TECHNOLOGY BRIEF

Brain-Synchronized Technology for Improving Sleep and Brain Health

Adaptive Closed-Loop Sleep Modulation System

Lead Inventors:
Dr. George Ibrahim, Paediatric Neurosurgeon

Licensing Associate:
Mauricio Meza, mauricio.meza@sickkids.ca

Technology Summary

This technology is an adaptive, closed-loop sleep modulation system that improves sleep quality by synchronizing auditory stimulation to a person's natural brain rhythms. The system continuously monitors brain activity during sleep and delivers brief sounds only at moments when the brain is most receptive, reinforcing natural sleep processes rather than disrupting them.

The system has been validated in both healthy individuals and children with epilepsy, supporting applications in general sleep enhancement as well as neurological conditions.

At the core of the system is a real-time algorithm that adapts stimulation to each individual's brain activity throughout the night.

Problem

- High-quality sleep is essential for cognitive performance, brain health, and overall well-being.
- Most sleep technologies use pre-programmed or open-loop stimulation and do not respond to the brain's changing state during sleep.
- In neurological conditions such as epilepsy, poor sleep and abnormal brain activity can worsen each other.
- There is a need for a non-invasive, adaptive sleep technology that works with the brain's natural rhythms and can scale beyond disease-specific use.

Solution: Adaptive Closed-Loop Sleep Modulation

The system treats sleep as an **active process that can be guided in real time**.

How it works (at a high level):

- Continuously analyzes EEG signals during sleep
- Identifies natural slow-wave sleep rhythms associated with deep, restorative sleep
- Predicts the optimal timing within each brain wave
- Delivers auditory stimulation **only when timing and sleep conditions are optimal**

Rather than forcing the brain to follow an external signal, the system **locks stimulation to the brain's own rhythms**, making it gentle, personalized, and effective.

Validation and Evidence

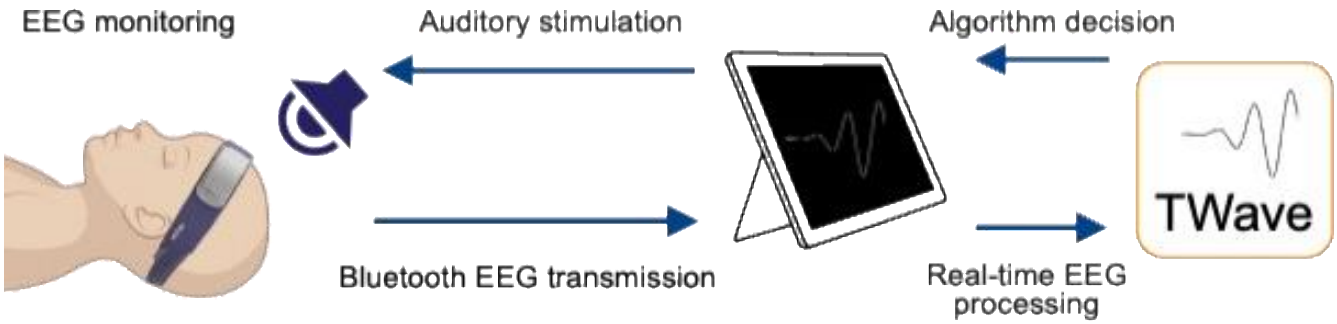
- **Healthy individuals:**
  Precisely timed stimulation strengthens slow-wave sleep, a key marker of sleep quality.
- **Epilepsy**:
  The system enhances normal sleep rhythms while significantly reducing abnormal brain activity during sleep.
- **Mechanistic insight:**
  Brain recordings show engagement of natural sleep-regulating networks, including deep brain structures involved in sleep stability.

Key Advantages

- Adaptive, brain-responsive (closed-loop)
- Non-invasive and drug-free
- Personalized to each user's brain activity
- Validated in both healthy and clinical populations
- Software-driven core with flexible hardware integration

Keywords: Sleep, Algorithm, Brainwave patterns, EEG

Tech ID: 1555



Potential Applications

- General sleep improvement and wellness
- Cognitive performance and memory support
- Pediatric and adult epilepsy
- Sleep disorders and sleep fragmentation
- Brain health, neurodevelopment, and aging

Commercial Opportunity

- Core IP resides in the adaptive control algorithm and closed-loop logic
- Hardware-agnostic and scalable
- Suitable for medical devices, digital health, and consumer sleep technologies
- Platform technology with multiple downstream indications

Intellectual Property

Patent pending, USA and Canada

IP&C is seeking licensing partners for this technology.

Keywords: Sleep, Algorithm, Brainwave patterns, EEG

Tech ID: 1555

Industry Partnerships & Commercialization | The Hospital for Sick Children
Peter Gilgan Centre for Research and Learning, 686 Bay Street, Toronto, ON M5G 0A4
ipc.requests@sickkids.ca | ipc.sickkids.ca