

Master project, 2017-2018

Use of Pulse Density Modulation (PDM) signal for Real Time simulation of electrical system

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Context

Real-World control systems were initially based on analog electronics. With the availability of low cost high-performance digital platforms such as microprocessors and microcontrollers, control system implementation evolved into the more flexible digital form which is now used almost exclusively. The main objective of such digital systems is the implementation of the control law, meeting the system real-time constraints, and the interfacing to the analog world via multi-bit analogue-to digital (A/D) and digital-to-analog (D/A) converters. In typical applications, the control law implementation directly drives such high performance electromechanical systems at sample rates of greater than 10 kHz; failure to meet the real-time control requirements of these target applications can lead to critical failure. Many A/D and D/A converters make use of an intermediate Σ/Δ modulating stage for high quality data conversion. This Σ/Δ -modulator converts signals into a simple 1-bit stream, at very high sampling frequencies which can reach 100MHz and is generally called a Pulse Density Modulation (PDM) signal. This bit-stream contains all the useful information of the input thus making it possible to perform digital signal processing directly on those "fast" 1-bit signals.

Puissance+ is a company which manufactured linear power amplifiers. It is owned by the company Sphera which design test bench for military, automotive and aeronautics applications.

L2EP in collaboration with Puissance+ and Sphera are now designing a new power amplifier and a real-time simulation solver which is executed on specialized components. However, they are based on classical digital signal processing.

Objectives

This project is related to the partnership with Puissance+ and Sphera. The objectives of the proposed internship are, firstly, to design a simple control law based on PDM signal and then extend that for simulation of electrical systems. Evaluation of achievable performances compared to classical solutions are also expected.

Work steps

1. Bibliographic study on PDM signal and 1-bit processor for real-time applications,
2. Modelling of PDM signal generation,
3. Control of a second order system based on PDM signal inputs
4. Simulation of simple electrical based on PDM signal processing
5. Comparison with classical digital signal processing

Salary

900€ to 1000€/month

Localization

25% at Puissance+ in Montauban

75% at ENSAM in Lille

Keywords

Real-Time Simulation, PDM signal, Σ/Δ modulating, Digital control.

Skills

- General knowledge in electrical engineering and control theory
- Basic knowledge on digital signal processing
- Software: Matlab

references

Wu, X., & Goodall, R. M. (2005). *One-bit processing for digital control*. *IEE Proceedings-Control Theory and Applications*, 152(4), 403-410.

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Al-Makhles, D., Swain, A., & Patel, N. (2012, November). *Delta-Sigma based bit-stream controller for a DC motor*. In *TENCON 2012-2012 IEEE Region 10 Conference (pp. 1-5)*. IEEE.