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Digital Oscillatory Neural Networks for AI Edge Applications

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**ARTIFICIAL INTELLIGENCE AT THE EDGE**
- Constraints:
  - Bandwidth (inference/second)
  - Latency (frames/second)
  - Privacy concerns
  - Power consumption

**NEUROMORPHIC COMPUTING**
- Support online learning
- Fast and efficient inference
- Low power consumption
- Scalability
- Low cost

**OSCILLATORY NEURAL NETWORKS**

**PHASE COMPUTING PARADIGM [1]**
- Brain-inspired computing paradigm
- Neurons are oscillators
- Synapses are coupling elements between oscillators
- Information encoded in oscillators’ phases

**ASSOCIATIVE MEMORY**
- Learn patterns
- Associate corrupted input with correct output

**APPLICATIONS AND USE CASES**

**Digits recognition (AAM) [2]**

Camera stream to HDMI screen

- ONN 10x16
- LUTs 117
- Flip-Flops 2.6%
- Accuracy 100%

**Obstacle avoidance (AAM) [3]**

with an Arduino robot

- ONN Frequency 488 MHz
- LUTs (33 280) 11.5%
- Flip-Flops (41 000) 5.0%
- Accuracy 100% 74%

**Obstacle avoidance (AAM) [4]**

with the industrial robot €4 from A.I.Mergence

- ONN Frequency 12 MHz
- LUTs (33 280) 20.07%
- Flip-Flops (41 000) 7.36%
- Accuracy 100% 100%

**Image edge detection (HAM) [5]**

Camera stream to HDMI screen (10x6 ONN)

- ONN Frequency 2.7 MHz
- LUTs 104
- Flip-Flops (41 000) 60.9%

**CONCLUSION**

- Development of a proof of concept of the ONN computing paradigm with a digitally implemented ONN on FPGA
- Development of various demonstrators using the digital ONN on FPGA
- Digits recognition from a camera stream
- Obstacle avoidance on mobile robots from sensory data measurements
- Image edge detection using ONN as HAM

**REFERENCES**


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