Universidade do Minho
Escola de Engenharia

Plano de Trabalho de Dissertação

Ano Letivo 2022/2023

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N.º Estudante	PG47150
Curso	Mestrado em Engenharia Eletrónica Industrial e Computadores
Título da Dissertação (em Português)	Gerador de TFR acelerado em FPGA para aplicações baseadas em técnicas de CNN
Título da Dissertação (em Inglês)	FPGA accelerated TFR generator for applications based on CNN techniques

Enquadramento e Motivação (150 - 200 palavras)

A Convolutional Neural Network (CNN) is a Deep Learning (DL) method widely used for image and video classification [1], being an arising technology in recent years due to its powerful learning ability and the high accuracy achieved [2].

A Time-Frequency Representation (TFR) displays the time-frequency domain of a signal, i.e., the frequency content as a function of time, being particularly useful when the signal is non-stationary [3]. Therefore, a signal's TFR can be applied to a CNN model to detect and identify the patterns in a captured signal.

TFRs are utilized in the context of many applications. In the automotive industry, a microphone can be used to detect the alarm sirens of emergency vehicles trying to pass, alerting the drivers about their presence [4]. In the industry segment, TFR and CNN allow to diagnose machinery faults, easing the reparation of the fault and reducing costs [1].

However, the TFR generation algorithms are complex and time-consuming tasks, making it suitable for development in a FPGA platform. This dissertation proposes to design and implement a FPGA accelerated system capable of sampling an input signal, generating the respective TFR, and sending it to another system to be analyzed by a CNN model.

Objetivos e Resultados Esperados (150 - 200 palavras)

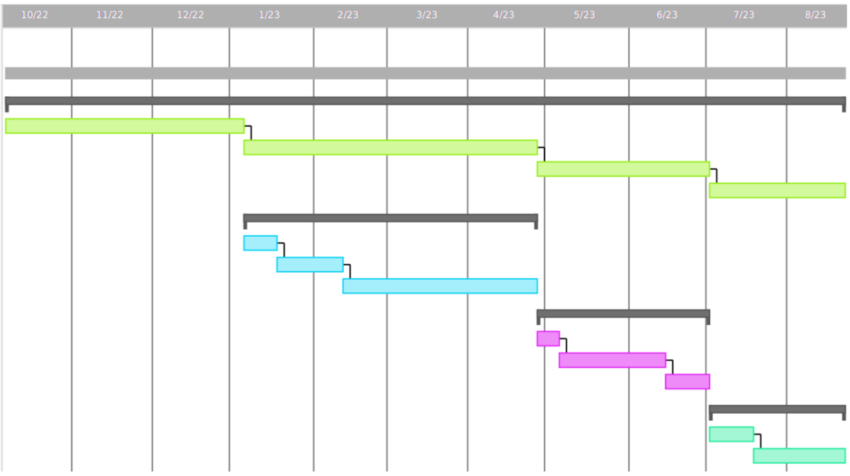
The system will sample two signals: one from an accelerometer and one from a microphone. The sampling frequency needs to be adequate for the type of signals to be studied. Knowing that the limits of human hearing [5] are roughly between 20 and 20 kHz, one defines the minimum sample frequency for the microphone as 40 kHz, which corresponds to two times higher than the maximum frequency of a signal. The sampling frequency for the accelerometer may be lower because vibration signals have lower frequency components than sound signals. It will be designed and fabricated a PCB to accommodate and supply both sensors.

This dissertation proposes to design and implement a FPGA-based hardware accelerator for generation of TFRs, according to the state-of-the-art techniques. It will be evaluated the FPGA resource utilization and investigated the potential for scaling the system to handle a greater number of sensors or higher data rates.

It will also be evaluated the performance of the proposed system, compared to software based TFR generators and other state-of-the-art TFR generators, being expected a better performance with the proposed system.

Calendarização

	start	end
Research & Documentation	**06/10/22**	**22/08/23**
Introduction & State-of-the-art	06/10	04/01
Design	05/01	26/04
Implementation	27/04	30/06
Results & Conclusions	03/07	22/08
Design Phase	**05/01/23**	**26/04/23**
Sensors selection	05/01	17/01
PCB	18/01	10/02
TFR generator	13/02	26/04
Implementation Phase	**27/04/23**	**30/06/23**
PCB	27/04	04/05
TFR generator	05/05	14/06
System integration	15/06	30/06
Results Phase	**03/07/23**	**22/08/23**
TFR generator	03/07	18/07
Full system	19/07	22/08



Referências Bibliográficas (5 - 10 referências)

[1] Gao, D., Zhu, Y., Wang, X., Yan, K., & Hong, J. (2019). A Fault Diagnosis Method of Rolling Bearing Based on Complex Morlet CWT and CNN. *Proceedings - 2018 Prognostics and System Health Management Conference, PHM-Chongqing 2018*, 1101–1105. doi: 10.1109/PHM-CHONGQING.2018.00194.
[2] Liu, H., Li, L., & Ma, J. (2016). Rolling Bearing Fault Diagnosis Based on STFT-Deep Learning and Sound Signals. *Shock and Vibration*, *2016*, 1–12. doi: 10.1155/2016/6127479
[3] Hlawatsch, F., & Boudreaux-Bartels, G. F. (1992). Linear and quadratic time-frequency signal representations. *IEEE Signal Processing Magazine*, 21–67. doi: 10.1109/79.127284
[4] Pramanick, D., Ansar, H., Kumar, H., Pranav, S., Tengshe, R., & Fatimah, B. (2021). Deep learning based urban sound classification and ambulance siren detector using spectrogram. *2021 12th International Conference on Computing Communication and Networking Technologies, ICCCNT 2021*. doi: 10.1109/ICCCNT51525.2021.9579778.
[5] Purves, D., & Williams, S. M. (2001). *Neuroscience. 2nd edition*. Sinauer Associates 2001, ch. 12.
Purves, D., & Williams, S. M. (2001). *Neuroscience. 2nd edition*. Sinauer Associates 2001.
doi: ebk01:3450000000002013.

Justificação de Coorientação (se aplicável)

O plano de trabalho deve ser preenchido *offline* e realizado o *upload* do mesmo, depois de assinado, no formulário do requerimento de pedido de admissão à dissertação, disponível em http://dissertacao.eng.uminho.pt

Assinaturas

Estudante

Orientador (tal como previsto no ponto 1 do Artigo 169.° do RAUM)

Diretor do Ciclo de Estudos

Orientador (tal como previsto no ponto 3 do Artigo 169.° do RAUM. Neste caso, é obrigatório existir um Orientador pelo ponto 1 do Artigo 169.° do RAUM)

Assinatura digital qualificada com Cartão de Cidadão ou Chave Móvel Digital. Para os estudantes, nos casos em que tal não seja possível, os mesmos deverão imprimir este plano, assinar manualmente e, após digitalização, os restantes intervenientes usam a assinatura digital qualificada.