Embedded Hardware Spiking Neural Network for UWB Bladder Volume Classification

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Introduction

This project aims to develop an embedded SNN bladder volume classifier using previously reported Ultra Wideband (UWB) Radar Target Signatures of a bladder phantom [1]. The proposed UWB dataset SNN classifier is being prototyped on the EMBRACE Embedded Hardware SNN platform [4].

EMBRACE Embedded Hardware SNN

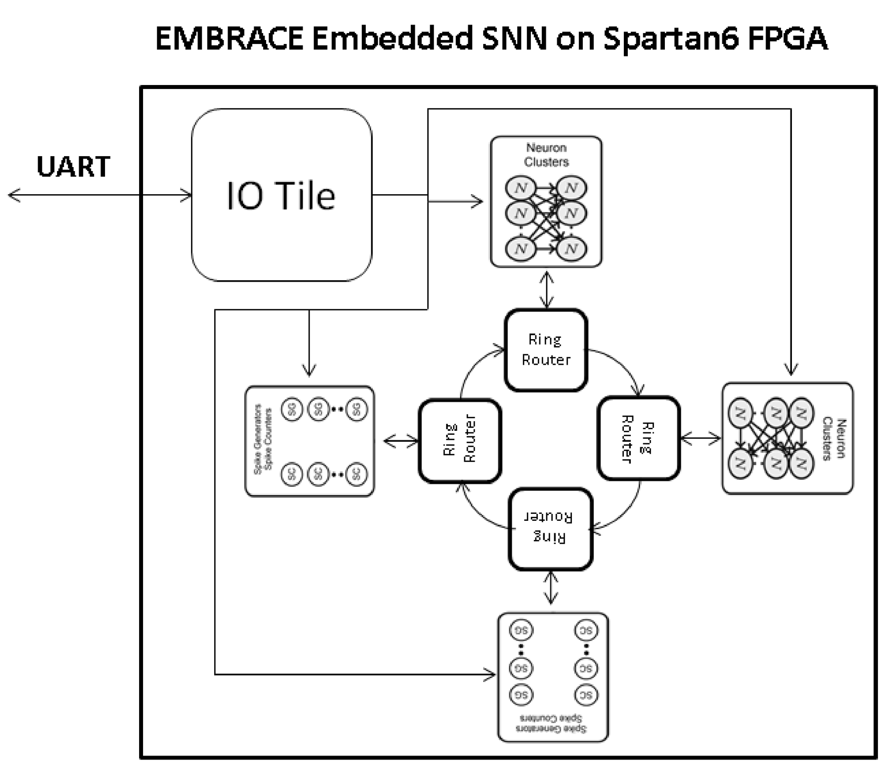

Fig.1. Diagram of EMBRACE [4] Embedded HW SNN on Spartan6

- Prototyped on Xilinx Spartan6 FPGA
- Fixed local spike latency
- Configurable topology
- Fully connected clusters
- 64 LIF neurons, 32 spike generators and counters
- Classifier is evolved using a host GA (Fig. 3)
- Previously tested with the Wisconsin Cancer dataset

UWB Bladder Volume Phantoms

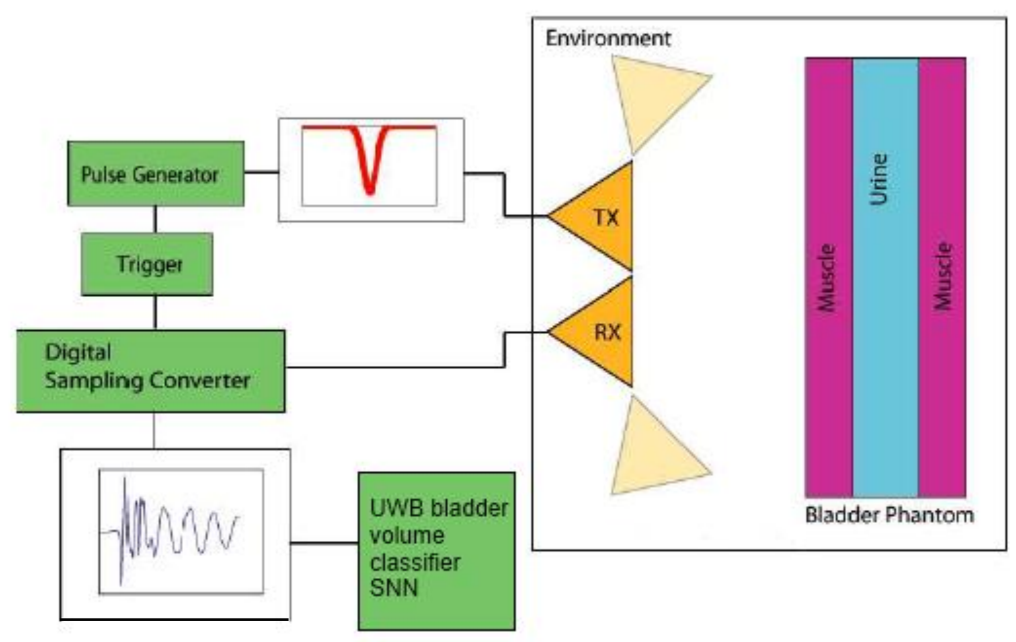

Fig.2. Block diagram of the UWB bladder system setup. [1]

- Bladder widths are varied
- UWB pulse is transmitted into the phantom and the reflection recorded [1]
- Signals are preprocessed
- Features are extracted from resulting Radar Target Signatures by Principle Component Analysis
- Dataset has 15 features and 180 observations

GA for Classifier Evolution

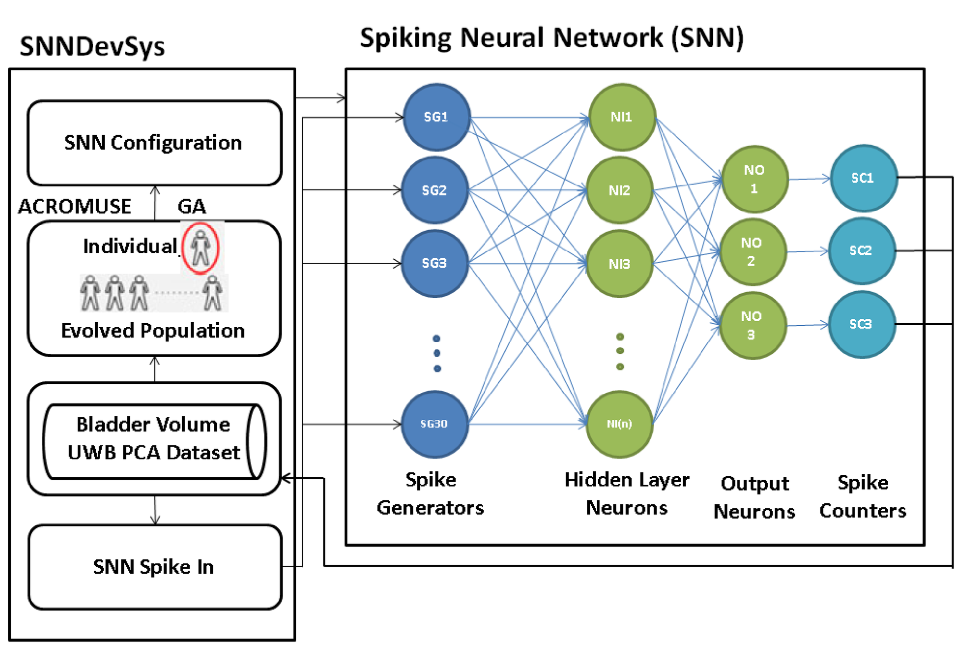

Fig.3. Block diagram of hardware/software SNN UWB bladder volume classifier and the host ACROMUSE SNN evolution system (SNNDevSys).

- Proof of concept SNN classifier in SW only
- 2 layer feed-forward network classifies each observation consisting of 30 inputs from dataset
- ACroMuSe [3] adaptive GA evolves a classifier
- SNNs are evaluated in a Software SNN
- Spike rate coding used

Preliminary Results

SNN	Fisher's IRIS	BVM PCA
SW	91.332%	67.778%

Fig.4. Table of Software Classifier results

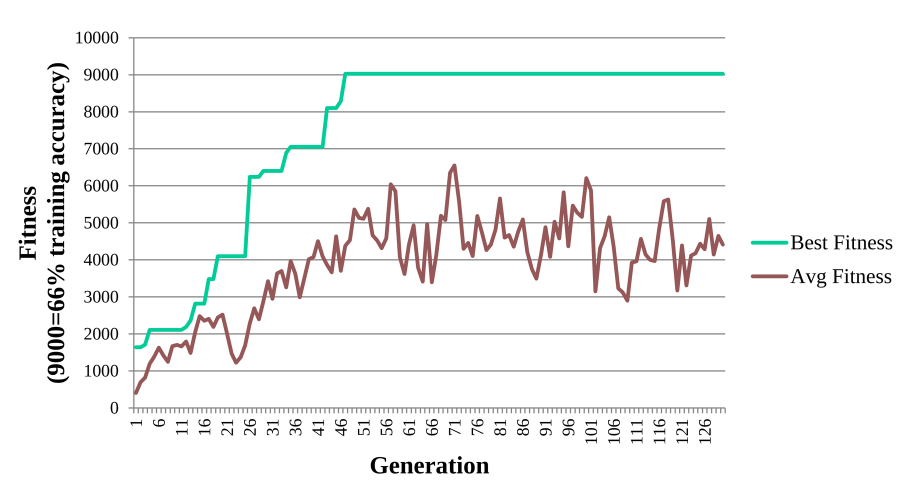

Fig.5. Graph of typical fitness evolution for BVM dataset

- Standard Fisher's Iris dataset was used as a test for the SW system
- Datasets were shuffled and split into 10 sets
- Both classifiers were evolved with 4 hidden layer neurons
- BVM classification results indicate incomplete classifier

Conclusions

- IRIS classification results indicate GA and Software SNN system is functional
- UWB BVM PCA data appears to be more difficult to solve by GA and SNN than Iris dataset with only 68% accuracy opposed to 91.3%
- BVM may require larger dataset for accurate classification

Future Work

- Evolution of EMBRACE Embedded Hardware classifier
- Investigation of suitability of alternative SNN training methods including SpikeProp and SWAT for the purpose of lifelong learning
- Development of anatomically correct pelvis and bladder phantom

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