FPGA Accelerated Gradient Analysis for Tumors Characterization

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INTRODUCTION

- The project focuses on implementing an adaptive contour detection filter and tumor characterization using a hybrid of hardware and software components on an FPGA.
- This hybrid approach efficiently computes gradients to identify contours and evaluates their significance through thresholding techniques.
- The FPGA executes a dedicated algorithm, enabling real-time image processing and visualization of results on a monitor.
- Through simulation and synthesis, the effectiveness of the architecture, particularly in advancing biomedical imaging and enhancing MRI tumor boundary delineation, is clearly demonstrated.
- The project underscores the pivotal role of FPGA technology in biomedical imaging advancements, particularly in achieving precise boundary delineation for MRI tumor characterization, thereby contributing significantly to improved diagnosis and treatment planning in medical settings.

MOTIVATION

- Precise healthcare diagnostics hinge on the clarity of biomedical imaging, making it a vital aspect of medical practice.
- The effectiveness of biomedical imaging is heavily reliant on the proper functioning of edge detection algorithms, which help discern important features.
- By utilising FPGA technology, we hope to accelerate MRI diagnosis and enable medical professionals to provide better patient care and improved health outcomes.

PROBLEM STATEMENT/OBJECTIVE

In Biomedical imaging, the lengthy duration of tumour characterization processes presents a challenge, impeding real-time analysis required for adaptive radiotherapy.
To address this issue, the project intends to use FPGA technology to accelerate gradient analysis algorithms.
This initiative aims to overcome hardware constraints, optimize data transfer, and seamlessly integrate with existing equipment, ultimately improving the speed and efficiency of tumour characterization in medical.

BLOCK DIAGRAM

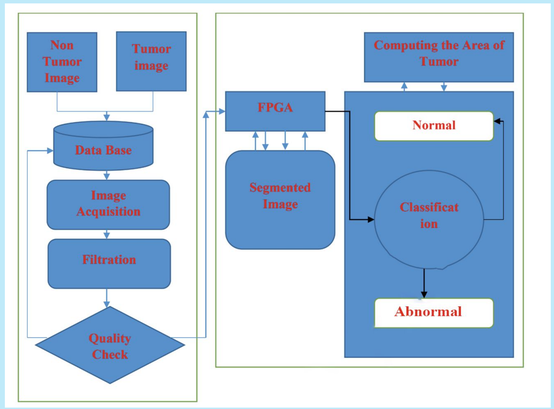

Figure 1:Block Diagram

DESIGN

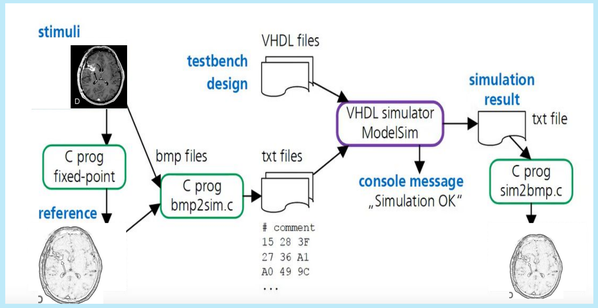

Figure 2:Test bench

REALISTIC CONSTRAINTS

- Addressing compatibility hurdles when integrating with existing medical systems, especially concerning proprietary protocols, requires meticulous planning to ensure seamless integration while upholding data privacy and security standards.
- Finding the right balance between processing accuracy and real-time diagnostic requirements is crucial, requiring effective algorithms to fulfil deadlines without sacrificing diagnostic precision.
- In order to ensure successful image processing within hardware constraints, the project must carefully manage processing power and memory. It also needs to balance scale and complexity for effective diagnostics while preserving computing resources.

ENGINEERING STANDARDS

- Optimized algorithms for limited processing power and memory, ensuring scalability while adhering to computational constraints for complete image processing.
- Create algorithms that balance real-time requirements with accuracy, addressing time constraints for rapid but precise diagnostics in medical imaging.
- Ensure compliance with data privacy regulations and resolve compatibility issues for seamless integration into existing medical systems, with a focus on security and interoperability.

RESULTS

Software Result:

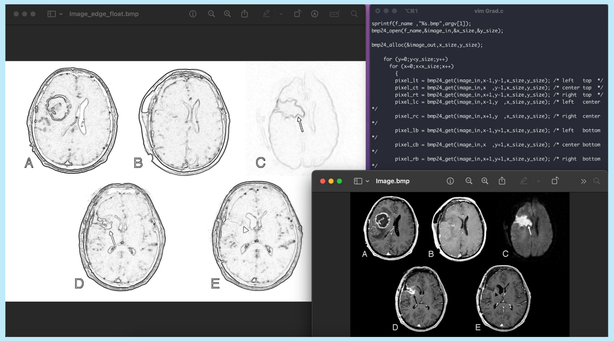

Figure 3:Output in C Compiler

FPGA Emulation on Remote Server Result:

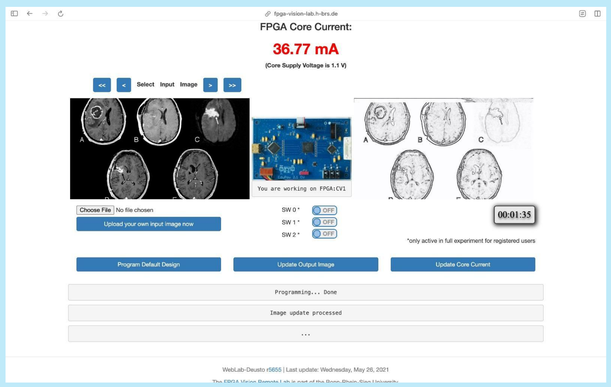

Figure 4:Output in FPGA

CONCLUSIO`N

- Our project successfully developed an FPGA-based tumor detection system, integrating advanced image processing algorithms.
- We adhered to rigorous medical device standards throughout development, ensuring regulatory compliance and quality assurance.
- By collaborating across disciplines, we bridged theoretical knowledge with practical application, resulting in a solution.

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CONFERENCE /JOURNAL PUBLICATION

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