ECSE 444: Final Project Proposal

Eren Ozturk
Dept. of Electrical and Computer Eng.
McGill University
Montreal, Canada
eren.ozturk@mail.mcgill.ca

Mohammed Al Noman
Dept. of Electrical and Computer Eng.
McGill University
Montreal, Canada
mohammed.alnoman@mail.mcgill.ca

Rafid Saif
Dept. of Electrical and Computer Eng.
McGill University
Montreal, Canada
rafid.saif@mail.mcgill.ca

Karim Elgammal
Dept. of Electrical and Computer Eng.
McGill University
Montreal, Canada
karim.elgammal@mail.mcgill.ca

I. Introduction

For the final project, we are proposing an accelerometer-based motion classification device. It will detect motions like brushing teeth, drinking a glass of water, eating with utensils, and more. The device will be the B-L4S5I-IOT01A microcontroller development board attached to the wrist. The classifier will be a neural network that is run on the device, and the net will be trained using a database included in the citations section. We have been inspired by that research for our project, and training data is already available. Tentatively, we are considering TensorFlow Lite as the platform for off-board training and CMSIS-NN as the framework for the on-board neural network.

The project has multiple possible motivations. It can be used for a health application that tracks daily activities and helps keeps track of them. It can help people with obsessive compulsive disorder. Keeping track of tasks can also aid those with dementia and similar short-term memory loss problems.

II. Planned Features

Feature List

- I2C Sensor
- CMSIS DSP
- Kalman Filter
- CMSIS NN
- OS Threading
- UART
- QSPI Flash*
- Multiple Sensors*

The motion detection device will first take input from the accelerometer and perform some pre-processing on the data. The onboard accelerometer will be used to receive inputs, while CMSIS DSP functions will be used for filtering and scaling. Tentatively, we are considering a Kalman filter for denoising.

The neural network will be trained offline using TensorFlow Lite, and CMSIS NN will be used to construct the network on the chip. The weights generated by TFLite will be transferred over. We are also considering different approaches for the network, such as using ST's own machine learning tool to build the network on the microcontroller. The exact methodology will be determined by discussions. As for general processing, the OS will divide microprocessor operation into multiple threads. The UART interface will be used to output the task being performed.

An optional feature is the use of QSPI flash to save new training data every 10 minutes to improve the performance of the neural network. Using more training data, it will be possible to train the network more on TensorFlow and gradually improve it. Another optional feature is the use of multiple boards to confirm output and/or add more detection functionality.

III. Development Milestones

Timeline

March 31st	Pre-Processing (Mohammed)
April 4th	Training the Network (Eren and Karim)
April 10th	Transfer to Microcontroller (Rafid and Eren)
	User Interface*
	Interfacing with Multiple Boards*
	QSPI Flash to Improve Neural Network*

References

[1] V. Nunavath et al., "Deep Learning for Classifying Physical Activities from Accelerometer Data," Sensors, vol. 21, no. 16, p. 5564, Aug. 2021, doi: https://doi.org/10.3390/s21165564.

[2] "UCI Machine Learning Repository: Dataset for ADL Recognition with Wrist-worn Accelerometer Data Set," archive.ics.uci.edu. https://archive.ics.uci.edu/ml/datasets/Dataset+for+ADL+Recognition+with+Wrist-worn+Accelerometer (accessed Mar. 26, 2023).

[3] Project Proposal Document myCourses.

* indicates an optional feature or goal that may be implemented if time permits