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BRAINS OF THE FUTURE

Advancing Neuromorphic Computing in India

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Executive Summary

This report provides a comprehensive exploration of **neuromorphic computing** as a transformative force in **Artificial Intelligence (AI)** and advanced computing. As global competition in high-performance computing accelerates, it is vital for policymakers and technology leaders to develop robust, sovereign capabilities in neuromorphic systems—emerging as critical infrastructure for next-generation AI.

Traditional **Von Neumann-based** architectures face fundamental constraints: they separate memory and processing units, creating a "memory wall" that severely limits data throughput, parallelism, and power efficiency. Neuromorphic computing addresses these issues by closely emulating the structure and signaling mechanisms of biological neural networks. In these systems, memory and compute elements are co-located, while event-driven, spike-based signaling drastically reduces data-transfer overhead. This architectural shift improves energy efficiency, supports high degrees of parallel processing, and enables real-time decision-making.

At the core of neuromorphic hardware are advanced semiconductor technologies, such as memristors, Phase-Change Memory (PCM), and Resistive RAM (ReRAM), that can store and process information simultaneously. When combined with **Spiking Neural Network (SNN)** models, neuromorphic chips enable on-device learning and adaptation, reducing reliance on cloud-based computing. As AI applications continue to expand across healthcare diagnostics, autonomous vehicles, robotics, industrial automation, and edge computing, these features become pivotal for developing low-latency, large-scale systems.

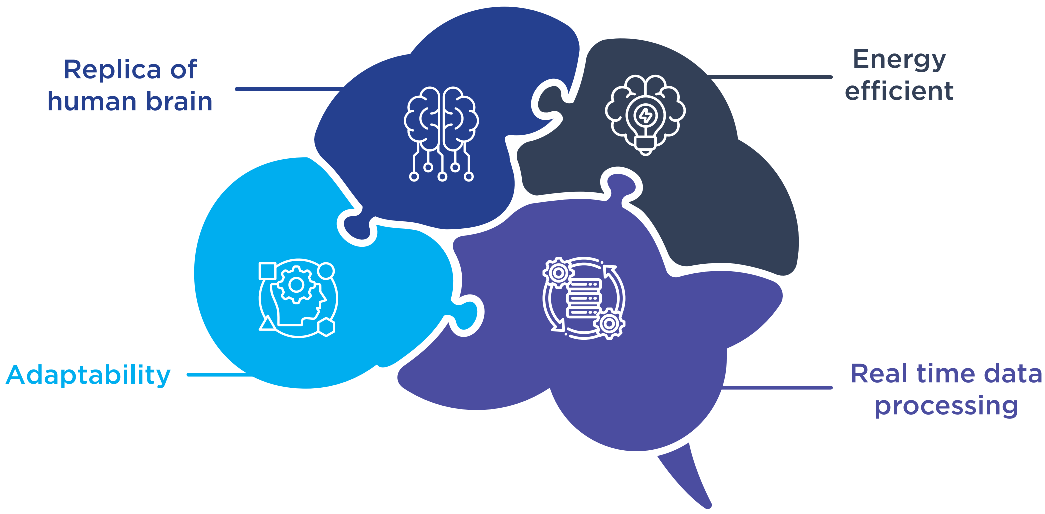
This report surveys the current **neuromorphic computing ecosystem**, highlighting key market players and active research initiatives. It examines notable academic–industry collaborations and discusses how neuromorphic approaches can overcome bottlenecks in conventional architectures, particularly for AI workloads. By synthesizing technical insights and industry trends, the report aims to guide a broad range of stakeholders—semiconductor manufacturers, AI developers, and policymakers in formulating effective strategies around neuromorphic technologies.

As neuromorphic solutions move toward widespread adoption, they hold the promise to redefine **global AI capabilities**, deliver substantial gains in energy efficiency, and spur innovation in intelligent, autonomous systems across multiple sectors. By cultivating expertise and investing in neuromorphic R&D, nations and organizations can position themselves at the forefront of next-generation computing, shaping both technology leadership and economic growth.

Introduction

The rapid advancement of **Artificial Intelligence (AI)** and computational technologies has driven efforts to develop architectures that not only emulate the human brain's cognitive abilities but also perform critical tasks at high speed and low error rates. **Neuromorphic computing** represents one such high-potential paradigm, designed around the principles of biological neural networks. By employing artificial neurons and synapses that mimic the brain's parallel processing capabilities, neuromorphic systems aim to deliver faster, more energy-efficient, and adaptive AI solutions. This synthesis of **neuroscience, artificial intelligence, and semiconductor technology** aspires to narrow the gap between current AI methods and the remarkable efficiency observed in biological intelligence.

Core Principle of Neuromorphic Computing



Although the concept of neuromorphic computing may seem cutting-edge, its roots date back to Carver Mead's pioneering work at Caltech in 1986.[1] Since then, the field has evolved to address key bottlenecks associated with Von Neumann architectures—particularly the limited bandwidth between memory and processing units that hampers traditional computing when faced with complex, large-scale AI workloads. In contrast, neuromorphic designs co-locate memory and computation, enabling massive parallelism and reduced data transfer overhead.[2] As a result, neuromorphic computing has emerged as an important avenue for next-generation systems, fueling innovation in real-time processing, on-device learning, and energy-efficient AI applications.

1 Carver Mead: Microelectronics, neuromorphic computing, and life at the frontiers of science and technology, The International Society for Optics and Photonics

2 Neuromorphic Computing, IBM

Evolution of Neuromorphic Computing

1940s – 1960s

- Von Neuman Architecture introduced
- Proposal of Spiking Neural Models
- Perception invention for pattern recognition

1970s – 1980s

- Neuromorphic computing introduced at Caltech by Carver Mead
- Use of floating gate transistors as synapse
- Backpropagation learning

1990s-2000s

- AER for on chip spike communication
- GPUs formally introduced as parallel computing processors
- Proposal of spiking neurons as computational units for neural networks
- Spike-timing-dependent plasticity (Bi & Poo)

2010s

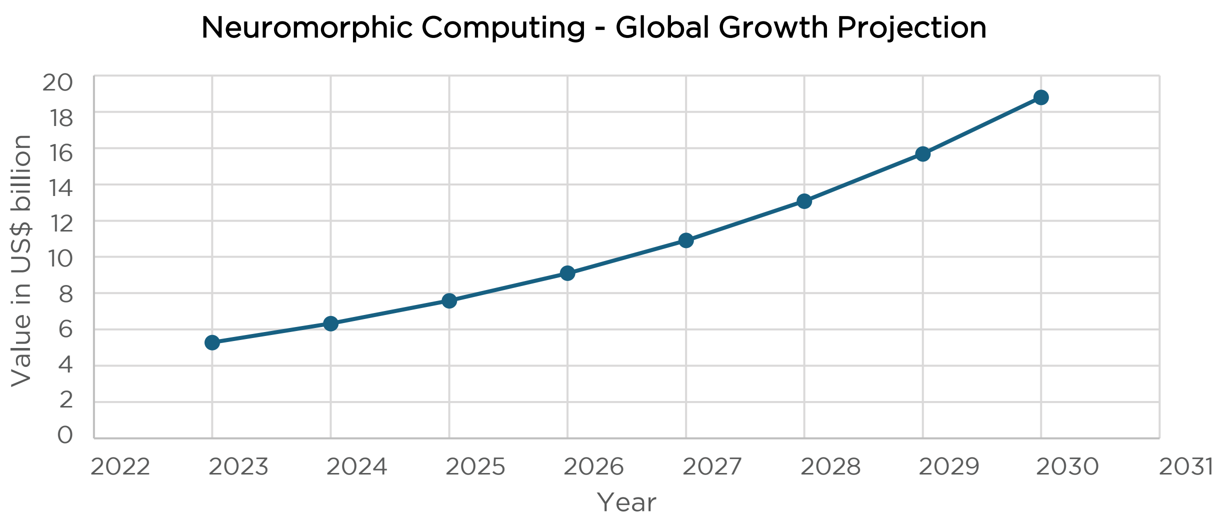
- Development of Big Brain chips like Loihi and Truenorth

2020s

- Developing training algorithms for SNNs on available (or by modifying) ML frameworks such as PyTorch and Caffe
- Extending SNNs beyond vision tasks for active learning environments
- Algorithm-hardware co-design
- In setu implementation of Synaptic efficacy and plasticity in RRAM, PCM and other crossbars

Industry Overview

In 2023, the neuromorphic computing market was valued at US $ 5.28 billion. The market is estimated to grow at CAGR of 19.9% from 2024 to 2030.[3]



As per Gartner's research, the cumulative investment in neuromorphic computing was US $ 253 million from 2014 to 2022 mainly focusing on developing chip technology – hardware and software.[4] Gartner has identified Neuromorphic Computing as a transformational technology that has 5 to 10 years to mainstream adoption in their Deep Technology Hype Cycle, 2025.

The initial investment has laid the groundwork for the current market expansion, with resources strategically allocated to fundamental chip architecture development rather than immediate commercialization. This methodical approach has allowed researchers and companies to overcome significant technical challenges in mimicking neural structures through silicon-based systems before scaling to mass production. As the technology matures from experimental prototypes to commercially viable products, we're now witnessing the transition from research-intensive investment to market growth, explaining the substantial difference between historical R&D funding and current market dynamics.

Technology – Segmentation & Composition

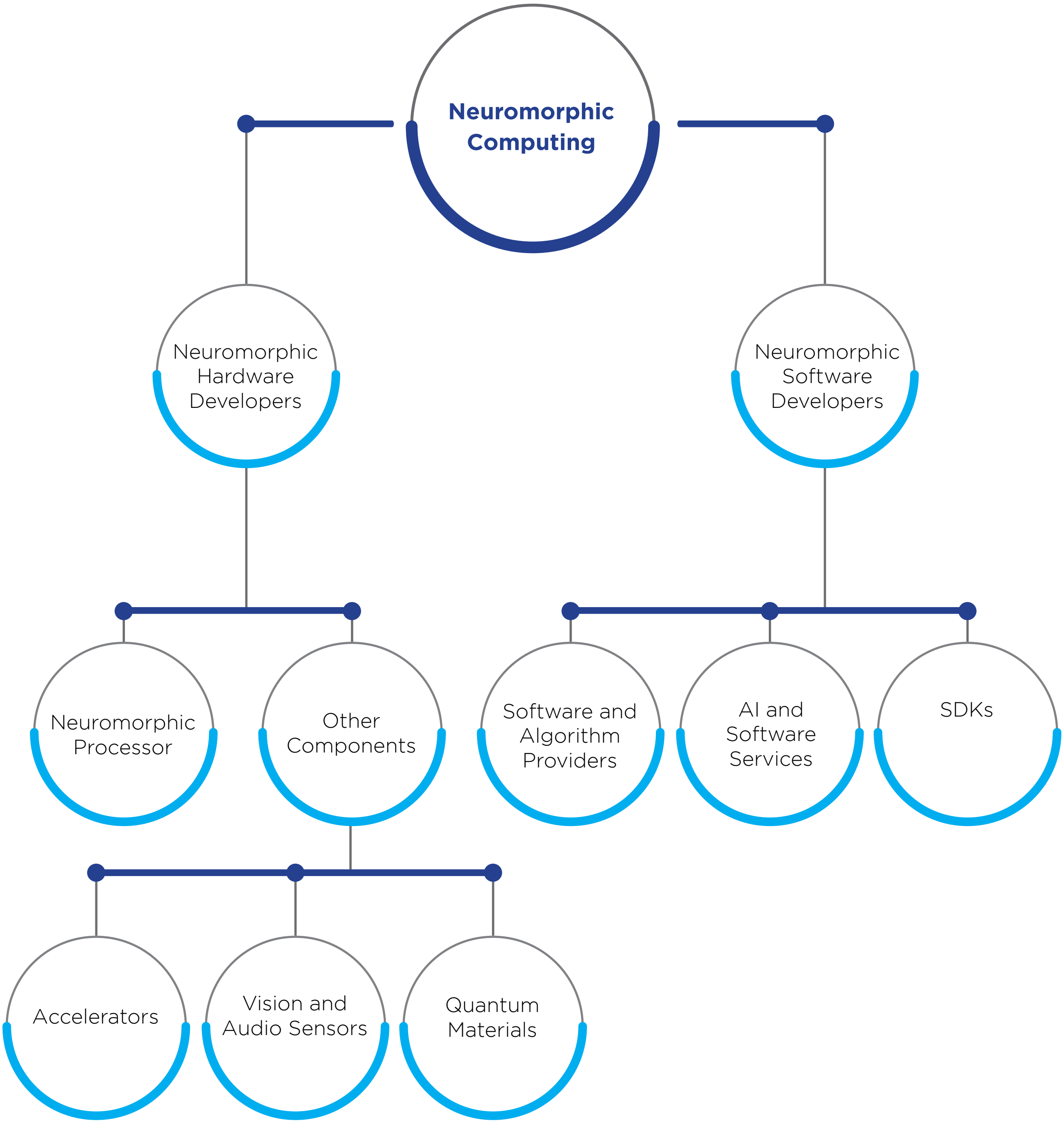
Neuromorphic computing technology can be broadly divided into **hardware** and **software** components. On the hardware side, specialized neuromorphic chips and processors integrate

[3] Grand View Research - Neuromorphic Computing Market Trends

[4] Executive Briefing on Emerging Technology – Neuromorphic Computing, Gartner

memory and compute elements, allowing them to outperform traditional CPUs and GPUs in both **processing speed** and **energy efficiency.** These chips are designed to handle massive parallelism and event-driven computation, making them well-suited for real-time AI applications.

Neuromorphic **software** consists of advanced algorithms and frameworks that implement Spiking Neural Networks (SNNs) and other biologically inspired models. These software stacks often include **Software Development Kits (SDKs)** that provide developers with the necessary tools, libraries, and interfaces to design, train, and deploy neuromorphic applications. By combining low-power hardware with robust software support, neuromorphic computing promises to deliver faster, more efficient, and highly scalable AI solutions.



Industry Drivers and Challenges

Drivers	Challenges
Limitations of traditional computing for AI workloads	Intricate hardware architectures and brain-inspired algorithms
Increasing demand for AI and ML – need for more efficient and powerful computing solutions	Challenging Hardware-Software co-design
Focus on energy efficient technologies	Absence of unified industry standards – low adoptability
Government research and investment	Integrating neuromorphic processors with existing ecosystems requires significant architectural and software adaptations
Increasing demand for real-time decision making in crucial infrastructure	High R&D costs and uncertain commercial viability
Advancement in Neuromorphic Hardware like Loihi, Truenorth, Akida	High reliance on novel materials and circuit design
High performance, low latency computing needs in various industries	Despite being energy efficient – required significant computational resources for simulation, training, and optimization

Neuromorphic Technology Ecosystem – Industry Analysis

The neuromorphic technology industry is largely driven by major players such as Intel, IBM, and Qualcomm, which focus on hardware solutions and advancements. In contrast, the software segment presents significant opportunities for startups to innovate and introduce new products, contributing to the expansion of the ecosystem.

Neuromorphic Hardware Components

Neuromorphic computing hardware consists of physical components and architectures engineered to replicate the structure and functionality of the human brain for computational purposes including parallel processing, event-driven computation, and adaptive learning.

Processing and Memory Chips: Companies developing specialized neuromorphic processors with integrated memory capabilities that overcome traditional von Neumann bottlenecks. These chips feature massively parallel architectures that mimic neural networks' connectivity.

Specialized Component Developers:

AI Accelerators: Leading research institutions have announced new phase-change memory based synaptic arrays for neuromorphic computing, offering dramatic improvements in computational efficiency for neural network operations.

Vision and Audio Sensors: Manufacturers creating biomimetic sensors that process information similarly to human sensory systems, with particular emphasis on event-based vision sensors that drastically reduce power consumption.

Quantum Material Development: Organizations working on molecular film creation and other advanced materials that enable more efficient and scalable neuromorphic hardware implementation.

Neuromorphic Software Providers

The software segment of the neuromorphic computing industry focuses on creating the programming environments and algorithms necessary to effectively utilize specialized hardware.

Software and Algorithm/Framework Providers: Organizations developing neuromorphic software that enables efficient utilization of neuromorphic hardware through specialized programming models, neural network implementations, and learning algorithms.

SDKs – Software Development Kits: Organizations offering comprehensive development environments that include libraries, programming interfaces, and simulation tools to support neuromorphic application creation.

Neuromorphic Solution Providers

A growing segment of the industry includes organizations offering integrated solutions that combine neuromorphic computing hardware and software into cohesive platforms targeting specific industry applications. These providers deliver end-to-end systems designed for particular use cases such as industrial automation, computer vision, or signal processing, typically featuring:

- Customized hardware configurations optimized for specific workloads
- Application-specific software stacks and development tools
- Integration capabilities with existing enterprise systems
- Implementation and optimization services

Neuromorphic Hardware

Intel

Product

Loihi; Loihi – 2; Halapoint

Focus Areas

Processors using advanced semiconductor technology

SK hynix

Product

GDDR6-AiM

Focus Areas

Optimized AI framework and HPC applications with CPU & GPU-accelerated containers

IBM

Product

TrueNorth

Focus Areas

Hardware and Research - Neuromorphic Computing, In memory computing, Intelligent Fab, AI Hardware, Logic Technology

Samsung

Product

Exynos 980

Focus Areas

Proposing method to "copy and paste" the brain's neuronal wiring onto a semiconductor chip

SynSense

Product

SPECK, XYLO, DYNAP

Focus Areas

Event-driven neuromorphic vision SoC

SST – A Microchip Technology Company

Product

SuperFlash; MemBrain

Focus Areas

Embedded Non-Volatile Memory (NVM)

Atmel / Microchip

Product

ATmega MCUs, Atxmega MCUs; Attiny MCUs

Focus Areas

MCU focusing on capacitive touch solutions, advanced logic, mixed-signal, NVM and Radio Frequency (RF) components

General Vision

Product

NeuroMem Chip

Focus Areas

Hardware and software to provide real intelligence at the edge

GrAI Matter Labs

Product

GrAI One

Focus Areas

Brain-inspired chips that behave like humans and real time assisting AI solutions

Neuromorphic Hardware

Company	Product	Focus Areas
Qualcomm	Zeroth	Build devices that have embedded cognition driven by brain inspired computing
MemComputing	MemCPU	Employs a unique collective computing model where computational units are inherently interconnected
Quadric	Chimera GPNPU	Provide ML and Semiconductor IP
BrainChip	Akida	Mimic the human brain to analyze only essential sensor inputs at the point of acquisition of information
Neuronics	Metis	AI-based PdM algorithm
Innatera	T1	AI Hardware
Axelera	Metis AIPU; Metis AI Evaluation System	AI Hardware and accelerators
eMemory	NeoEE; NeoMTP; EcoBit	Advances AI SoCs
Kneron	Kneron RANN	Reconfigurable Artificial Neural Network

Neuromorphic Hardware

Prophesee

Product

Silkyevcam; Visioncam

Focus Areas

Event based meta vision sensors

ROHM Semiconductor

Product

ROHM AI Chip

Focus Areas

Integrate on-device learning algorithms in AI sensor chips

Hailo

Product

Hailo 15 AI Vision Processor

Focus Areas

Processors that enable high performance deep learning applications on edge devices

MXIC – Macronix International Co., Ltd.

Product

eMMC

Focus Areas

Memory to meet the needs of high-capacity storage and high reliability applications

Hewlett Packard Enterprise

Product

dCAM

Focus Areas

Vision sensor cameras – Memristor

TDK

Product

TDK Spin Master

Focus Areas

Memristors

Eta Compute

Product

Talia

Focus Areas

Battery powered vision sensor that counts and monitors people at the entrance of spaces

Mythic

Product

Mythic AMP

Focus Areas

Compute devices for data centers

Untether AI

Product

tsunAImi; speedAI240; runAI200

Focus Areas

Accelerators

Neuromorphic Software

DENSO

Product
Denso MaaS

Focus Areas
Neuromorphic solution for automotive Industry

SynSense

Product
SINABS, SAMNA & TONIC

Focus Areas
Open source PyTorch based library, developed to design and implement SCNNs

SONY make.believe

Product
AITROS

Focus Areas
Optimizes vision AI at the edge with less data, less complexity, and faster results

Numenta

Product
Thousand Brain Project

Focus Areas
Developing a new type of artificial intelligence based on sensorimotor framework for intelligence, the Thousand Brains Theory

brainchip

Product
Akkida IP

Focus Areas
Digital neuromorphic processor IP – mimics the human brain to analyse sensor inputs

abR

Product
TSP1

Focus Areas
Develops software tools and frameworks for spiking neural networks (SNNs), including the Nengo platform

another brain

Product
Organic AI

Focus Areas
Software mimicking cortical brain function, enabling real-time, low-power, on-chip neuromorphic computing with autonomous learning and explainability

natural INTELLIGENCE

Product
Neuromorphic Photonic System – PaaS

Focus Areas
Brain-inspired analogue neuromorphic chips that enable ultra-low-power, edge-native AI through event-driven computation and continuous learning.

Integrated Solutions

Company	Focus Areas
Microchip	memBrain nonvolatile in-memory compute technology
neurones	AI powered vision inspection and predictive maintenance
Kneron	Kneron RANN (Reconfigurable Artificial Neural Network)
cea leti	Transistor inspired by human synapses; focused on microelectronics and nanotechnology, including neuromorphic devices
vicarious	Human Level AI Robots

Software Development Kits

Prophesee	**Metavision SDK Pro** - Event-based vision software toolkit
innatera	**Talamo SDK -** Using a PyTorch integrated environment, offers developers a workflow to build and deploy end-to-end AI models onto the Spiking Neural Processor
memryX	**Smart Compiler** - Python and C/C++ low and mid-level APIs for AI integration – optimized and automated AI mapping
General Vision	**NeuroMem I/Os -** Harwdare driver to access the neurons through their parallel bus or other communication bus such as I2C and SPI
Microchip	**VectorBlox** - Accelerator SDK offers power-efficient Convolutional Neural Network (CNN)-based AI/ML inference
Quadric	**Chimera** - SDK for General Purpose Neural Processing Unit (GPNPU)
Untether AI	**imAIgine -** an automated path to running neural networks on Untether AI's inference acceleration solutions

Strategic Collaborations

Industry players have consistently collaborated with academic institutions to drive research and development in neuromorphic computing technologies. Such partnerships continue to fuel groundbreaking innovations in the field.

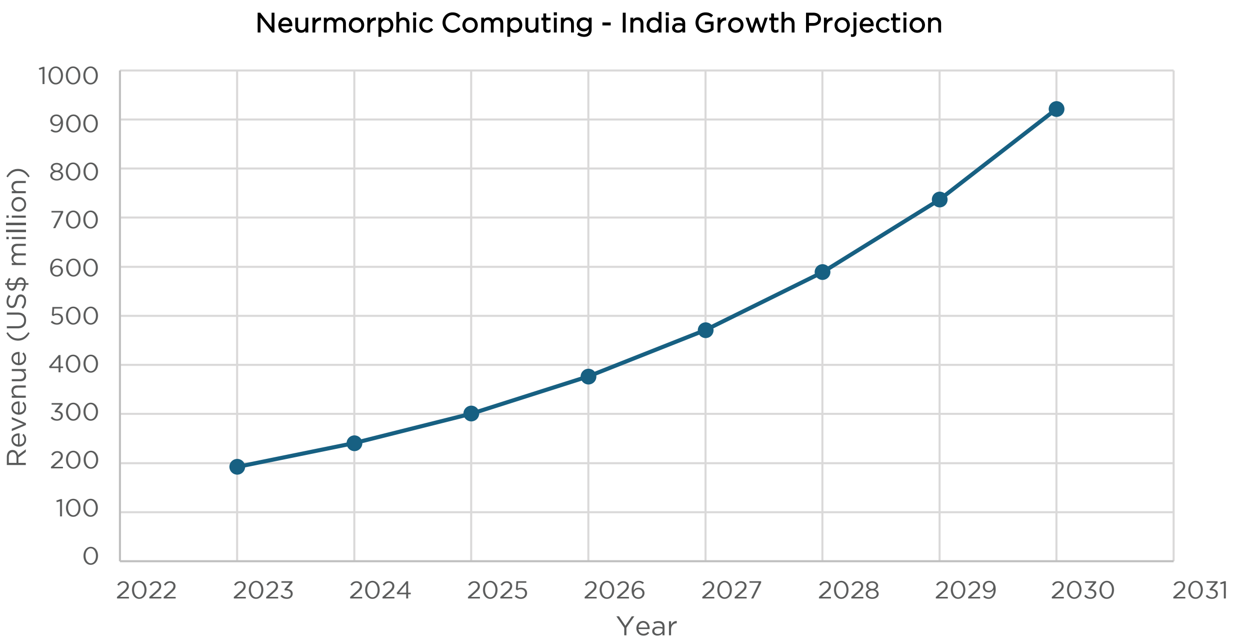
5 UNIVERSITY OF CAMBRIDGE	NeuCam - The Cambridge centre for neuromorphic computing; NeuCam will work together with a UK network grant on "Neuromorphic Materials and Devices for Future AI"
6 IBM | Universität Zürich	Working together on brain-inspired online training algorithms for neuromorphic hardware; key partners in Neurotech Consortium
7 ARM | MANCHESTER 1824 The University of Manchester	Developed SpiNNaker along with EU, Human Brain Project and European Research Council. SpiNNaker is a novel computer architecture inspired by the working of the human brain
8 intel | Sandia National Laboratories	Exploring the value of neuromorphic computing for scaled-up computational problems
9 brainchip intel | European Union	Research on neuromorphic computing in AI and robotics
10 | UNIVERSITY OF WATERLOO	Developing and integrating neuromorphic computing hardware systems to enable energy-efficient, real-time AI processing in future mobility platforms by leveraging SNN and event driven architecture
11 UK Research and Innovation | Aston University BIRMINGHAM UK	UK Multidisciplinary Centre for Neuromorphic Computing in partnership with Microsoft Research, Thales, BT, QinetiQ, Nokia Bell Labs, Hewlett Packard Labs, Leonardo, Northrop Grumman, etc. with focus on innovation and collaboration in neuromorphic computing
12 TDK cea leti | TOHOKU UNIVERSITY	Focus on advancing neuromorphic computing through next-generation embedded AI hardware, leveraging non-volatile memory and energy-efficient architecture

5 University of Cambridge
6 IBM x Zurich University
7 ARM x Manchester
8 Intel x Sandia National Laboratories
9 Cornell x Brainchip
10 Mercedes x University of Waterloo
11 UK Research and Innovation x Aston University
12 TDK x CEA x Tohoku University

Neuromorphic Computing–Indian Landscape

The Indian neuromorphic computing industry is still in its early stages but holds significant potential, driven by the country's growing focus on Artificial Intelligence (AI), semiconductor manufacturing, and advanced computing technologies. The Indian government is also fostering an ecosystem conducive to neuromorphic research and development with initiatives like the India AI Mission, the Semiconductor India Program, and the Make in India campaign.

The Indian neuromorphic computing industry generated revenue of US $ 192.2 million in 2023 and is expected to reach US $ 923.7 million by 2030 at a CAGR of 25.1%.[13]



[13] Grand View Research - Neuromorphic Computing in India

Neuromorphic Technology Providers in India – Detailed Analysis

The following companies have major operations and are headquartered in India.

Hardware

MORPHING MACHINES

Product

REDEFINE

Focus Areas

A many-core, massively parallel, runtime reconfigurable embedded processor

Tyrone (A Netweb Brand)

Product

Kubyts

Focus Areas

Optimized AI framework and HPC applications with CPU & GPU-accelerated containers

NeuRonICS Lab (Neurally - inspired Reconfigurable Intelligent Circuits & Systems)

Product

Aryabhat

Focus Areas

Neuromorphic trainable analog integrated chip

NETRASEMI

Product

Tej NPU
NETRA-SOC Family Edge-AI Chips - Netra-R1000, Netra-A2000 and Netra-A4000

Focus Areas

SoCs powered with a unique domain specific architecture that scales from tiny edge devices to edge servers

PROX

Product

ProX AI Workstations

Focus Areas

HPC workstation and hardware

EDGENEURAL.ai

Product

ENAP Studio - EDGENeural AI Platform

Focus Areas

ENAP cloud dashboard for ENAP training containers and ENAP edge containers for edge optimization

Netweb TECHNOLOGIES

Product

Tyrone Cluster Manager

Focus Areas

High power computing system

YantraVision

Product

Falcon Camera

Focus Areas

FPGA integrated camera module

Software

Product
Quantum AI Bank
Focus Areas
For BFSI - autonomous and decision-making tool

Product
AI Sorter
Focus Areas
Can identify foreign material at high speed in conveyer belt

Product
Polyblocks
Focus Areas
“Blocks” that can be used to build compilers and code generators for high-performance computing

Product
Cogniphi’s AI Vision
Focus Areas
Vision Intelligence Platform

Product
NETRA SmartEdge Studio AI Software Framework
Focus Areas
SDK

Product
Computer Vision Accelerator
Focus Areas
Artificial Neural Network, Convolutional Neural Network, LSTM and Recurrent Neural Network

Product
DeepOptics
Focus Areas
A low-code AI platform to power digital transformation for enterprises

Product
Falcon eye, Falcon Compute
Focus Areas
IPs to support vision sensor cameras

Services

NeuroFlares

Product

Convolutional Neural Network

Focus Areas

Assistance app for bedridden patients - hand free communication, accurate detection technology

edgeble

Product

EAI-CM6

Focus Areas

Pre-trained AI accelerator platform for edge AIoT-enabled solutions

Myelin Foundry

Product

Fovea Edge - ECV+, ECV, HANDi, MICI - Mobile in Cabin Intelligence

Focus Areas

High compute AI algorithms and mobile phone-based system that can be easily set up in any automobile-cabin environment

Product

Developed smallest neuromorphic electrical neuron of the world and in the process of developing a complete neuromorphic system

In India, the neuromorphic computing market is primarily driven by software and algorithm providers, likely due to the country's strong presence and focus on the IT services and engineering R&D industry.

Neuromorphic Computing - Strategic Collaborations in India

In India, neuromorphic computing is still at a nascent stage. Industry and academia collaborations have accelerated the research and development in the technology through constant support.

Institute	Brief about the Initiative	Concerned Working Group
[14] x Ministry of Education x STARS	Scheme for Transformational and Advanced Research in Sciences (STARS) – Development of neuromorphic hardware with ultrathin cobalt layer with built-in memory	Prof. Pranaba Kishor Muduli, IIT Delhi Prof. Debanjan Bhowmik, IIT Bombay
[15] x accenture	Advanced Technology Center to jointly develop IPs in neuromorphic computing along with other next generation computing technologies like edge and quantum	Prof. Govindan Rangarajan, Director, IISc Bengaluru
[16] x Department of Science & Technology	Funded by DST – Exploring advanced AI/ML algorithms and neuro-optimization algorithms for neuromorphic computing	Dr. Shubham Sahay, IIT Kanpur
[17] x Infosys	Center for Computational Brain Research–Set up in 2015 with focus on exploiting engineering tools for analyzing the structure and activity of neural circuits and advancing machine intelligence with brain-inspired hardware and software architecture	Prof. Sukhendu Das Prof. Sutanu Chakraborti

Academic Research Centers

Institute	Details	Working Group
IIT Bombay – Computational Nanoelectronics and Quantum Transport Group[18]	Established in 2010 – current research scope includes energy-efficient neuromorphic hardware using spintronics and hybrid simulations that integrate spin-transport, magnetization dynamics, and CMOS elements.	Prof. Bhaskaran Muralidharan
IIT Kanpur – NeuroCHaSe Group[19]	Research group focuses on neuromorphic computing, in-memory processing, and energy-efficient hardware systems for AI and signal processing applications.	Associate Professor. Shubham Sahay
IIT Madras - Robert Bosch Center for Data Science and Artificial Intelligence[20]	Developing bio-plausible (neuromorphic) machine learning algorithms and hardware architectures for energy-efficient computing at the edge	Gopalkrishnan Srinivasan, Assistant Professor

[14] https://home.iitd.ac.in/show.php?id=36&in_sections=Research

[15] Accenture and IISc Collaborate for Research in Cloud Continuum and Neuromorphic Computing

[16] IIT Kanpur - Advanced AI ML algorithms for neuromorphic computing

[17] Center for Computational Brain Research

[18] https://cnqt-group.org/?p=953

[19] https://home.iitk.ac.in/~ssahay/research.html

[20] https://rbcdsai.iitm.ac.in/tags/neuromorphic-computing/

Institute	Details	Working Group
IIT Madras - Centre for Computational Brain Research (CCBR)[21]	Interdisciplinary research integrating neuroscience, machine learning, and neuromorphic engineering to understand and replicate brain-like intelligence	Prof H N Mahabala N.R. Narayanamurthy Prof CR Muthukrishnan
IIT Delhi - NVM and Neuromorphic Hardware Research Group	Cyran AI Solution developed; other research work focuses on Semiconductor Non-Volatile Memory (NVM) technology and its advanced applications (neuromorphic, AI, security, computing, sensing)	Dr. Manan Suri
IIT Roorkee – Centre for Nanotechnology[22]	Neuromorphic computing with nano-systems, intelligent sensing systems, computational nanotechnology, AI-ML and optimization, modelling and simulations, nanoelectronics, optoelectronics, multiscale device design	Dr. Ankush Kumar
IIT Jodhpur – Control and Computing Lab[23]	Exploring neuromorphic and brain-inspired computing architectures for energy-efficient and scalable AI hardware systems	Prof. Bharat Singh Rajpurohit
IIT Gandhinagar – Emerging Devices & Systems Lab (EDSL)[24]	Neuromorphic hardware, low-power computing, and spiking neural network systems for real-time embedded AI applications	Sandeep Lashkare, Assistant Professor
IIT Mandi – Center for Quantum Science and Technologies[25]	Brain-like computing using molecular electronics and fractal networks, aiming to develop neuromorphic architectures beyond conventional silicon-based systems	Prof. Anirban Bandyopadhyay
IIT Indore - Hybrid Nanodevice Research Group[26]	Atomic-scale RRAMs and crossbar architectures for neuromorphic computing and logic, alongside sensors and optoelectronic devices	Prof. Shaibal Mukherjee
IISc Bengaluru – NeuRonICS Lab[27]	Focus areas include brain-inspired computing, developing intelligent systems through research in analogue/digital VLSI design, neuromorphic algorithms, and event-based sensors	Dr. Chetan Singh Thakur, Associate Professor
IISc Bengaluru – Centre for Nano Science and Engineering[28]	Research scope includes neuromorphic computing, spintronics, 2D quantum materials and devices	Prof. Ambarish Ghosh

Other notable institutes focusing on neuromorphic computing research are – IIT BHU, Jawaharlal Nehru Centre For Advanced Scientific Research, IISER Thiruvananthapuram, and Digital University Kerala.

21 https://ccbr.iitmadras.in/
22 https://iitr.ac.in/Centres/Centre%20for%20Nanotechnology/Home.html
23 https://iitj.ac.in/electrical-engineering/en/Control-and-Computing-Laboratory
24 https://sites.google.com/iitgn.ac.in/edrl/home
25 https://cqst.iitmandi.ac.in/
26 https://hnrg.profiles.iiti.ac.in/
27 https://labs.dese.iisc.ac.in/neuronics/
28 https://www.cense.iisc.ac.in/

Research and Development

Patent and Innovation Focus

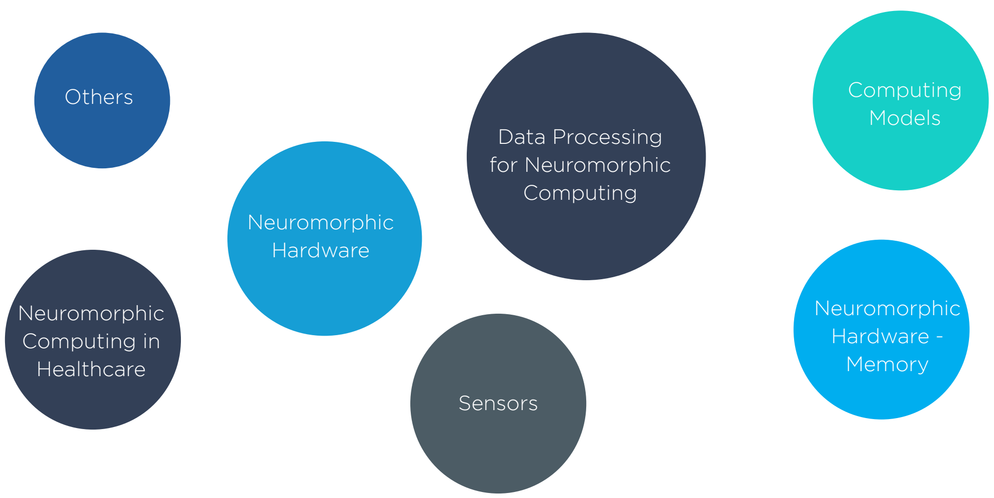
The neuromorphic computing research and development landscape reveals distinct priorities. The industry's innovation focus spans hardware architectures, processing methodologies, and application-specific implementations. The most significant concentration of innovation activity centers on neuromorphic hardware. This category encompasses specialized memory systems and processor architectures designed to mimic neural structures. The substantial investment in hardware patents reflects the industry's recognition that fundamental architectural breakthroughs are essential to achieving the efficiency gains that make neuromorphic computing commercially viable.

Data processing methodologies represent the second largest patent category, underscoring the critical importance of algorithmic innovations in translating theoretical neuromorphic principles into practical computing advantages. These patents typically address specialized data handling techniques optimized for spike-based information processing and event-driven computation.

The distribution also reveals growing diversification into application-specific domains, with healthcare emerging as an active sector. Neuromorphic computing in healthcare applications has generated significant patent activity around medical imaging analysis, diagnostic systems, and real-time patient monitoring—areas where the pattern recognition capabilities of neuromorphic systems offer substantial advantages.

Neuromorphic hardware (memory and processor) are the most researched topics when it comes to filed patents in neuromorphic computing.

Patents Applied in Neuromorphic Computing



Neuromorphic Computing – Patents applied globally since July 2023[27]

Publication Number	Patent Title	Applicants	Key Focus Areas
AU2024287245	Photonic-Neuromorphic Computing System With Neuromorphic Memory, Binarized Logic, Silicon Photonics, Pqc Readiness, Intrusion-Based Resource Allocation, Adaptive Cooling, And Quantum Interface Option	Sense2 Pty Ltd	Integration of photonic neuromorphic computing with memory, binarized logic, and silicon photonics for secure, scalable, and quantum-ready AI processing systems.
WO2025124948	Neuromorphic Devices Of Heusler Alloy Based Spin-Transfer-Torque Magnetic Tunnel Junctions	IBM	Magnetic tunnel junction-based neuromorphic computing array leveraging Heusler compounds and layered nitride templating for high-density, PMA-enabled memory and logic operations.
US20250124299	Noise Leveraging Method And Computing Device For Training Efficient And Robust Neural Network In Neuromorphic Device	Alsemy Inc	A noise-aware training method that enhances efficiency and robustness of neuromorphic neural networks by leveraging low-rank noise modelling during gradient-based weight updates.
WO2025072958	Systems And Methods For Using Artificial Neurons And Spike Neurons To Model Nonlinear Dynamics And Control Systems	Ohio State University	Implements a neuromorphic framework to model nonlinear dynamic systems using spiking and artificial neurons for real-time state estimation and control through vector field approximation and integration.
WO2024231907	Method And System For Large-Scale Computation Of Quantum Algorithms Using Neuromorphic Quantum Computing	Dynex Development Establishment	Simulates quantum algorithms on classical hardware at scale, preserving quantum-like fidelity, to overcome current limitations in qubit scalability and error correction.

[27] WIPO data

Publication Number	Patent Title	Applicants	Key Focus Areas
WO2025062034	Feature Extraction And Encoding Of Spiking Neural Networks Using Convolutional Neural Network And Trainable Encoders For Deployment In Neuromorphic Chips	Innatera Nanosystem	Training method for neuromorphic processors combining CNNs and SNNs using differentiable surrogate functions to enable gradient-based learning from temporally encoded signals.
US20250094794	Neuromorphic Computing Circuit And Method For Control	Fujitsu Limited	Neuromorphic circuit architecture using bidirectional spike timing and counter-based updates to dynamically modulate connection strength and spike generation based on temporal correlations.
US20240256848	High-Density Neuromorphic Computing Element	Samsung Electronics	High-density neuromorphic device using vertically stacked flash-like cells for efficient analogue computation with non-volatile weight storage and fast processing.
WO2024203769	Analog Computing Element And Neuromorphic Device	TDK Corporation	An analogue computing element using exponential voltage-current conversion and current-voltage ratio computation to enable precise analogue operations critical for neuromorphic inference.
US20240310866	PCSELs For Optical Neural Networks/ Photonic Computing/ Neuromorphic Computing	Seagate Technology LLC	Photonic crystal surface emitting laser (PCSEL) array for parallel, beam-modulated optical computing—suitable for neuromorphic or optical neural network systems.
US20240310866	Multi-Resistor Unit Cell Configuration For Implementation In Analog Neuromorphic Circuits	Brisk Computing	Analogue neuromorphic circuit using configurable resistor banks for adaptive input processing and parallel analogue computation.

Publication Number	Patent Title	Applicants	Key Focus Areas
WO2024158851	Semiconductor Device Including Ferroelectric Material, Neuromorphic Circuit Including The Semiconductor Device, And Neuromorphic Computing Apparatus Including The Neuromorphic Circuit	Samsung Electronics	Stacked ferroelectric transistor architecture enabling enhanced synaptic behaviour and compact integration for neuromorphic computing circuits.
US20240113127	Energy Efficient Memristor Based On Orthorhombic Tin Selenide (Snse) Micrometric Flakes, Method Of Obtaining Thereof And Applications Thereof	National Institute of Material Physics, Romania	Low-power tin selenide-based memristor with gradual resistance switching for scalable, energy-efficient neuromorphic and IoT applications.
EP4376009	Solving Optimization Problems Using Spiking Neuromorphic Network	Intel Corporation	Spiking neuromorphic network architecture for solving optimization problems using neuron-driven variable updates and convergence detection.
US20240054331	Apparatus For Determining An Angular Deviation, Vehicle And Method For Determining An Angular Deviation	Rheinmetall Electronics	Neuromorphic camera-based system for real-time angular deviation correction in firearms using coherent light beam tracking.
US20240070446	Neuromorphic Computing	Secqai Ltd	Magnetoresistive elements for multi-level synaptic weight modulation in neuromorphic neural network hardware.

Neuromorphic Computing – Patents applied in India since July 2023[28]

Application Number	Patent Title	Applicants	Key Focus Areas
202511055305	Neuromorphic Risc-Inspired Scalable System Using Dljlfet	Rajkiya Engineering College National Institute of Technology Patna	Ultra-energy-efficient silicon-based LIF neurons using doping less junction less FETs (DL-JLFETs) for high-speed, scalable spiking neural networks (SNNs).
202541050656	A Method For Developing And Remotely Controlling A Neuromorphic Device	IIT Hyderabad	Fabrication of a neuromorphic memristive device using thermally annealed α-Fe_2O_3 as the switching layer on FTO substrate for resistive switching applications.
202541047037	Quantum Dot-Based Neuromorphic Photodetectors For Advanced Imaging	SR University	Quantum dot-based neuromorphic photodetectors for intelligent imaging with in-sensor computing, enabling real-time, low-power, brain-inspired visual processing.
202541043802	Low-Power Neuromorphic Processor For Edge Ai	SNS College of Technology	Energy-efficient neuromorphic processor for event-based edge AI, featuring spike compression and low-power synaptic memory in 180nm CMOS ASIC design.
202541042754	Self-Healing Ai Models For Edge Devices Using Neuromorphic Computing	Saveetha Engineering College	Neuromorphic self-healing AI architecture for edge devices enabling autonomous, offline recovery from adversarial or hardware faults without cloud support.
202541042128	Neuromorphic Approach To Resolving The Speed Power Accuracy Tradeoff In Adcs	CVR College of Engineering	Design of a trainable 4-bit neuromorphic ADC using memristive neural networks and online SGD for low-power, adaptive real-time signal conversion.

[28] Indian Patent Office Data - InPass

Application Number	Patent Title	Applicants	Key Focus Areas
202541039300	Neuromorphic And Brain Computer Interfaces	A.M.Reddy Memorial College of Engineering and Technology	Real-time, adaptive, and energy-efficient neuromorphic brain-computer interface system using spiking neural networks to enhance human-device interaction across assistive, medical, and immersive applications.
202541038596	Neuromorphic-Ai-Integrated Quantum Encryption System For Ultra Secure Data Transmission And Storage	Arunachal College of Engineering for Women	Neuromorphic-AI-based encryption system using spiking neural networks and behaviour-driven authentication for post-quantum, adaptive, and secure communication across critical digital infrastructures.
202511023512	Process For Synthesizing Gold-Doped Metal Oxide Embedded Inside Polymer Composites For Enhanced Flexible Resistive Switching Artificial Synapses In Neuromorphic Computing Applications	Netaji Subhas University of Technology	Fabrication of a flexible Au-doped ZnO-NiO-PVA nanocomposite memristor for neuromorphic computing and RRAM applications using low-cost, solution-based techniques.
202511023512	Process For Synthesizing Gold-Doped Metal Oxide Embedded Inside Polymer Composites For Enhanced Flexible Resistive Switching Artificial Synapses In Neuromorphic Computing Applications	Netaji Subhas University of Technology	Development of a cost-effective, flexible memristor using Au-doped ZnO-NiO-PVA nanocomposites for neuromorphic computing and next-gen memory (RRAM) application
202541014688	Integrating Neuromorphic Computing And Reinforcement Learning In Hybrid Ai For Autonomous Systems	Canara Engineering College	Hybrid AI framework combining neuromorphic computing and reinforcement learning for low-latency, energy-efficient, real-time adaptive decision-making in autonomous systems.

Application Number	Patent Title	Applicants	Key Focus Areas
202541010217	Brain-Inspired Computer Architecture Subsystems For Neuromorphic Computing Systems	REVA University	Brain-inspired neuromorphic system using SNN-based processing, ReRAM/PCM memory, and self-adaptive learning for efficient, fault-tolerant AI in edge and robotics applications.
202417104806	Neuromorphic Analog Signal Processor For Predictive Maintenance Of Machines	Polyn Technology Limited	Neuromorphic analogue circuit for edge-based predictive maintenance using sensor input and partial neural network inference.
202411101586	Neuromorphic Semiconductor Chip For Artificial Intelligence-Powered Edge Computing	Vivekananda Institute of Professional Studies-Technical Campus (VIPS-TC)	Energy-efficient, scalable neuromorphic chip for edge AI with on-chip learning, spiking neural cores, and built-in security for real-time processing in IoT and autonomous systems.
202411099785	Neuromorphic Processor For Real-Time Adaptive Machine Learning	Chandigarh University	Hybrid digital-analogue neuromorphic processor with on-chip STDP learning and energy harvesting for scalable, real-time, low-power AI across edge and autonomous systems.
202441097992	A Neuromorphic Controller For Power Electronic Converters	Ecole Centrale School of Engineering, Mahindra University	Neuromorphic-inspired analogue controller for dynamic dead-time adjustment in power converters to improve switching efficiency and reduce energy loss.
202441027226	Biomimetic Neuron Model For Efficient Neuromorphic Computing	P.E.S. College of Engineering	Biomimetic FPGA-based neuromorphic architecture replicating mammalian spatial navigation (grid/place cells) for efficient, sensor-free autonomous robotic navigation.
202414006149	Global And Cluster Contrast Detection In Vision Neuromorphic Sensors	Prophesee	Event-based vision sensor with clustered pixel architecture generating spike-based outputs from summed photocurrents for low-latency visual processing.

ANRF funded ongoing research in Neuromorphic Computing

Title	Institute	Professor	Key Focus Area
Design and Development of Neuromorphic Quantum Computing Architectures for High Throughput and Energy Efficient Applications	IIT Patna	Prof. Jawar Singh	Hybrid neuromorphic-quantum computing platform that leverages quantum correlations and silicon-based artificial neurons to enable scalable, energy-efficient, and reconfigurable architectures for complex AI tasks.
Design and Development of Transition Metal Oxide Based Synaptic Devices for Brain-Inspired Neuromorphic Computing Applications	M.S.Ramaiah University Of Applied Sciences, Bengaluru	Dr. Priyanka KP	Nano-transition metal oxide-based artificial synapses using solution-based synthesis methods for energy-efficient neuromorphic computing, with emphasis on both electrical and optical tunability to mimic complex human cognition.
2D materials based CMOs compatible crossbar array for neuromorphic computing applications	Institute of Physics, Bhubaneswar	Dr. Satyaprakash Sahoo	2D material-based crossbar arrays (using MoS_2, WS_2) to enable low-power, scalable, and CMOS-compatible neuromorphic computing hardware for efficient implementation of artificial neural networks
Bionanocomposite Electrospun Nanofibers for Biocompatible and Biodegradable Artificial synaptic Devices for Energy-Efficient Neuromorphic Computing Applications	Shivaji University, Maharashtra	Dr. Tukaram Dattatray Dongale	Eco-friendly bionanocomposite nanofiber-based synaptic devices with biological-scale switching voltage and timing, aimed at advancing sustainable, high-speed neuromorphic computing for AI pattern recognition tasks.
Ferrimagnet based artificial synaptic device for neuromorphic computing	IIT Hyderabad	Dr. Chandrasekhar Murapaka	Ferrimagnetic synaptic devices using RE-TM thin films to achieve multistate switching with high speed and low power for neuromorphic computing, leveraging the advantages of spin-orbit torque and domain wall dynamics.

Title	Institute	Professor	Key Focus Area
Exploring normally-on Ferroelectric FinFET devices for neuromorphic computing applications	IIT BHU	Dr. Shivam Verma	Design and simulation of ferroelectric spiking neurons (FSNs) using normally-on ferroelectric FinFET devices to enable energy-efficient, scalable neuromorphic computing at advanced technology nodes.
Artificial synapse for brain-inspired neuromorphic electronics hardware based on skyrmion-domain	IIT Guwahati	Dr. Tanmay Dutta	Skyrmion-based artificial synapses for neuromorphic in-memory computing, enabling ultra-low power, multi-state, and compact memory architectures to support AI and IoT applications across critical sectors.
Design and Fabrication of Energy Efficient In-Memory Computing Design Framework for Analog Neural Processor with Improved Linearity for Neuromorphic Computing Applications	IIT Jodhpur	Dr. Bhupendra Singh Reniwal	Energy-efficient in-memory computing (IMC) architectures capable of executing precise MAC operations directly within memory arrays, to support high-throughput, low-power AI applications like image recognition, speech processing, and autonomous systems.
Fabrication and Optimization of Lead-free Inorganic Halide Perovskite based Memrsitive Devices and Systematic Investigation of Synaptic Characteristics for Neuromorphic Applications	Assam University	Dr. Pranab Kumar Sarkar	Flexible, lead-free halide perovskite-based memristor devices that mimic biological synapses for neuromorphic computing, with emphasis on synaptic plasticity, thermal stability, and mechanical flexibility for next-generation in-memory and perception-learning systems.
Fabrication of oxide heterostructures of hybrid spin valve - resistive switching memory devices for artificial intelligence	Centre For Nano And Soft Matter Sciences (Cens)	Dr. Angappane S	Hybrid neuromorphic memory devices that integrate ReRAM and spintronic technologies to combine high-speed switching, low power consumption, improved ON/OFF ratios, and enhanced endurance addressing the limitations of each technology for next-generation bio-inspired computing systems

Title	Institute	Professor	Key Focus Area
Developing inorganic-organic hybrid thin-film architectures as artificial neurons for non-von Neumann architecture	IIT Patna	Dr. Ajay D Thakur	Development of inorganic, organic, and hybrid thin-film resistive switching devices (RSDs) to emulate biological neuron behaviors like STP, LTP, and LIF, enabling scalable crossbar architectures for neuromorphic computing.
2D Spintronic-based Logic-in-Memory Devices for beyond Von-Neuman Architecture	IIT Delhi	Dr. Muzafar Gani	Spintronic computing systems using 2D materials to build energy-efficient, high-speed, and non-volatile devices that integrate memory and logic, enabling neuromorphic architectures beyond the Von-Neumann paradigm.
Development and testing of broadband optoelectronic synaptic devices employing ferroelectric/ photoelectric 2D material hybrid system	S. N. Bose National Centre For Basic Sciences, West Bengal	Dr. Avijit Chowdhury	Hybrid ferroelectric–2D material-based optoelectronic synaptic devices that integrate electrical and optical signal processing to emulate brain-like synapses, enabling energy-efficient, high-density, and broadband neuromorphic computing architectures.
Nanometer-scale Ultra-low Energy Molecular Memristors	Indian Institute Of Science, Bangalore	Dr. Sreetosh Goswami	Ultra-low energy molecular memristors for neuromorphic and in-memory computing, targeting attojoule-level switching to address scalability and energy efficiency challenges in large-scale AI implementations.
Crystallization Kinetics Investigations of Arsenic Doped Phase Change Memory Devices	National Institute Of Technology Calicut (NITC), Kerala	Dr. Vinod Erkkara Madhavan	Investigating doped Ge-Sb-Te phase change materials for ultrafast, multilevel memory and neuromorphic computing applications, with emphasis on understanding nanoscale crystallization dynamics critical for brain-like selective ignition and high-speed AI hardware.

Title	Institute	Professor	Key Focus Area
Engineering High Performance Resonant Magnetic Tunnel Junctions:-"Weaving NEGF+DFT based quantum transport with magnetization dynamics"	IIT Ropar	Mr. Abhishek Sharma	Energy-efficient heterostructure-based MTJs using quantum transport and magnetization dynamics models to enable advanced spintronic devices for neuromorphic computing and next-generation non-volatile memory systems.
Modulating Photo-induced Ferroelectric switching in 2D-Ferroelectric and Graphene Heterostructure	IIT Kharagpur	Dr. Krishna Prasad Maity	2D ferroelectric materials and light-controlled imprint/screening fields using graphene electrodes to enable low-power, optoelectronic neuromorphic computing and next-generation logic devices.
Novel spin-orbit materials and emergent phenomena for next-generation spin current-driven nanodevices	IIT Roorkee	Dr. Himanshu Fulara	Advancing Spin Orbitronics by engineering materials with strong spin-orbit coupling to develop high-speed, low-power SOT-MRAM and spin-orbit-based logic for beyond-CMOS memory and neuromorphic computing applications.
Low-frequency electronic noise studies and device engineering in artificial spin ice architecture	SRM University, Sonepat	Ms. Neeti Keswani	Exploring artificial spin ices (ASI) to investigate emergent magnetic monopoles and their influence on electronic noise and magneto-transport, with potential applications in spintronic and neuromorphic computing devices.
Extended Dissipative Performance for Delayed Discrete-Time Neural Networks and its Engineering Applications	The Gandhigram Rural Institute (Deemed To Be University), Tamil Nadu	Dr. G. Nagamani	Energy-based performance evaluation of delayed discrete-time neural networks (DNNs) and discrete-time memristor-based neural networks (DMNNs) using dissipativity theory, with applications in secure encryption and neuromorphic system modelling.

Neuromorphic Computing Applications

Neuromorphic systems excel in handling complex cognitive tasks, making them ideal for applications that require low power consumption, fast decision-making, and continuous learning. It can be integrated in various industries to pave the way for intelligent, autonomous, and efficient solutions.

- Supports real-time, event-driven processing without the need for cloud connectivity, making it ideal for edge computing due to low latency.
- For control, navigation and real-time processing of sensor data, paving the way for more intelligent, efficient, and adaptive robots across industries.
- Real-time processing of visual data and object detection to avoid collision and reduce accidents in ADAS and e-vehicles.
- Potential in military, defense and aerospace purposes including autonomous drones and unmanned aerial vehicles, space exploration, radar monitoring and target recognition.
- Real time diagnostics, medical imaging, personalized monitoring, brain machine interfaces (BMI), AI assisted decision support, and real time robotic surgery and automation.
- Smart factories and industrial settings – quality control, inventory management, predictive maintenance and disaster control.
- Integrated in smart assistants, IoT devices, smart home devices, wearable health monitoring devices, AR and VR devices, etc. to enhance functional ability in consumer electronic devices.
- Smart cities solutions like dynamic traffic flow optimization, waste management, smart energy management, pollution control, public safety and surveillance.
- Precision farming, autonomous farming equipment, crop health monitoring, pest and disease prediction, soil and environmental monitoring.

Future Outlook for Neuromorphic Computing – India's Perspective

India's neuromorphic computing landscape, though still in its infancy, is gaining strategic traction through interdisciplinary academic research, government-backed semiconductor and AI initiatives, and early-stage collaborations with global technology firms. Several IITs, national laboratories, and deep-tech startups are exploring material innovations, device architectures, and bio-inspired algorithms tailored for edge computing, robotics, and low-power AI systems. The momentum is also supported by policy signals such as the Digital India and India Semiconductor Mission, which are gradually fostering the infrastructure and talent pipeline necessary for deep-tech breakthroughs. The trajectory ahead, however, will be shaped by sustained ecosystem development, access to advanced fabrication nodes, and alignment with national AI, electronics, and quantum missions.

Against this backdrop, India's neuromorphic prospectus can be understood across three interlinked stages, each representing a distinct shift in technological capability, application maturity, and ecosystem readiness:

Exploratory Phase (1–3 Years)

- **Accelerated Academic Research:** A surge in research on spintronics, memristive synapses, and analogue neural devices across IITs, IISc, and emerging technology universities, supported by DRDO, MeitY, and DST grants.
- **Strategic International Collaborations:** India is engaging with global partners such as the EU and UK on neuromorphic design frameworks, brain-inspired hardware, and silicon-photonic integration.
- **Edge-Centric Deployments:** Early deployment of neuromorphic processors in sensor-rich environments such as surveillance drones, predictive maintenance systems, and biomedical signal processing.
- **Incubation of Startups & IP Development:** Growing interest from Indian deep-tech startups in creating proprietary neuromorphic architectures, simulation toolchains, and AI inference accelerators.
- **Toolchain and Simulation Stack Maturity:** Adoption of open-source platforms (e.g., Intel's Lava, IBM's Compass) in Indian academic research will enable prototyping of neuromorphic models across spiking neural networks (SNNs) and hybrid AI systems.

Transformation Phase (3–7 Years)

- **Hybrid Architectures:** Emergence of neuromorphic co-processors integrated with CMOS or RISC-V-based systems for intelligent edge nodes, enhancing compute capacity without energy trade-offs.
- **Healthcare, AgriTech, and Defence Applications:** Indian use-cases such as neuroprosthetics, real-time disease diagnosis, autonomous agricultural robots, and low-power battlefield intelligence will drive niche deployments.
- **Design-for-Manufacture Readiness:** India's expanding semiconductor ecosystem (SCL, Dholera fab initiatives) could begin prototyping mixed-signal neuromorphic chips if IP localization and materials research are scaled.
- **Rise of Neuromorphic Cloud Services:** Integration with national AI compute infrastructure (like CDAC's PARAM series) for simulation of large-scale SNNs or bio-inspired algorithms.
- **Educational Curriculum and Talent Pipelines:** Development of specialized neuromorphic computing programs at the postgraduate level, along with national fellowships for brain-inspired computing research.

Mature Phase (7+ Years)

- Neuromorphic systems could enable AI models that support context-awareness, low-shot learning, and self-organization, particularly in conjunction with quantum-inspired models and advanced materials like 2D ferroelectrics.
- **Artificial General Intelligence (AGI) Research:** India's neuroscience labs, cognitive computing initiatives, and AI research centres may begin exploring AGI-enabling substrates using neuromorphic architectures.
- **Standardization and Industry Frameworks:** India may align with global consortia on SNN standards, neuro-inspired hardware protocols, and ethical governance of adaptive machines.
- **Mass-Scale Commercialization:** As hardware matures and cost curves flatten, neuromorphic chips could be integrated into mobile, automotive, and consumer devices through partnerships with foundries and device makers.
- **Digital Public Infrastructure:** Integration of neuromorphic intelligence into India's digital health, financial inclusion, and smart infrastructure programs to drive ambient intelligence at scale.

Despite its transformative potential, neuromorphic computing faces several critical challenges that must be addressed to enable scalable innovation, commercial viability, and broader industry adoption:

- **Fabrication Scalability:** India's current fabs are not yet equipped for neuromorphic-grade devices (e.g., nanoscale RRAM, STT-MRAM), necessitating partnerships or foundry access abroad.
- **Tool and Software Ecosystem Gap:** Limited availability of localized neuromorphic development tools, simulators, and compiler stacks hinders wider experimentation and adoption.

- **ROI Uncertainty:** Commercial adoption requires clear performance benchmarks and total cost of ownership (TCO) validation over traditional AI accelerators.
- **Skills and Interdisciplinary Knowledge:** Scaling neuromorphic R&D requires bridging materials science, neuroscience, microelectronics, and machine learning—an intersection currently underrepresented in Indian academia.
- **Global Competition and IP Lock-ins:** With US, EU, and China making significant proprietary advances, India must invest in sovereign IP, patents, and public-private co-development models.

Neuromorphic computing presents India with a unique opportunity to leapfrog in energy-efficient AI, embedded intelligence, and next-generation processors if nurtured through long-term investments in R&D, manufacturing, and cross-domain talent development. As the nation builds out its semiconductor and AI capabilities, neuromorphic platforms could become a cornerstone of its vision for secure, sustainable, and sovereign digital innovation.

NOTES

Data Security Council of India (DSCI) is a premier industry body on data protection in India, setup by nasscom, committed to making the cyberspace safe, secure and trusted by establishing best practices, standards and initiatives in cybersecurity and privacy. DSCI brings together governments and their agencies, industry sectors including ITBPM, BFSI, telecom, industry associations, data protection authorities and think-tanks for policy advocacy, thought leadership, capacity building and outreach initiatives.

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