Reconfigurable Embedded Hardware Design for Patient Health Monitoring

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Background

- Portable health monitoring is often required for patients with chronic illnesses or people in extreme conditions.
- Health monitoring devices need to be able to detect critical symptoms accurately and ahead of time.
- Current technology allows us to monitor different physiological signals that can help with detection of these symptoms before they happen. Some examples:
  - A patient with an EEG cap that has electrodes to measure brain waves.
  - EEG waves of a patient with epileptic seizure.

Goals

- Develop a portable, power-efficient, and configurable device that can be programmed to detect seizures and other symptoms.
- Build an experimental framework for designing, integrating, and testing different signal analysis modules and learning neural networks.
- Design a configurable controller to coordinate the different modules.

Fundamental Questions/Challenges

- For the experimental framework:
  - Use a processor that allows different ways of connecting modules (peripherals).
  - Find an efficient way to configure and control all the modules.
  - Allow modules to work simultaneously by making the data flow between them without passing through the processor.

Research Plan

- Adopt the Xilinx MicroBlaze soft processor core as the controller for testing the framework.
- Develop an interface that can read/write data directly from shared memory and can be controlled from the processor.
- Create an effective protocol for the interface to communicate with a variety of attached modules.
- Demonstrate the hardware with an example scenario:
  - A seizure detection using variance and comparator modules.

Hardware framework organization. The MicroBlaze processor is used for controlling the interface, which allows direct data flow from modules to memory.

Research Results

- Implemented hardware framework and demonstrated it on seizure detection scenario using variance and comparator modules.
  - Use pre-collected EEG data.
  - Seizures detected by computing the variance of an EEG signal.
  - Variance not equal to zero indicates seizure.

Future Work

- Create different signal analysis modules that can be configured to monitor a variety of symptoms and conditions.
- Create an independent controller to coordinate the interactions between modules and to enable reconfiguration.

References