A Study on CMOS Time-of-Flight Range Image Sensors

2008

Izhal Abdul Halin

Two types of CMOS (Complementary Metal Oxide Semiconductor) image sensors capable of range imaging using the time-of-flight (TOF) method are studied. The first pixel proposed is the CMOS active pixel TOF sensor where a high gain amplifier separates charge into two capacitors connected to its feedback path via switches. The time delay dependant charge separation is confirmed by computer simulation.

Another type of CMOS TOF sensor that uses gates on field oxide structure to acquire time delay dependant charge is also proposed. The proposed technique of multiple integration of time delay dependant charge induced by small duty cycle infrared light pulses aids in reduction of background illumination induced charge effects which is accomplished using background charge draining structures within the pixel. From the fact that this new pixel structure is based on CCD, a small pixel covering only $15 \times 15\mu m_2$ can be realized.

The CMOS gates on field oxide range image sensor with 80,672 pixels was fabricated using a two poly triple metal CMOS process with only one added fabrication step. The derived range resolution equation states that range resolution is inversely proportional to the square root of the number of signal electrons detected and is in close agreement with the measured results. Using a 100ns light pulse width, range resolution is measured to be 2.35cm at 30fps for 1.05V signal intensity. It is improved to 0.75cm at 3fps. This fact proves that range resolution up to the sub-millimetric region is achievable for small pixel sizes.