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(57) Abstract :

NEUROMORPHIC SUPER-INTELLIGENT SMART WATCH 5 The invention relates to a wearable neuromorphic smartwatch system that employs a hybrid architecture integrating a System-on-Chip (SoC), a neuromorphic processing core, and a multi-sensor assembly for continuous behavioural and physiological monitoring. The system includes a biobehavioural authentication engine configured to generate a confidence score 10 corresponding to the identity of a wearer based on gait, micro-movements, cardiac waveform characteristics and interaction patterns. A power management unit dynamically regulates sensor duty cycles and neuromorphic workloads based on battery conditions and optionally incorporates kinetic, thermal and/or solar energy harvesters. The system 15 further includes secure storage, a wireless communication module, and haptic or audio feedback components. By utilising event-driven neuromorphic computation, the smartwatch provides continuous authentication and context-aware monitoring with reduced energy consumption while preserving user privacy through encrypted storage and restricted transfer of processed 20 summaries instead of raw bio-signals.

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FORM 2
THE PATENTS ACT, 1970
(39 OF 1970)
AND
THE PATENTS RULES, 2003
COMPLETE SPECIFICATION
(*See* section 10; rule 13)

1. TITLE OF THE INVENTION

   NEUROMORPHIC SUPER-INTELLIGENT SMART WATCH

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3. PREAMBLE TO THE DESCRIPTION

The following specification particularly describes the invention and the manner in
which it is to be performed.

FIELD OF THE INVENTION

The present invention relates to the field of neuromorphic computing–enabled wearable technologies. More particularly, the invention pertains to smart wearable devices employing event-based sensing, spiking neural network (SNN) processing, and hardware-native plasticity for ultra-low-power, continuous physiological and behavioural monitoring. The invention further relates to privacy-preserving on-device intelligence, adaptive health-state inference, continuous authentication, and context-aware intervention systems implemented within a wrist-worn or similar wearable platform

BACKGROUND OF THE INVENTION

The evolution of wearable technology has rapidly advanced from simple digital timepieces to sophisticated smart devices capable of monitoring health, fitness, and connectivity parameters. However, these devices continue to depend on conventional algorithmic frameworks and cloud-based machine learning systems, which impose limitations of latency, energy consumption, and data-privacy concerns. The next frontier in wearable innovation therefore lies in integrating cognitive intelligence—enabling devices not merely to measure but to think, learn, and adapt in a manner analogous to the human brain. The proposed "Neuromorphic Super-Intelligent Smart Watch" arises from this shift, drawing upon principles of neuroscience and artificial intelligence to create a self-learning, context-aware, and continuously adaptive wearable ecosystem.

Traditional smartwatches predominantly operate on predefined models and remote analytics. Even with developments in edge computing, most current devices remain heavily dependent on cloud-based processing for decision-making. This reliance introduces challenges in bandwidth usage, real-time accuracy, and data security, which become particularly significant in sensitive applications such as medical monitoring, emergency response, or defense operations. The present innovation addresses these constraints by incorporating distributed neuromorphic processors that perform local learning and inference. Through brain-inspired architectures, spiking neural

networks, and event-driven computation, the smartwatch processes information in real time with ultra-low power requirements and without reliance on external servers.

The background of this invention lies in the shortcomings of existing wearable AI systems, which lack the ability to autonomously self-organize, evolve, and adapt their models over time. Neuromorphic computing introduces a biologically inspired paradigm wherein spiking neurons and synaptic plasticity allow the device to mimic natural learning processes. By continuously updating its internal representations, the smartwatch adapts to changes in user physiology, behavioural patterns, and environmental conditions. This capability enables always-on monitoring of multiple bio-signals including heart rate variability, electrodermal activity, brainwave patterns, and micro-movements, to derive real-time insights into the user's physical, emotional and cognitive states.

Historically, wearable AI efforts have centered on pattern recognition and predictive analytics, typically executed through static or cloud-trained models. Such systems are inherently limited because they cannot perform parallel, asynchronous, and adaptive computation. Neuromorphic architectures overcome these limitations by enabling event-driven and inherently parallel processing. In the present invention, sensory information from integrated biosensors, motion detectors, environmental analyzers, and chemical sensors is interpreted collectively. Instead of merely detecting isolated physiological parameters, the system correlates them—such as elevated heart rate with thermal signatures, oxygenation levels, or stress indicators—to infer contextual meaning with higher accuracy. This associative intelligence represents a significant advancement over current smartwatch capabilities.

The invention also responds to the increasing global need for sustainable, energy-efficient, and privacy-preserving AI systems. Traditional cloud-centric architectures require continuous transmission of personal data, raising privacy concerns and contributing to energy consumption through large-scale data-center operations. In contrast, the Neuromorphic Super-Intelligent

Smart Watch performs most computation on-device, thereby reducing cloud dependency while ensuring data sovereignty. The neuromorphic framework further supports federated or collaborative learning across devices, enabling population-level insights without compromising individual privacy. This decentralization mirrors biological neural ecosystems, where intelligence emerges from distributed nodes rather than centralized processing.

Advances in material science and flexible electronics further enable the realization of this innovation. Neuromorphic chips and multimodal sensors can be embedded into ultra-thin, skin-compatible substrates, allowing the device to conform seamlessly to the user's physiology while maintaining high computational density. Complementary micro-energy harvesting mechanisms such as kinetic, thermal, or solar conversion support continuous neuromorphic computation without the need for frequent recharging. Additionally, secure operation is enhanced through post-quantum encryption for data transmission and bio-authentication using neural and vascular signatures. These features collectively establish the proposed smartwatch as an embodiment of artificial intelligence that senses, learns, and evolves symbiotically with its wearer.

Accordingly, the Neuromorphic Super-Intelligent Smart Watch marks a transformative milestone in the convergence of neuroscience, advanced materials, neuromorphic engineering, and wearable technology. By integrating brain-like computation directly into a wearable device, the invention provides a highly adaptive, sustainable, and privacy-preserving platform capable of continuous real-time learning. It represents a new class of embodied artificial intelligence one that bridges personal analytics with cognitive adaptation and aligns with the emerging demand for intelligent, energy-efficient wearable systems.

OBJECTS OF THE INVENTION

The principal object of the present invention is to provide a neuromorphic super-intelligent smart wearable device, such as a wrist-worn smart watch, that enables continuous, ultra-low-power physiological and behavioural

monitoring through a combination of multi-modal sensors, event-based signal encoding, and on-device spiking neural network (SNN) processing.

Another object of the invention is to provide a wearable system incorporating asynchronous event-encoding front-end circuitry configured to convert multi-modal sensor outputs into sparse spike trains generated only upon meaningful signal changes, thereby enabling always-on operation at microwatt-level power consumption.

A further object of the invention is to enable lifelong on-device personalization of the wearer's physiological and behavioural baselines exclusively through hardware-native spike-timing-dependent plasticity (STDP), reward-modulated plasticity, and other neuromorphic learning rules, without ever transmitting raw physiological data outside the device.

Another object of the invention is to provide neuromorphic processing units comprising hierarchical multi-modal context fusion layers capable of inferring high-level wearer states, including cognitive load, stress, sleep stages, exercise intensity, or pathological deviations, entirely on-device.

A further object of the invention is to incorporate a bio-behavioural continuous authentication subsystem that maintains a high-dimensional spiking template of the legitimate wearer's physiological and micro-movement signatures and dynamically adjusts trust scores, triggering security protocols when confidence falls below a learned threshold.

Another object of the invention is to provide a dynamic power-management framework with multi-source energy harvesting that reallocates energy between sensing, computation, and communication based on harvested energy predictions and system context, enabling elastic intelligence and graceful degradation under low-energy conditions.

Yet another object of the invention is to support privacy-preserving federated learning by transmitting only encrypted synaptic-weight deltas or abstracted model updates while raw data permanently remains on-device, thereby ensuring end-to-end user data confidentiality.

Another object of the invention is to enable the neuromorphic cores to continuously learn and adapt anomaly-detection thresholds and decision boundaries based on an evolving personalized physiological and behavioural manifold.

5   A further object of the invention is to provide privacy-safe acoustic perception through an environmental microphone coupled with feature extraction circuitry that generates spike events from non-speech acoustic patterns without storing or transmitting raw audio.

Another object of the invention is to implement the neuromorphic cores using 10   non-volatile synaptic devices, such as memristors, phase-change memory, or ferroelectric transistors, enabling retention of learned synaptic weights even under complete power loss.

A further object of the invention is to allow hierarchical low-energy degradation modes wherein, under critically low energy, non-critical functions 15   are power-gated and only life-critical event detection remains active at sub-microwatt power.

Yet another object of the invention is to provide early detection of infection or inflammation by learning personalized multi-day correlations between heart-rate metrics, temperature trends, and movement patterns.

20   Another object of the invention is to deliver context-aware haptic, visual, and auditory interventions precisely timed to the inferred physiological and behavioural state of the wearer, while minimizing unnecessary notifications.

A final object of the invention is to provide a method of operating the neuromorphic smart watch that includes event-based sensing, spiking neural 25   processing, lifelong adaptation, personalized manifold generation, anomaly detection, and context-aware interventions, all while ensuring that no raw physiological time-series data leaves the device during normal operation.

SUMMARY OF THE INVENTION

The present invention provides a neuromorphic super-intelligent smart 30   wearable device that integrates multi-modal physiological and behavioural sensing with event-based signal encoding and on-device spiking neural

network (SNN) computation to achieve continuous, ultra-low-power monitoring. The wearable device comprises a wrist-worn enclosure housing a plurality of sensors, event-encoding front-end circuitry, neuromorphic processing units, a system-on-chip, a power-management subsystem with

5 energy harvesting, and a user interface. Sensor outputs are converted into sparse asynchronous spike trains, which are processed by SNN cores implementing hardware-native spike-timing-dependent plasticity (STDP) and reward-modulated learning rules, enabling lifelong personalization of each wearer's physiological and behavioural baseline entirely on-device.

10 The neuromorphic architecture includes hierarchical multi-modal fusion layers capable of inferring high-level contextual and health states such as stress, sleep stages, cognitive load, exercise, or anomalies indicative of pathological conditions. The invention further incorporates a bio-behavioural continuous authentication subsystem that maintains a high-dimensional

15 spiking template of gait, cardiac morphology, micro-movements, skin conductance, and interaction patterns to assess user authenticity in real time and trigger protective actions when confidence decreases.

The power-management unit dynamically reallocates energy between sensing, computation, and communication based on harvested energy from kinetic,

20 thermoelectric, or photovoltaic sources, enabling elastic intelligence and graceful degradation during low-energy conditions. The device additionally supports privacy-preserving federated learning by transmitting only encrypted synaptic-weight deltas or abstracted model updates while raw physiological data remains stored exclusively on-device.

25 The invention also provides privacy-safe acoustic sensing, early detection of infection or inflammation through personalized multi-day physiological correlations, and context-aware haptic, visual, and auditory interventions optimized to reduce notification fatigue. A corresponding method of operation is disclosed, enabling continuous event-based sensing, neuromorphic

30 processing, personalized manifold updating, anomaly detection, and context-aware intervention without ever transmitting raw physiological time-series data outside the device during normal operation.

BRIEF DESCRIPTION OF DRAWINGS

Fig 1: Detailed flow chart of the invention

1. START – System Initialization: Upon power-on or reactivation of the monitoring engine, the firmware systematically initializes all hardware subsystems: neuromorphic processing cores, multi-modal sensor array, wireless radios, secure memory, real-time clock, power-management circuitry, and energy harvesters. User-specific cryptographic keys, learned synaptic weights, personalized baselines, and configuration profiles are securely loaded from non-volatile storage into both the neuromorphic cores and the conventional SoC. Following successful self-test and stabilization, the watch seamlessly transitions into its continuous, always-on monitoring loop.

2. SENSOR DATA ACQUISITION – Adaptive Multi-Modal Sensing: The watch continuously acquires physiological, kinematic, and environmental signals through its integrated sensor suite, including optical/ECG-based heart-rate and heart-rate-variability monitoring, pulse oximetry (SpO_2), 6- or 9-axis inertial measurement (accelerometer + gyroscope), skin and ambient temperature sensing, electrodermal activity (EDA), ambient light sensing, and environmental audio feature extraction via microphone. Acquisition parameters are dynamically adjusted by the SoC and power controller based on remaining energy, detected activity intensity, time of day, and user-defined policies, enabling intelligent duty-cycling or full event-driven operation while preserving essential coverage.

3. EVENT ENCODING – Transformation into Spike Domain: Raw analog and digital sensor streams are immediately converted by dedicated front-end encoders into asynchronous spike trains or time-encoded events optimized for neuromorphic processing. Examples include: precise timing of each heartbeat as an input spike train encoding inter-beat intervals; sudden

acceleration transients exceeding adaptive thresholds as motion events; abrupt rises in skin conductance as sympathetic arousal events; and significant deviations in temperature or SpO_2 as physiological change markers. This event-driven encoding eliminates transmission and processing of redundant or stable data, dramatically reducing power consumption and data volume while preserving rich temporal information critical for spiking neural networks.

4. NEUROMORPHIC PROCESSING – Core Pattern Recognition and Lifelong Learning: All encoded event streams are routed directly into the on-device spiking neural network cores. Hierarchical layers of spiking neurons perform real-time feature extraction, temporal pattern recognition, and online learning via hardware-native synaptic plasticity mechanisms (STDP, reward-modulated STDP, and homeostatic regulation). The network continuously detects and classifies complex signatures such as personalized gait dynamics, HRV stress patterns, sleep-stage transitions, tremor onset, or composite emotional–physiological responses, while simultaneously refining its internal model of the wearer's unique behavioral and physiological baseline over days, weeks, and months, thereby achieving true personalization without cloud dependency.

5. CONTEXT FUSION & STATE ESTIMATION – Holistic Multi-Modal Inference: A dedicated fusion layer spanning neuromorphic and conventional processing integrates interpreted spiking patterns with contextual metadata (time of day, location if available, recent activity history, ambient conditions) to generate high-level state estimates. The system reliably disambiguates physiologically similar but semantically different conditions (e.g., elevated heart rate + motion + stable EDA = exercise; elevated heart rate + stillness + rising EDA = anxiety; irregular rhythm + low SpO_2 during sleep = potential apnea), producing a continuously updated, semantically rich representation of the wearer's current state: "focused work," "deep recovery sleep," "acute stress episode," "post-exercise fatigue," or "emerging anomaly."

9

6. ABNORMAL PATTERN DETECTION? – Adaptive Anomaly Decision: The system evaluates the current state and anomaly scores against the wearer's continually evolving personal manifold. Thresholds and decision boundaries are not fixed but learned and dynamically adjusted by the neuromorphic cores themselves. If all parameters remain consistent with the individualized baseline, the flow proceeds along the normal path; if statistically significant deviations or previously unseen pathological combinations emerge, the abnormal branch is triggered.

7A. NORMAL PATH → CONTEXTUAL FEEDBACK & INSIGHTS: In the absence of anomalies, the watch delivers subtle, non-intrusive, and highly personalized guidance: gentle haptic reminders to move after prolonged stillness, hydration prompts aligned with detected dehydration risk, post-exercise recovery scores, daily cognitive-load summaries, or optimal break timing based on circadian and fatigue trends, all tuned to minimize notification fatigue while maximizing long-term behavioral benefit.

7B. ABNORMAL PATH → URGENT ALERT & INTERVENTION: When an abnormal pattern is confirmed, the watch immediately escalates response intensity: strong haptic patterns, prominent visual warnings, and optional audible cues notify the wearer of critical conditions (e.g., suspected arrhythmia, fall event, severe hypoxia, acute stress crisis). Context-aware recommendations are provided ("sit down," "initiate guided breathing," "seek medical attention"), and, per user consent, automatic outreach to emergency contacts or healthcare providers may be prepared if no acknowledgment is received.

8. DECISION LOGIC – Policy Execution Layer: A higher-level policy engine, informed by neuromorphic outputs, user preferences, regulatory constraints, and historical context, determines appropriate actions: local-only logging, heightened monitoring sensitivity, temporary restriction of functions due to suspected unauthorized use (via integration with the bio-behavioural authentication subsystem), or escalation to external systems. This layer ensures all responses remain safe, proportionate, and legally compliant.

9. LOG & UPDATE PERSONAL MODEL – Closed-Loop Adaptation: Every episode, whether normal or abnormal, is logged as a compressed, privacy-preserving summary (timestamp, inferred state, anomaly score, actions taken, user feedback). Confirmed outcomes (e.g., user dismissal of a false alert or subsequent medical validation) are used as supervisory signals to further refine synaptic weights, decision boundaries, and sensitivity profiles, continuously improving accuracy, reducing false positives, and enhancing early detection capability for that specific individual.

10. OPTIONAL ENCRYPTED SYNC – Privacy-Preserving Ecosystem Integration: When connectivity is available and explicitly permitted, the watch establishes an end-to-end encrypted channel with a companion device or trusted cloud aggregator. Only de-identified summaries, encrypted synaptic-weight deltas, or abstracted model updates are transmitted, never raw physiological data. In federated learning mode, these updates contribute to population-level model improvement while downloaded generic priors enhance future personalization, all while maintaining strict on-device data sovereignty.

11. RETURN TO CONTINUOUS LOOP: The process returns to adaptive sensor acquisition, perpetuating an ultra-low-power, always-on, self-improving cycle that delivers genuine neuromorphic super-intelligence: continuous sensing → event-driven encoding → deep pattern learning → contextual understanding → intelligent intervention → lifelong adaptation → optional privacy-first collaboration, repeating seamlessly throughout wear time.

Fig 2: System Architecture

1. Wrist-Worn Enclosure: A compact, ergonomic, IP68-rated housing that ensures reliable skin contact for body-coupled sensors, effective heat dissipation, optimal antenna placement, and robust protection against sweat, dust, impact, and daily mechanical stress while preserving wearing comfort and aesthetic appeal.

2. Multi-Modal Sensor Array: The foundational sensing layer comprising:

11

- Photoplethysmography (PPG)/ECG heart-rate & HRV sensor providing precise beat-to-beat timing for stress, recovery, and arrhythmia analysis

- Pulse oximeter (SpO$_2$) for blood oxygen monitoring and respiratory event detection

- High-resolution IMU (accelerometer + gyroscope + optional magnetometer) enabling step counting, gesture recognition, fall detection, tremor analysis, and gait-based authentication

- Dual skin & ambient temperature sensors supporting fever detection, circadian modeling, and thermal stress evaluation

- Electrodermal activity (EDA/GSR) sensor as a direct marker of sympathetic arousal and emotional load

- Ambient light sensor for display adaptation and circadian context

- Environmental microphone extracting only privacy-safe acoustic features (noise level, spectral events)

All sensors feed dedicated event-encoding front-ends that generate spike trains for direct ingestion by the neuromorphic core.

3. Neuromorphic Processing Unit – Spiking Neural Network Core**

The brain-inspired heart of the system which is a dedicated, ultra-low-power SNN fabric (implemented in CMOS, memristive, or other neuromorphic substrates) executing event-driven computation, hierarchical feature learning, real-time anomaly detection, bio-behavioural authentication, and lifelong on-device plasticity. Operating only when meaningful spikes arrive, it delivers sophisticated intelligence at microwatt average power.

4. Central System Integration & Orchestration: The overarching control plane that manages event routing, global user-state tracking, policy coordination, power budgeting, security enforcement, and seamless interaction between neuromorphic cores, conventional SoC, storage, communication modules, and the user interface, ensuring coherent, safe, and efficient operation of the entire super-intelligent platform.

5. System-on-Chip (SoC) / Microcontroller: This module serves as the primary digital processing unit of the system.

- Runs the core operating system / firmware, user interface, communication stacks, and conventional (non-neuromorphic) algorithms.

- Manages configuration of sensors, operational thresholds, and parameters of the neuromorphic core.

- Interprets outputs generated by the neuromorphic engine and translates them into user-facing actions such as notifications, logs, alerts, or application-level events.

- Handles memory management, file systems, diagnostics, and over-the-air (OTA) firmware/model updates.

In functional terms, the SoC operates as the central coordinator or "manager," while the neuromorphic processing unit performs high-efficiency, event-driven, specialized computation.

6. Bio-Behavioural Authentication Engine: A logical subsystem jointly implemented using the neuromorphic core and the SoC.

- Continuously analyses behavioural and physiological signatures such as gait, micro-movement patterns, heartbeat morphology, device-usage rhythm, and interaction gestures.

- Generates a personalized authentication template for the legitimate wearer during enrolment.

- Computes an ongoing confidence score indicating whether the current wearer matches the enrolled profile.

- Upon detecting reduced confidence (e.g., device theft, unauthorized usage, or atypical wearing pattern), the subsystem:
  o Restricts or locks access to sensitive functions (e.g., payments, data export, device control).
  o Prompts for secondary authentication (PIN, paired-phone confirmation).
  o Triggers tampering or security alerts if anomalous activity is detected.

This provides continuous, passive, behaviour-based authentication that significantly enhances security beyond simple PINs or static biometrics.

7. Power Management Unit (PMU): The PMU supervises all aspects of power generation, storage, and consumption.

- Interfaces with the rechargeable battery and optional energy-harvesting modules.

- Monitors system voltage, current, thermal conditions, and estimates remaining battery life.

- Dynamically adapts sensor duty cycles, event thresholds, display brightness, radio activity, and neuromorphic workload based on available energy.

- Implements a "graceful degradation" policy wherein, under low-power conditions, only essential health and safety functions remain active while non-critical analytics are deferred.

8. Rechargeable Battery: The principal energy reservoir of the device.

- Typically implemented using a Li-ion or solid-state chemistry optimized for safety, thermal stability, and cycle life.

- Dimensioned such that, combined with neuromorphic efficiency and energy harvesting, the system can operate continuously in an always-on monitoring mode.

- Integrates with wired or wireless charging circuitry.

9. Energy Harvesters (Kinetic / Thermal / Solar): Optional modules designed to augment the primary battery by harvesting ambient energy.

- **Kinetic harvesters:** miniature generators or piezoelectric elements driven by wrist movement.

- **Thermal harvesters:** thermoelectric devices utilizing skin-to-environment temperature gradients.

- **Solar harvesters:** thin-film photovoltaic cells embedded in the bezel or strap.

  Collected energy is routed through appropriate regulators and used to support or recharge the battery, improving autonomy and enabling adaptive ("elastic") computation based on real-time energy availability.

10. **Wireless Communication Module:** Responsible for all external radio communication.

- Bluetooth for pairing with smartphones, accessories, or peripheral devices.
- Wi-Fi for direct access to cloud services or local networks.
- LTE/5G (where provided) for independent, smartphone-free connectivity.

Its functions include secure pairing, encryption, protocol management, cloud synchronization, firmware/model updates, and participation in federated learning workflows where only model updates not raw bio-signals are transmitted.

11. **Haptic and Audio Feedback Interface:** A multimodal output subsystem for delivering subtle, context-aware notifications.

- Haptic actuators (vibration motors or linear-resonant actuators) provide differentiated pulse patterns for specific alert types (e.g., health anomalies, incoming messages, guided-breathing cues).
- Audio output (miniature speaker or bone-conduction driver) supports tones, alerts, and voice prompts.

Notifications are intelligently modulated by the joint operation of the neuromorphic engine and the SoC to ensure relevance and minimize user annoyance.

12. **Display and Touch Interface:** The primary user interface of the device.

- High-resolution OLED/LCD or equivalent capacitive touchscreen.
- Displays standard smartwatch functions along with neuromorphic-derived insights such as stress trends, sleep analytics, anomaly warnings, and personalized recommendations.

- Accepts touch gestures including taps, swipes, and long presses which are also used as behavioural input signals for the authentication engine.

13. Secure Storage (Encrypted Memory): A protected non-volatile memory subsystem, implemented using flash, secure-element hardware, or a combination thereof.

- Stores encrypted user data, summaries, logs, and preference profiles.
- Preserves neuromorphic model parameters, behavioural authentication templates, and associated metadata.
- Holds cryptographic keys for secure communication, boot integrity, and firmware verification.

Access control is enforced by the SoC, and sensitive regions may be hardware-isolated to resist probing, cloning, or other forms of tampering.

14. Companion Device / Cloud (Optional, Encrypted): Represents the extended ecosystem supporting the device.

- Companion devices (smartphone, tablet, or PC) allow configuration, visualization of detailed analytics, and secure data export.
- Cloud infrastructure (where used) supports encrypted backups, longitudinal analytics, clinician dashboards, and federated-learning aggregation.

Data exchange with this ecosystem is minimized, encrypted end-to-end, and typically restricted to processed summaries or model updates to preserve user privacy while still enabling ecosystem-level intelligence.

DETAILED DESCRIPTION OF INVENTION

The present invention pertains to a Neuromorphic Super-Intelligent Smart Watch comprising a compact, wrist-worn housing that encloses one or more dedicated neuromorphic processing units implemented as spiking neural network (SNN) chips or cores fabricated using CMOS or emerging

neuromorphic device technologies such as memristive synapses, phase-change memories, or electrochemical transistors, a conventional low-power microcontroller or system-on-chip (SoC), a plurality of integrated multi-modal sensors including optical heart-rate and heart-rate-variability sensors, inertial

5 measurement unit (IMU) combining accelerometer and gyroscope, skin and ambient temperature sensors, SpO_2 sensor, electrodermal activity sensor, ambient light sensor, environmental microphones, and optionally surface electrodes capable of capturing electromyographic or low-grade electroencephalographic signals where permitted, memory units, advanced

10 power-management and energy-harvesting circuitry incorporating kinetic generators, thermoelectric elements, and flexible photovoltaic cells, wireless communication modules, and a user interaction interface comprising a high-resolution display, haptic actuators, and optional microphones or speakers. Each sensor or sensor group is connected to specialized front-end circuits that

15 convert raw analog outputs into asynchronous spike trains using level-crossing detection, delta modulation, or other event-encoding techniques, with these spike trains routed directly to the neuromorphic cores via a configurable interconnect fabric while a parallel digital path simultaneously supplies conventionally sampled data to the SoC for tasks less suited to event-driven

20 processing.

During operation, the watch executes a fully integrated sensing–preprocessing–inference pipeline overwhelmingly governed by its neuromorphic architecture, whereby sensors operate in event-driven or intelligently duty-cycled modes that generate spikes only when meaningful changes in acceleration, rotation,

25 heartbeat events, or other bio-signals cross adaptive, neuromorphically learned thresholds, thereby achieving true always-on intelligence at microwatt-level power consumption. Incoming spike trains are received by input layers of the neuromorphic cores that perform temporal encoding and early feature extraction, with subsequent hierarchical layers progressively learning and

30 recognizing higher-order spatiotemporal patterns such as unique gait signatures, stress-induced heart-rate-variability alterations, composite motion-emotion correlations, or early illness markers through continuous online adaptation using hardware-native spike-timing-dependent plasticity

17

(STDP), reward-modulated STDP, and homeostatic mechanisms supervised by the companion SoC. This lifelong on-device learning process continuously refines a deeply personalized model of the wearer's baseline physiology, habits, routines, and contextual responses directly on the wrist, transforming the device into a self-evolving cognitive companion whose decision boundaries and predictive capabilities dynamically co-evolve with the individual user without ever requiring cloud-based retraining or generic frozen models.

A deep multi-modal neuromorphic context fusion engine, implemented entirely within the spiking cores in tight cooperation with the conventional SoC via a bidirectional bridge, encodes and associatively learns latent correlations across all available modalities, enabling the inference of complex, non-directly measurable states such as cognitive overload, burnout risk, anomalous post-exertion recovery, dehydration onset, or impending infection far beyond the superficial sensor fusion of prior art. A context-aware neuromorphic orchestration layer continuously predicts situational relevance and dynamically allocates sensor activation, event thresholds, neuromorphic circuit partitioning, and computational resources, autonomously deciding whether to remain fully on-device or selectively escalate to trusted edge or cloud infrastructure only when genuinely beneficial, thereby constituting a radical departure from rigid, pre-programmed sensing pipelines.

The invention further incorporates a dedicated bio-behavioural authentication and security subsystem realized as a specialized neuromorphic sub-network that continuously maintains and compares a high-dimensional spiking template of the legitimate wearer's gait cycles, wrist micro-movements, cardiac waveform morphology, skin conductance dynamics, interaction rhythms, and habitual notification-response patterns, generating real-time confidence scores such that any significant deviation automatically triggers progressive graceful degradation of sensitive functions, requests explicit re-authentication, or initiates tamper-response protocols including freezing of learning to prevent attacker adaptation for delivering a fundamentally novel, implicit, and living security model far superior to static PINs, one-time biometrics, or proximity checks.

Privacy-preserving federated learning is natively supported whereby only encrypted synaptic-weight deltas, gradient-like updates, or abstracted feature representations, never raw bio-signals, are selectively shared with trusted infrastructure, allowing population-level improvement on rare medical or behavioural patterns while keeping each user's sensitive data permanently confined to the watch, with the SoC securely managing long-term summaries, rolling histories of derived indicators, and encrypted communication with paired devices or aggregators.

Power management and elastic intelligence are profoundly redefined through a neuromorphic-aware controller that learns which tasks are critical for the specific user and context, seamlessly reconfiguring the sensor–compute graph and power-gating individual neuron populations or entire layers in response to battery state and harvested energy from kinetic, thermal, and solar sources, enabling the same device to operate in an ultra-minimal safety-guardian mode when energy is scarce while automatically expanding into a rich, high-resolution cognitive-assistant mode when energy is abundant, all without manual intervention and with idle power approaching zero due to the inherently event-driven architecture.

Finally, the user-facing interface translates this sophisticated neuromorphic intelligence into intuitive, contextually appropriate feedback through adaptive visualizations (cognitive-load gauges, recovery-quality scores, stress heat-maps), state-aware haptic and subtle audio interventions timed to the wearer's precise physiological moment, and dramatically reduced false alerts achieved by evaluating patterns against personalized, continually updated baselines, ensuring that the revolutionary depth of on-device spiking intelligence remains largely transparent while delivering unprecedented accuracy, timeliness, personalization, privacy, security, and energy resilience in a familiar wrist-worn form factor. This tightly unified integration of native neuromorphic cores, lifelong local learning, deep multi-modal fusion, behavioural security, privacy-first federation, and elastic energy–intelligence trade-offs within severe wearable constraints embodies the core novelty of the claimed invention, distinguishing it decisively from all prior smartwatches and emerging AI wearables.

We claim:

1. A neuromorphic smart wearable device comprising:

   a wrist-worn enclosure housing

   a plurality of multi-modal sensors including at least photoplethysmography (PPG) and/or ECG sensor, pulse oximeter (SpO_2), inertial measurement unit (IMU), skin and ambient temperature sensors, electrodermal activity (EDA) sensor, and ambient light sensor;

   event-encoding front-end circuitry configured to convert sensor outputs into asynchronous spike trains;

   one or more on-device neuromorphic processing units comprising spiking neural network (SNN) cores;

   a system-on-chip (SoC) or microcontroller;

   a power management unit with energy harvesting means; and

   a user interface;

   characterized in that the neuromorphic processing units perform lifelong on-device personalization of the wearer's physiological and behavioural baseline exclusively through hardware-native spike-timing-dependent plasticity (STDP) and reward-modulated plasticity without ever transmitting raw physiological data outside the device.

2. The neuromorphic super-intelligent smart watch as claimed in claim 1, wherein the event-encoding front-end circuitry generates spike trains only upon meaningful signal changes using level-crossing detection or delta modulation, thereby enabling always-on monitoring at average power consumption in the microwatt range.

3. The neuromorphic super-intelligent smart watch as claimed in claim 1, wherein the spiking neural network cores include a hierarchical multi-modal context fusion layer that infers high-level wearer states including cognitive overload, acute stress, deep sleep, exercise, or pathological conditions entirely on-device

4. The neuromorphic super-intelligent smart watch as claimed in claim 3, wherein a bio-behavioural authentication subsystem implemented as a dedicated sub-network within the neuromorphic processing units that

continuously maintains and compares a high-dimensional spiking template of the legitimate wearer's gait, cardiac morphology, micro-movements, skin conductance, and interaction patterns to generate real-time authentication confidence scores.

5. The neuromorphic super-intelligent smart watch as claimed in claim 4, wherein a confidence score falling below a learned threshold automatically triggers restriction of sensitive functions, secondary authentication prompts, or tamper-response protocols including freezing of synaptic learning

6. The neuromorphic super-intelligent smart watch as claimed in claim 5, wherein the power management unit dynamically reallocates energy between sensor duty cycles, event thresholds, and neuromorphic computation based on energy harvested from at least two of kinetic, thermoelectric, and photovoltaic sources, thereby providing elastic intelligence with automatic graceful degradation under low-energy conditions.

7. The neuromorphic super-intelligent smart watch as claimed in claim 6, configured to support privacy-preserving federated learning by transmitting only encrypted synaptic-weight deltas or abstracted model updates while raw physiological data permanently remains on-device

8. The neuromorphic super-intelligent smart watch as claimed in claim 7, wherein anomaly detection thresholds and decision boundaries are continuously learned and adapted by the neuromorphic cores based on the individual wearer's evolving personal manifold.

9. The neuromorphic super-intelligent smart watch as claimed in claim 1, wherein the neuromorphic processing units employ reward-modulated spike-timing-dependent plasticity (R-STDP) using reward signals derived from user feedback, alert acknowledgments, or inferred outcomes for closed-loop lifelong adaptation.

10. The neuromorphic super-intelligent smart watch as claimed in claim 9, further comprising an environmental microphone coupled to a privacy-safe acoustic feature extractor that generates spike events only from spectral energy or non-speech sound classes, said acoustic spikes being

fused by the neuromorphic cores without storage or transmission of raw audio.

11. The neuromorphic super-intelligent smart watch as claimed in claim 10, wherein the power management unit predicts near-term harvested energy using activity patterns learned by the neuromorphic cores and proactively increases computational resolution or sensor fidelity when energy surplus is anticipated.

12. The neuromorphic super-intelligent smart watch as claimed in claim 11, wherein the spiking neural network cores are implemented using memristive synapses, phase-change memory, or ferroelectric transistors providing non-volatile on-fabric storage of synaptic weights capable of surviving complete power loss.

13. The neuromorphic super-intelligent smart watch as claimed in claim 12, configured to operate in a hierarchical low-energy degradation mode wherein, under critically low battery, non-safety functions are power-gated and the neuromorphic cores transition to a minimal configuration preserving only life-critical event detection at sub-microwatt power.

14. The neuromorphic super-intelligent smart watch as claimed in claim 13, wherein the spiking neural network cores include a dedicated sub-network for early detection of infection or inflammation by learning personalized multi-day correlations between resting heart rate, heart-rate variability, skin temperature gradients, and movement patterns.

15. The neuromorphic super-intelligent smart watch as claimed in any one of claims 1–14, wherein the system delivers context-aware haptic, visual, and auditory interventions precisely timed to the wearer's physiological state and modulated to minimize notification fatigue.

16. A method of operating a neuromorphic super-intelligent smart watch as claimed in claim 1, comprising:

continuously converting multi-modal sensor signals into asynchronous spike events on-device;

processing said spike events through on-device spiking neural networks with lifelong hardware-native plasticity;

inferring high-level contextual and health states entirely on-device;

continuously updating a personalized physiological and behavioural manifold;

detecting anomalies against said evolving manifold; and

triggering context-aware interventions,

5   characterized in that no raw physiological time-series data leaves the device during normal operation or learning.

17. The method as claimed in claim 16, further comprising selectively transmitting only encrypted synaptic-weight updates or abstracted model gradients to a remote federated learning server while maintaining

10   end-to-end zero-knowledge of individual raw data by the server.

Dated this 25th day of November 2025

Sudarshana Bandyopadhyay
Regn. No.: IN/PA 2802
Agent for the applicant
Phn No. 9748818235
Email: bandyopadhyay.sudarshana@gmail.com
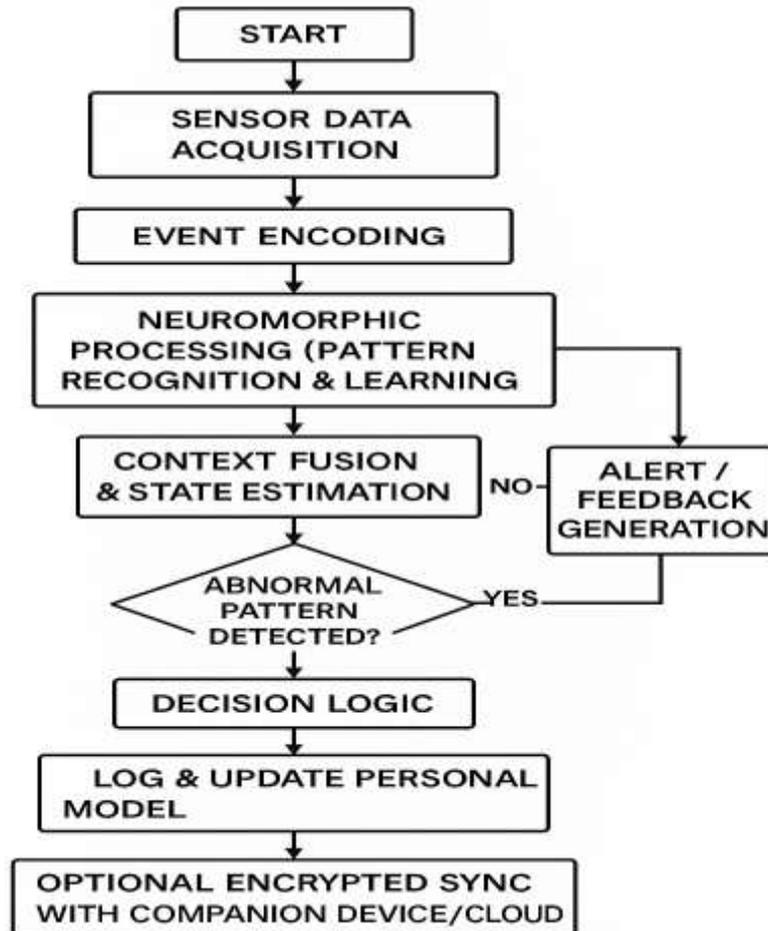
ABSTRACT

NEUROMORPHIC SUPER-INTELLIGENT SMART WATCH

5   The invention relates to a wearable neuromorphic smartwatch system that employs a hybrid architecture integrating a System-on-Chip (SoC), a neuromorphic processing core, and a multi-sensor assembly for continuous behavioural and physiological monitoring. The system includes a bio-behavioural authentication engine configured to generate a confidence score

10   corresponding to the identity of a wearer based on gait, micro-movements, cardiac waveform characteristics and interaction patterns. A power management unit dynamically regulates sensor duty cycles and neuromorphic workloads based on battery conditions and optionally incorporates kinetic, thermal and/or solar energy harvesters. The system

15   further includes secure storage, a wireless communication module, and haptic or audio feedback components. By utilising event-driven neuromorphic computation, the smartwatch provides continuous authentication and context-aware monitoring with reduced energy consumption while preserving user privacy through encrypted storage and restricted transfer of processed

20   summaries instead of raw bio-signals.
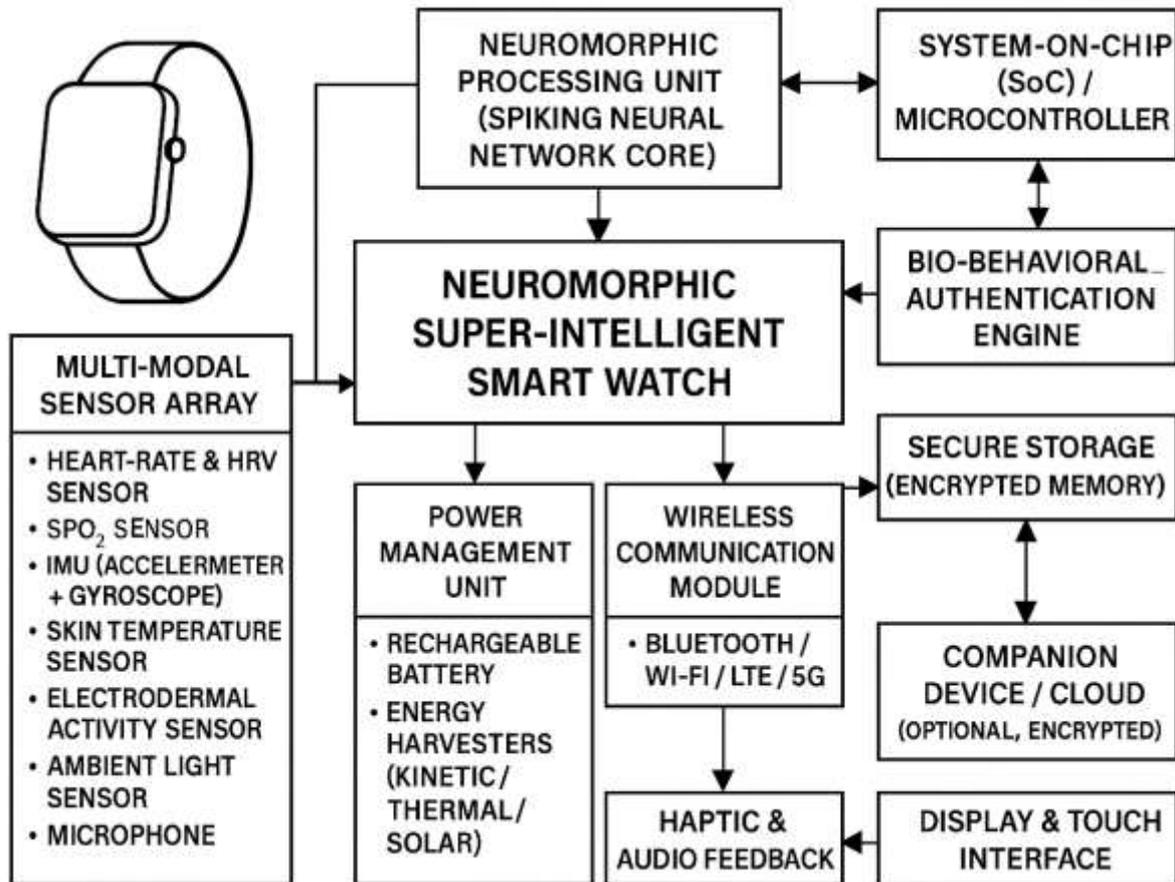
Fig 2

Sheet 1 of 2

Detailed Flowchart

Figure 1

Sudarshana Bandyopadhyay
Regn No.: IN/PA 2802
Agent for the Applicants

Figure 2 of 2

Detailed Architecture

Figure 2

Sudarshana Bandyopadhyay
Regn No.: IN/PA 2802
Agent for the Applicants

FORM 5
THE PATENTS ACT, 1970
(39 of 1970)
&
THE PATENTS RULES, 2003

Declaration as to Inventorship
[*See* section 10(6) and rule 13(6)]

1. **NAME OF APPLICANT**: SRJX RESEARCH AND INNOVATION LAB LLP,

hereby declare that the true and first inventor(s) of the invention disclosed in the complete specification filed in pursuance of our application numbered _____ dated 25 November 2025 are:

2. **INVENTORS:**

   I. a) Name: **DR SOUMYA RANJAN JENA**
   b) Nationality: An Indian National
   c) Address: Plot No - 3E/474, Sector-9, CDA, Post- Markat Nagar,
        Cuttack-753014, Odisha, India

Dated this 25th day of November 2025

Sudarshana

Name of the signatory:

Dated this 25th day of November 2025

Sudarshana Bandyopadhyay
Regn No.: IN/PA 2802
Agent for the Applicants
Email: bandyopadhyay.sudarshana@gmail.com
Phn No: 9748818235

To,
The Controller of Patents,
The Patent Office
At Kolkata

UDYAM REGISTRATION CERTIFICATE

UDYAM REGISTRATION NUMBER	UDYAM-OD-07-0095836

NAME OF ENTERPRISE	SRJX RESEARCH AND INNOVATION LAB LLP

TYPE OF ENTERPRISE *

SNo.	Classification Year	Enterprise Type	Classification Date
1	2025-26	Micro	16/08/2025

MAJOR ACTIVITY

SERVICES

SOCIAL CATEGORY OF ENTREPRENEUR

GENERAL

NAME OF UNIT(S)

S.No.	Name of Unit(s)
1	SRJX RESEARCH AND INNOVATION LAB LLP

OFFICAL ADDRESS OF ENTERPRISE

Flat/Door/Block No.	PLOT NO-3E/474	Name of Premises/Building	SECTOR-9
Village/Town	CDA CUTTACK	Block	NA
Road/Street/Lane	Avinab Bidanasi	City	Cuttack Sadar
State	ODISHA	District	CUTTACK , Pin 753014
Mobile	9090255155	Email:	soumyajena1989@gmail.com

DATE OF INCORPORATION / REGISTRATION OF ENTERPRISE	05/05/2025

DATE OF COMMENCEMENT OF PRODUCTION/BUSINESS	05/05/2025

NATIONAL INDUSTRY CLASSIFICATION CODE(S)

SNo.	NIC 2 Digit	NIC 4 Digit	NIC 5 Digit	Activity
1	72 - Scientific research and development	7210 - Research and experimental development on natural sciences and engineering	72100 - Research and experimental development on natural sciences and engineering	Services

DATE OF UDYAM REGISTRATION	16/08/2025

* **In case of graduation (upward/reverse) of status of an enterprise, the benefit of the Government Schemes will be availed as per the provisions of Notification No. S.O. 2119(E) dated 26.06.2020 issued by the M/o MSME.**

Signature Not Verified
Digitally Signed.
Name: Sudarshana
Bandyopadhyay
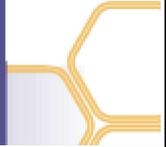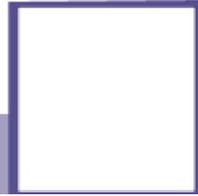Date: 25-Nov-2025 23:12:58
Reason: Patent Efiling

For any assistance, you may contact:

1. District Industries Centre: CUTTACK (ODISHA)

2. MSME-DFO: CUTTACK (ODISHA)

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Udyam Registration Number : UDYAM-OD-07-0095836

Type of Enterprise	MICRO	Major Activity	Services
Type of Organisation	Limited Liability Partnership	Name of Enterprise	SRJX RESEARCH AND INNOVATION LAB LLP
Owner Name	SRJX RESEARCH AND INNOVATION LAB LLP	PAN	AFPFS4480L
Do you have GSTIN	No	Mobile No.	9090255155
Email Id	soumyajena1989@gmail.com	Social Category	General
Gender	Male	Specially Abled(DIVYANG)	No
Date of Incorporation	05/05/2025	Date of Commencement of Production/Business	05/05/2025

Bank Details

Bank Name	IFS Code	Bank Account Number
Punjab national bank	PUNB0787800	7878002100002490

Employment Details

Male	Female	Other	Total
3	2	0	5

Investment in Plant and Machinery OR Equipment (in Rs.)

S.No.	Financial Year	Enterprise Type	Written Down Value (WDV)	Exclusion of cost of Pollution Control, Research & Development and Industrial Safety Devices	Net Investment in Plant and Machinery OR Equipment[(A)-(B)]	Total Turnover (A)	Export Turnover (B)	Net Turnover [(A)-(B)]	Is ITR Filled?	ITR Type
1	2023-24	Micro	0.00	0.00	0.00	0.00	0.00	0.00	No	NA

Unit(s) Details

SN	Unit Name	Flat	Building	Village/Town	Block	Road	City	Pin	State	District
1	SRJX RESEARCH AND INNOVATION LAB LLP	PLOT NO-3E/474	SECTOR-9	CDA CUTTACK	NA	Avinab Bidanasi	Cuttack Sadar	753014	ODISHA	CUTTACK

Official address of Enterprise

Flat/Door/Block No.	PLOT NO-3E/474	**Name of Premises/ Building**	SECTOR-9
Village/Town	CDA CUTTACK	**Block**	NA
Road/Street/Lane	Avinab Bidanasi	**City**	Cuttack Sadar
State	ODISHA	**District**	CUTTACK , **Pin :** 753014
Mobile	9090255155	**Email:**	soumyajena1989@gmail.com
Latitude	20.5021859203546	**Longitude:**	85.88860428847029

National Industry Classification Code(S)

SNo.	Nic 2 Digit	Nic 4 Digit	Nic 5 Digit	Activity
1	72 - Scientific research and development	7210 - Research and experimental development on natural sciences and engineering	72100 - Research and experimental development on natural sciences and engineering	Services

Are you interested to get registered on Government e-Market (GeM) Portal	No
Are you interested to get registered on TReDS Portals(one or more)	No
Are you interested to get registered on National Career Service(NCS) Portal	No
Are you interested to get registered on NSIC B2B Portal	No
Are you interested in availing Free .IN Domain and a business email ID	N/A
Are you interested in getting registered on Skill India Digital Portal	No
District Industries Centre	CUTTACK (ODISHA)
MSME-DFO	CUTTACK (ODISHA)
Date of Udyam Registration	16/08/2025
Date of Printing	16/08/2025

IEC Details

IEC Number	
IEC Status	Inactive
IEC Registration Date	
IEC Modifification Date	

"FORM 1 THE PATENTS ACT 1970 (39 of 1970) and THE PATENTS RULES, 2003 **APPLICATION FOR GRANT OF PATENT** (See section 7, 54 and 135 and sub-rule (1) of rule 20)	(FOR OFFICE USE ONLY)	
	Application No.	
	Filing date:	
	Amount of Fee paid:	
	CBR No:	
	Signature:	

1. APPLICANT'S REFERENCE / IDENTIFICATION NO. **(AS ALLOTTED BY OFFICE)**	

2. TYPE OF APPLICATION [Please tick (✓) at the appropriate category]

Ordinary (✔)		Convention ( )		PCT-NP ( )	
Divisional ( )	Patent of Addition ( )	Divisional ( )	Patent of Addition ( )	Divisional ( )	Patent of Addition ( )

3A. APPLICANT(S)

Name in Full	Nationality	Country of Residence	Address of the Applicant
SRJX RESEARCH AND INNOVATION LAB LLP	Indian	India	SRJX RESEARCH AND INNOVATION LAB LLP, Plot No - 3E/474, Sector-9, CDA, Post- Markat Nagar, Cuttack-753014, Odisha, India

3B. CATEGORY OF APPLICANT [Please tick (✓) at the appropriate category]

Natural Person ( )	Other than Natural Person		
	Small Entity (✔)	Startup ( )	Others ()

4. INVENTOR(S) [Please tick (✓) at the appropriate category]

Are all the inventor(s) same as the applicant(s) named above?	Yes ( )	No (✔)

If **"No"**, furnish the details of the inventor(s)			
Name in Full	Nationality	Country of Residence	Address of the Inventor
DR SOUMYA RANJAN JENA	Indian	India	Plot No - 3E/474, Sector-9, CDA, Post-Markat Nagar, Cuttack-753014, Odisha, India

5. TITLE OF THE INVENTION

NEUROMORPHIC SUPER-INTELLIGENT SMART WATCH

6. AUTHORISED REGISTERED PATENT AGENT(S)	IN/PA No.	2802
	Name	Sudarshana Bandyopadhyay
	Mobile No.	9748818235

7. ADDRESS FOR SERVICE OF APPLICANT IN INDIA	Name	**SUDARSHANA BANDYOPADHYAY**
	Postal Address	Ground Floor, S-456, LGF, Greater Kailash – II, New Delhi – 110048, India
	Telephone No.	NA
	Mobile No.	97488 18235
	Fax No.	NA
	E-mail ID	bandyopadhyay.sudarshana@gmail.com

8. IN CASE OF APPLICATION CLAIMING PRIORITY OF APPLICATION FILED IN CONVENTION COUNTRY, PARTICULARS OF CONVENTION APPLICATION

Country	Application Number	Filing date	Name of the applicant	Title of the invention	IPC (as classified in the convention country)
N.A.					

9. IN CASE OF PCT NATIONAL PHASE APPLICATION, PARTICULARS OF INTERNATIONAL APPLICATION FILED UNDER PATENT CO-OPERATION TREATY (PCT)

International application number	International filing date

N.A.	

10. IN CASE OF DIVISIONAL APPLICATION FILED UNDER SECTION 16, PARTICULARS OF ORIGINAL (FIRST) APPLICATION

Original (first) application No.	Date of filing of original (first) application
N.A.	

11. IN CASE OF PATENT OF ADDITION FILED UNDER SECTION 54, PARTICULARS OF MAIN

Main application/patent No.	Date of filing of main application
N.A.	N.A.

12. DECLARATIONS

(i) Declaration by the inventor(s)

(**In case the applicant is an assignee**: the inventor(s) may sign herein below or the applicant may upload the assignment or enclose the assignment with this application for patent or send the assignment by post/electronic transmission duly authenticated within the prescribed period).

We, the above-named inventor(s) is/are the true & first inventor(s) for this Invention and declare that the applicant(s) herein is/are my/our assignee or legal representative.

(a)   Date:
(b)   Signature:
(c)   Name: **Dr Soumya Ranjan Jena**

(ii) Declaration by the applicant(s) in the convention country

(In case the applicant in India is different than the applicant in the convention country: the applicant in the convention country may sign herein below or applicant in India may upload the assignment from the applicant in the convention country or enclose the said assignment with this application for patent or send the assignment by post/electronic transmission duly authenticated within the prescribed period)

I/We, the applicant(s) in the convention country declare that the applicant(s) herein is/are my/our assignee or legal representative. – **N.A.**

   (i) Date
   (ii) Signature(s)
   (iii) Name(s) of the signatory

(iii) Declaration by the applicant

We the applicant hereby declare that: -

[✔] We are in possession of the above-mentioned invention.

[✔] The complete specification relating to the invention is filed with this application.

[x] The invention as disclosed in the specification uses the biological material from India and the necessary permission from the competent authority shall be submitted by me/us before the grant of patent to me/us.

[✔] There is no lawful ground of objection(s) to the grant of the Patent to us.

[x] We are the true & first inventor(s).

[✔] We are the assignee or legal representative of true & first inventor(s).

[x] The application or each of the applications, particulars of which are given in Paragraph-8, was the first application in convention country in respect of my invention(s).

[x] We claim the priority from the above mentioned application(s) filed in convention country/countries and state that no application for protection in respect of the invention had been made in a convention country before that date by us or by any person from which I derive the title.

[x] Our application in India is based on international application under Patent Cooperation Treaty (PCT) as mentioned in Paragraph-9.

[x] The application is divided out of my /our application particulars of which is given in Paragraph-10 and pray that this application may be treated as deemed to have been filed on DD/MM/YYYY under section 16 of the Act.

[x] The said invention is an improvement in or modification of the invention particulars of which are given in Paragraph-11.

13. FOLLOWING ARE THE ATTACHMENTS WITH THE APPLICATION

(a) Form 2

Item	Details	Fee	Remarks
Complete/ provisional specification	No. of pages= 19	1600	Including Form 2, description,
No. of Claim(s)	No. of Claims = 17 No. of Pages = 4	320 X7	Claim pages
Abstract	1		Abstract page
No. of Drawing(s)	No. of drawings = 2 and No. of pages =2		Drawing sheets

\# In case of a complete specification, if the applicant desires to adopt the drawings filed with his provisional specification as the drawings or part of the drawings for the complete specification under rule 13(4), the number of such pages filed with the provisional specification are required to be mentioned here.

    b. Form 3: Statement and Undertaking
    c. Form 5: Declaration as to inventorship
    d. Power of Attorney
    e. Form 28
    f. Form 9

Total fee ₹ 6340/- is being paid online through electronic portal

We hereby declare that to the best of our knowledge, information and belief the fact and matters stated herein are correct and we request that a patent may be granted to us for the said invention.

Dated this 25th day of November 2025.

Signature:

Sudarshana

Name: Sudarshana Bandyopadhyay
(Regn No: IN/PA 2802)
Agent for the Applicant
Phn no.: 97488 18235
email: bandyopadhyay.sudarshana@gmail.com

To,
The Controller of Patents
The Patent Office,
at Kolkata

FORM 28

THE PATENTS ACT,

1970 (39 of 1970)

AND

THE PATENTS RULES, 2003

TO BE SUBMITTED BY A SMALL ENTITY /STARTUP/EDUCATIONAL INSTITUTION

[See rules 2 (fa), 2(fb), 2(ca) and 7]

1	Name, address and nationality.	We, SRJX RESEARCH AND INNOVATION LAB LLP, of the address Plot No - 3E/474, Sector-9, CDA, Post- Markat Nagar, Cuttack-753014, Odisha, India, applicant in respect of the patent application no. _____ dated 25 November 2025 hereby declare that we are a micro entity in accordance with rule 2(fa) and submit the following document as a proof :
2	Documents to be submitted	
	i. For claiming the status of a **micro** entity:	
	A. For an Indian applicant: Evidence of registration under the Micro, Small and Medium Enterprises Act, 2006 (27 of 2006).	
3	To be signed by the applicant(s) / patentee (s) / authorised registered patent agent.	The information provided herein is correct to the best of my/our knowledge and belief. Dated this 25th day of November 2025
4	Name of the natural person who has signed.	Signature: *Sudarshana*

	Designation and official seal, if any, of the person who has signed.	Sudarshana Bandyopadhyay Regn. No.: IN/PA 2802 Agent for the applicant Phn No. 9748818235 Email: bandyopadhyay.sudarshana@gmail.com To The Controller of Patents, The Patent Office, At Kolkata

We, SRJX RESEARCH AND INNOVATION LAB LLP, of the address Plot No - 3E/474, Sector-9, CDA, Post- Markat Nagar, Cuttack-753014, Odisha, India, hereby request for an early publication of our Patent Application No. _____ filed on 25 November 2025 under Section 11A(2) of the Act.

Dated this 25th day of November 2025

Sudarshana Bandyopadhyay
Regn No.: IN/PA 2802
Agent for the Applicants
Email: bandyopadhyay.sudarshana@gmail.com
Phn No: 9748818235

To,
The Controller of Patents,
The Patent Office
At Kolkata

INDIA NON JUDICIAL

Government of National Capital Territory of Delhi

e-Stamp

Certificate No.	:	IN-DL35961746213944X
Certificate Issued Date	:	16-Aug-2025 11:10 AM
Account Reference	:	IMPACC (IV)/ dl962703/ DELHI/ DL-ESD
Unique Doc. Reference	:	SUBIN-DLDL9627030 5293890128756X
Purchased by	:	SRJX RESEARCH AND INNOVATION LAB LLP
Description of Document	:	Article 48(c) Power of attorney - GPA
Property Description	:	Not Applicable
Consideration Price (Rs.)	:	0 (Zero)
First Party	:	SRJX RESEARCH AND INNOVATION LAB LLP
Second Party	:	ZAINAB SYED AND ASSOCIATES
Stamp Duty Paid By	:	SRJX RESEARCH AND INNOVATION LAB LLP
Stamp Duty Amount(Rs.)	:	100 (One Hundred only)

Please write or type below this line   IN-DL35961746213944X

Signature Not Verified
Digitally Signed.
Name: Sudarshana
Bandyopadhyay
Date: 25-Nov-2025 23:20:12
Reason: Patent Filing

FORM-26
The Patents Act, 1970
(39 of 1970)
FORM FOR AUTHORIZATION OF A PATENT AGENT/OR ANY PERSON IN A
MATTER OR PROCEEDING UNDER THE ACT
[See Sections 127 and 132; Rule 135]

I, **SRJX RESEARCH AND INNOVATION LAB LLP**, Indian, of the address SRJX RESEARCH AND INNOVATION LAB LLP, Plot No - 3E/474, Sector-9, CDA, Post- Markat Nagar, Cuttack-753014, Odisha, India, hereby authorize **Zainab Syed & Associates** having address 3E, Nawab Bhagwanpora, Lal Bazar, Srinagar, Jammu & Kashmir, 190023, India **(Mobile No.: +91 9748818235, Email: bandyopadhyay.sudarshana@gmail.com)** through **Ms. Sudarshana Bandyopadhyay (IN/PA 2802)** and **Ms. Meenu Sharma (IN/PA-2856),** registered Indian Patent Agents, to act on our behalf and to further appoint attorney(s)/agent(s) in connection with the filing and prosecution of our patent applications for grant of Letters Patent, filing of request for examination, filing request for amendment, recordal of change of name and address, ownership, change of address of service in India, renewal of patent, recordal of assignments, filing and defending oppositions and infringement actions, restoration of patents, registration of documents and such other actions and all proceedings under the Patents Act, 1970 and the Patent Rules, 2003 and all such proceedings before the Patent Office or the Government of India or any Court in India and all acts and things as the said attorney may deem necessary or expedient in connection therewith or incidental thereto.

We further request that all notices, requisitions and communication relating thereto may be sent to such person/s at the corresponding address mentioned below:

Ground Floor, S-456, LGF, Greater Kailash – II, New Delhi – 110048, India,

(Contact No.: +91 9748818235; Email: bandyopadhyay.sudarshana@gmail.com)

We, hereby, revoke all previous authorizations, if any, in respect of the proceedings.

We, hereby, assent to the action already taken by the said person/s in the above matter.

Dated this **14th day of August, 2025**

<div style="text-align:right">

SRJX RESEARCH AND INNOVATION LAB LLP
Through:

Signature: _Soumya Ranjan Jena_

Name: Dr. Soumya Ranjan Jena

Company
Seal:

SRJX Research and Innovation Lab LLP
LLPIN· ACO-1435

</div>

To,
The Controller of Patents,
The Patent Office,
Kolkata

NOTARY
R.V. Singh
Advocate
Reg. No.2282
Commission
Expire On
24-10-2027
Area-Delhi
GOVT. OF INDIA

ATTESTED

Notary Public Delhi

1 6 AUG 2025

Signature Not Verified

Digitally Signed.
Name: Sudarshana
Bandyopadhyay
Date: 25-Nov-2025 23:15:21
Reason: Patent Efiling

	that we undertake that upto the date of grant of the patent by the Controller, we would keep him informed in writing the details regarding corresponding applications for patents filed outside India within six months from the date of filing of such application. Dated this 25th day of November 2025
4. To be signed by the applicant or his authorized registered patent agent.	*Sudarshana* Signature. ....
5. Name of the natural person who has signed.	Sudarshana Bandyopadhyay Regn. No.: IN/PA 2802 Agent for the applicant Phn No. 9748818235 Email: bandyopadhyay.sudarshana@gmail.com
	To The Controller of Patents, The Patent Office, at Kolkata
Note.- Strike out whichever is not applicable;	