**Rambus**

# Lensless Smart Sensors

Low-power, low-cost sensor technology that captures information-rich images in a tiny form factor using a revolutionary new approach to optical sensing that replaces traditional lenses with tiny diffractive optics.

## Enhanced Sensing

- Collects information-rich sensing data in the thermal or visible spectrum
- Captures motion, optical flow, depth and change

## Reduced Cost

- Eliminates the use of lenses
- Enables new form factors and low-cost infrastructure

## Ultra-low Power

- Application–specific optics and algo-rithms extract image data with low-power computer vision

## Tiny Form Factor

- Replaces lenses with ultra-miniature phase grating optics

## Overview

Imaging and smart sensors are essential for the Internet of Things to become a reality. In order for the objects and machines around us to adapt and anticipate our changing needs, they must be able to gather and act upon relevant data from their surroundings quickly and cost-effectively.

We have pioneered a new class of computational imagers ideally suited for ubiquitous sensing with our ultra-miniature Lensless Smart Sensors (LSS). LSS take a novel approach to reduce the size, cost and power consumption for sensing and imaging by replacing traditional visible and thermal lenses with a low-cost diffraction grating attached directly to the image sensor array. Each grating has a unique design that creates a predictable and pattern on the sensor that is used to capture data-rich images and information about its surroundings.

The gratings and computational algorithms are combined with standard visible or thermal sensors and optimized for specific applications. The net result is a smart sensor with a smaller form factor, better power efficiency, greater precision, and lower cost compared to a traditional image sensor with computer vision.  LSS is be used for a broad range of tasks including point tracking, gesture recognition, change detection, motion flow and range finding. This enables adoption of LSS thermal and visible sensing into a broad ranger of IoT applications including automotive, virtual and augmented reality, and smart home use cases.
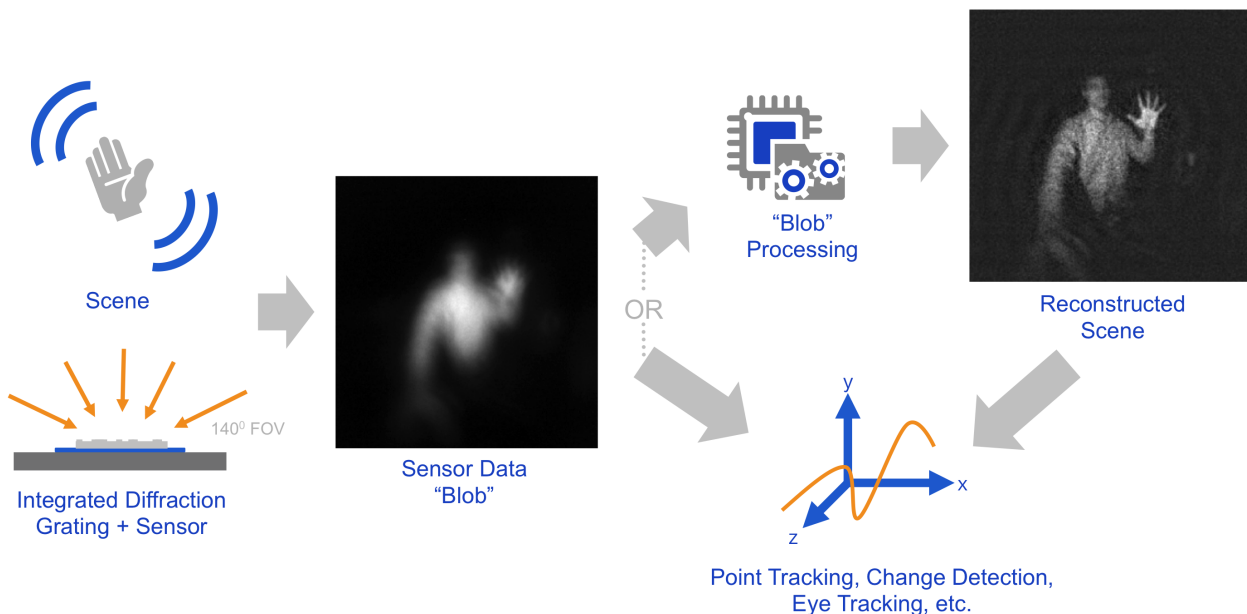
## Features

- Extremely thin, small, solid state
- Highly cost effective
- Extended depth of field (mm to ~∞)
- Enhanced sensing (motion, depth, change, etc.)
- Ultra-low power computer vision (energy consumption)

## Applications

- Automotive
- Virtual and Augmented Reality Eyewear
- Smart Homes
- Manufacturing
- IoT Devices
- Medical

## LSS Operational Architecture



Scene

Integrated Diffraction Grating + Sensor

$140^0$ FOV

Sensor Data "Blob"

OR

"Blob" Processing

Reconstructed Scene

Point Tracking, Change Detection, Eye Tracking, etc.

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