Real-time 3-D reconstruction of complex scenes from long distances are shaping our present and future

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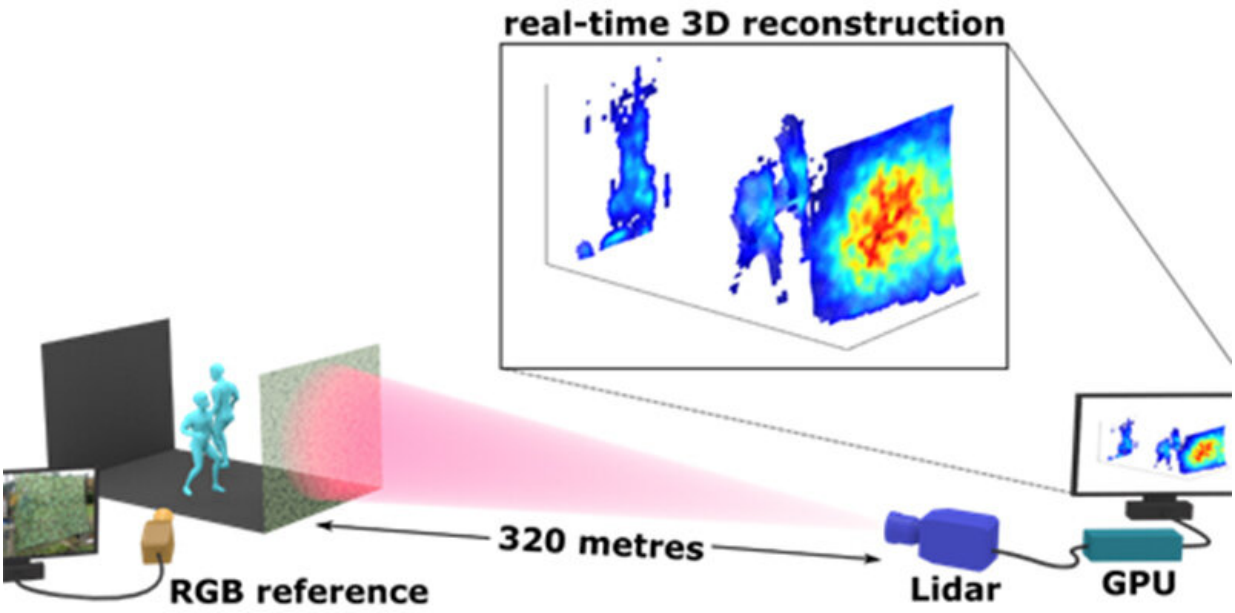

Credit: Heriot-Watt University

Researchers at Heriot-Watt University, in collaboration with researchers from the University of Toulouse, France, have proposed a novel framework that combines statistical models with highly scalable computational tools from the computer graphics community to

accurately extract the 3-D information in real-time (50 frames per second).

The novel method allows for target detection and imaging through cluttered scenes, enabling robust, real-time target reconstruction of complex moving scenes, and a fore-runner for the eventual sensing technologies needed for long-range automotive sensing, a key capability for next generation driverless cars.

Reconstruction of 3-D scenes has many important applications that are shaping our present and future, including autonomous cars, environmental monitoring and defense.

Researchers from Heriot-Watt have announced the remarkable new results on real-time image reconstruction in the prestigious science journal, *Nature Communications*.

One of these researchers, Prof. Stephen McLaughlin, head of the School of Engineering and Physical Sciences spoke of the research.

He said: "The ability to deliver real time 3-D video reconstruction enables the deployment of new sensing technologies for long-range automotive sensing, a key capability for next generation driverless cars."

Prof. Gerald S. Buller from the Institute of Photonics and Quantum Sciences said: "This work represents the most advanced real-time 3-D image reconstruction of a complex real-world scene yet demonstrated, placing Heriot-Watt firmly at the forefront of international efforts in this emerging field."

Dr. Yoann Altmann, RAEng Research Fellow at the School of Engineering and Physical Sciences said: "This work combining photonics, statistical image processing and computer graphics tools really

illustrates how significant leaps forward can be achieved via multidisciplinary research."

Primitive laser-based radar—or lidar—techniques are currently being used in recent generations of cars to assess distance to neighboring vehicles or other potential obstacles.

Heriot-Watt has pioneered the use of the advanced time-correlated single-photon counting lidar approach which several advantages over existing approaches, allowing the use of eye-safe laser sources and enabling excellent resolution at long range (hundreds of meters to kilometers).

Recently, this technique was used to successfully reconstruct high resolution 3-D images in extreme environments such as through fog, with cluttered targets, in highly scattering underwater media, and in free-space at ranges greater than 10 km.

However, until now, a major limitation has been the significant amount of time required for the analysis of the recorded data. Recovering the 3-D information from the individual timed single-photon detection events is a challenging task that requires intensive image processing algorithms. Previous methods required dozens of seconds or even minutes to process a single lidar frame or imposed restrictive assumptions on the scene to recover, hindering practical 3-D imaging applications.

The findings were published today, Friday, November 1 in the scientific journal, *Nature Communications*.

More information: Julián Tachella et al. Real-time 3D reconstruction from single-photon lidar data using plug-and-play point cloud denoisers, *Nature Communications* (2019). DOI: 10.1038/s41467-019-12943-7