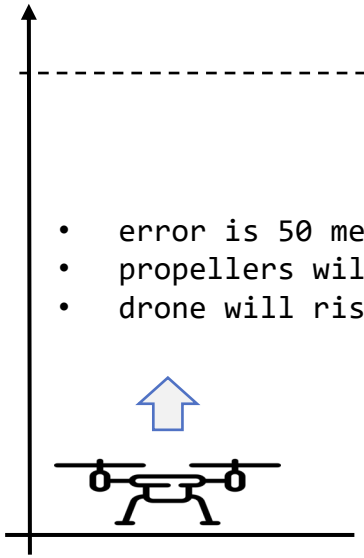

50m
+
50m-0m
= 50m
-
0.1
walking speed
location
0m
System we want to control
feedback path


0m
50m
75m

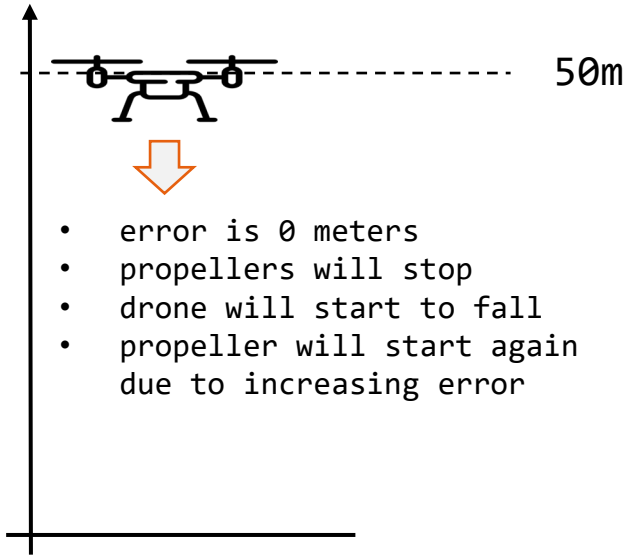

distance
50m
error
0.2
0.1
0.05
time


walking speed
10m/s
5m/s
2.5m/s
fast when far away
slow when far close
time

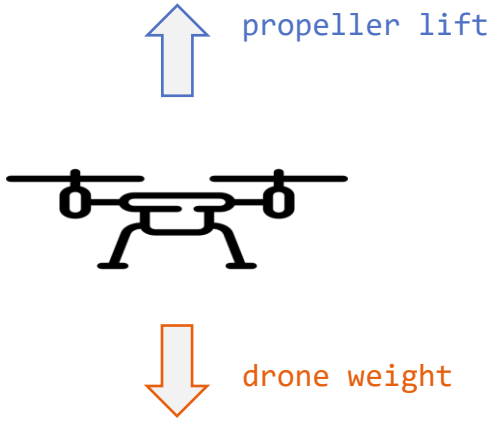




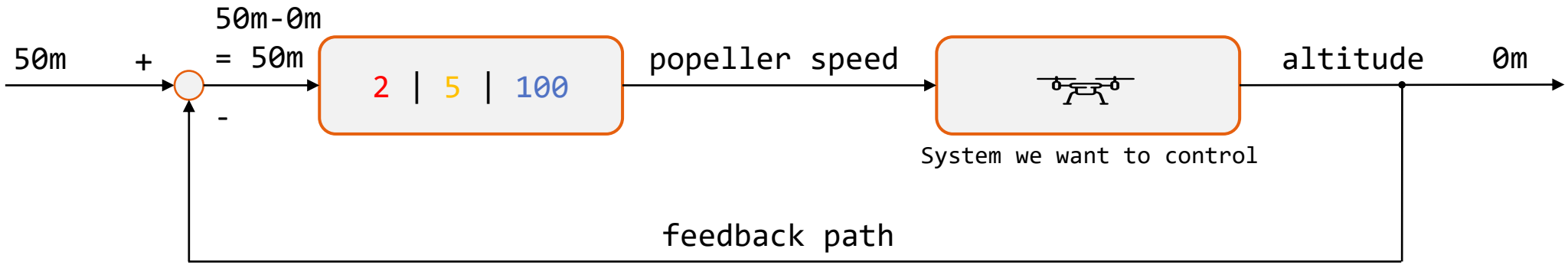
- error is 50 meters
- propellers will spin up
- drone will rise, reducing the error

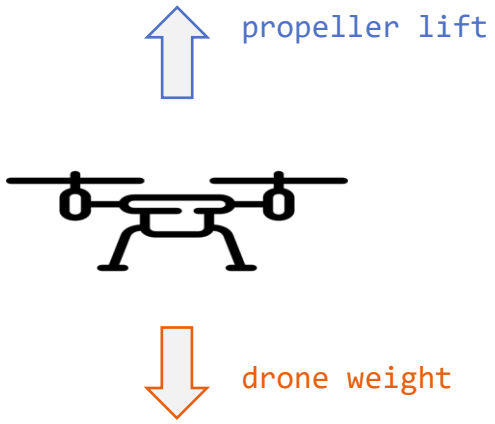


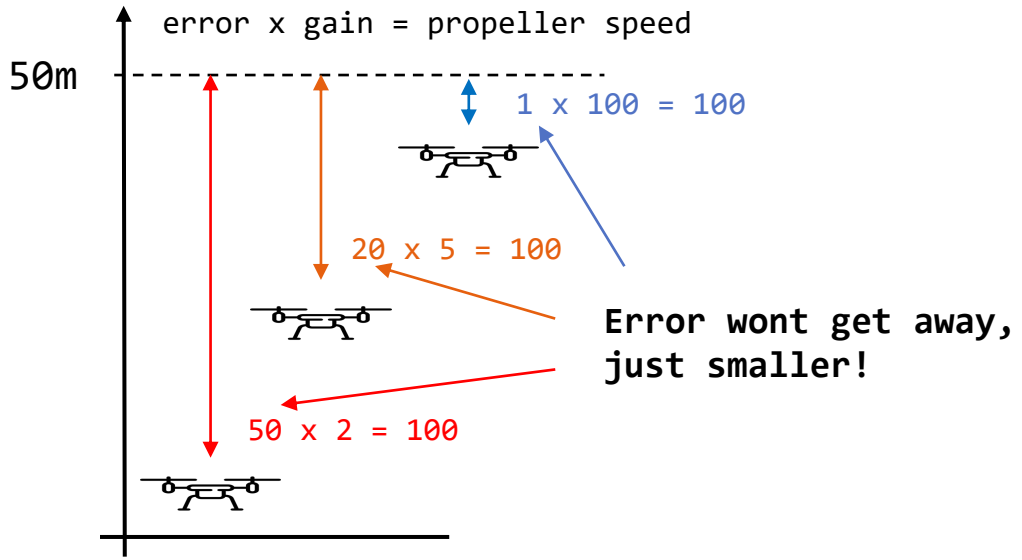
- error is 0 meters
- propellers will stop
- drone will start to fall
- propeller will start again due to increasing error

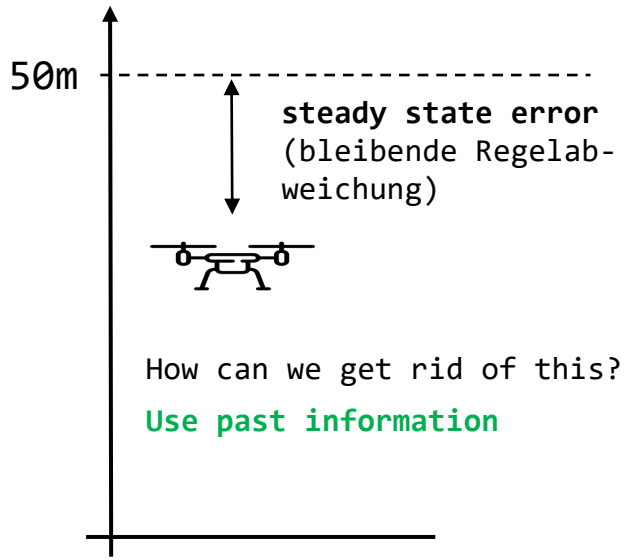


At which propeller speed will the drone hover? **Assumtion: 100 rpm**

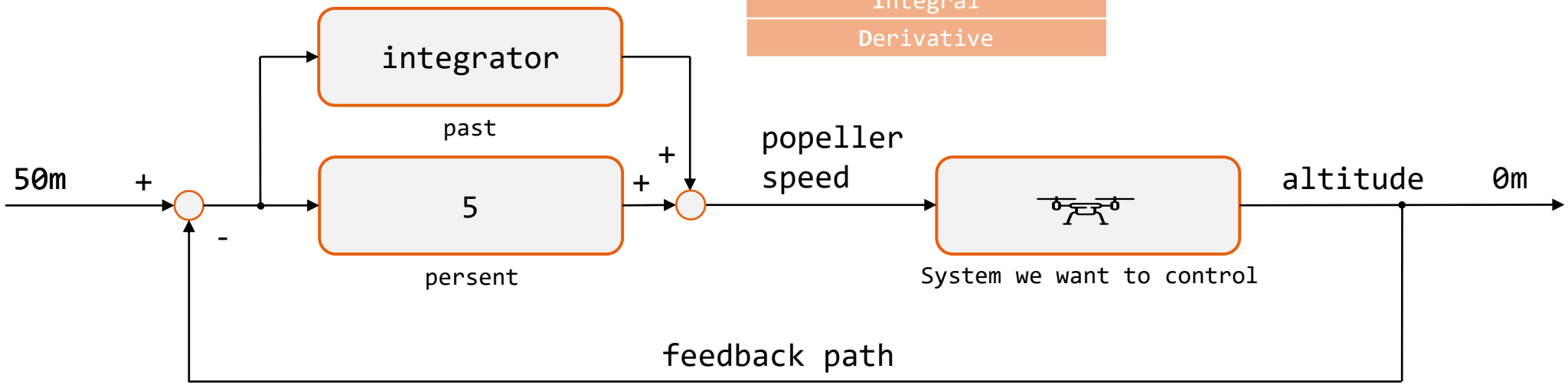

50m
+
-
50m-0m
= 50m
2 | 5 | 100
popeller speed
altitude
0m
System we want to control
feedback path

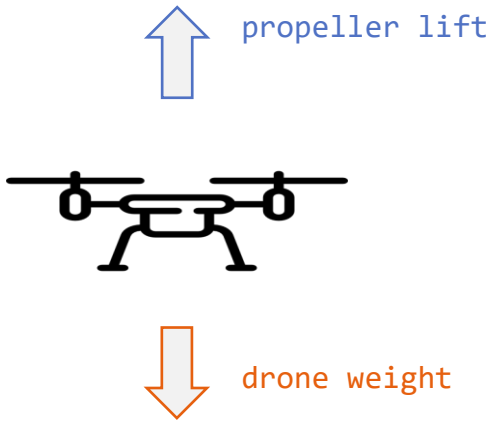

propeller lift
drone weight
Hovering at 100rpm


error x gain = propeller speed
50m
1 x 100 = 100
20 x 5 = 100
50 x 2 = 100
Error wont get away,
just smaller!

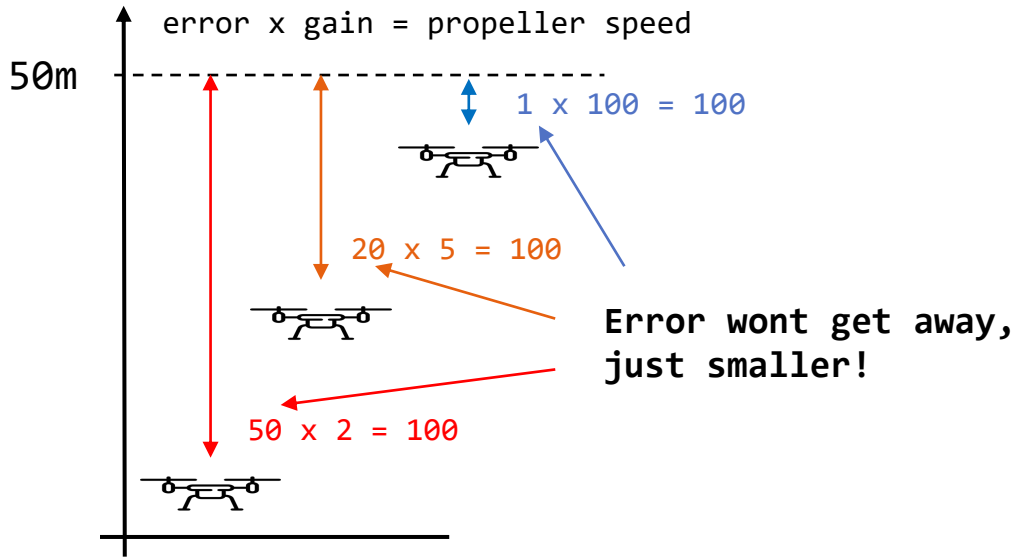

50m
steady state error
(bleibende Regelab-
weichung)
How can we get rid of this?
Use past information

Proportional
Integral
Derivative

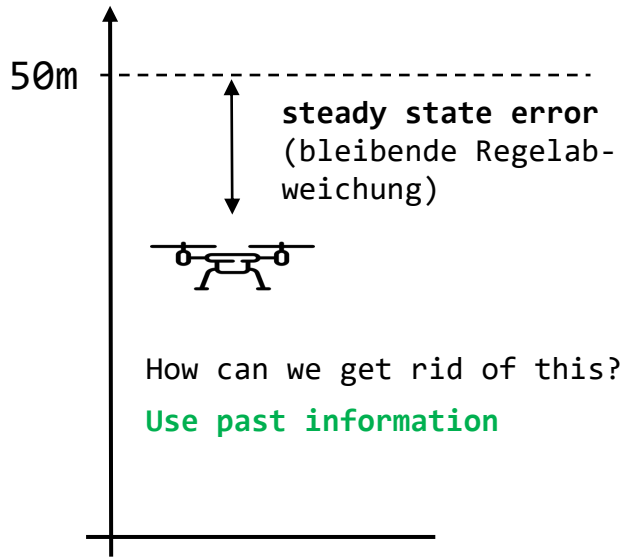




Hovering at 100rpm

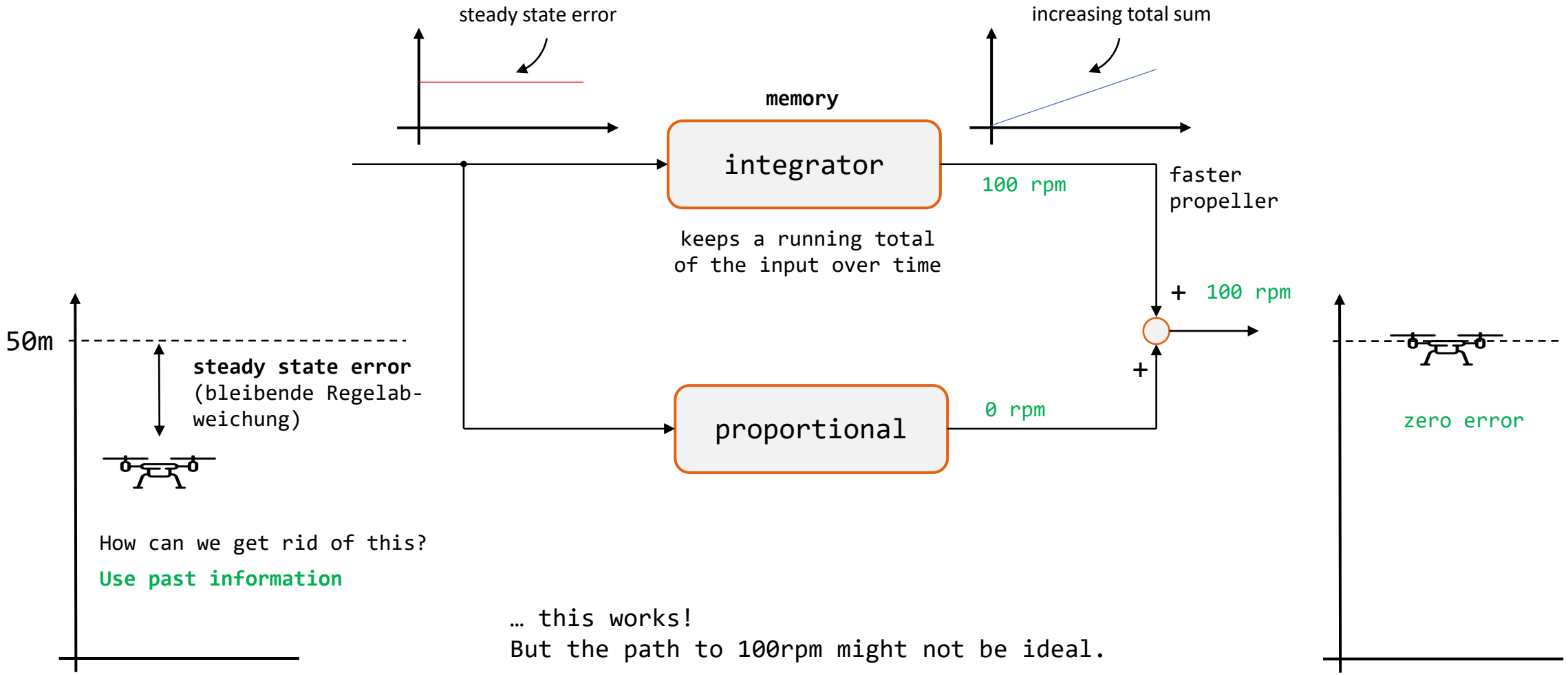


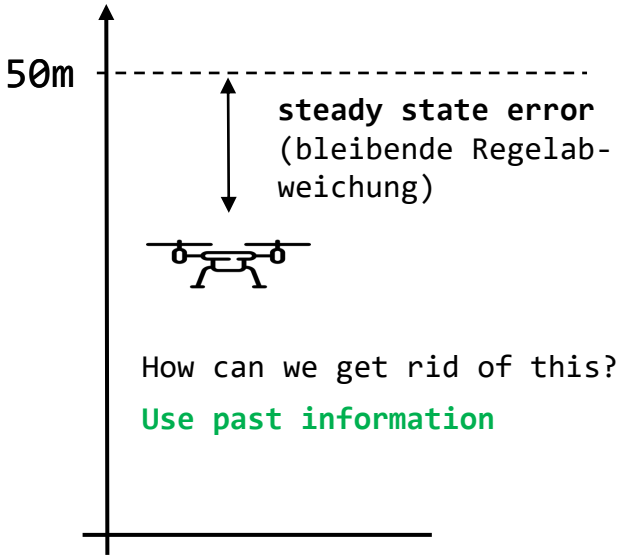
Error wont get away, just smaller!

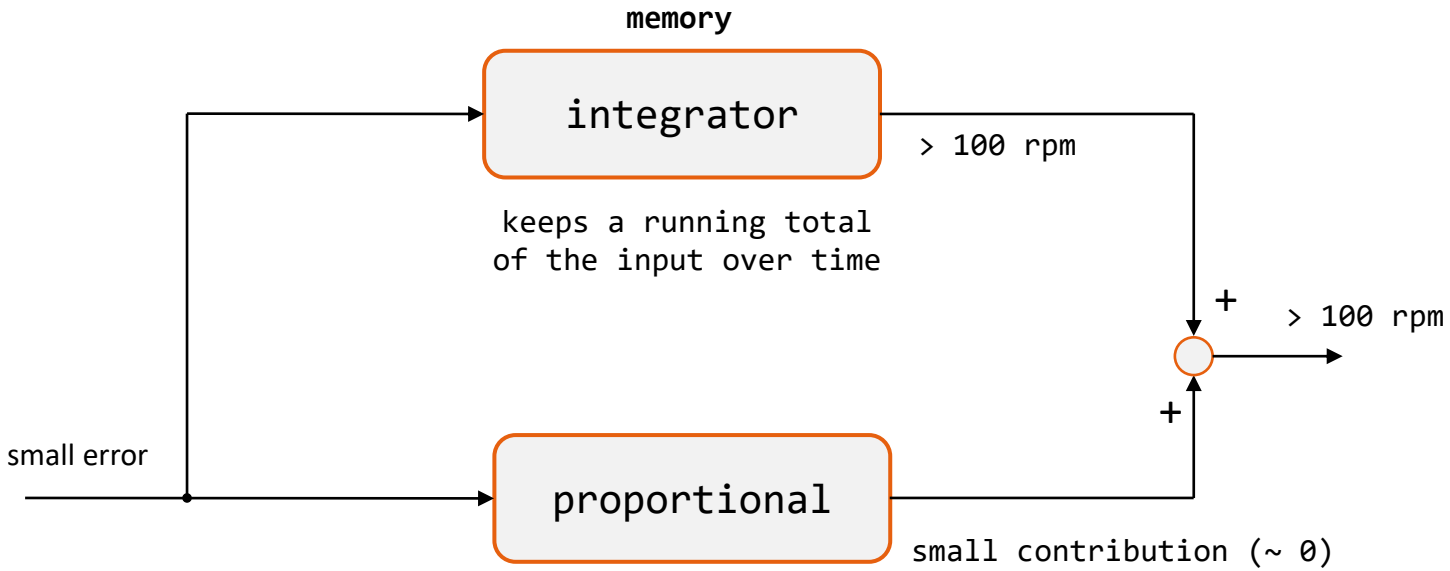


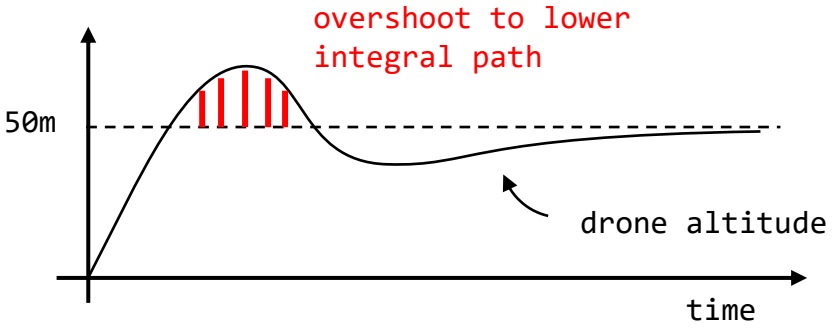
How can we get rid of this?

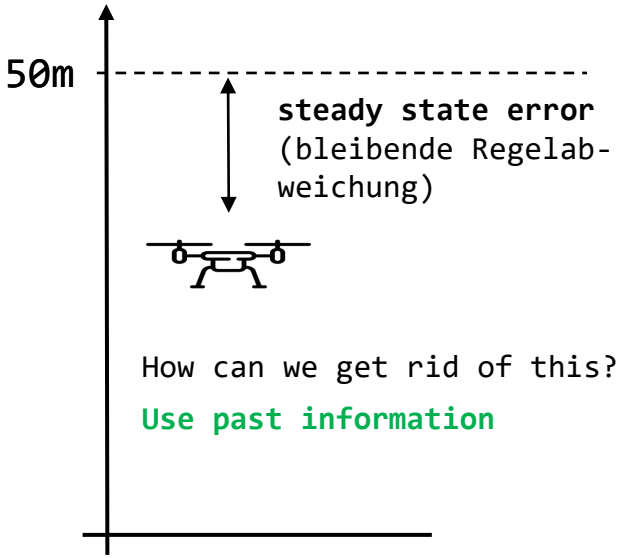
Use past information

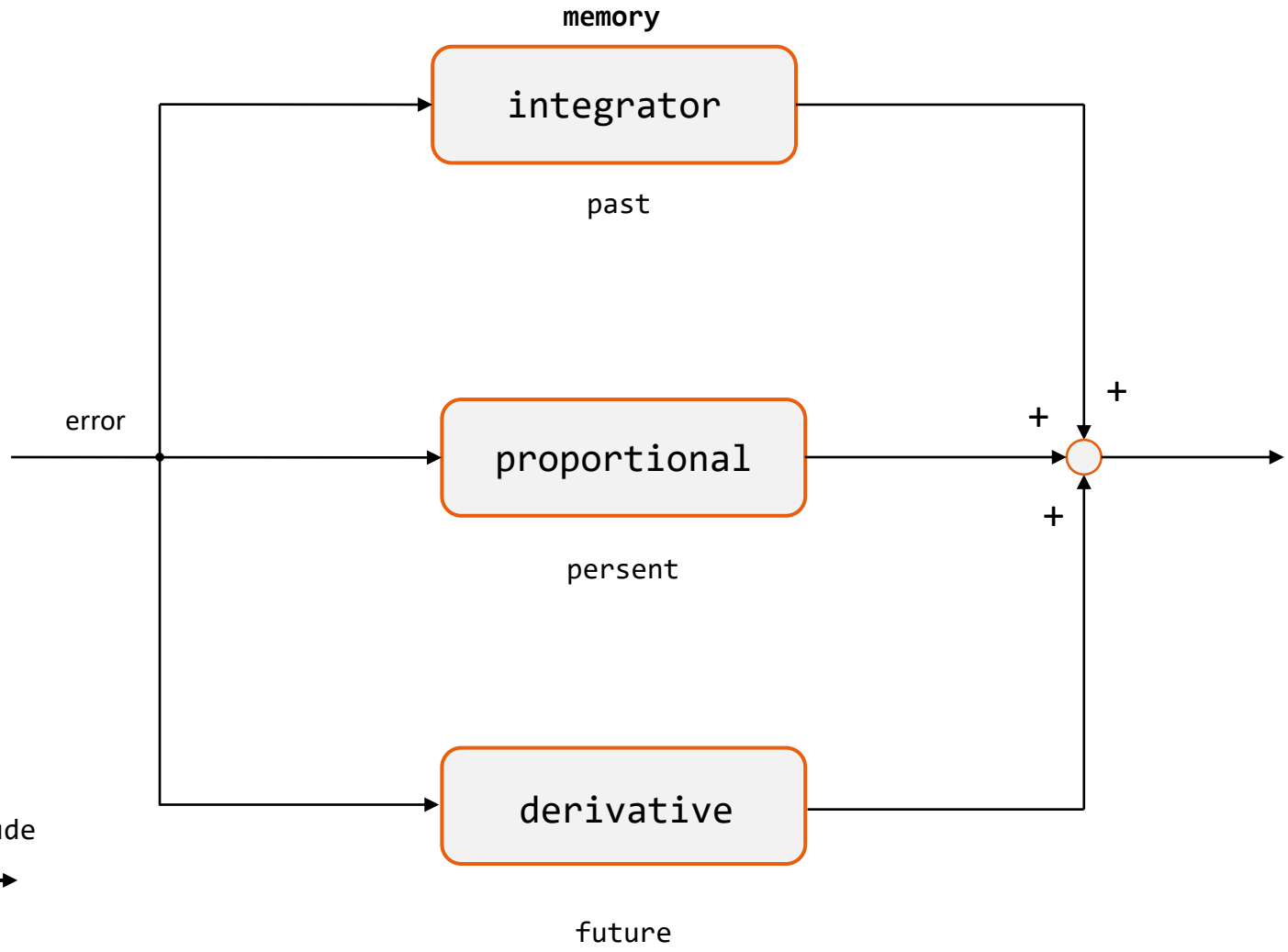

steady state error
increasing total sum
memory
integrator
100 rpm
faster propeller
keeps a running total of the input over time
+ 100 rpm
+
50m
steady state error (bleibende Regelab-weichung)
proportional
0 rpm
zero error
How can we get rid of this?
Use past information
… this works!
But the path to 100rpm might not be ideal.

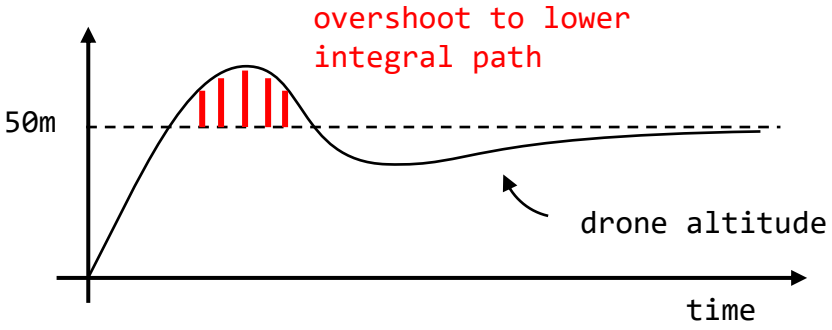

50m
steady state error
(bleibende Regelab-
weichung)
How can we get rid of this?
Use past information

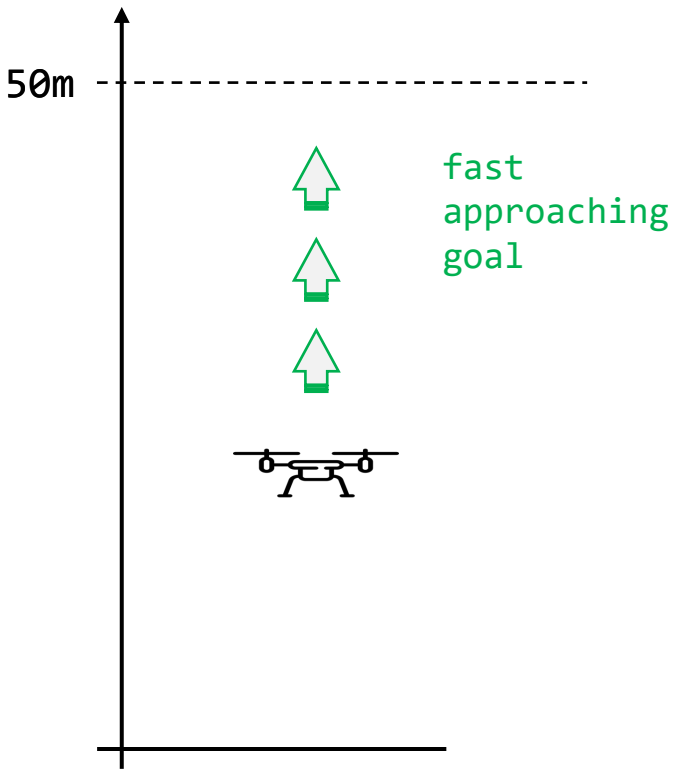

memory
integrator
> 100 rpm
keeps a running total
of the input over time
+
> 100 rpm
+
small error
proportional
small contribution (~ 0)

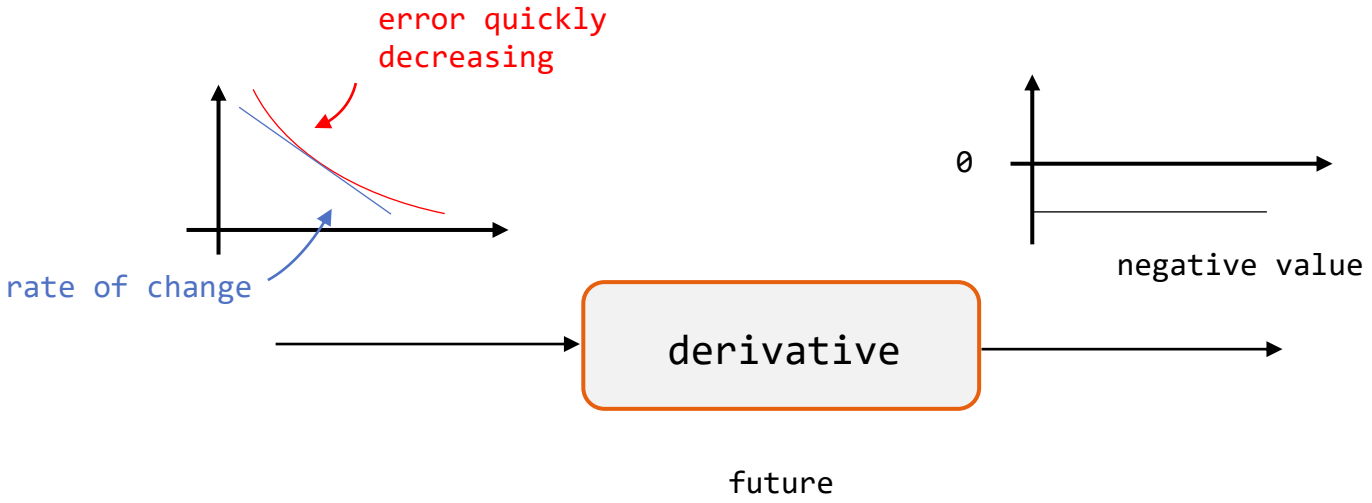

overshoot to lower
integral path
50m
drone altitude
time


50m
steady state error
(bleibende Regelab-
weichung)
How can we get rid of this?
Use past information

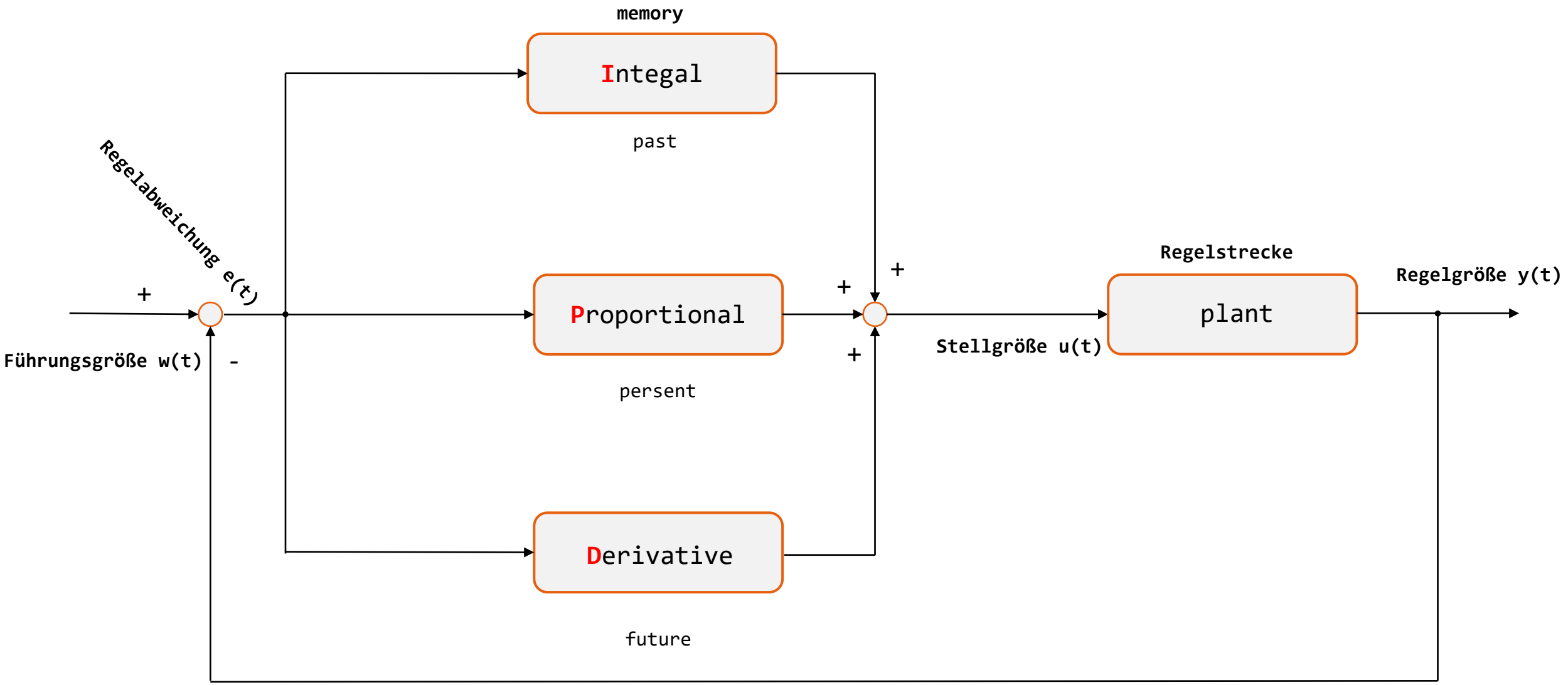

memory
integrator
past
error
proportional
persent
derivative
future
+
+
+

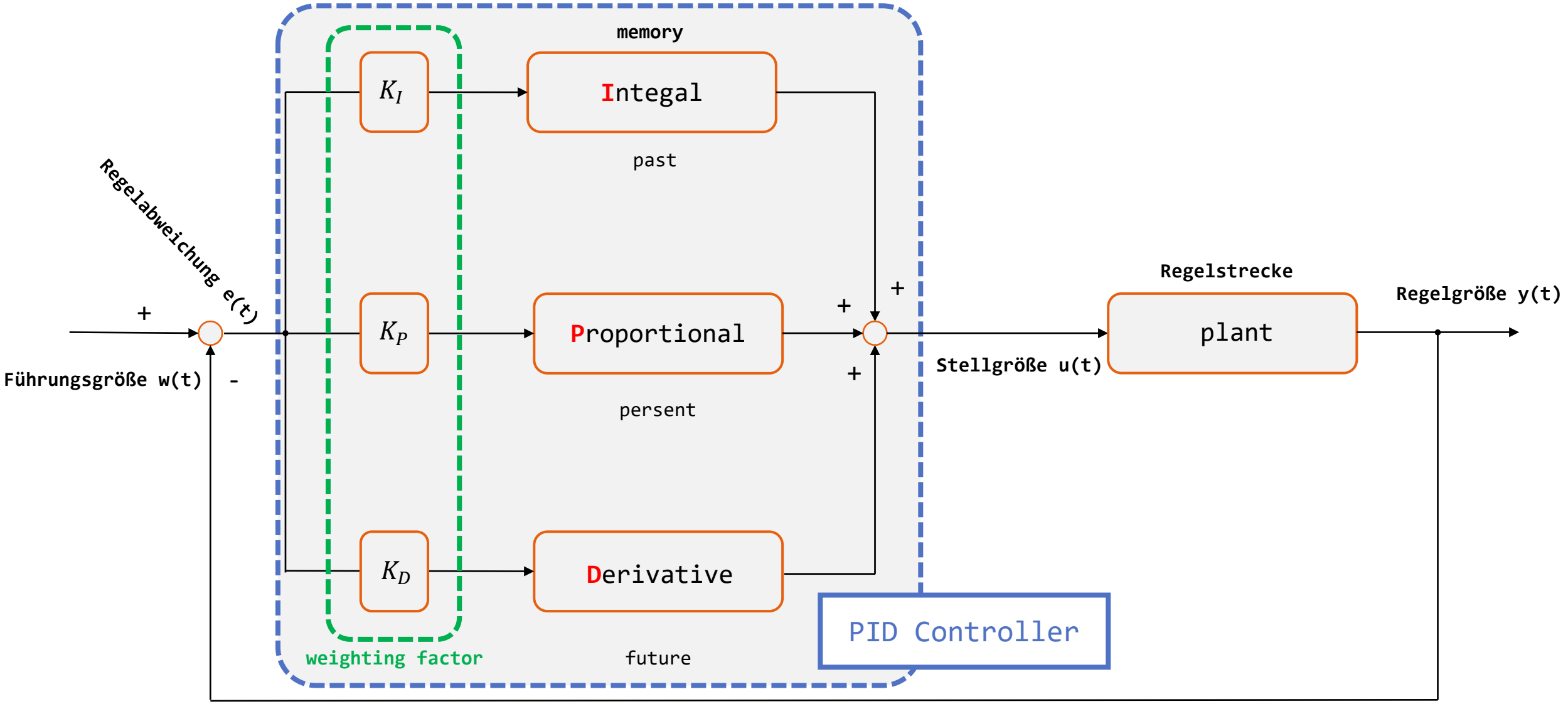

overshoot to lower
integral path
50m
drone altitude
time





- Look at the current rate of change of the error
- Determine how we are approching the goal
- Permaturly slow down the propellers


memory
Integal
past
Regelabweichung e(t)
+
Führungsgröße w(t)
-
Proportional
persent
+
+
+
Derivative
future
Regelstrecke
plant
Stellgröße u(t)
Regelgröße y(t)


memory
K_I
Integal
past
Regelabweichung e(t)
+
K_P
Proportional
persent
+
+
+
Regelstrecke
Regelgröße y(t)
plant
Führungsgröße w(t)
-
Stellgröße u(t)
K_D
Derivative
future
PID Controller
weighting factor