# Project 1, Part 2: Auto tuning of PID controller

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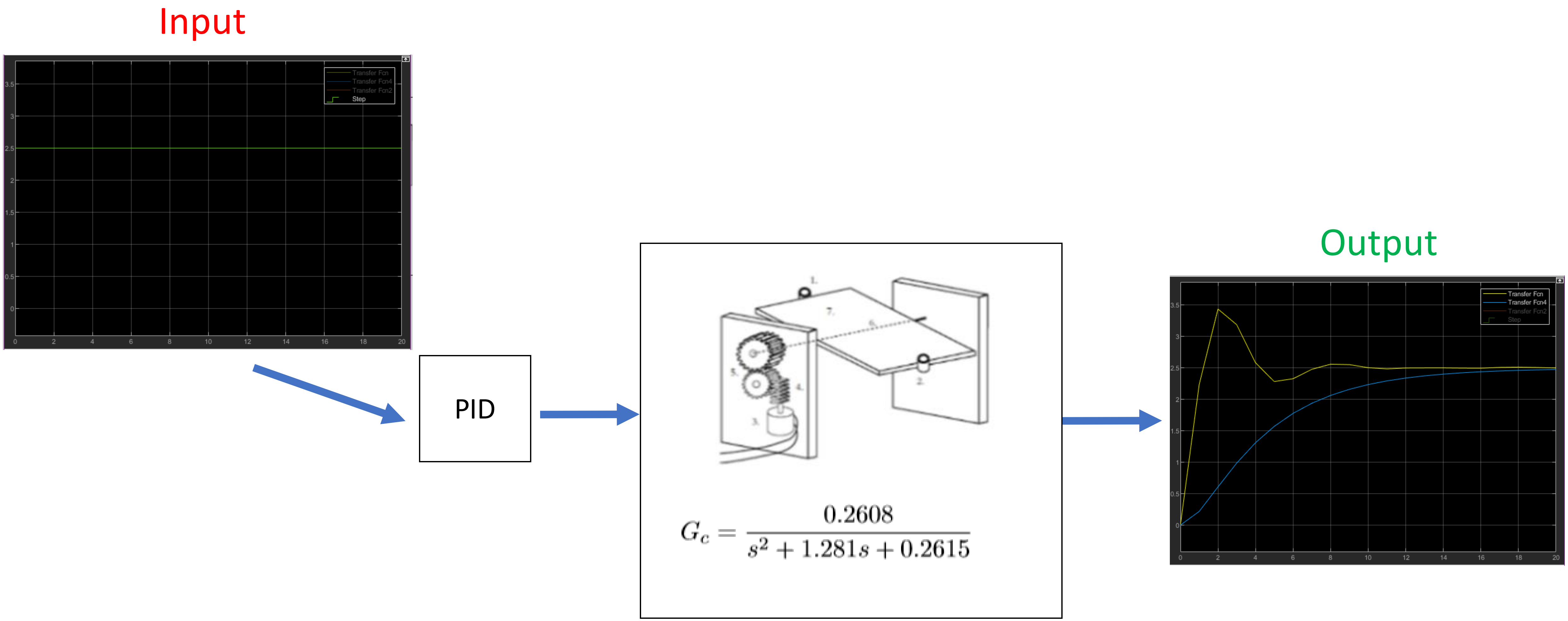
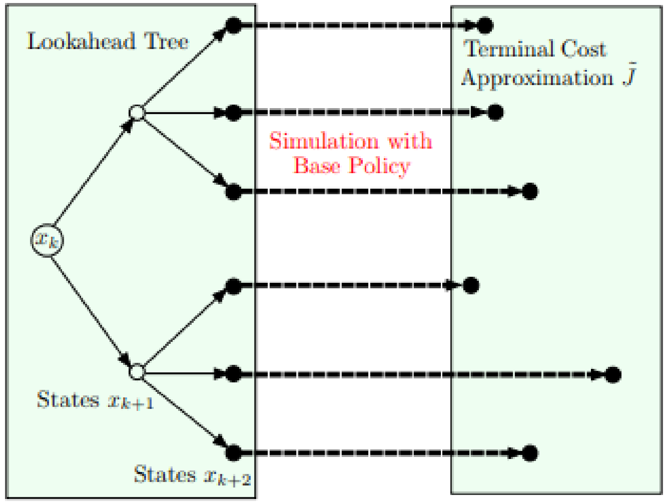
# 1 Description of the problem



# 2 Mathematical formulation

**Rollout: On-Line Simulation-Based Approximation in Value Space**




$$Tapprox = \frac{Va}{2.9}$$

$$g_k(x_k, u_k) = \mathbf{E}[|Curve_k - Va|]$$

$$\tilde{J}_k = Gdiff_k$$

Xi= Kp, Ki, Kd
Increase ratio ~ U(0,10)

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**Algorithm 1:** Approximate method

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**Result:** Gdiff, Ki, Kp, Kd
Ki, Kp, Kd, Va, Tapprox;
**while** *While Tapprox > Gdiff* **do**
  Increment gains sequentially, simulate and obtain $\text{Gdiff}_k$;
  **if** $Gdiff_k < min(Gdiff)$ **then**
    *Update gains*
  **else**
    *Discard gains*
  **end**
**end**

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# 3 Results and analysis

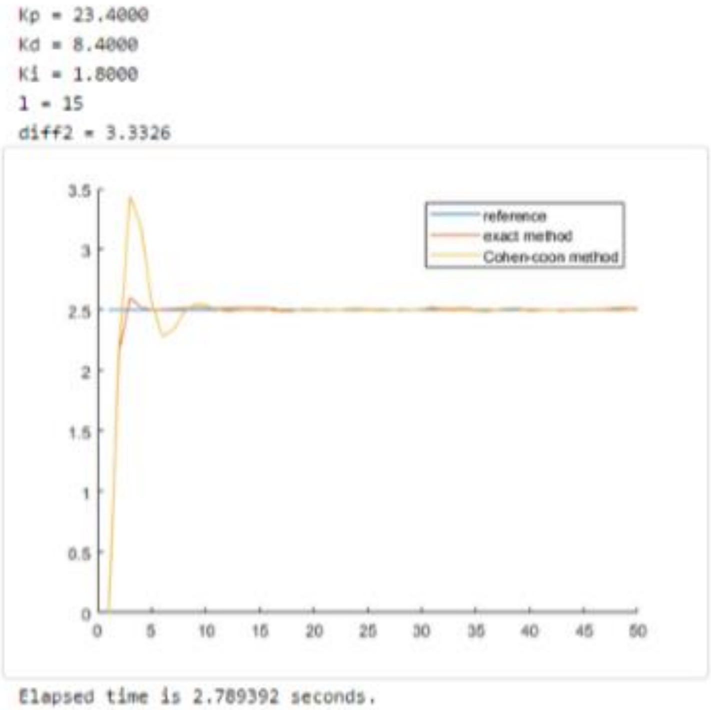


Figure 3: Response to the signal with different solution methods

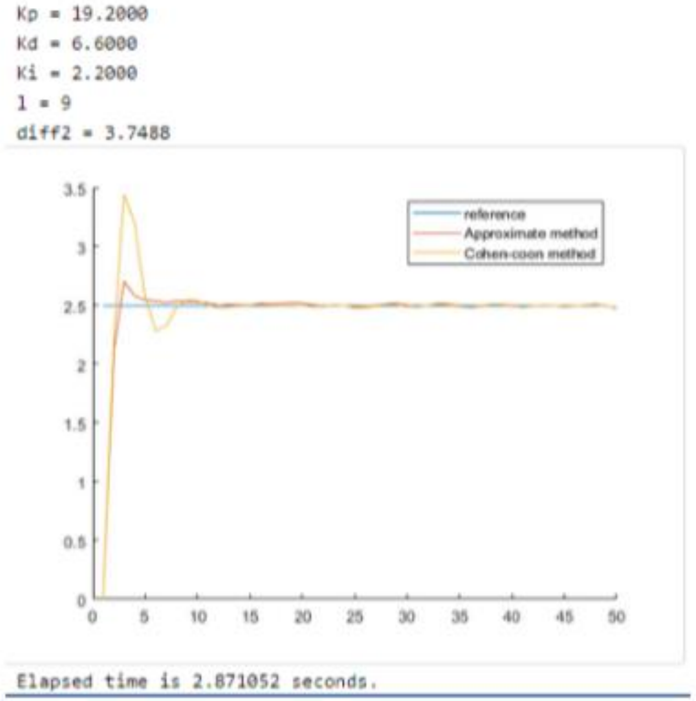


Figure 5: Response to the signal with different solution methods

| method | Gdiff | numer of steps |
|---|---|---|
| Exact | 3.6 | 20.7 |
| Approximate | 4.8 | 16 |

Table 1: Average difference between *curve* and reference value

# 3 Results and analysis

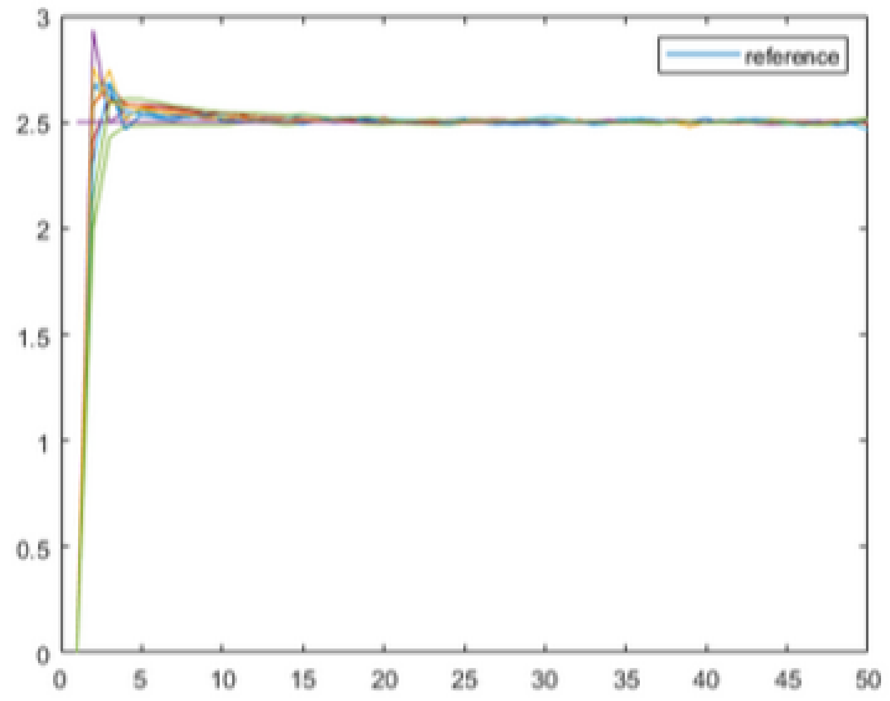


Figure 4: Variance in the exact method solutions

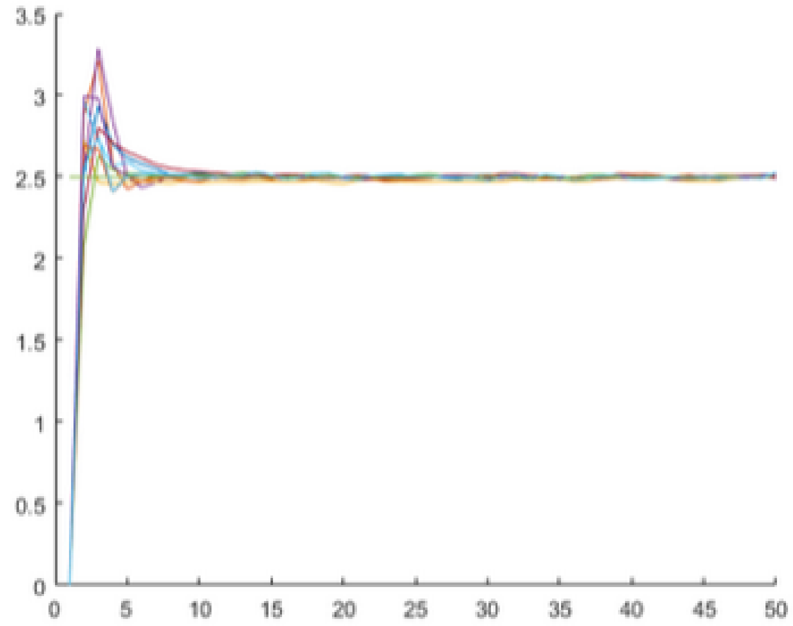


Figure 6: Variance in the approximate method solutions

# References


- [1] Dimitri P. Bertsekas. (August 2010). Rollout Algorithms for Discrete Optimization: A Survey. Handbook of Combinatorial Optimization, Springer, 2013, 20. 4/8/2019, From MIT data base.
- [2] Doerr et al. (8 Mar 2017). Model-Based Policy Search for Automatic Tuning of Multivariate PID Controllers. IEEE., 2017, 7. 4/08/2019, From arxiv data base.