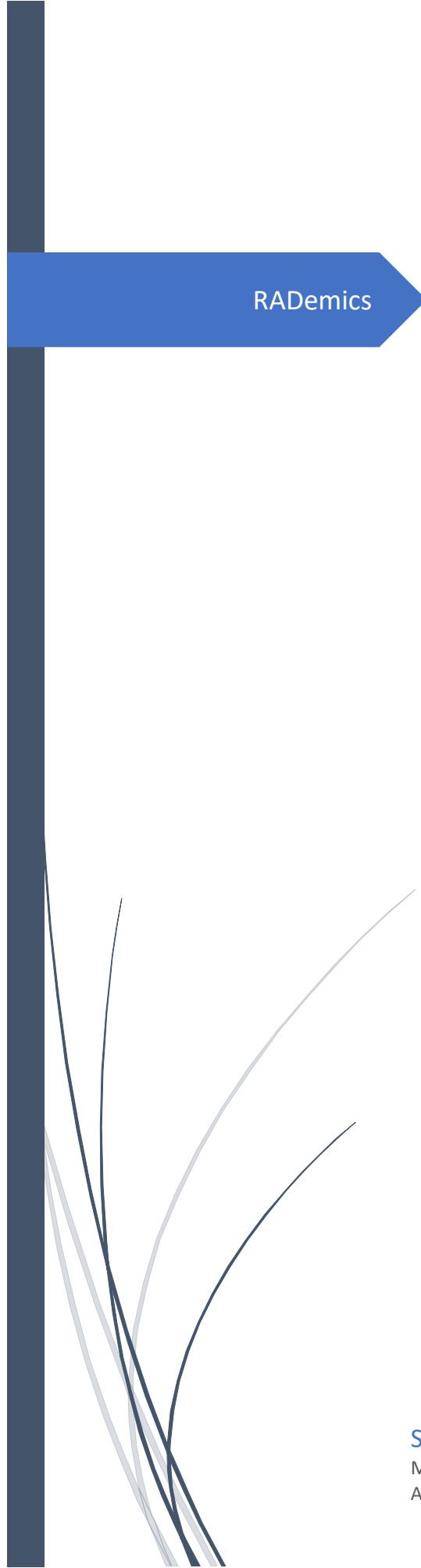


The logo for RADemics, featuring the text "RADemics" in white on a blue arrow-shaped background. The arrow points to the right and is part of a larger blue graphic element on the left side of the page.

RADemics

Design and Implementation of Low Power ARM Cortex Microcontrollers for Edge AI Computing

An abstract graphic on the left side of the page, consisting of a thick dark blue vertical bar and several thin, curved lines in dark blue and light gray that sweep upwards from the bottom left towards the center.

Shaik Maheboob, Shaik Lal John Basha
MARRI LAXMAN REDDY INSTITUTE OF TECHNOLOGY
AND MANAGEMENT, VIT-AP UNIVERSITY

Design and Implementation of Low Power ARM Cortex Microcontrollers for Edge AI Computing

¹Shaik Maheboob, Associate Professor, CSE Department, Marri Laxman Reddy Institute of Technology and Management, Hyderabad, Telangana, India. shaikmaheboob@mlritm.ac.in

²Shaik Lal John Basha, Research Scholar and Assistant professor(C), School of Electronics Engineering, VIT-AP University, Amaravati, Guntur, Andhra Pradesh, India. sk.laljohn@gmail.com

Abstract

The integration of Artificial Intelligence (AI) into embedded systems has accelerated the evolution of edge computing, particularly within power-constrained environments such as educational institutions and intelligent learning infrastructures. This book chapter presents a comprehensive examination of the design and implementation strategies for low-power ARM Cortex microcontrollers tailored for AI-driven edge applications. Emphasis is placed on architectural innovations, execution efficiency, real-time responsiveness, and memory management techniques essential for deploying lightweight machine learning models on resource-constrained devices. The chapter explores the capabilities of various Cortex-M cores, delving into their instruction set architecture, interrupt handling mechanisms, and power management features, while highlighting optimization practices that balance energy efficiency with computational performance. Use cases in AI-based learning analytics, student engagement systems, and adaptive educational technologies illustrate the practical deployment of such architectures. Through theoretical analysis and application-oriented perspectives, the chapter outlines how Cortex-M microcontrollers are enabling scalable, intelligent, and secure AI systems at the edge of educational ecosystems.

Keywords: Edge AI, ARM Cortex-M, Low Power Computing, Embedded Systems, Learning Analytics, Real-Time Processing

Introduction

The rapid advancement of Artificial Intelligence (AI) has catalyzed a significant transformation in embedded system design, particularly within edge computing environments where localized data processing and real-time responsiveness are crucial [1]. In educational technology, the shift toward intelligent, autonomous systems has placed a growing emphasis on developing solutions that can function with minimal energy consumption and computational overhead [2]. This demand has propelled the integration of AI into resource-constrained platforms, with ARM Cortex microcontrollers emerging as ideal candidates for implementing edge AI systems [3]. Their efficient instruction set architecture, low power footprint, and hardware support for deterministic execution make them suitable for executing lightweight AI models, enabling real-time analytics and decision-making within distributed learning ecosystems [4]. The relevance of these systems is especially evident in applications such as adaptive learning platforms, student monitoring devices,

and classroom environmental sensing, where continuous operation and real-time feedback are essential [5].

ARM Cortex-M microcontrollers offer a scalable architecture that meets the performance and energy requirements of edge AI deployment [6]. The Cortex-M series, ranging from M0 to M85, supports a variety of applications by providing different levels of computational capabilities, memory access mechanisms, and integrated peripherals [7]. These cores are designed with a Harvard architecture, Thumb-2 instruction set, and advanced interrupt handling features, which collectively contribute to efficient execution and fast response times [8]. For AI workloads, these characteristics are vital in maintaining low-latency inference and conserving energy during idle states [9]. In the context of higher education, where edge devices are increasingly used to enhance personalized learning and institutional analytics, the ability to manage real-time data locally without relying on cloud connectivity enhances both reliability and privacy [10].