Real-time for control systems

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Outline

Real-time systems

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What is a real-time system?

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  - ... AND meets specified time constraints – the so called "deadlines"

Non-real-time VS real-time - 1/2

Example of non-real-time algorithm

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            double result = w1*u1+w2*u2;
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We should exploit (indirectly) the hardware architecture and (directly) the operating system, in order to meet the time constraint

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  - **Remember: real-time does not necessarily means "fast"!**

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- **Note: usually a periodic task should also meet a deadline**

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- Real world (real-time) systems have a mix of hard/soft components
- The distinction between hard and soft real-time is somewhat subjective
- **Soft real-time is not Non-real-time (!)**

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- Given n real-time tasks. . .

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      `End_time(task_k)-Start_time(task_k)` $\leq$ `Deadline(task_n)`
    - Are the periodic tasks executed with the required accuracy? Do they meet their deadlines?
- There exist formal methods that permits to assess schedulability (under given assumptions)

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- Timer support
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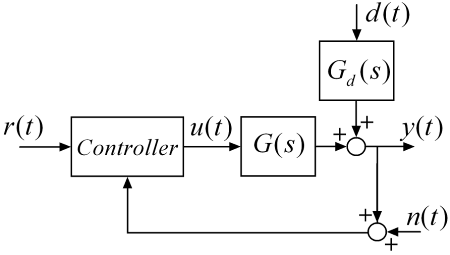
Some RTOS

- WindRiver VxWorks
- QNX Neutrino
- RTAI (Linux patch)
- FreeRTOS
- Windows CE

Example - Continuous control system 1/2



The plant

$$G(s) = \frac{2.5 \cdot 10^5}{(s+10)(s^2+80s+2500)}$$

Example - Continuous control system 2/2

The continuous-time controller

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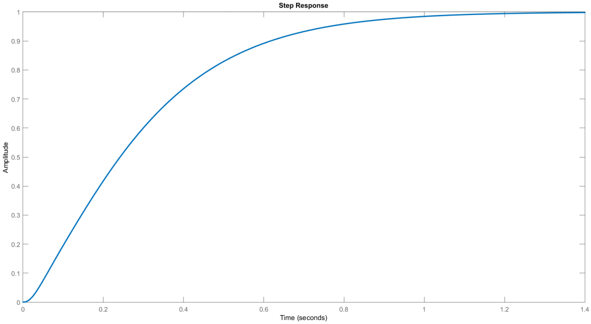
Open-loop step response



Example - Controller discretization

The discrete-time controller

Given the sampling frequency $f_s = 200$ Hz, the Tustin approximation of the controller (1) is

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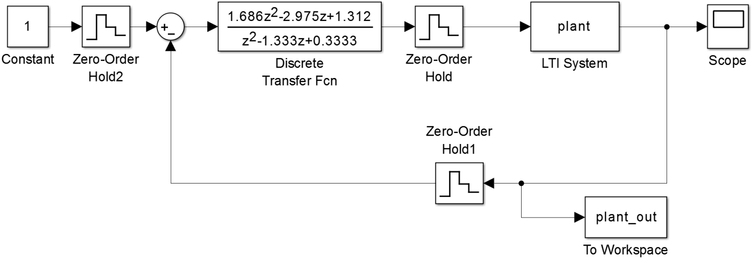
- Implementing the discrete-control law (2) means
  - **Functional requirement:** to write a task that computes the correspondent difference equation
  - **Non-functional requirement:** to execute the task every 5 ms (assuming negligible execution time)

To meet or not to meet (the deadlines)?

Use Simulink. . .



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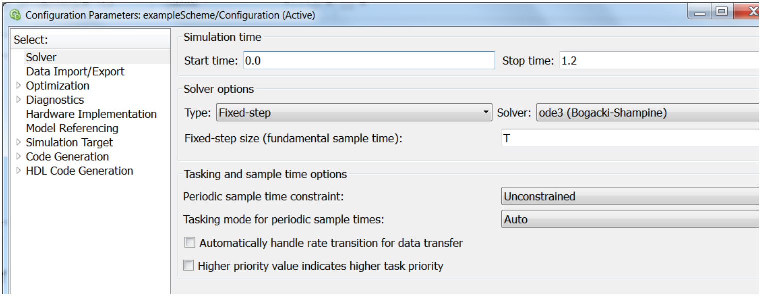
. . .with Fixed time-step solver. . .



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. . .changing the time step