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Good morning everyone. I am Tharindu Rathnayaka, student ID E/17/286, and I am here to present my proposal for the final year research project under ME420 Mechanical Engineering Individual Research Project. The topic of my project is 'Configurable Neuromorphic Architecture for Spiking Neural Networks', supervised by Dr. Isuru Nawinne

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this is the content of the my presentation

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- First, I will present an introduction to my research project, focusing on the significance of Spiking Neural Networks (SNNs). SNNs are a type of neural network that simulate the behavior of biological neurons and synapses.

- The importance of SNNs lies in their ability to closely mimic the behavior of biological neural networks, which makes them a promising tool for improving machine learning and artificial intelligence.

- The basic components of an SNN consist of neurons, synapses, and input/output spikes. These elements work together to create a network that can process and analyze complex data

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- In contrast to traditional artificial neural networks (ANNs), which rely on abstract mathematical models, SNNs process information based on the timing and frequency of spikes.

- SNNs have a wide range of applications, including speech recognition, image processing, and robotics. Compared to ANNs, SNNs offer several potential advantages such as improved energy efficiency and higher accuracy.

- As we continue to explore SNNs in this research project, we hope to shed further light on their potential benefits and applications

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- Neuromorphic computing can be implemented using digital, analog, or mixed-signal circuits, as well as specialized hardware like memristors.

- This field has the potential to impact machine learning, robotics, and brain-computer interfaces, among others. The significance of neuromorphic computing lies in its potential to revolutionize computing by enabling machines to process information in ways that are more natural and human-like.

- As we delve deeper into neuromorphic computing in this research project, we hope to explore its full potential and possible applications.

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- Neuromorphic computing is an approach to computing that takes inspiration from the hardware and software principles of the human brain.

- The ultimate goal of neuromorphic computing is to create computers that can perform complex tasks with energy efficiency and robustness similar to that of biological neural networks.

- Compared to traditional von Neumann architecture, neuromorphic computing offers potential advantages such as lower power consumption, faster processing, and more efficient use of memory. As we explore neuromorphic computing further in this research project, we hope to uncover its full potential and applications.

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- There is a gap in the current literature regarding the development of configurable neuromorphic processor architectures that are easy to use for programmers with varying skill levels, using RISC-V as the basis for the architecture.

- While existing hardware designs and specific accelerators for spiking neural networks (SNNs) exist, they may be challenging for non-experts to utilize effectively. However, recent research has shown the effectiveness of using

RISC-V as a basis for developing configurable neuromorphic architectures that are accessible to a wider range of users and researchers.

- In this research project, we aim to address this gap by developing a configurable neuromorphic processor architecture that uses RISC-V and is user-friendly for programmers of various skill levels.

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- The aim of our research project is to develop a high-performing, low-power configurable neuromorphic processor architecture for spiking neural networks, utilizing the RISC-V instruction set architecture. Through our research, we aim to demonstrate that this architecture is an attractive solution for a range of applications, and can effectively bridge the gap between hardware and software for non-experts.

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- Our research project has several objectives that we aim to achieve:

- To design and implement a configurable neuromorphic processor architecture specifically for spiking neural networks.
- To create a RV32IM pipelined CPU using Verilog as a starting point for the design.
- To complete the current RISC-v NOC (Network on Chip) FPGA implementation for SNNs and integrate it into the processor architecture.
- To develop a test SNN application to verify the functionality and performance of the processor architecture.
- To evaluate the power consumption and speed of the configurable neuromorphic processor architecture and compare it with existing solutions in the literature.

- Through these objectives, we aim to create a configurable neuromorphic processor architecture that is both high-performing and low-power, providing an effective solution for a range of applications.

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Our research project has several learning outcomes that we aim to achieve:

- ❖ To gain a deep understanding of the principles and concepts of spiking neural networks and neuromorphic computing.

- ❖ To become familiar with the RISC-V instruction set architecture and its implementation in hardware

- ❖ To gain experience in developing and testing SNN applications.

- ❖ To understand the trade-offs between power consumption, performance, and area in processor architecture design.

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slide 8 methodology

- Our research methodology consists of two main stages:

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1.Implementing a RV32IM pipelined CPU in Verilog as a starting point for the design.

2. Completing the current RISC-v NOC (Network on Chip) FPGA implementation for spiking   neural networks (SNNs) and integrating it into the processor architecture

- For the first stage, we will use Verilog as the hardware description language to implement the RV32IM pipelined CPU. This will serve as a foundation for the design and will allow us to build upon existing RISC-v architecture.

- For the second stage, we will use FPGA to implement the NOC for SNNs and integrate it into the processor architecture. This will enable us to develop a configurable neuromorphic processor architecture for spiking neural networks.