School of Engineering
Institute Electrical & Micro Engineering
Embedded Systems Laboratory

Master or Semester Project

Real-time epileptic seizure alarms on a smartwatch

Epilepsy, a neurological disorder characterized by recurrent seizures, affects millions of people worldwide. Among the various seizure types, *generalized tonic-clonic seizures* are particularly concerning due to their sudden onset and potential life-threatening consequences. These seizures can lead to injuries, loss of consciousness, and even death. The unpredictability of seizures places a significant burden on patients, caregivers, and healthcare providers.

Real-time seizure alarms would provide many benefits patients such as an alert to caregivers to that would allow caregivers to respond promptly, ensuring patient safety. It would also provide reassure to loved ones as families and friends would gain peace of mind, knowing that help is on the way.

The real-time systems benefit from recent developments in wearable technology and artificial intelligence (AI). Modern smartwatches are equipped with sensors (e.g., accelerometers, heart rate monitors) that continuously collect data. These sensors can capture physiological changes associated with seizures, providing valuable input for detection algorithms. In turn, machine learning and deep learning techniques enable the development of accurate seizure detection models. These algorithms analyze sensor data in real time, identifying seizure patterns and distinguishing them from normal activity.

While the potential of real-time seizure detection devices is clear, implementing seizure detection on a smartwatch presents challenges:

Computational Constraints:

- Smartwatches have limited processing power and memory.
- Running large neural networks directly on the watch is impractical or infeasible.

Energy Efficiency

- Smartwatches operate on battery power, necessitating energy-efficient algorithms.
- Balancing accuracy with computational cost is crucial.

Tasks:

The master student will tackle the following tasks:

1. Algorithm Evaluation:
   - Assess the computational complexity of an existing seizure detection algorithm.
   - Understand its resource requirements (CPU, memory) and identify bottlenecks.

2. Optimization Strategies:

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- Investigate pruning (removing unnecessary model components), quantization (reducing precision), and architecture exploration.

- Adapt the algorithm to fit within the smartwatch's constraints.

3. Data Compression:

- Explore compression techniques to transmit raw sensor data from the watch to a smartphone.

- Balance data fidelity with transmission efficiency.

4. Integration with Smartphone:

- Develop a communication protocol between the smartwatch and smartphone.

- Ensure seamless data transfer and alarm notifications.

Prerequisite Skills and Competence

To succeed in this project, the student should possess:

- Machine Learning: Understanding of classification algorithms, neural networks, and model optimization.

- Programming: Proficiency in Python and the Android development ecosystem.

- Embedded Systems: Familiarity with resource-constrained devices.

- Problem-Solving: Ability to address complex challenges creatively.

By combining technical expertise with empathy for patients, the student can contribute to improving the lives of those affected by epilepsy.

Lab: ESL

Sections: SEL

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