Neuro-Kinematic BNN Classiffier

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0000 50 MHz HDL Project

github.com/joyqxia/BNN-medical-classifier-new

"Hardware-accelerated Cleveland Heart Disease classifier using a Binarized Neural Network."

How it works

Neuro-Kinematic is a hardware-accelerated Application-Specific Integrated Circuit (ASIC) designed to diagnose heart disease entirely on-chip.

Instead of relying on a power-hungry CPU or cloud connection, we synthesized a Binarized Neural Network (BNN) directly into physical logic gates. The hardware takes 8 thresholded biometric markers from the Cleveland Heart Disease dataset. It processes these inputs through parallel XNOR gates (representing our quantized PyTorch weights) and a physical adder tree (Popcount). If the patient's match score hits the binarized threshold, the hardware flags the diagnosis in a single clock cycle.

How to test

To test the chip, provide an 8-bit binary input to the dedicated input pins (ui_in[7:0]). Each pin corresponds to a specific thresholded medical feature:

- ui_in[0]: Age (> 50 years)
- ui_in[1]: Resting Blood Pressure (> 140 mmHg)
- ui_in[2]: Cholesterol (> 240 mg/dl)
- ui_in[3]: Max Heart Rate (< 100 bpm)
- ui_in[4]: Chest Pain Type (Asymptomatic/Typical)
- ui_in[5]: Exercise Induced Angina (Yes)
- ui_in[6]: Oldpeak ST Depression (> 1.5)
- ui_in[7]: Sex (Male)

Once the input is provided, the chip will immediately evaluate the data. Read the first dedicated output pin (uo_out[0]).

- A reading of 1 indicates High Risk of heart disease.
- A reading of 0 indicates Healthy.

External hardware

No complex external microcontrollers are required. To physically test this chip once manufactured, you only need a standard 8-position DIP switch to

manually toggle the patient vitals (inputs) and a single LED connected to uo_out[0] to display the diagnostic result.

Project Pinout

Digital Pins

#	Input	Output	Bidirectional
0	age	disease_risk_flag	unused
1	blood_pressure	unused	unused
2	cholesterol	unused	unused
3	max_heart_rate	unused	unused
4	chest_pain	unused	unused
5	exang	unused	unused
6	oldpeak	unused	unused
7	sex	unused	unused