Αθήνα 29-11-2023

Θέμα	Πρόταση για την διεξαγωγή Διδακτορικής Διατριβής στο Τμήμα Μηχανικών Βιοϊατρικής του Πανεπιστημίου Δυτικής Αττικής
Προτεινόμενος Επιβλέπων	Κωστόπουλος Σπυρίδων, Αναπληρωτής Καθηγητής, Τμήμα Μηχανικών Βιοϊατρικής, ΠΑΔΑ
Τίτλος	**Hardware-Accelerated Real-Time Vessel Segmentation for Clinical Applications** Τμηματοποίηση ιατρικής εικόνας αγγείων σε πραγματικό χρόνο με την χρήση τεχνικών Hardware Acceleration
Θεματική Περιοχή	Ανάλυση ιατρικής εικόνας, Μηχανική μάθηση, Παράλληλος προγραμματισμός, Τμηματοποίηση Εικόνας
Λέξεις κλειδιά	Image analysis, Machine learning, Deep learning, Image segmentation, GPU computing
Προτεινόμενη γλώσσα συγγραφής	Αγγλικά

PhD Proposal

Medical imaging plays a pivotal role in diagnostics and interventions, and the timely and accurate segmentation of blood vessels is crucial for various clinical applications. This Ph.D. research proposal aims to explore and develop hardware-accelerated solutions for real-time blood vessel segmentation, addressing the pressing need for efficient processing in clinical settings.

Motivation: The motivation behind this research stems from the increasing demand for real-time or near-real-time processing in medical imaging, especially during interventions and surgeries. Traditional computational methods for blood vessel segmentation may encounter challenges in meeting the stringent timing requirements, necessitating the exploration of hardware acceleration solutions.

Scope and Objectives: The primary scope of this research is to investigate and optimize hardware platforms such as GPUs or TPUs for efficient and real-time blood vessel segmentation. The objectives include identifying suitable algorithms, parallelization strategies, and model compression techniques to leverage the parallel processing capabilities of the chosen hardware.

Data Collection: In this research, publicly available data are going to be used for developing the segmentation algorithms. Data sources like The Cancer Imaging Archive (cancerimagingarchive.net), OASIS (OASIS Brains - Open Access Series of Imaging Studies (oasis-brains.org)) and Standford University Shared Datasets (Shared Datasets | Center for Artificial Intelligence in Medicine & Imaging (stanford.edu)) could be used to obtain medical imaging data. All data are anonymized and there is no way to trace back to real patients data.

Algorithmic Adaptation: The research will delve into algorithmic adaptation, exploring parallel computing strategies and model compression techniques to ensure optimal resource utilization. Special attention will be given to maintaining or improving segmentation accuracy while significantly reducing processing times.

Validation and Benchmarking: The research will establish comprehensive performance metrics, benchmarking the hardware-accelerated solution against traditional CPU-based methods and relevant benchmarks. Evaluation criteria will include speed, accuracy, and resource utilization.

Implementation Challenges: Addressing challenges related to data throughput, memory bandwidth, and potential bottlenecks will be a key focus. The research will explore solutions that balance computational efficiency with energy efficiency, ensuring applicability in diverse medical imaging scenarios.

Adaptability and Generalization: The proposed solution will be designed to be adaptable to different types of hardware, fostering versatility and generalization across diverse datasets and imaging conditions.

User Interface Integration: The development of user-friendly interfaces and integration into existing clinical systems will be explored to ensure seamless adoption by healthcare professionals.

Security and Privacy Considerations: Given the sensitive nature of medical imaging data, the research will address security and privacy concerns associated with processing on accelerated hardware, adhering to healthcare regulations and standards. While medical imaging data planned to be used are free from sensitive patient information, we are planning to investigate potential ways of applying GDPR compliance protocols and data anonymization prior transferring images to any external network (if it is necessary).

Human-in-the-Loop Approaches: Interactive systems will be explored, allowing clinicians to actively participate in the segmentation process and providing valuable feedback for improved accuracy and reliability.

This research aims to bridge the gap between cutting-edge computer vision techniques and the practical needs of healthcare professionals, contributing to advancements in real-time blood vessel segmentation for enhanced clinical decision-making and patient care.

Bibliography

1 Marco Eichelberg, Klaus Kleber, Marc Kämmerer, "*Cybersecurity in PACS and Medical Imaging: an Overview*" Journal of Digital Imaging (2020) 33:1527 – 1542

2 Nitin Satpute, Rabia Naseem, Rafael Palomar, Orestis Zachariadis, Juan Gómez-Luna, Faouzi Alaya Cheikh, Joaquín Olivares, "*Fast parallel vessel segmentation*", Compute Methods Programs Biomed 2020 Aug:192:105430.

3 Giles Tetteh, Velizar Efremov, Nils D. Forkert, Matthias Schneider, Jan Kirschke, Bruno Weber, Claus Zimmer, Marie Piraud, Björn H. Menze , "*DeepVesselNet: Vessel Segmentation, Centerline Prediction, and Bifurcation Detection in 3-D Angiographic Volumes*", Front. Neurosci., 08 December 2020, Sec. Brain Imaging MethodsVolume 14 - 2020

4 *Marcin Ciecholewski, Michał Kassjański, "Computational Methods for Liver Vessel Segmentation in Medical Imaging: A Review*", *Sensors* 2021, *21*(6), 2027