



Laboratorijski elektrohidraulički sustavi kao potpora projektu HiSkid

Prof. dr. sc. Željko Šitum



Naziv projekta: „Razvoj hibridnog skidera – HiSkid“
Šifra projekta: KK.01.1.1.04.0010

Prof. dr. sc. Željko ŠITUM
Full Professor
Department of Robotics and Production System Automation
Faculty of Mechanical Engineering and Naval Architecture
Ivana Lucica 5, HR-10000 Zagreb, Croatia
e-mail: zsitum@fsb.hr



Laboratorij za automatiku i robotiku

Katedra za strojarsku automatiku

Zavod za robotiku i automatizaciju proizvodnih sustava



2. radionica: KK.01.1.1.04.0010 „Razvoj hibridnog skidera – HiSkid“

■ Elektrohidraulički sustavi

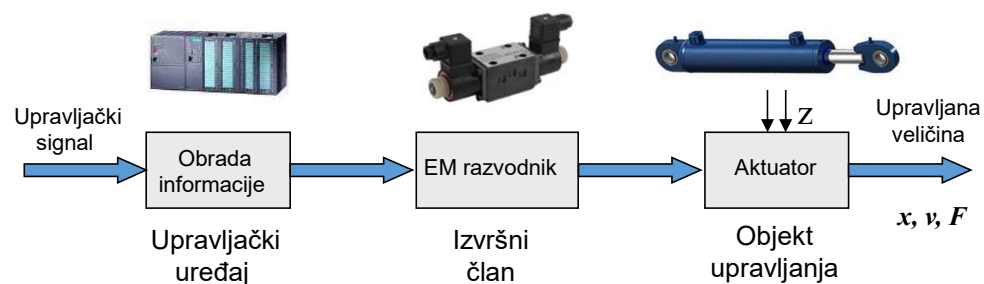
Regulacija
TRANSLACIJSKOG gibanja

Regulacija
SILE

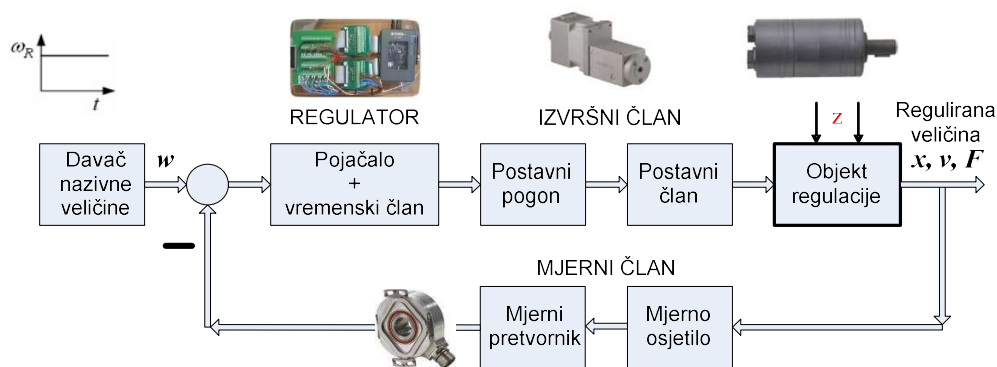
Regulacija
ROTACIJSKOG gibanja



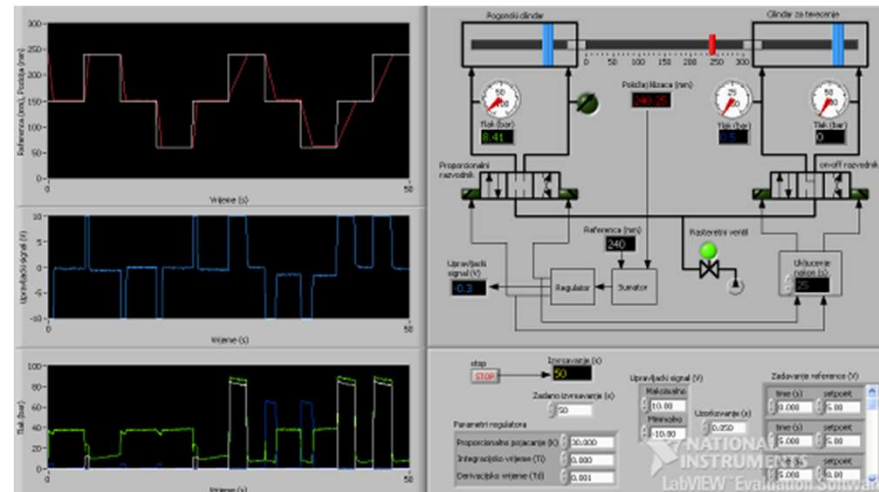
UPRAVLJANJE (eng. *open loop control*, njem. *steuerung*)



REGULACIJA (eng. *closed loop control*, njem. *regelung*)



■ Hidraulički sustav – regulacija translacijskog gibanja



■ Regulacija položaja hidrauličkog cilindra primjenom upravljačkog uređaja **CompactRIO** i grafičkog programa **LabVIEW**

NI CompactRIO



NI myRIO



PLC Beckhoff

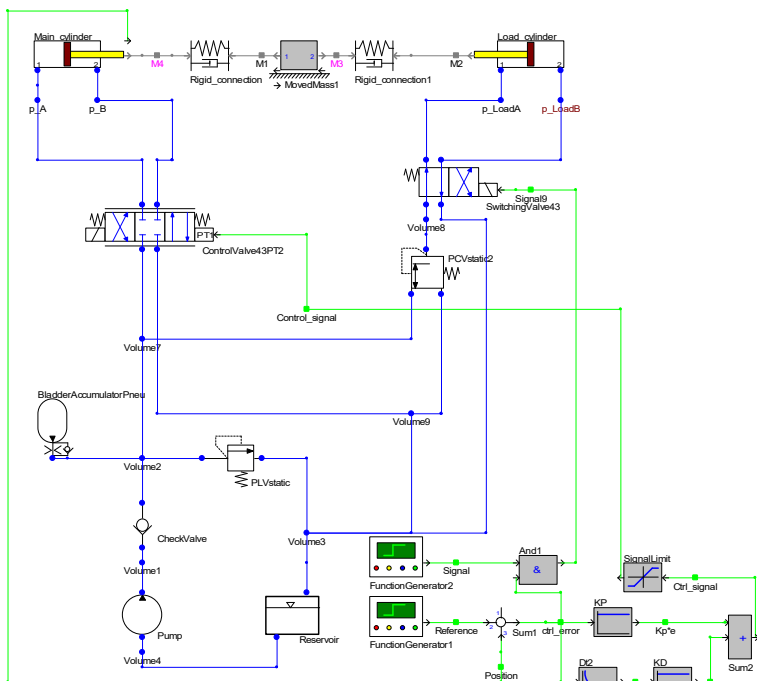


PLC Siemens

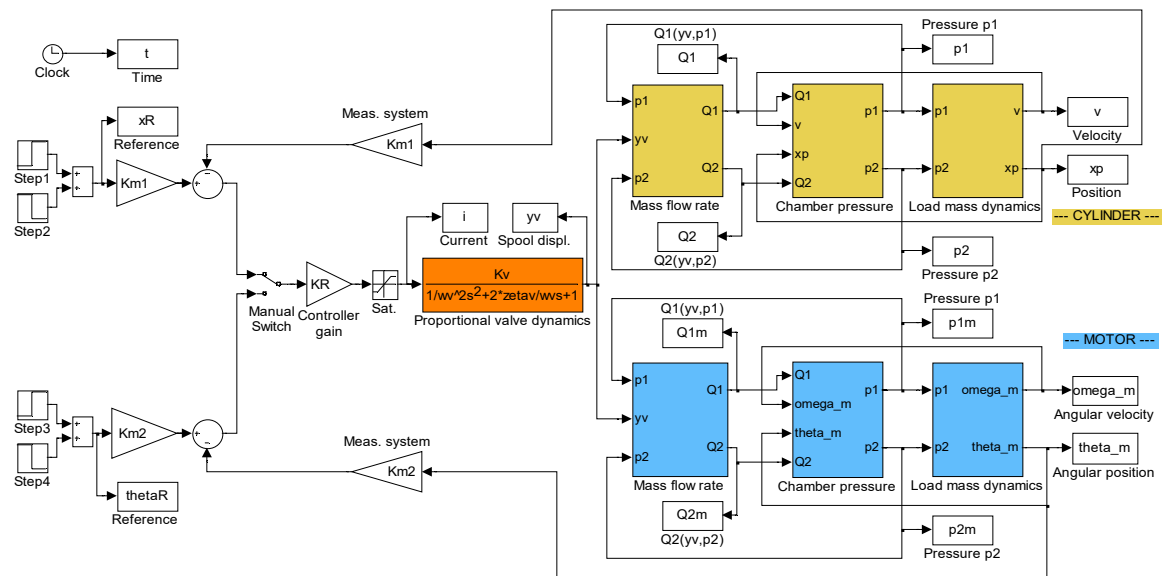


Šitum, Ž., Lobrović, M. PLC/PAC/PC - based control of an electro-hydraulic servo system. Ventil, 19, no. 1 (2013): 34-40.

Simulacija hidrauličkih sustava



Simulacijski model - DSHplus Fluid power simulation program

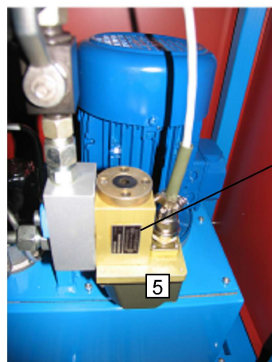


Simulacijski model – Matlab/Simulink program

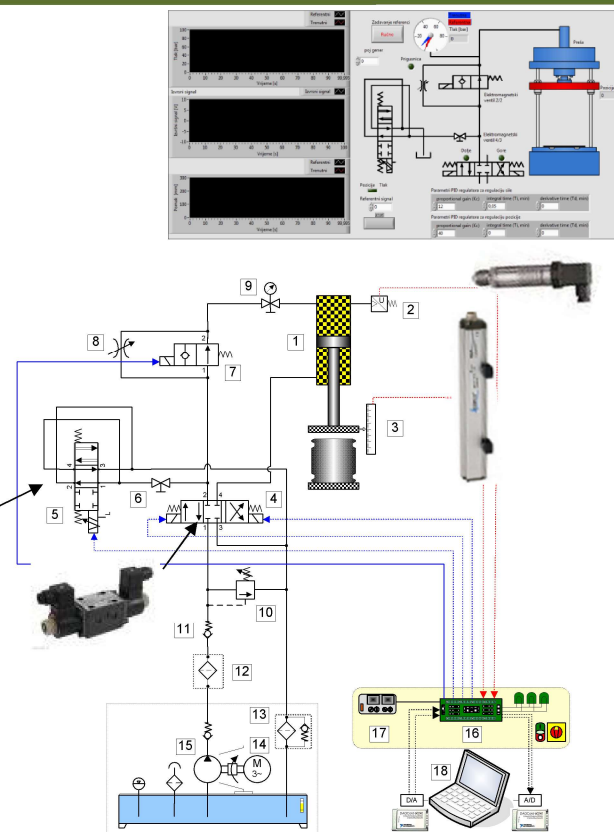
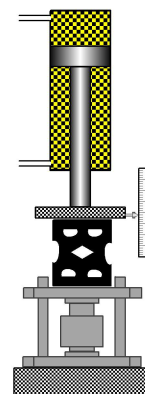
■ Hidraulički sustav – regulacija sile



PROIZVODNJA STROJEVA I UREĐAJA



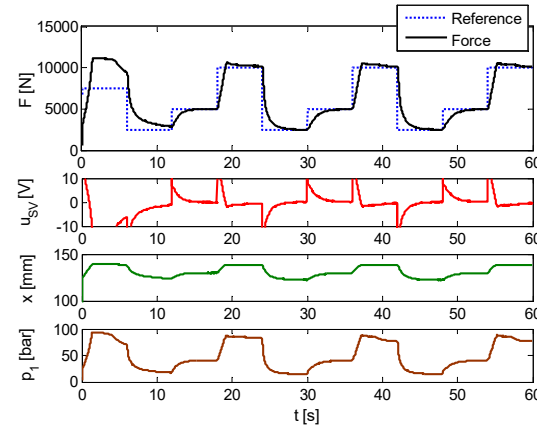
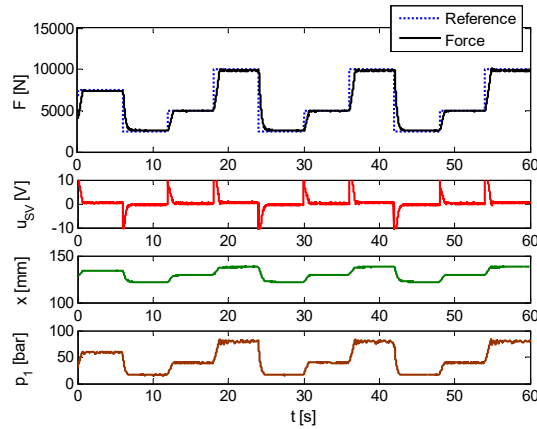
■ Regulacija sile hidrauličke preše



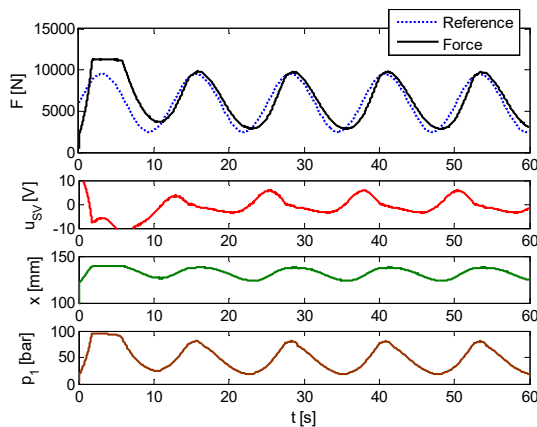
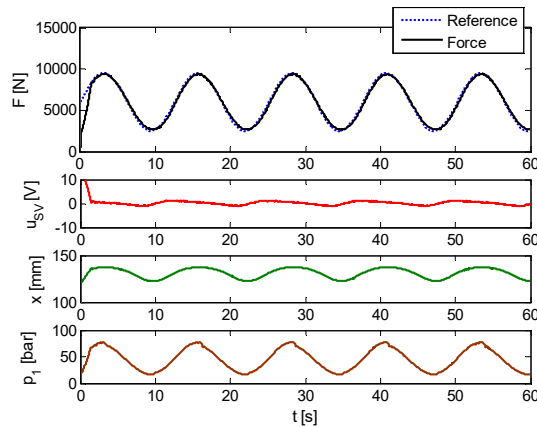
Shematski dijagram

Hidraulički sustav – regulacija sile

- referentni signal u obliku odskočne funkcije



- referentni signal u obliku sinusne funkcije



a) Backstepping controller

b) PI controller with anti-windup

Šitum, Ž., et.al., Design, Construction and Computer Control of a Hydraulic Press, *The 12th Scandinavian Conference on Fluid Power*, May 18-20, 2011, Tampere, Finland, Vol. 3, pp. 93-103

**Hidraulički sustav –
regulacija rotacijskog gibanja**



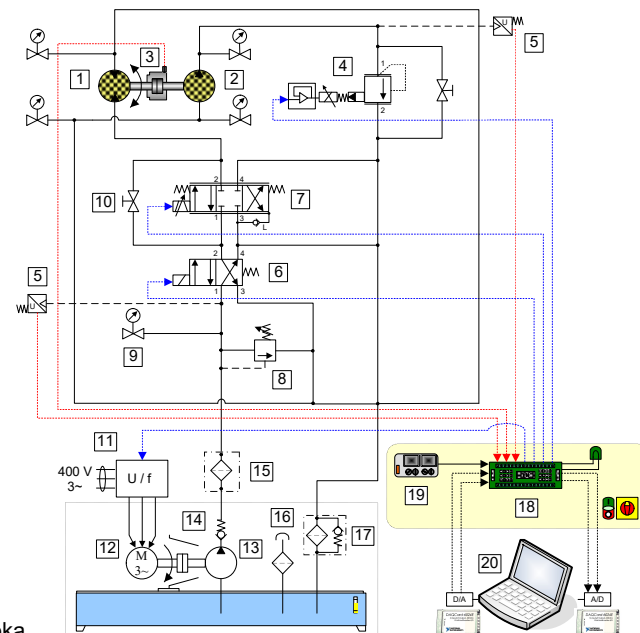
■ Regulacija brzine vrtnje hidrauličkog motora



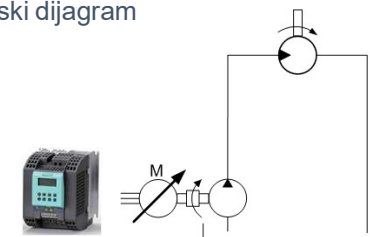
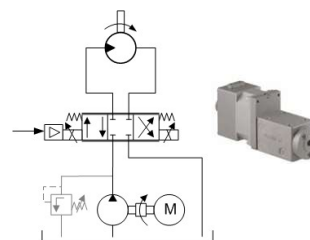
Servoventil –
upravljanje prigušenjem



Frekvencijski pretvarač –
upravljanje promjenom protoka

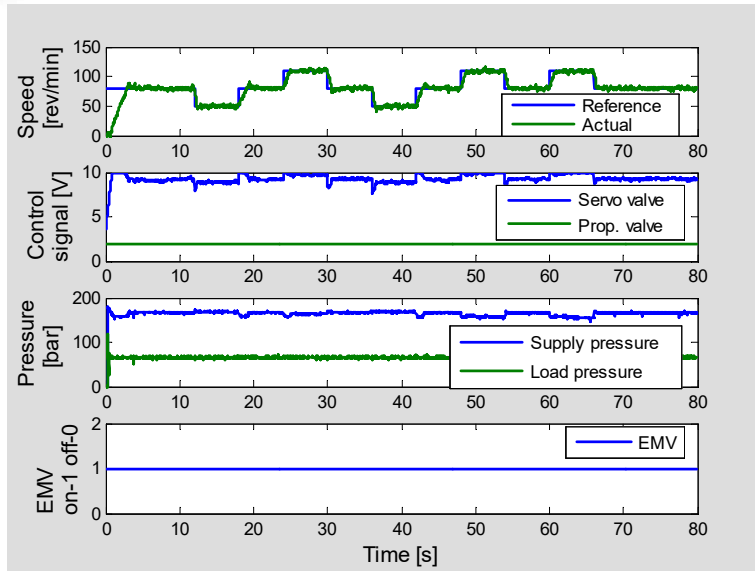


Shematski dijagram

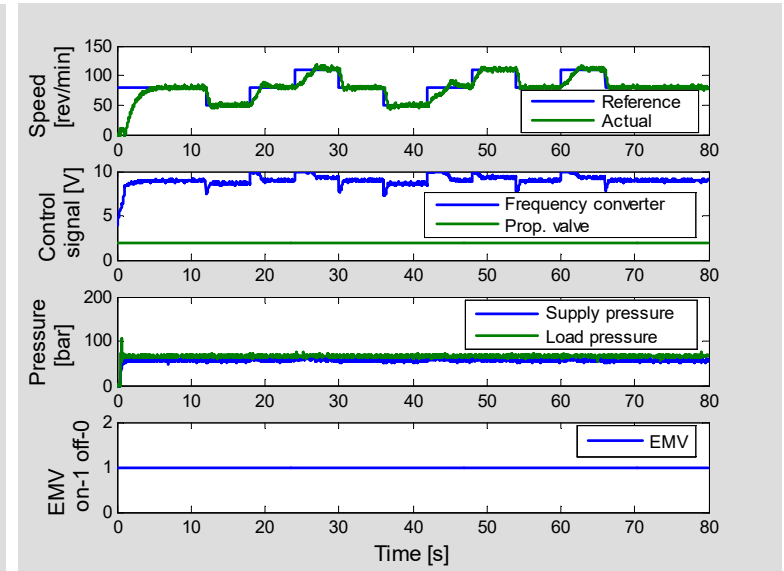


Hidraulički sustav – regulacija rotacijskog gibanja

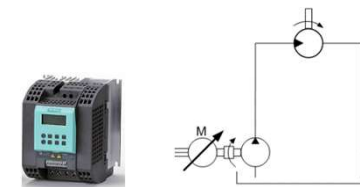
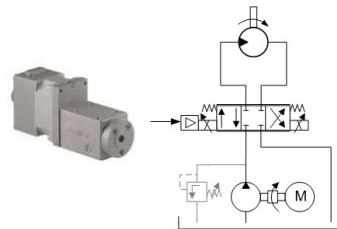
Regulacija brzine vrtnje hidrauličkog motora



(a) Servoventil – upravljanje prigušenjem



(b) Frekvencijski pretvarač – upravljanje promjenom protoka



Šitum, Ž., et.al., Throttling and Volumetric Control Principle to an Electrohydraulic Velocity Servomechanism, 7th Int. Fluid Power Conference, 7th IFK, Aachen, Germany, 22-24 March 2010, Vol. 2-Workshop, pp. 379-390

**ELEKTROHIDRAULIČKI
ROBOTSKI
MANIPULATOR
- E H R O M -**



Hidraulika Kutina d.d.



RASCO d.o.o.
Tvornica komunalne opreme



U Laboratoriju za automatiku i robotiku na Katedri za strojarsku automatiku **FSB-a** razvijen je prototip elektrohidrauličkog robotskog manipulatora (EHROM) namijenjenog za velike nosivosti radnih predmeta. Manipulator je izrađen u suradnji s dvije hrvatske tvrtke:

Hidraulika Kutina d.d. iz Kutine i **Rasco** d.o.o. iz Kalinovca.

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**ELEKTROHIDRAULIČKI
ROBOSKI
MANIPULATOR
- E H R O M -**

EHROM – elektrohidraulički robotski manipulator:

Tipični predstavnik složenih, nelinearnih, multivarijabilnih sustava s većim brojem promjenljivih parametara tijekom rada sustava

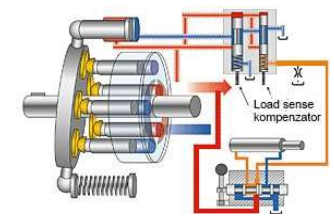
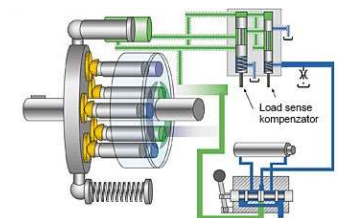
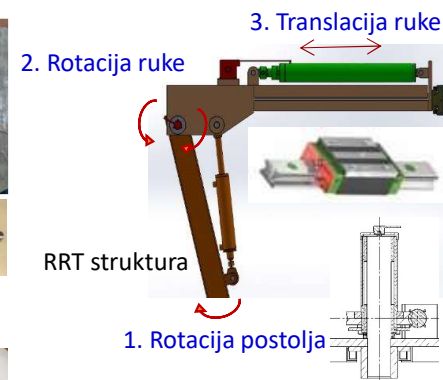
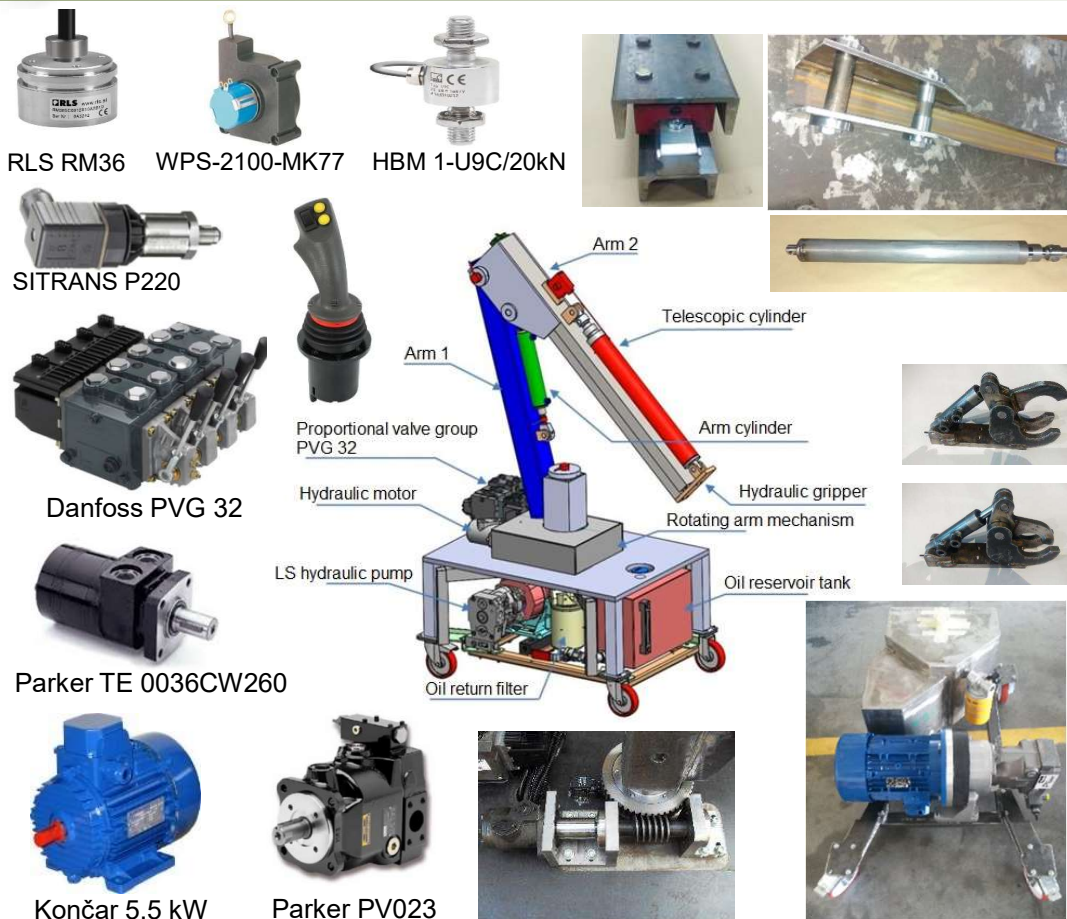
Projekt EHROM proširuje mogućnosti edukacije postojećih eksperimentalnih hidrauličkih sustava

Laboratorijski rad je važan segment procesa edukacije na tehničkim fakultetima

Studenti kroz rad na izradi eksperimentalnog sustava stječu potrebne vještine i kompetencije za buduće inženjerske poslove



**ELEKTROHIDRAULIČKI
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Load-sensing hydraulic system



Hidraulika Kutina d.d.



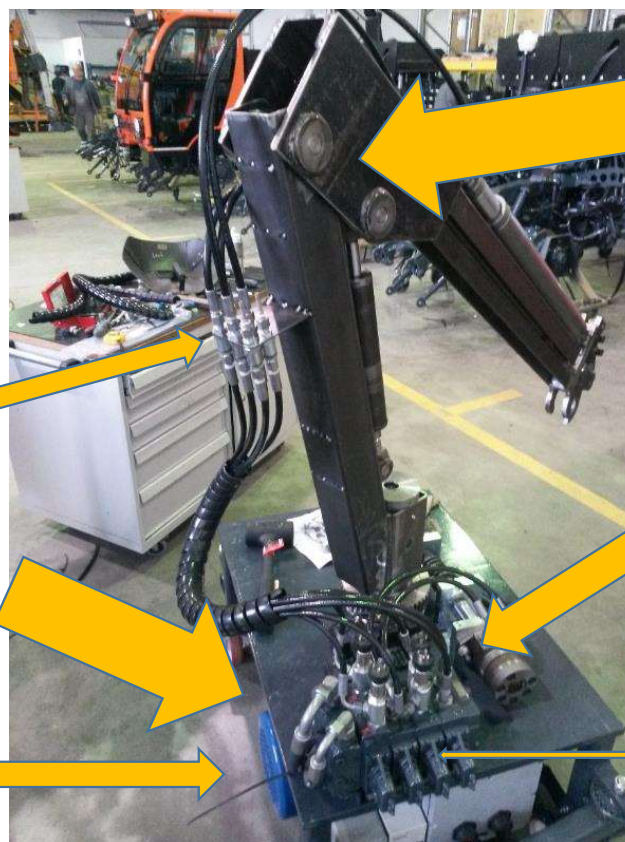
RASCO d.o.o.
Tvornica komunalne opreme

**ELEKTROHIDRAULIČKI
ROBOTSKI
MANIPULATOR
- EHRM -**

*Donatori opreme za
izradu EHRM-a*



Sveučilište u Zagrebu
University of Zagreb



HANSA FLEX

RASCO

**HABERKORN
CROATIA**



Hidraulika Kutina

SORMIKO



BIBUS
SUPPORTING YOUR SUCCESS



**ELEKTROHIDRAULIČKI
ROBOSKI
MANIPULATOR
- E H R O M -**



Video: Bežično upravljanje EHROM-a

Studenti koji su doprinijeli realizaciji projekta:

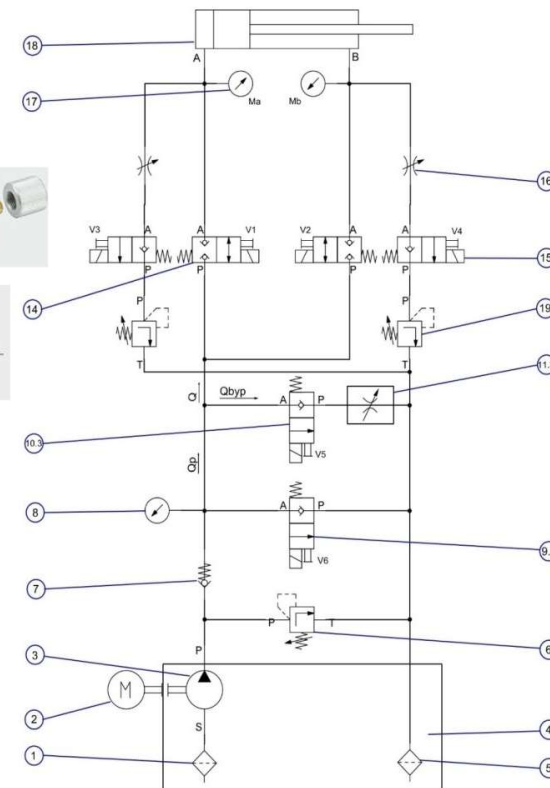
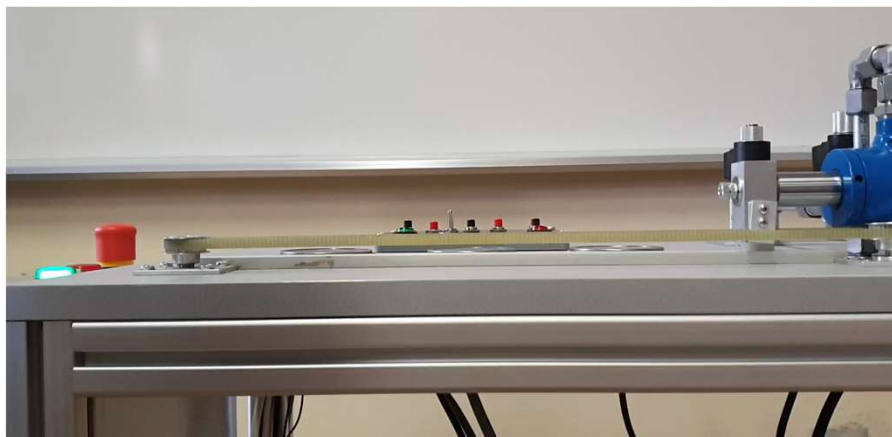
Darije Miloš
Ivica Ivanić
Dalibor Žgela
Anton Tomić
Deni Džafo
Ivo Cvjetković
Krešimir Šafarić
Ivan Janković



Šitum, Ž., Žgela, D., Benić, J., Wireless Control of an Electro-Hydraulic Robotic Manipulator, The 11th Int. Fluid Power Conference, 11th IFK, Aachen, Germany, 19-21 March 2018.

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■ Hidraulički sustav – regulacija položaja cilindra primjenom uložnih ventila (logic valves, cartridge valves)



■ Position control of the hydraulic cylinder



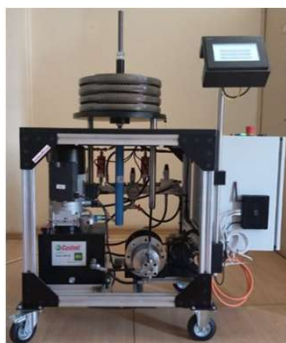
Controllino Maxi Automation device

Schematic diagram

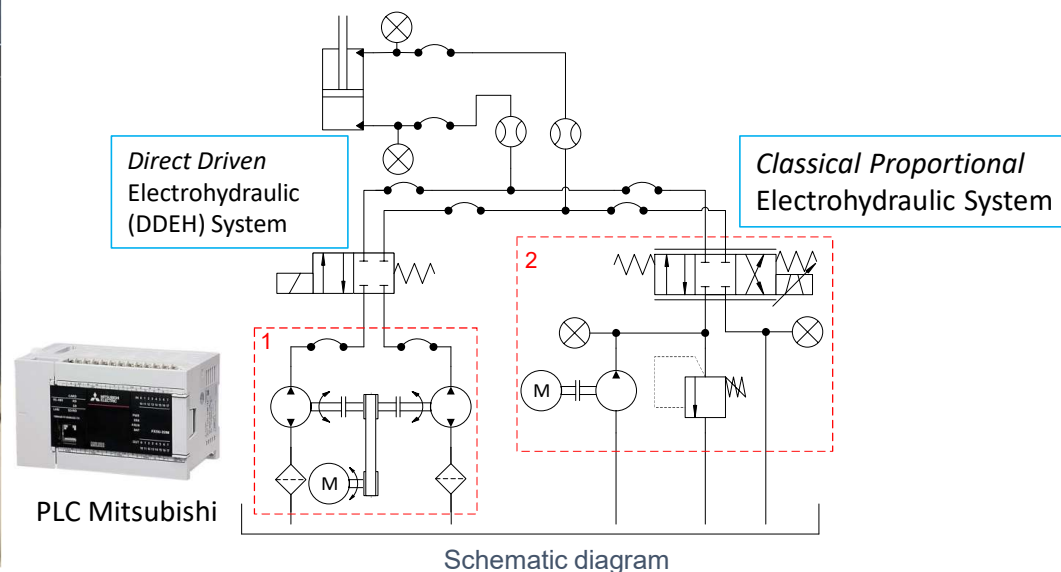


Cartridge valves (logic valves)

■ Hidraulički sustav –
klasični i direktno pogonjeni
elektrohidraulički sustav

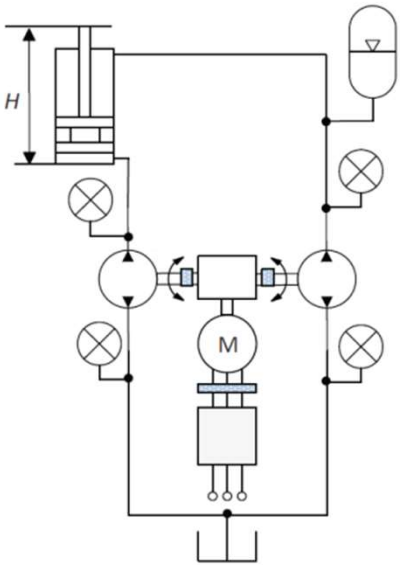


Juraj Benić, mag. ing. mech.
Doctoral Dissertation

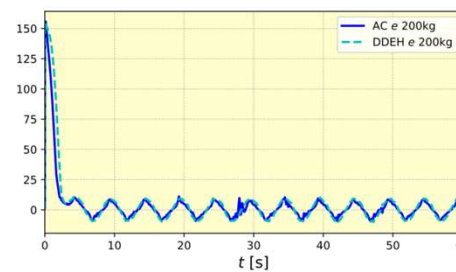
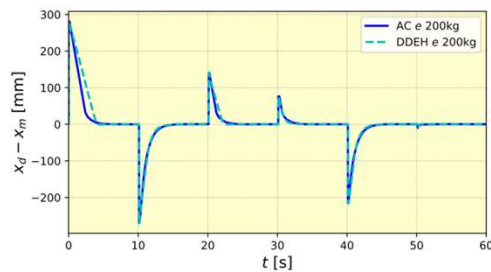
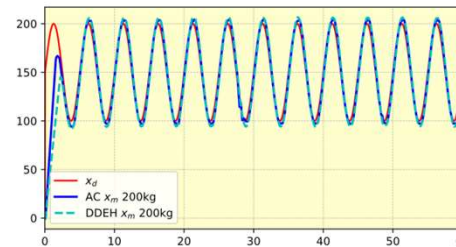
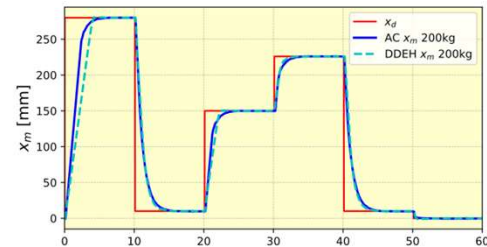


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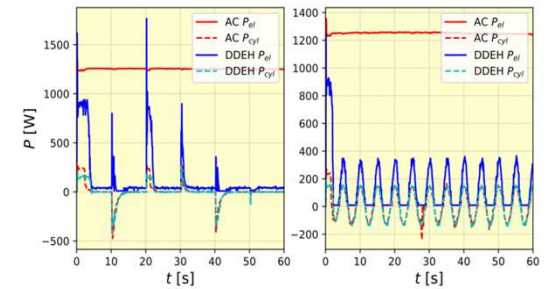
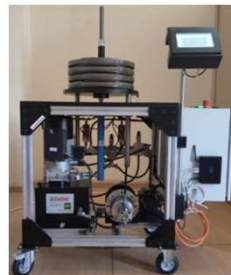
**Hidraulički sustav –
klasični i direktno pogonjeni
elektrohidraulički sustav**



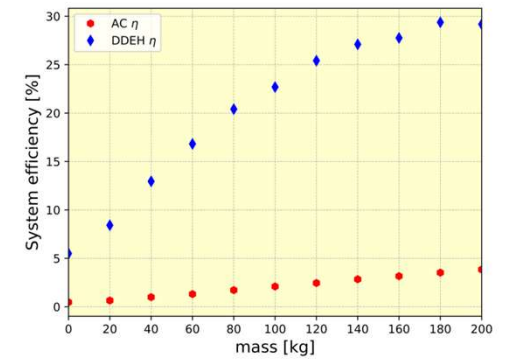
Eksperimental results



System response on step and sine wave reference signal with 200 kg load



Effective power for step and sine wave reference signal



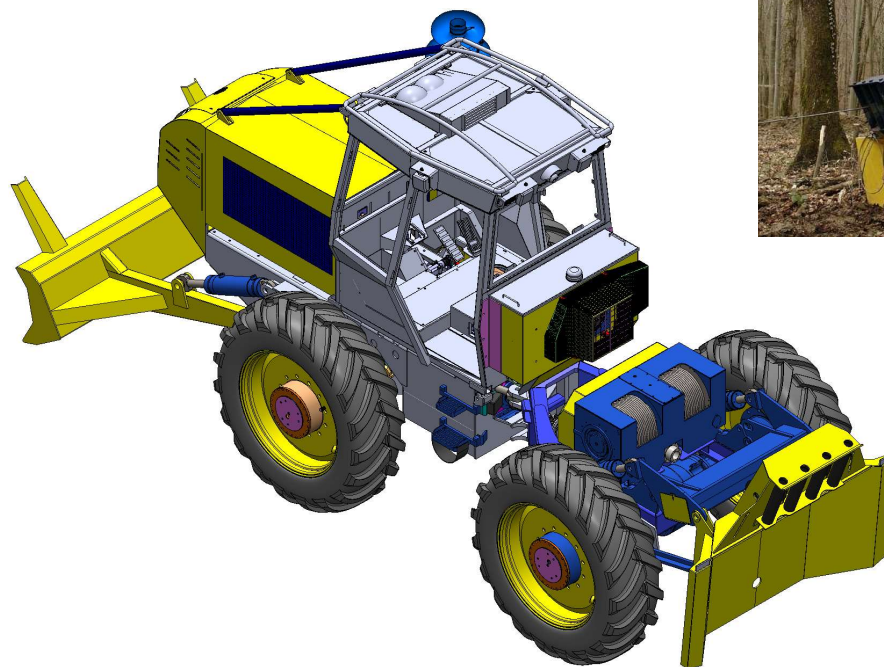
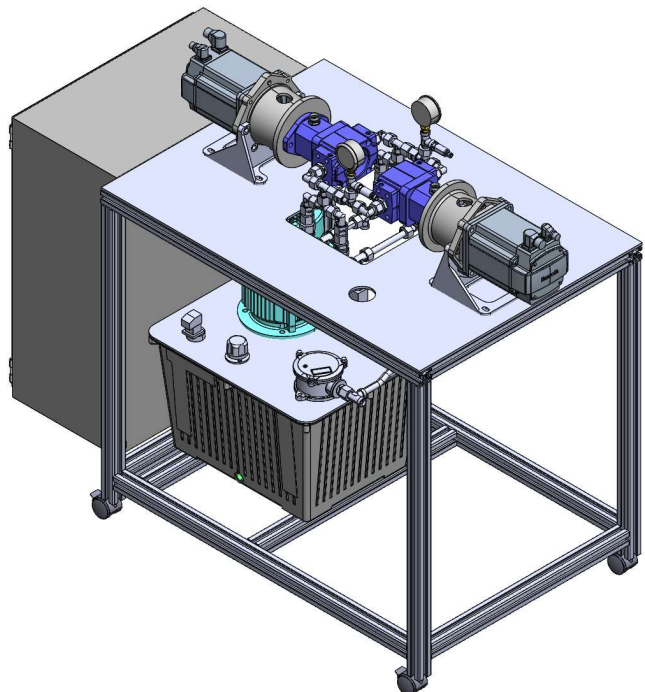
System efficiency for sine reference signal



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■ Razvoj hibridnog skidera – HiSkid

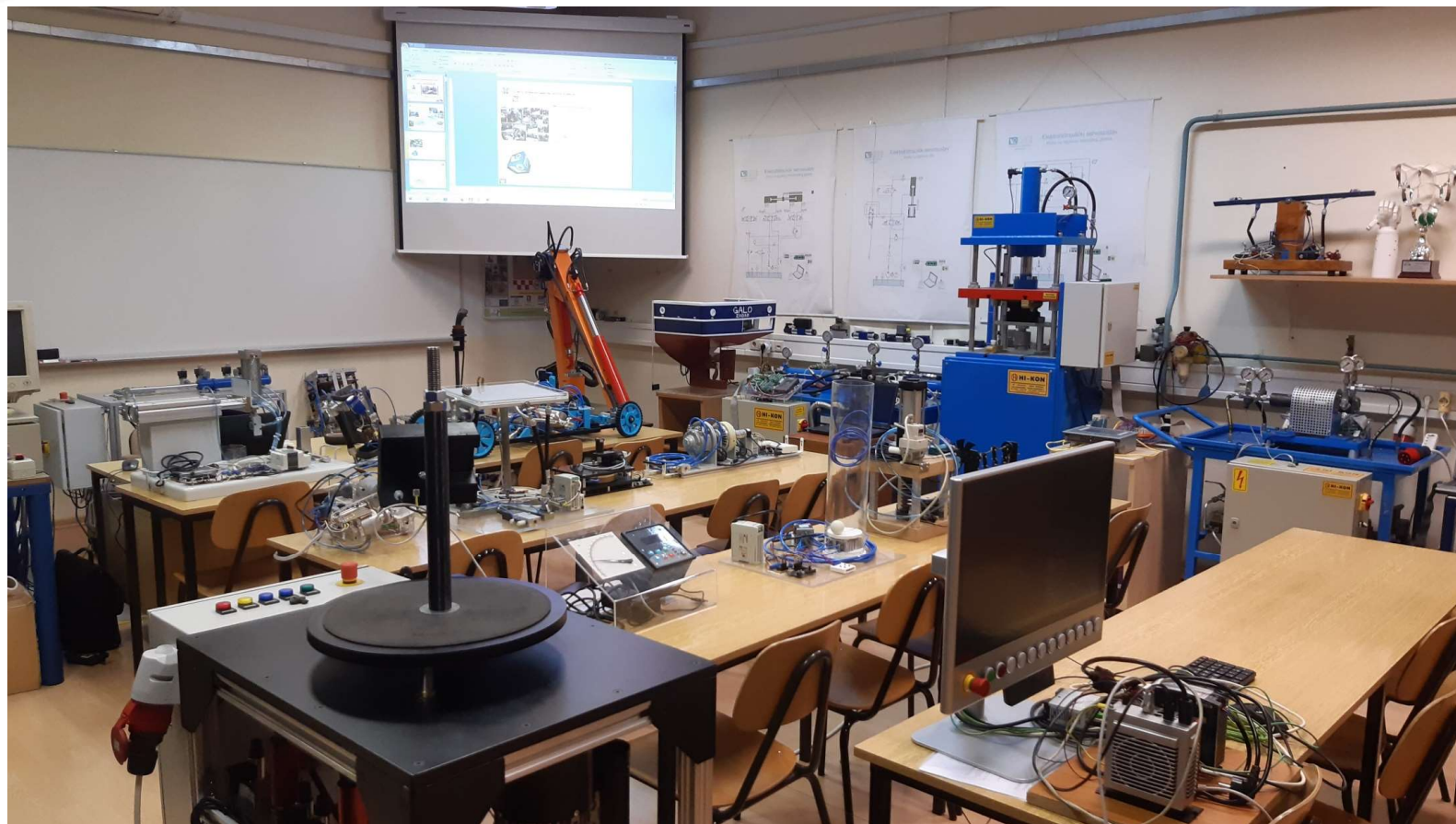
■ Eksperimentalni postav elektrohidrauličkog vitla



Hvala na
pozornosti!



zsitum@fsb.hr



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