Design Of Task-Specific Optical Systems Using Broadband Diffractive Neural Networks

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SUMMARY

UCLA researchers in the Department of Electrical and Computer Engineering have developed a diffractive neural network that can process an all-optical, 3D printed neural network for deep learning applications.

BACKGROUND

Deep learning, a method of machine learning that mimics the human brain's connectivity through a series of "neural networks", has been used in widespread applications such as image recognition and natural language processing. Existing forms of deep learning use either 3D print or lithography to create tandem sheets of networks that use input sensory information to recognize patterns and compute an image using designated algorithms. Diffractive deep neutral networks, deep learning networks that use optical computing instead of 3D print or lithography, has been investigated to tackle tasks such as object classification—the 3D version of image recognition. Optical computing, however, has difficulty recognizing objects as it only works if the optical input is coherent and monochromatic. Given that light in the real world is incoherent and broadband, diffractive neutral networks need to be improved to be compatible with incoherent and broadband light to be used in the real-world applications such as real-time 3D image recognition in autonomous cars.

INNOVATION

UCLA researchers have developed an all-optical deep learning platform that inputs sensory information, diffracts the light in specific tunnels, and allows for immediate object detection and recognition. The network can be generalized to broadband sources and processes optical waves over a continuous, wide range of frequencies. This system requires no power source except for incident light and has been successfully prototyped onto an 8 x 8 cm square. Due to the increasing ease of 3D printing, the scale of the system can be increased well beyond the 8 cm x 8 cm squares utilized here. This innovation provides hope for instant-processing deep learning.

APPLICATIONS

- Autonomous vehicles
- Large data set processing
- Drug discovery/toxicology
- Image recognition
- Visual art processing
- Construction modeling
- Object classification
- Image recognition
- Spatial ranging

ADVANTAGES

- All-optical
- No power source necessary
- Processing at the speed of light
- Broadband light allows for more generalization of incoming materials

RELATED MATERIALS

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OTHER INFORMATION

KEYWORDS

artificial intelligence, deep learning, diffractive deep neutral network, neutral network, object classification, image recognition, processing, machine learning, 3D printing, image learning, computer learning, computing, optical, all-optical, broadband,

CATEGORIZED AS

- **Computer**
  - Software
- **Imaging**
  - Other
  - Remote Sensing
  - Software

RELATED CASES

2020-174-0

- ?X. Lin, Y. Rivenson, N. T. Yardimci, M. Veli, Y. Luo, M. Jarrahi, A. Ozcan, All-optical machine learning using diffractive deep neural networks. Science 361, 1004–1008 (2018).
- Jingxi Li, Deniz Mengu, Yi Luo, Yair Rivenson, Aydogan Ozcan, "Class-specific differential detection in diffractive optical neural networks improves inference accuracy," Adv. Photon. 1(4) 046001 (12 August 2019).

STATE OF DEVELOPMENT

Device has been successfully prototyped and demonstration was performed.

PATENT STATUS

Patent Pending

ADDITIONAL TECHNOLOGIES BY THESE INVENTORS

- Automated Semen Analysis Using Holographic Imaging
- Low-Cost And Portable Uv Holographic Microscope For High-Contrast Protein Crystal Imaging
- Extended Depth-Of-Field In Holographic Image Reconstruction Using Deep Learning-Based Auto-Focusing And Phase-Recovery
- Detection and Spatial Mapping of Mercury Contamination in Water Samples Using a Smart-Phone
- Computational Cytometer Based On Magnetically-Modulated Coherent Imaging And Deep Learning
- Lensfree Tomographic Imaging
- Single Molecule Imaging and Sizing of DNA on a Cell Phone
- Cross-Modality Deep Learning Brings Bright-Field Microscopy Contrast To Holography
- Microscopic Color Imaging And Calibration
- Quantification Of Plant Chlorophyll Content Using Google Glass
- Rapid, Portable And Cost-Effective Yeast Cell Viability And Concentration Analysis Using Lensfree On-Chip Microscopy And Machine Learning
- Holographic Opto-Fluidic Microscopy
- Ultra-Large Field-of-View Fluorescent Imaging Using a Flatbed Scanner
- Revolutionizing Micro-Array Technologies: A Microscopy Method and System Incorporating Nanofeatures
- Tunable Vapor-Condensed Nano-Lenses

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