Enhanced Photon Counting Model for Spectral Detection and Range Enhancement in X-ray Detection

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- Chemistry and Chemical Analysis

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- Detection
- Photons
- Sensors

Charge coupled device (CCD) sensors are the current state of the art in X-ray detection; however, by simply detecting and integrating the amount of X-ray charge deposited on each sensor of the pixel in the sensor over a period of time, CCDs are subject to readout noise. CCDs also suffer from detector pulse pileup, where a photon strikes the detector before the previous photon has been discharged, causing an underestimation of the number of photons actually striking the sensors. As a result of their limited sensing abilities, CCDs have a limited linear dynamic range and their spectral imaging is not strong.

Researchers at Purdue University have developed a statistical model for X-ray photon counting, representing the newest challenger to the state of the art in X-ray detection. The statistical model was developed to model the observed energy distribution across an array of photon counting sensors. Specifically, the model was used to mathematically calibrate the response of each pixel in the detector for its gain, variance, and charge sharing. While most of the potential advantages remain untapped, it is known that X-ray photon counting can eliminate readout noise. Also, the X-ray photon sensors can detect the distribution of observed photon energies, which inherently contain more information than the simple measurement of the number of photons that struck the detector. This model can also compensate mathematically for detector pulse pileup, providing a more accurate estimate of the X-ray photon distribution. Applications of the statistical model can be used to calibrate X-ray photon counting detectors more accurately, compensate for pulse pileup effects, increase the linear dynamic range of the detectors, and provide enhanced spectral imaging capabilities far beyond the previously demonstrated two-color separation.

Advantages:
-Eliminates readout noise
-Scans contain more information

Potential Applications:
-X-ray photon counting calibration
-Airport security

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