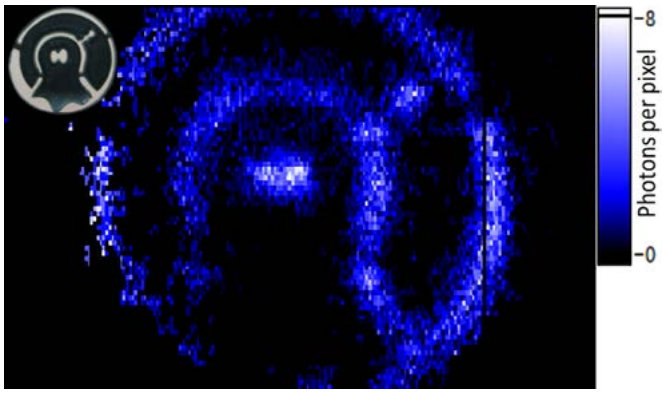
3D-GV recording of a dynamic scene with high depth resolution.



Quantum Ghost Imaging of an object with only one photon per pixel on average.

Active laser sensorics for reconnaissance

Military reconnaissance under adverse atmospheric conditions demands imaging techniques capable of returning high-resolution images through scattering and turbulent media. Active imaging is the method of choice for critical applications where high precision and reliability is required. Complete control over the illuminating light source enables extraction of a high level of information about the characteristics of distant targets, especially detailed range 3D information, as shown in the picture on the left. In addition to that, pulsed active imaging systems can gate the time of detection which suppresses noise and enhances visibility through fog, smoke and fire.

Gated viewing (GV) offers the perfect blend of 3D detection of non-cooperative targets in adverse conditions and detection speed. It utilizes a pulsed laser that is synchronized with a camera to illuminate distant objects of interest. A suitable timed gate only selects photons that are reflected by the object and suppresses photons belonging to its fore- and background. Thereby, you obtain a much higher target/background contrast than for a non-gated image. Furthermore, backscattered photons from particles in the atmosphere between sensor and object are not captured, thus providing advantages in conditions with poor visibility.

In a project commissioned by the German government, we are working on enhancing the performance of systems in use and developing and benchmarking modern systems for active imaging.

The systems typically operate in the short-wave infrared, retina-safe wavelength range with good properties for atmospheric propagation. The pulse energies range from several tens of microjoule in scanning mode up to tens of millijoule in flash mode. As non-detectability as well as extended coverage of spectral regions is of outstanding importance for operational use, we are investigating novel approaches to active imaging such as Compressive Sensing and Quantum Imaging.

With Compressive Sensing it is possible to detect distant objects using fewer detections compared to established active imaging systems by having control over the spatial distribution of the illumination pattern for each frame. This method requires only a single element detector for detection as the spatial information of the illuminated object can be reconstructed from the reflexion of these patterns.

Quantum Imaging has the potential to obtain images with a minimal number of single photons (picture on the right) and those systems can stay below detectability for external observers. The broadband quantum light source emits photons randomly in space and time and can thereby ideally mimic background noise. Only the sender has the key to separate real background noise from real signal via additional information from entangled photon partners. Furthermore, quantum systems are inherently hardened against hostile jamming attacks.

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