ClassificationCam: An exploration of hybrid and fully optical convolutional neural networks

Anonymous ECCV submission

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Abstract. The abstract should summarize the contents of the paper. LNCS guidelines indicate it should be at least 70 and at most 150 words. It should be set in 9-point font size and should be inset 1.0 cm from the right and left margins. Paper page limit is 14 pages, excluding references.

Keywords: We would like to encourage you to list your keywords within the abstract section

1 Introduction, pp. 1-2

CNNs are very important, but they require a lot of computation. Optics can offer passive, fast, highly parallel computation. This project explores incorporating optical computing in convolutional neural networks. We present several models and assess their limitations and potential.

2 Related Work, pp. 2-4

- CNNs for computer vision
- Computational imaging and embedded vision
- Optical computing, optical neural networks

3 ONN Toolbox, pp. 5-7

In this section we present building blocks for an optically implemented CNN. In this rest of this paper we focus on the convolutional layer, but we will briefly discuss other layers here too.

- Convolutional layer: Small kernel, tiled kernels, single large kernel (Fig. 1)
- Other layers that we didnt test in detail:
  Optical nonlinearities
  Max/avg pooling with spectral pooling
  Fully connected layers

4 Training, pp. 7

Here we talk about how we train the ONN offline in Tensorflow. PSF optimization followed by phase mask optimization OR end-to-end phase mask optimization.

5 Simulations, pp. 8-10

We use simulations to better understand the performance of optical CNNs. Fig. 2: diagram of possible ONN models. Table 1: Results.

- Introduce toy classification problem(s?), discuss constraints.
- Learned optical correlator (single optical conv. layer)
  Here we are able to use end-to-end learning.
  Possible figure with learned phase mask and PSF.
- Hybrid optoelectronic (one optical conv. layer)
  Talk about the dual channel positive and negative weights
  Grayscale
  With color filters Vincent?
  Fig. 3: Hybrid ONN phase masks and PSFs.
- All-optical convolutional neural network
  Doesnt fully work, but can discuss some results

6 Optical Prototype, pp. 10-11

Implement the hybrid optoelectronic two-layer neural network. Goal is to show that the hybrid ONN can perform on par with the electronic ONN, with the same number of layers, and better than the electronic ONN with one fewer layer.
Fig. 4: optical setup
Fig. 5: actual PSF and sample images
Table. 2: results

7 Discussion, pp. 12-13

- Not straightforward to generalize first optical conv. layer to multiple optical layers
- Discuss importance of negative weights Vincent?
- In the future, exploit other properties of light (polarization, phase)
- Specifically, coherent light and holography

8 Conclusion, p. 14

Important step towards optical CNNs.

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