POZNAN UNIVERSITY OF TECHNOLOGY

Poznan, Poland

CONTROL OF ELECTROHYDRAULIC SERVO DRIVES

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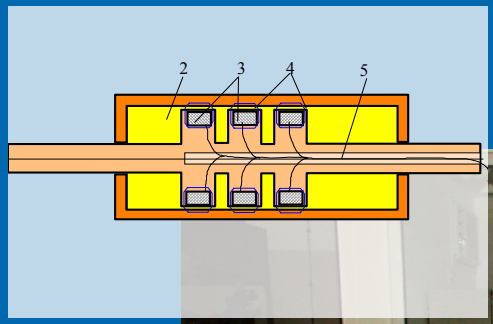
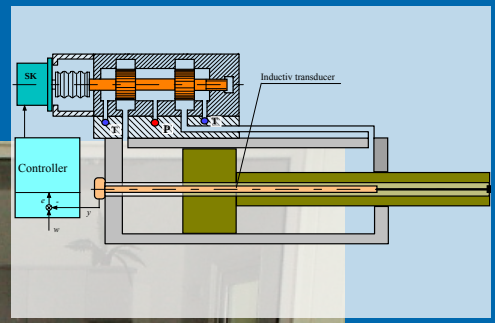
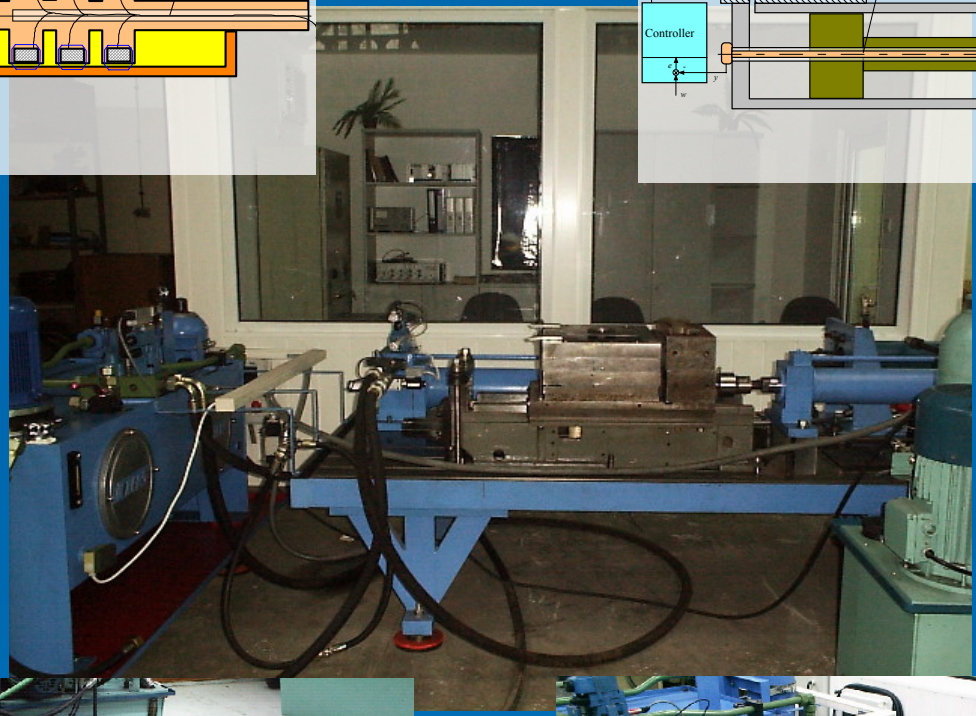
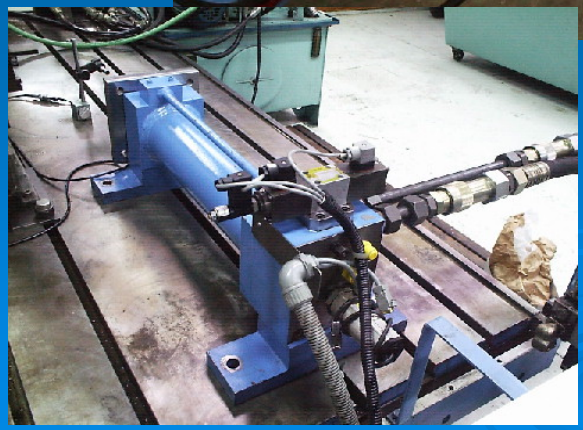
Institute of Mechanical Technology

HYDRAULICS LABORATORY





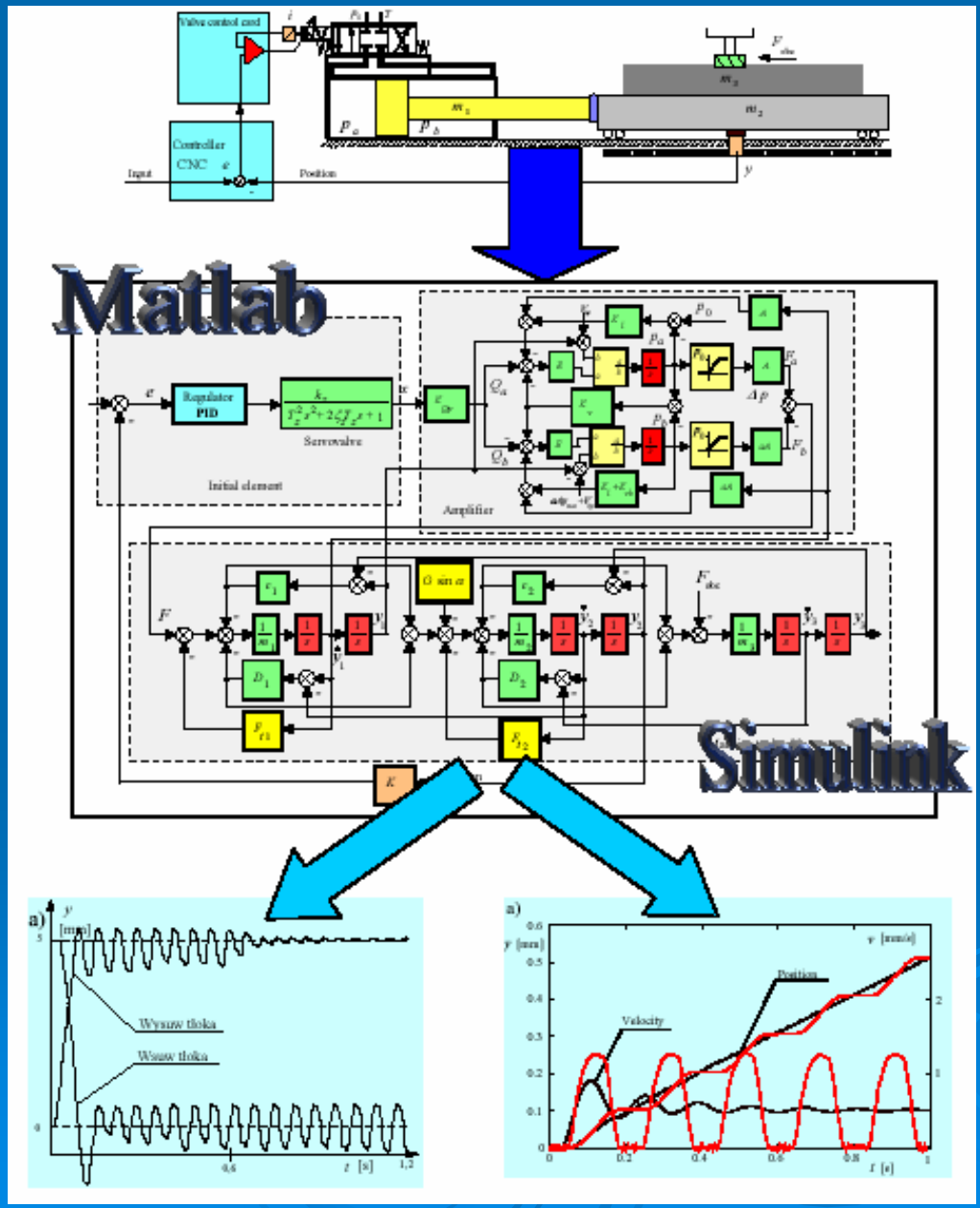




Investigation stand

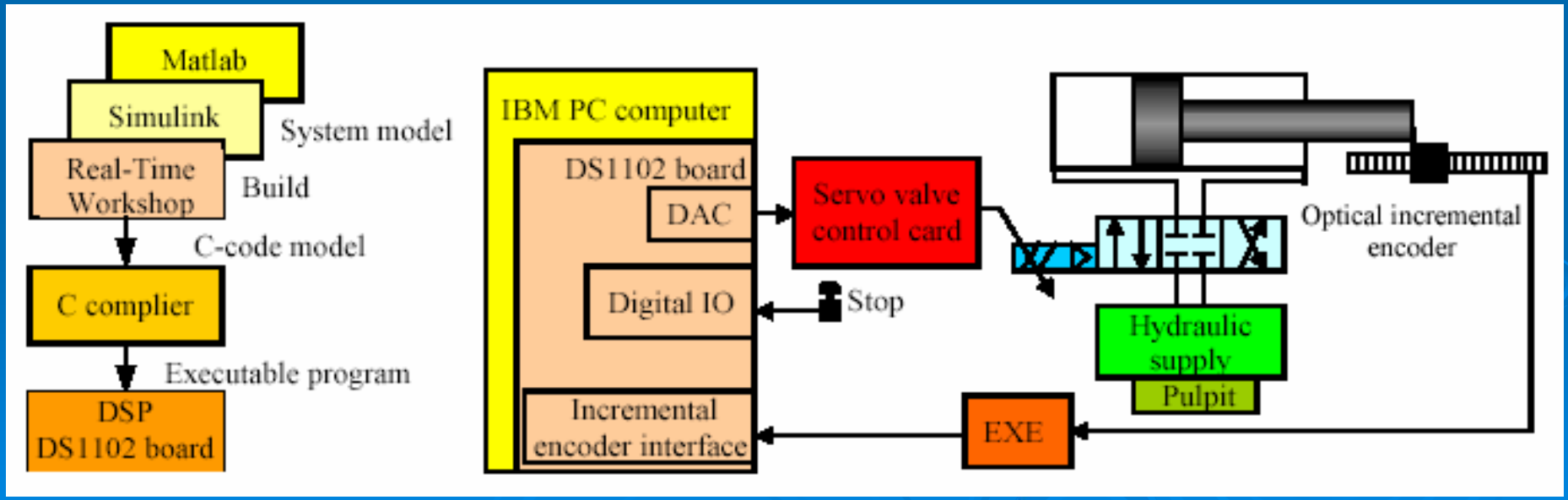
- servo valve with mechanical feedback linkage type SM4-20
- cylinder: stroke 400 mm and piston diameter 100/60 mm
- mass about 500 kg
- LVDT or optical encoder

MODELLING with MATLAB-SIMULINK

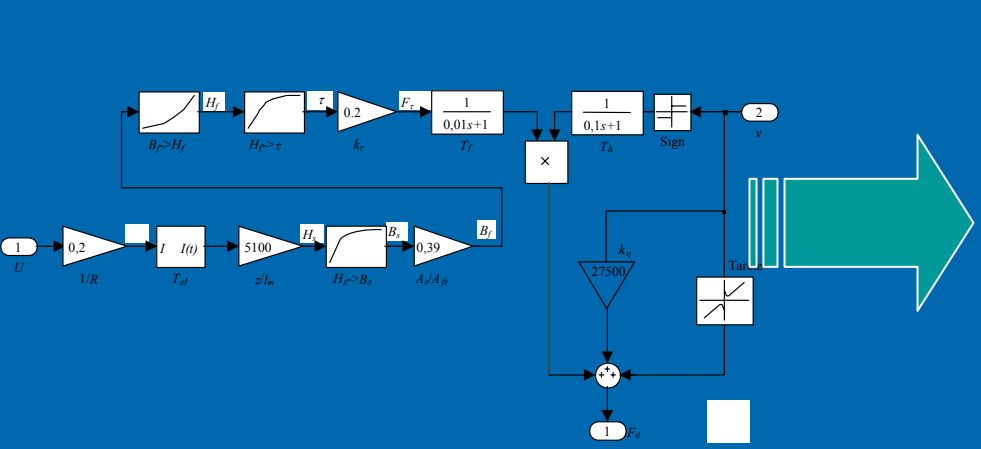


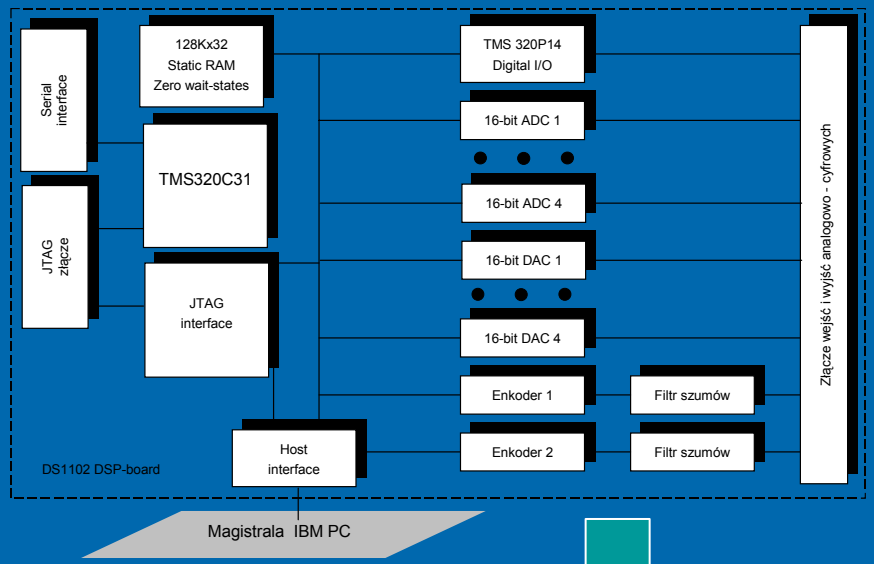
Rapid prototyping of device controllers by usage Matlab-Simulink platform

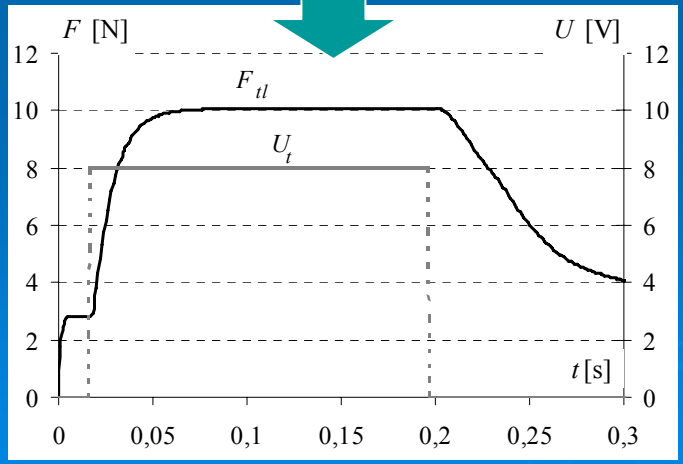
The main purpose is to check up the practical possibilities of usage rapid prototyping methods in design of controllers, which use modern control techniques. Such new control techniques like non–linear control methods, based on artificial intelligence methods, modern control methods should be investigated.
There are at PUT different worked out simulation models of mechatronic devices (between them models of electrohydraulic servo drives), which can be used in simulations.

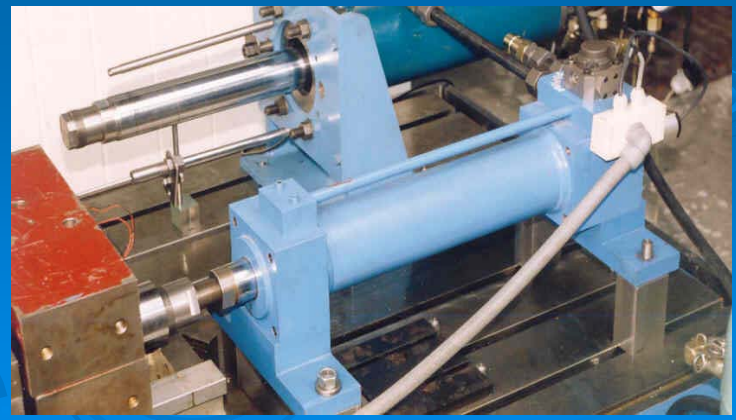


MATLAB-SIMULNK and dSPACE INPUT OUTPUT CARD

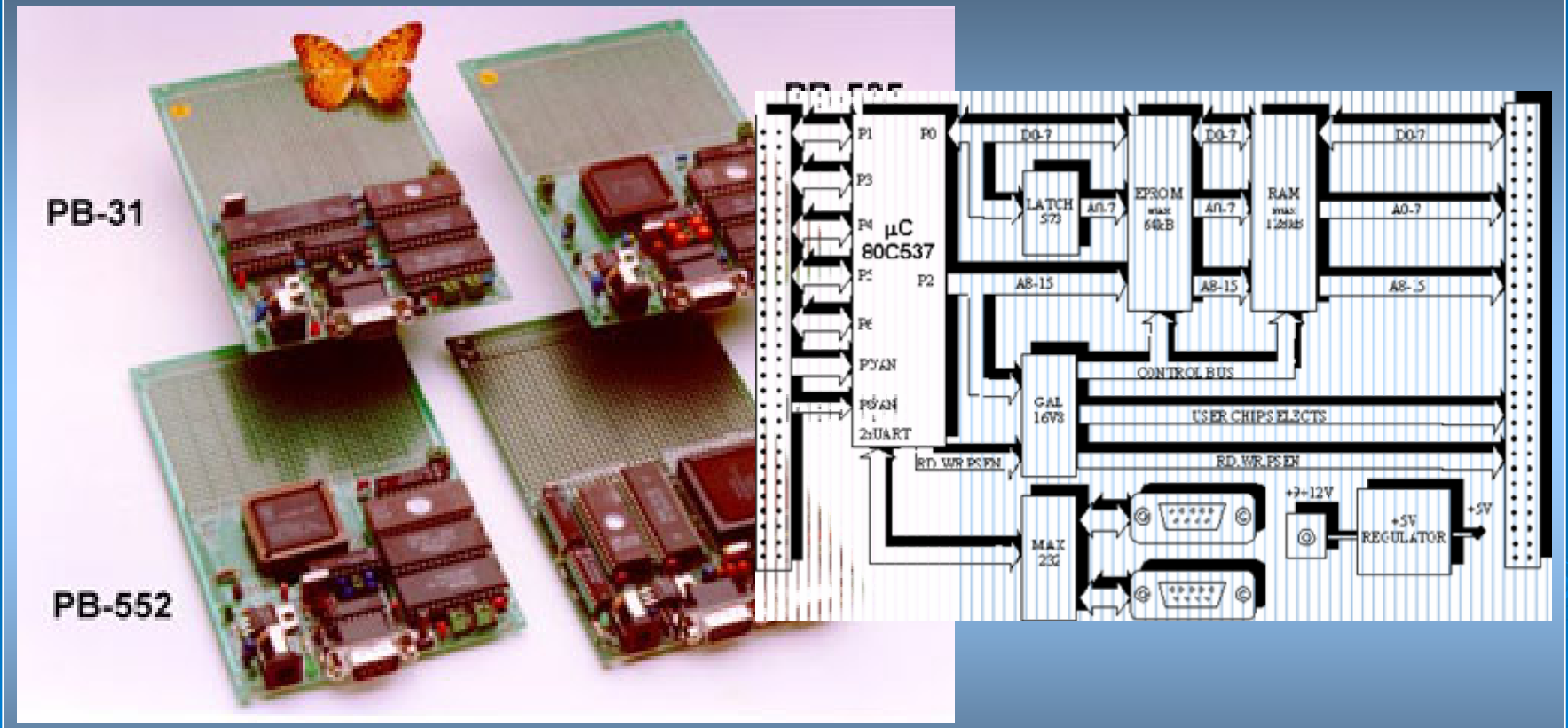








Microprocessor controllers

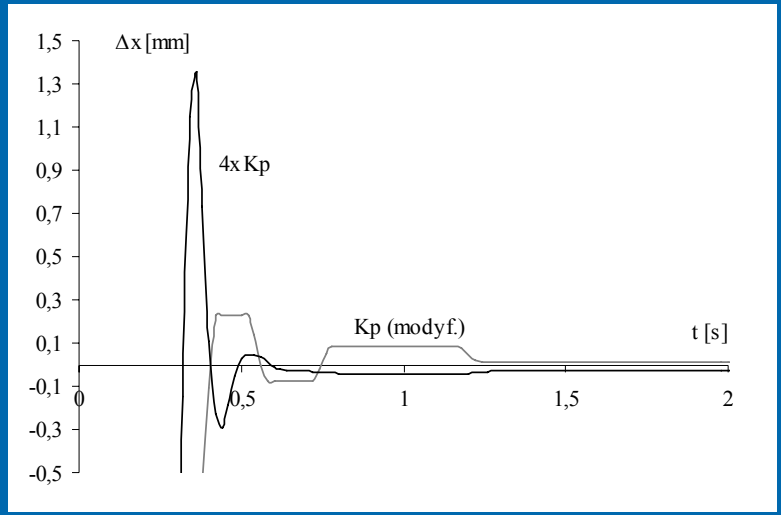


Keil software with emulators

PID – anti windup

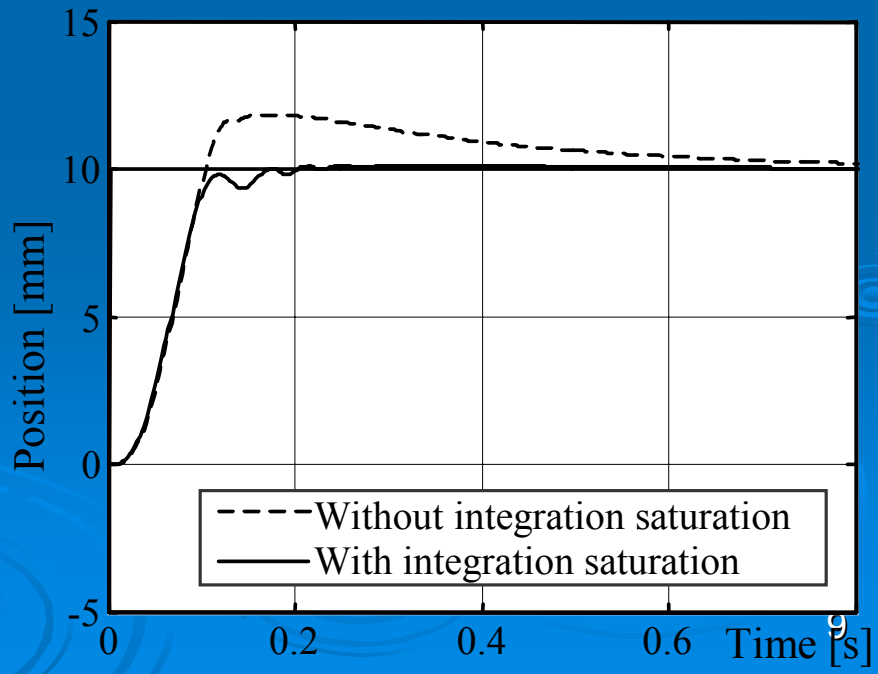
1. **Calculate:** $c_n = c_{n-1} + k_p \frac{\tau}{T_i} e_n$ $x_n = k_p \left(e_n + \frac{T_d}{\tau} (e_n - e_{n-1}) \right)$ $u_n = c_n + x_n$
2. **If** $e_n > 0$ $u_n > U_{\max}$ **than** $c_n = U_{\max} - x_n$ $u_n = U_{\max}$
3. **If** $e_n < 0$ $u_n < U_{\min}$ **than** $u_n = U_{\min}$
4. **Let** $e_{n-1} = e_n$ $c_{n-1} = c_n$
5. **Return to step 1**

Investigations results



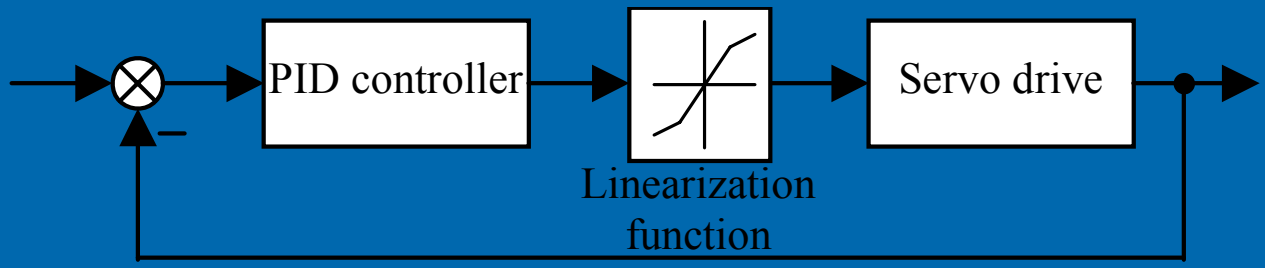
Positionning processes with constant and with reduced controller proportional gain

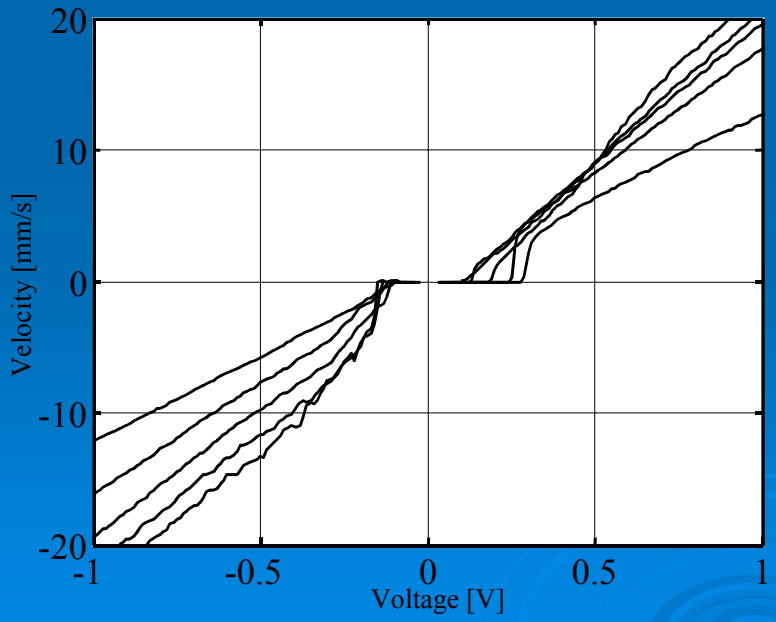
Step responses of servo drive with PI controller without and with integration saturation

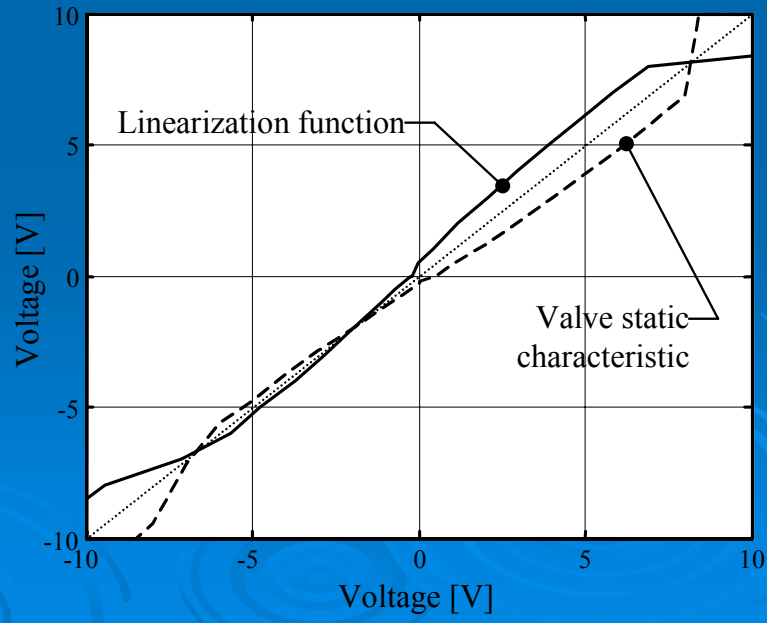


Valve linearization

The main idea is to add to the controller special non-linear function, which is inversion of the valve static characteristic

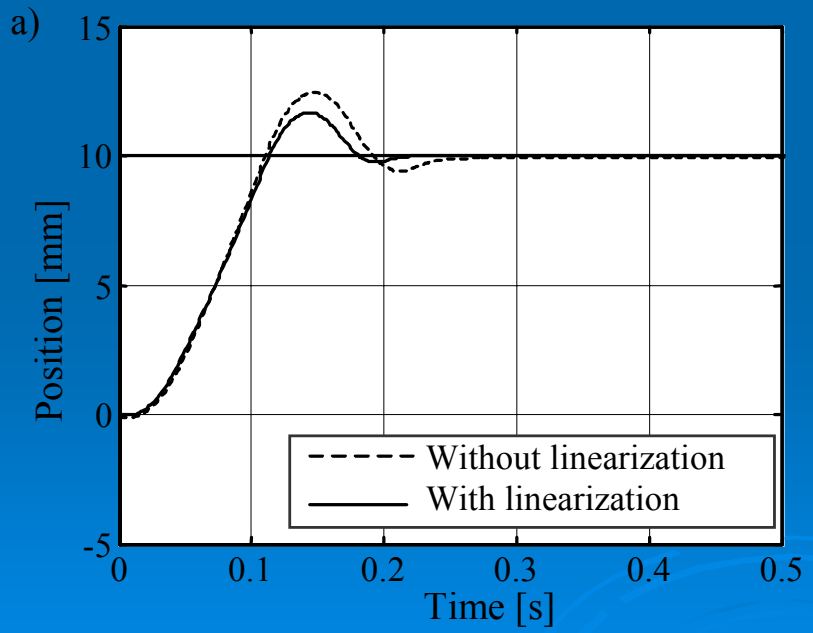


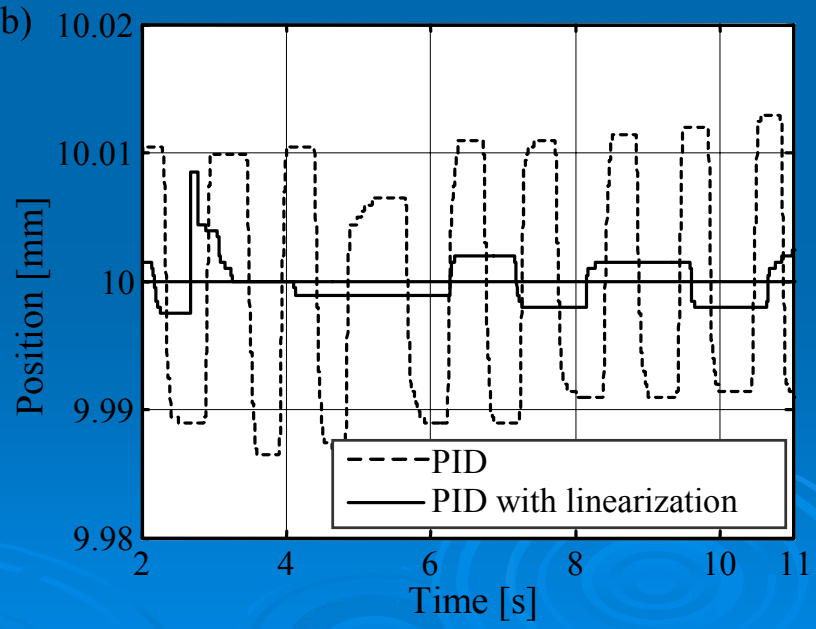




Investigation results

- The linearization has a positive effect on step responses and positioning accuracy.
- The overshot of servo drive with linearization is smaller.
- Also the oscillations amplitude of system with linearization is smaller and the positioning accuracy is better





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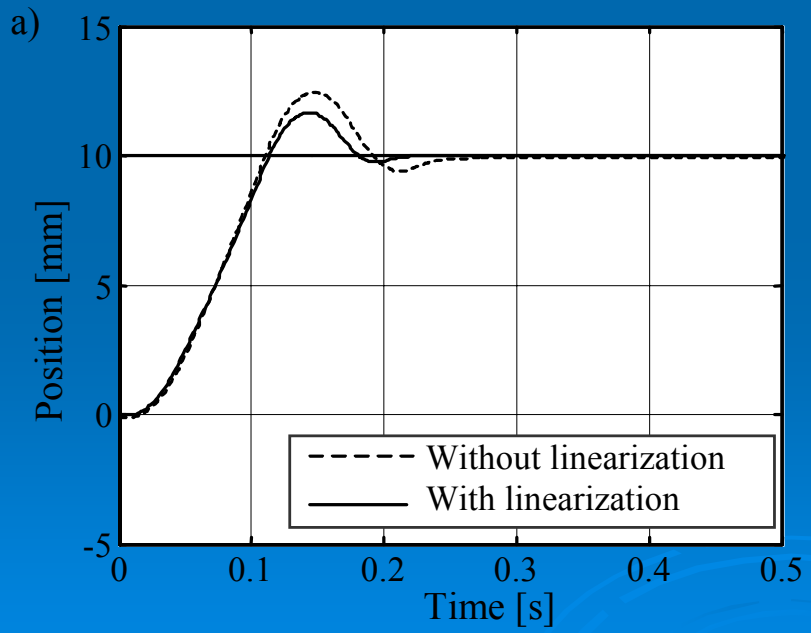
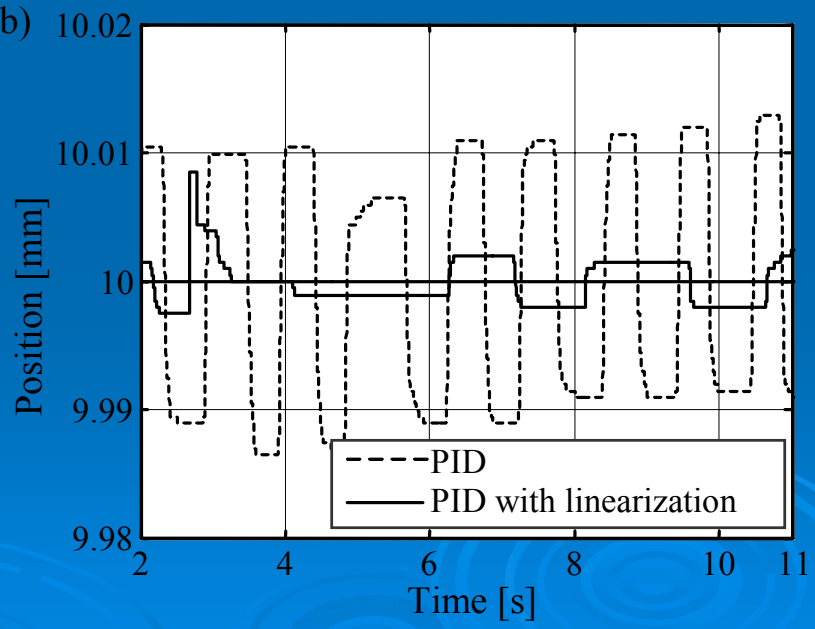
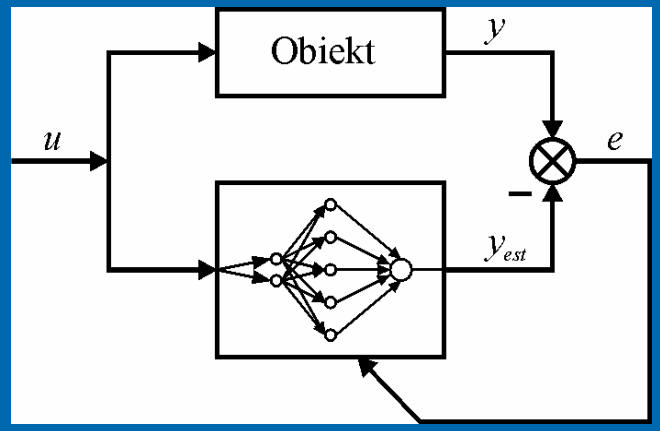
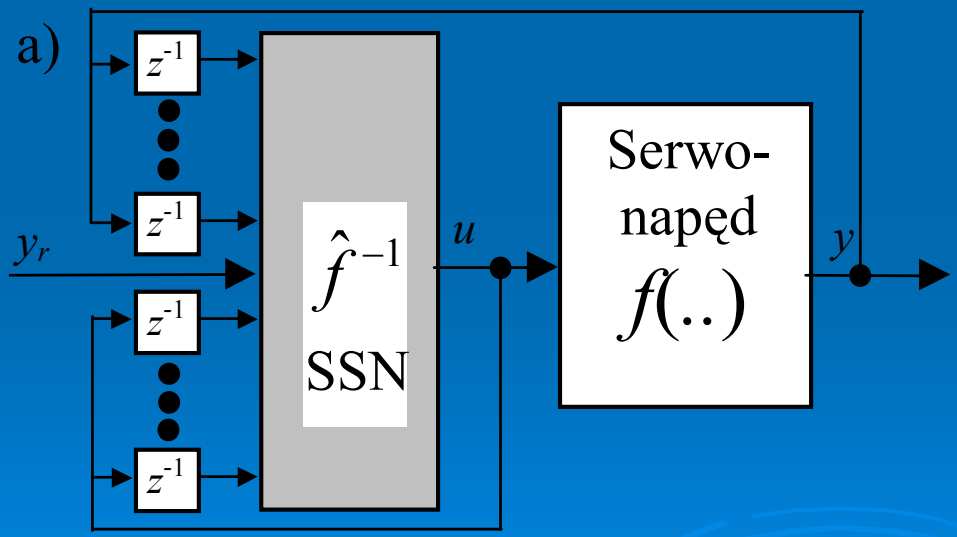


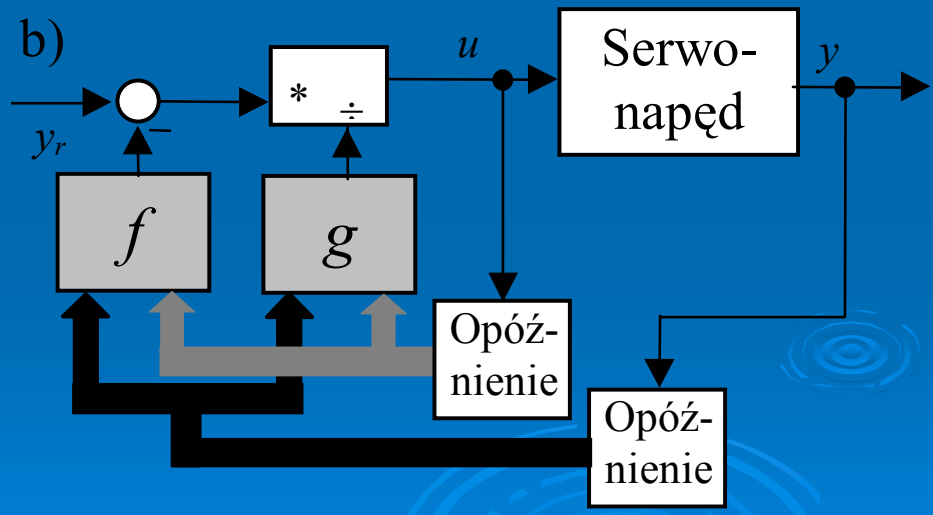


Artificial intelligence

- Modelling
- Inverse model controller
- ...er

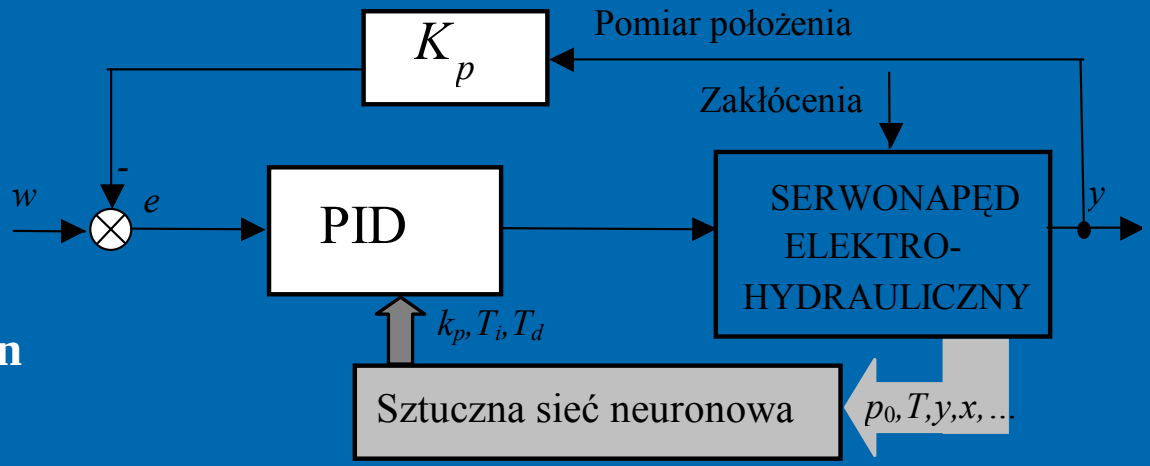


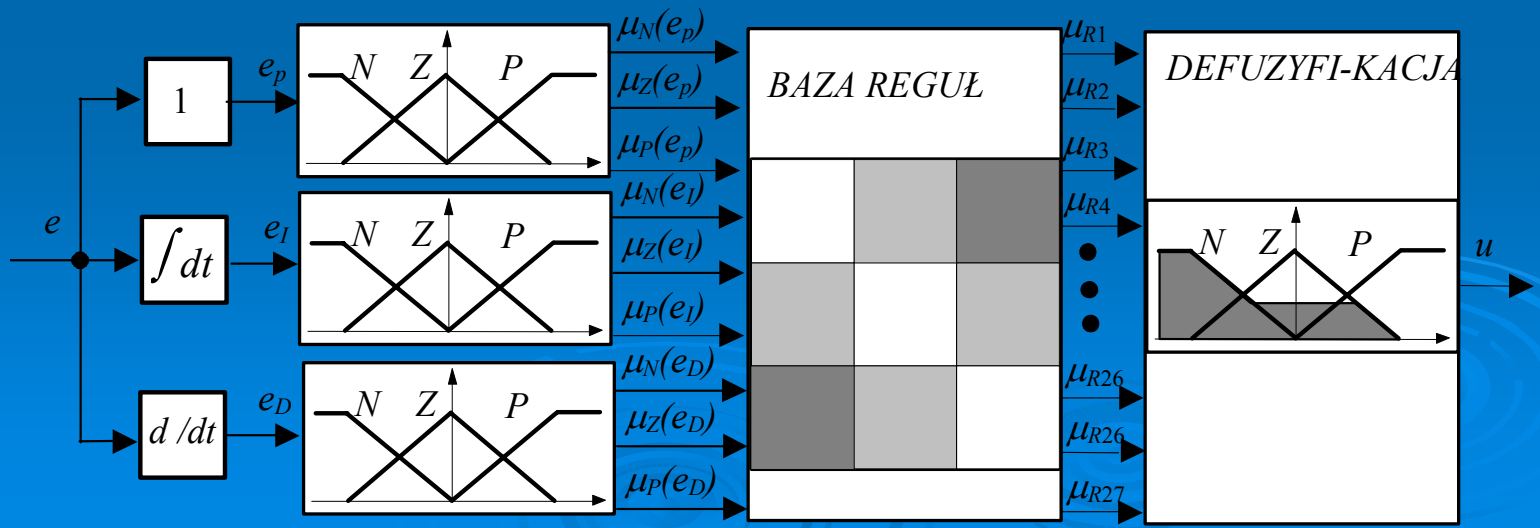




Artificial intelligence

- **Adaptive controller**
- **Fuzzy logic controller**
- **„stick-slip” effect reduction**





CONCLUSION

- The presented control possibilities can significantly improve electrohydraulic servo drives parameters.
- The made out analyses have shown, that the usage of modifications in PID algorithms can give additional step in the control methods.
- The usage of digital systems i.e. microcontrollers can be very useful especially by positioning and velocity control.
- Based on artificial intelligence methods opens new interesting possibilities.
- The results of investigations presented in the paper shown the necessity to continue the research in the future

THE END OF PRESENTATION

Thank you very much