High Dynamic Range Global Shutter CMOS Sensor

1. Background

CMOS Image sensors with a global shutter (GS) are ideal for a variety of applications including factory automation, unmanned aerial vehicles, and automobile advanced driver-assistance systems (ADAS). For these applications, CMOS imaging sensors with a global shutter are used to avoid image degradation caused by rolling shutter (RS) distortion. Figure 1 shows an image quality comparison between a rolling shutter imager and a global shutter imager.

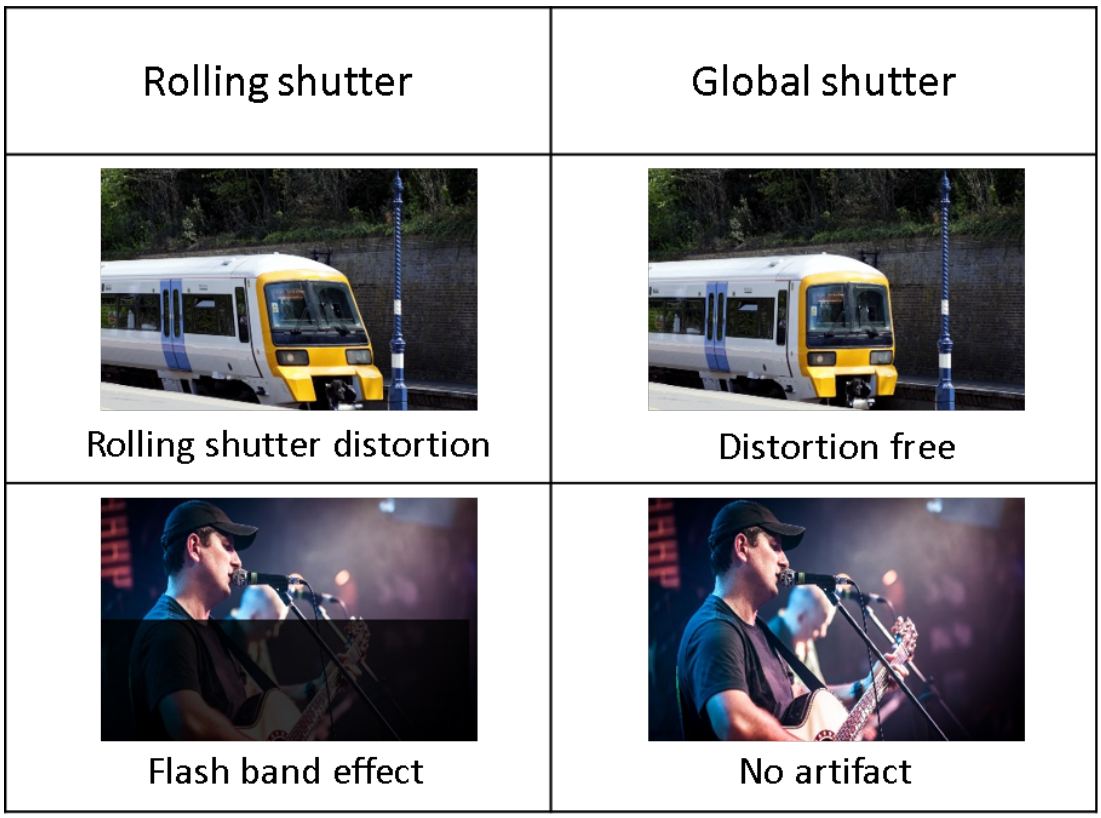

Figure 1

The image quality degradation in the rolling shutter imager is caused by the exposure procedure as shown in Figure 2. In the rolling shutter exposure procedure, pixels in each row are exposed at slightly different instances. This results in a time delay between each row and causes the image distortion when capturing very fast moving objects. On the other hand, in a global shutter imager, each pixel row is exposed simultaneously; therefore, the imager can capture the light signals in every row without a time delay. In addition to the global shutter functionality, imaging sensors for general applications are still expected to have high performance characteristics in all other aspects, including low noise, high sensitivity, high saturation, and high dynamic range. Keeping those additional specifications high while adding

global shutter functionality is one of the many challenges sensor designers face as performance demands increase.

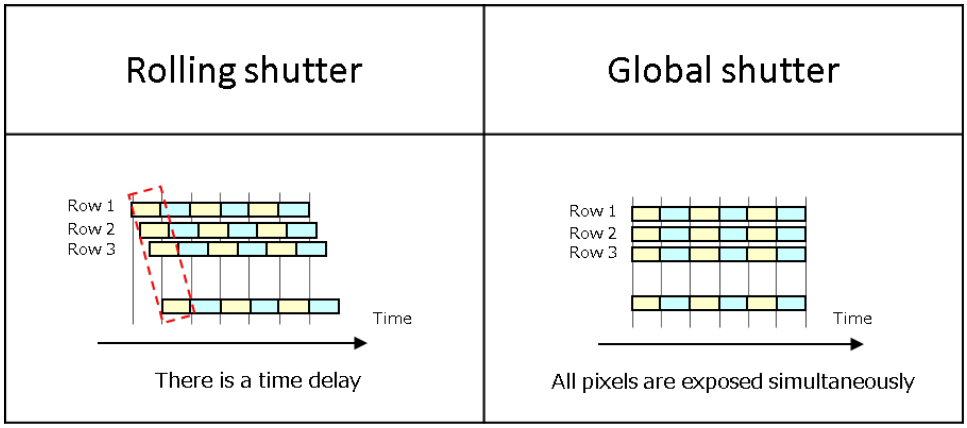

Figure 2

2. Features of Canon's global shutter imager

Canon's global shutter CMOS sensor has the capability to capture fast moving object accurately (distortion-free). Within this new sensor, Canon introduced novel drive technology resulting in a drastically enhanced saturation signal . In addition, Canon engineered a new pixel structure with optimized geometry to collect light efficiently, which achieves high sensitivity and low noise performance. The updated drive technology along with the new pixel design allows sensor performance with a remarkably high dynamic range allowing image creation in situations where there is a wide difference in brightness.

Figure 3 shows an image of Canon's new 5 megapixel, 2/3inch CMOS sensor. It has a square pixel arrangement with 5.33 million effective pixels (2592x2056). The sensor has a global electronic shutter for controlling the charge accumulation time and an all pixel progressive readout of 120fps.

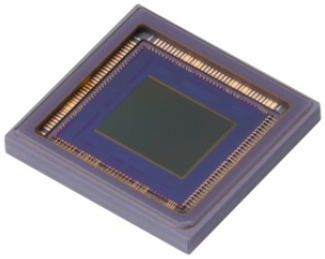

Figure 3

3. Technical advances

For the first time, Canon introduced a light guide structure within the global shutter pixel, making it possible to collect light from a wide variety of angles. The light guide contributes to increased sensitivity and wide incident light angle detection. Figure 4 shows a FDTD (Finite differential time domain method) light propagation simulation with and without a light guide. In this simulation, the incident light angle is 15 degrees.

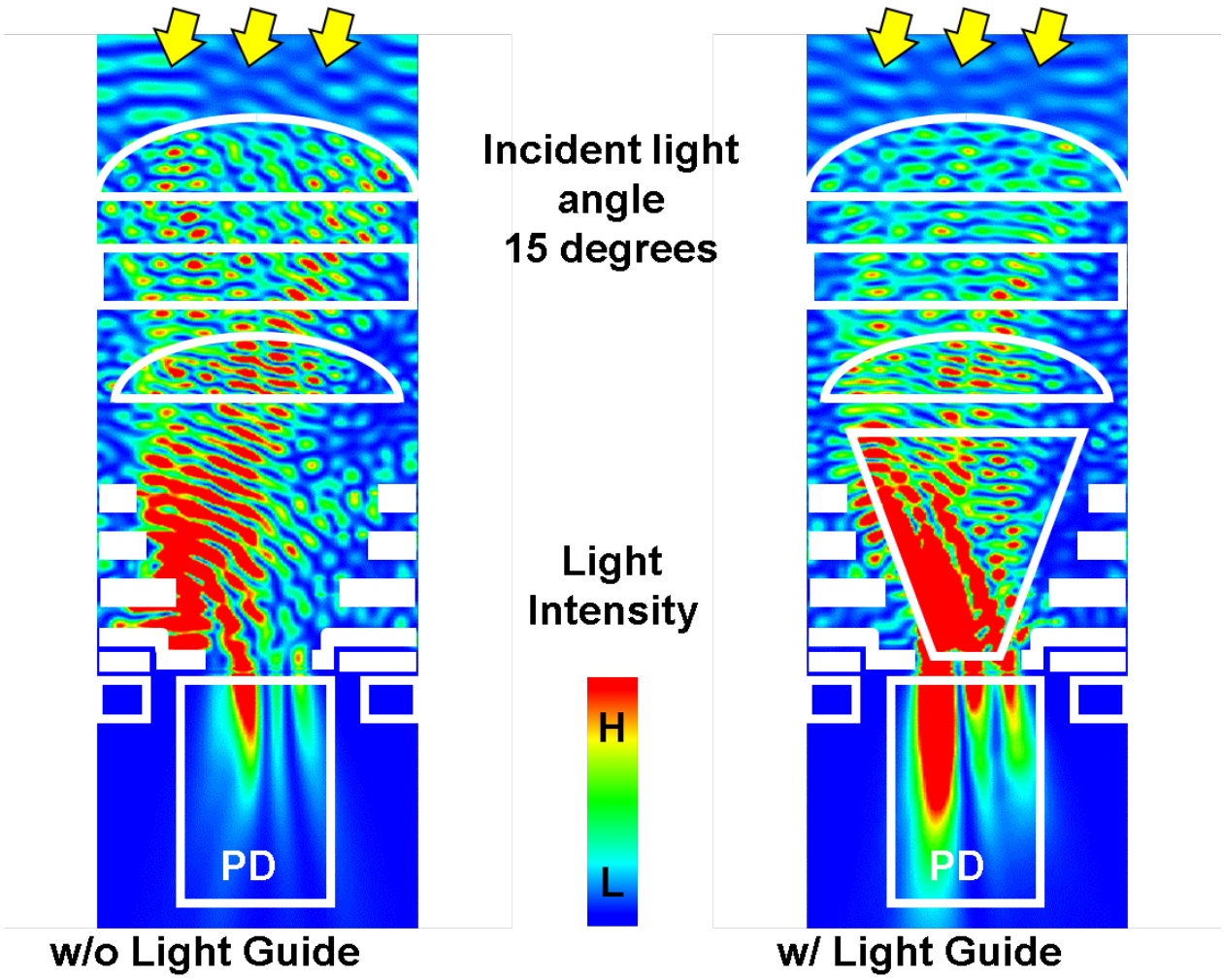

Figure 4

Figure 5 graphically shows the simulation results with other incident light angles considered. . The effectiveness of the light guide can be clearly seen through this simulation and the resulting data.

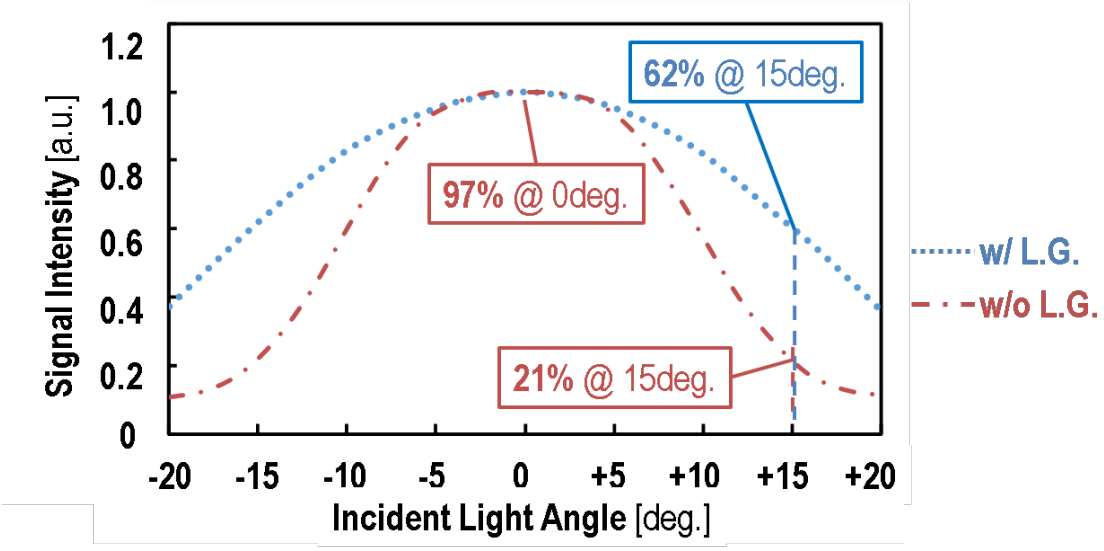

Figure 5

4. Summary

Incorporating superior pixel design, and introducing new drive and light guiding technologies, Canon has created a global shutter CMOS sensor capable of performance in the most demanding situations. Canon's proprietary CMOS sensors are among the most advanced in the world, capturing high-resolution images and featuring accurate color reproduction. The company continues to work to improve the sensitivity and resolution of CMOS imaging sensors, allowing them to enable new scientific and industrial applications.

5. Preliminary Specifications

	Sensor Specification	Note
Sensor Size	2/3 inch (8.8mm x 7.0mm)	
Filter Type	RGB on-chip filter, Monochrome	
Number of effective pixels	2,592h x 2,056v	
Pixel pitch (um)	3.4um	
Maximum Frame Rate (fps)	120fps	
Main Clock Frequency	36MHz	Recommended
Power Consumption	500mW	Typ. Full pixel scan at 60fps
Sensitivity	28,000e-/lux/sec (TBD)	Green
Saturation	14,000e (TBD)	Gain x1
Dark Random Noise	3.0e (TBD)	Gain x4
Dynamic Range	73dB (TBD)	
Power Supply Voltage	3.3V, 1.2V	
Package	180-pin ceramic LGA	
Function	ROI function (8 region) Inverted output function (horizontal and vertical	

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