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A multi-level computing architecture inspired by the human brain: A neuromorphic perspective

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Abstract

This paper proposes a multi-level computing architecture inspired by the human brain and formulated from a neuromorphic perspective to integrate perception, cognition, decision-making, and learning within a unified framework. The model is motivated by the limitations of classical von Neumann architectures in applications that require real-time response, contextual processing, and energy efficiency. It builds on principles such as hierarchical organization, distributed processing, event-based communication, and adaptive plasticity. The proposed architecture is structured into five functional levels, ranging from sensory encoding and perceptual integration to cognitive representation, executive decision-making, and adaptive learning. A proof-of-concept autonomous mobile robotic platform is used to illustrate the architecture. The experimental setup integrates six ultrasonic sensors, six Arduino Uno nodes for edge processing, an I2C network for inter-level communication, a Raspberry Pi 5 platform for higher-level processing, and four DC motors for locomotion. The paper also develops a mathematical model describing the interaction between distributed perception, cognitive fusion, decision selection, and motor control. Overall, the results support the feasibility of the proposed framework, while comprehensive quantitative validation of robustness, latency, and energy efficiency remains part of future work.

Keywords*: artificial intelligence; brain-inspired computing; cognitive computing; hierarchical processing; multi-level architecture; neuromorphic systems*

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