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Mechatronics Control System Architecture for Humanoid Robot Dynamic study Servo-valve driver

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1. CONTEXT

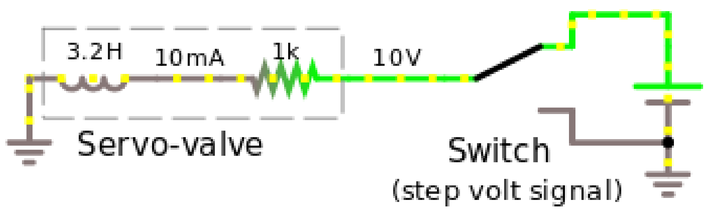
Mechatronics development of humanoid robots is one of the key challenges where we have hard constrains on both software and hardware used in the mechatronics control system architecture of the humanoid robot. Hydraulic robots like HYDROïD have additional challenges because of the complex hydraulic systems and the characteristics of servo-valve driving. We focus in this poster on the power amplifier stage of the servo-valve driver and the dynamic behavior.

2. RESEARCH QUESTION

The dynamics of humanoid robots is very high, for example, electrical robots like HRP4 robot perform a whole body control loop of 5ms while the local control loop perform at 1 kHz. The hydraulic control system is based on servo-valve. Commercial servo-valve do not provide quick response for high-inductance servo-valves. In addition, such drivers are bulky and cannot be embedded on humanoid robots.

3. THE NEED

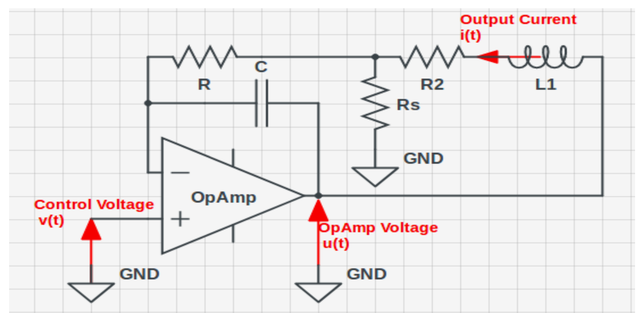
The need is to develop one customized driver to drive multiple servo-valves of the robot. The case study is Moog 30 series servo-valve, the electrical model of this servo-valve is R-L model (R=1 kOhm , L=3.2 Henry). The natural step response time is 10ms when using a voltage control signal or commercial driver, this performance is not enough for humanoid robot.



4. POWER STAGE and TRANSFER FUNCTION

We should use current control signal, and we propose current source configuration with high voltage supply,

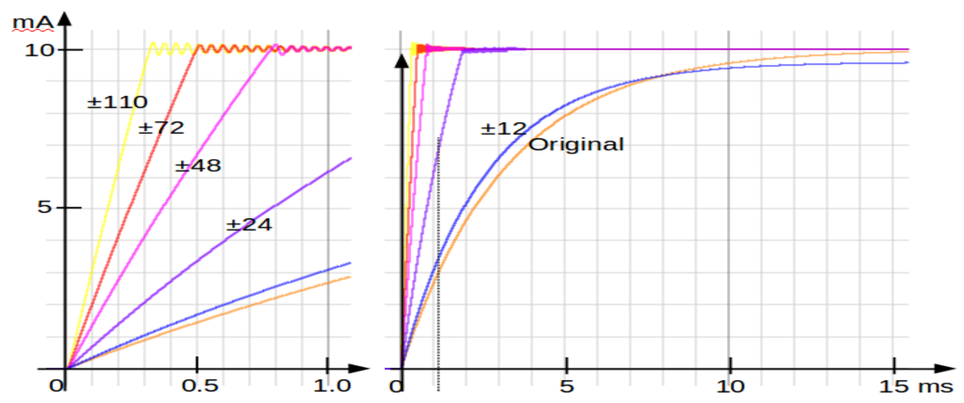
the transfer function is given by the following equation:



$$\frac{I(p)}{V(p)} = \frac{1 + RCp}{(R_v + L_v p)(R + R_s)Cp + R_s 1 + RCp}$$

5. RESULTS

We present dynamic performance of the presented power amplifier using different supply voltage. We compare it with commercial driver (orange curve).



6. FUTURE WORK

Our future objective is to apply this approach on the whole robot and integrate it with the other elements of the system architecture including the real-time software and the sensors. Then we apply highly dynamic movement.

REFERENCES

[1] Type 30 Nozzle-Flapper Flow Control Servo-Valves, Corporate Headquarters - Moog Inc., East Aurora, New York 14052-0018.

[2] S. Caron, A. Kheddar, O. Tempier. Stair Climbing Stabilization of the HRP-4Humanoid Robot using Whole-body Admittance Control. IEEE International Conference on Roboticsand Automation, May 2019, Montréal, France.

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