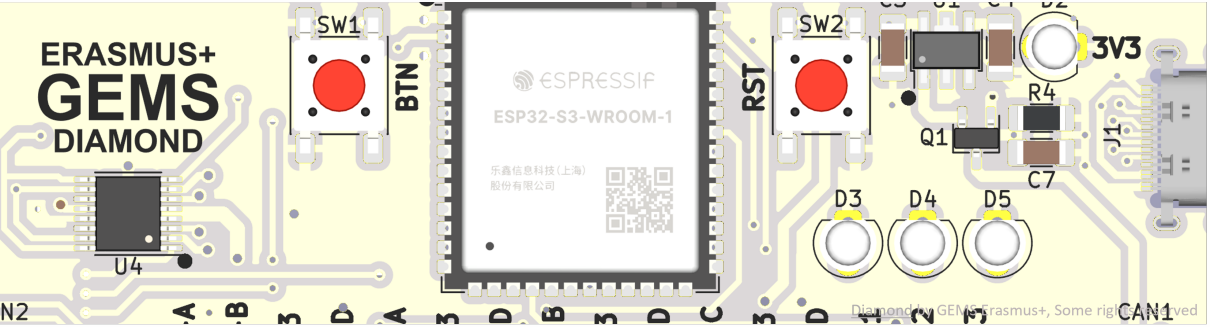

Tutorial 6

PID Control of Motor Drives

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TU Delft

1. Inner current control loop model
2. Speed control model
3. Continuous to Discrete time domain conversion
4. Implementation in ESP32 microcontroller

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Inner current control loop

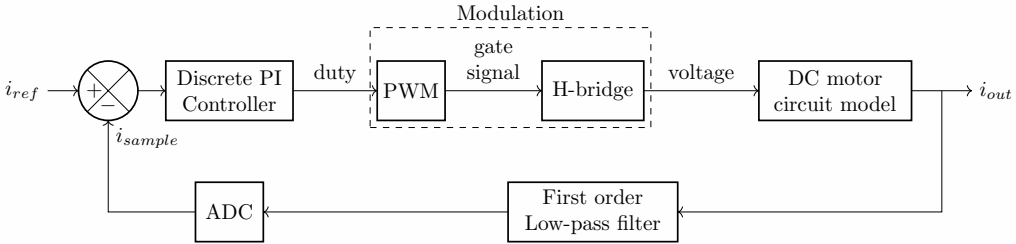
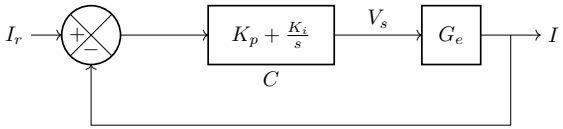


Figure: Typical inner current control loop

Current control loop model



$$C(s)G_e(s) = \frac{K_p s + K_i}{s} \frac{1}{R_a + sL_a} \quad (1)$$

PI parameters are set using pole-cancellation technique. -> Closed loop T.F. $= 1$

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Speed control loop

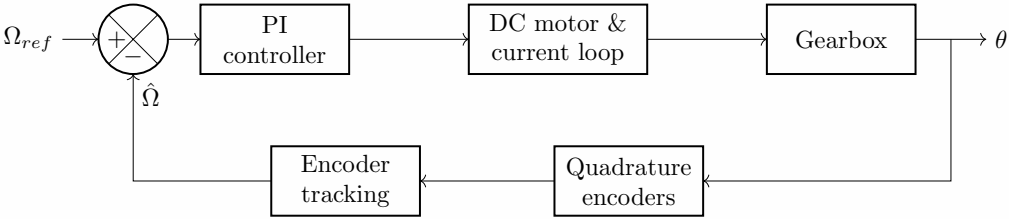
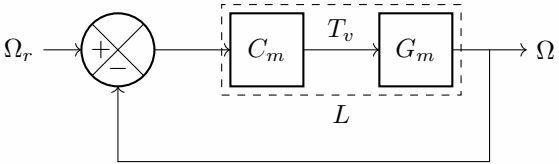


Figure: Speed control loop

Speed control model



$$L(s) = \frac{K_{pm}(\omega_{im} + s)}{s(Js + b)} \tag{2}$$

The speed loop gain is calculated as:

$$K_{pm} = \sqrt{(J\omega_m)^2 + b^2} \tag{3}$$

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Model in discrete time domain

Using c2d in Matlab/Octave:

```
Gm = (Kpm + Kim/s) * (1/(b + s*J));
tfOmega = Gm/(1+Gm);
tfOmegad = c2d(tfOmega, Ts, 'tustin');
```

The coefficients of the numerator and denominator can be access by:

```
tfOmegad.Numerator{1}
tfOmegad.Denomenator{1}
```

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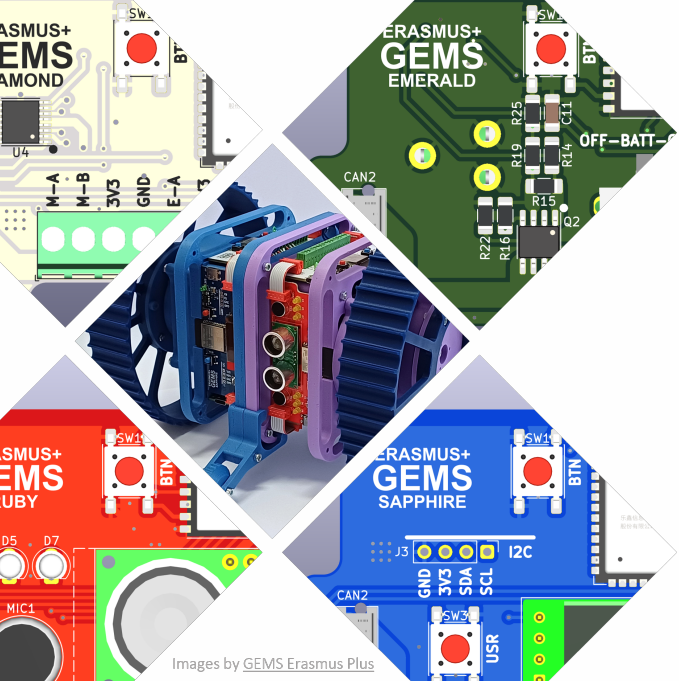
Difference equation

$$\begin{aligned}\Omega[n] =& a_1\Omega_r[n] + a_2\Omega_r[n-1] + a_3\Omega_r[n-2] + a_4\Omega_r[n-3] + a_5\Omega_r[n-4] \\ & - b_1\Omega[n-1] - b_2\Omega[n-2] - b_3\Omega[n-3] - b_4\Omega[n-4]\end{aligned}$$

Conclusion

- Review of the inner current control loop and speed control loop.
- Tuning of PI parameters for the two models.
- Discretization using Matlab.
- Implementation of the difference equation in ESP32 microcontroller.



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Thank you for watching!

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