2025 START Program
CFP Brief

THEME: **04. Camera Technologies**

SUB-THEME: **4.1. Computational Optics for Advanced Camera**

Context/ Overview

Cameras are an essential component in mobile devices such as smartphones and AR/VR glasses, and as a result the form factor and the KPIs of these devices depend heavily on the camera. Therefore, power consumption, security, privacy, and space efficiency in cameras have become areas of significant interest to Samsung, and to other mobile device manufacturers. To address the aforementioned needs, both industry and academia have increased the level of investment in Computational Optics and Sensing research.

Problem Statement

Computational Optics and Sensing broadly includes the design of optical elements, diffractive or otherwise, together with sensors and computational imaging algorithms. Recent advances in the design of meta-surfaces have enable optical elements that can function directly as part of a neural network. These so called Optical Neural Networks (ONNs) can be very fast and energy efficient, and have the potential to revolutionize imaging applications in mobile photography, AR/VR, and future products. Recent research publications in the field of ONNs have investigated learned thin diffractive elements designed for applications ranging from zoom, HDR imaging, hyperspectral imaging. However, challenges remain since optical elements do not presently support non-linearities in Neural Networks. There have been recent attempts to address this issue, but so far these solutions have not scaled sufficiently to make ONNs practical.

Solutions are needed to overcome the inability to support non-linearities, in an effective and efficient manner, allowing ONNs to be practically employed for imaging applications and products. Depending on the product category, the properties of ONNs may provide unique advantages.

1) For example, for super low latency requirements of visual-see-though VR cameras, ONN's may deliver a customer experience far exceeding current legacy solutions.

2) As another example, for wearable AR glass cameras, ONN's power efficiency benefits may enable always-on image sensing for an all-day use case.

3) As a final example, ONN's ability to optically encode information into representations useful for downstream application, without having to retain image data, means the system can preserve privacy while still enabling the system to sense and act upon the visual environment.

Objectives & Scope

The key objective is to design novel computational optical/sensing systems and algorithms that together address processing time, latency, power consumption, privacy, security and image quality for applications such as smartphones and AR/VR. Future applications using ONNs are also of interest, and creative proposals are welcome.

Specific Topics & focus areas *

1. Low-latency power-efficient imaging with Optical Neural Networks (ONNs)
2. Nonlinearity support for ONNs.
3. Application specific ONNs for super low latency VR sensing
4. Application specific ONNs for super-low-energy always-on visual sensing.
5. Privacy preserving computational optics/sensing.

※ The topics are not limited to the above examples and the participants are encouraged to propose other original ideas.

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