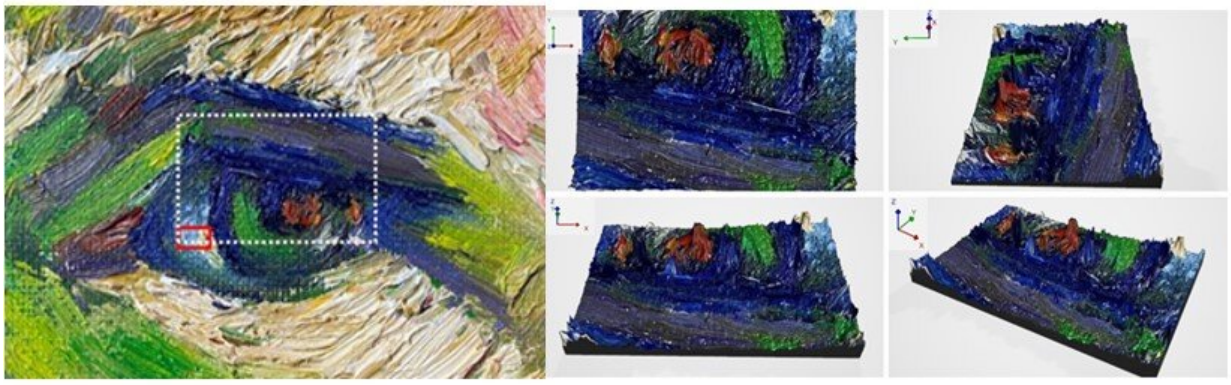
Laser-based technique captures 3-D images of impressionist-style brushstrokes

May 20 2020



The researchers acquired OCT imaging data of an impressionist-style oil painting (left image). OCT images within the dotted line were digitally stitched together to produce the 3D images shown in the panels on the right. Credit: Yi Yang, Penn State Abington

Researchers have developed a new strategy that uses optical coherence tomography (OCT) to acquire both the surface and underlying details of impressionist style oil paintings. This information can be used to create detailed 3-D reconstructions to enhance the viewing experience and offer a way for the visually impaired to experience paintings.

"Visitors to art museums can't closely examine paintings and see the artists' techniques because of security and conservation concerns," said research team leader Yi Yang from Penn State Abington. "Our new

technology can create 3-D reconstructions that can be rotated and magnified to view details such as brushstrokes. This would be especially useful for online classes."

Yang and colleagues from Penn State University Park and New Jersey Institute of Technology report the new technique in the Optical Society journal *Applied Optics*. The research team brought together specialists in art history and conservation with electrical and optical engineers.

The new approach combines OCT with a mechanical scanning stage and new software that allows real-time sampling and removal of image artifacts. Information captured by the technique can be used to 3-D print samples so that people with vision impairments can use touch to experience painting techniques such as Van Gogh's brushstrokes and the pointillism of Seurat's works.

"The ultra-high definition 3-D information can also be used to repair damaged art by allowing a conservator to 3-D print the damaged portion and attach it to the original painting," said Yang. "In addition, the imaging technique can capture high resolution details of artworks that can preserve a digital copy in case of worst-case scenarios such as war, terrorism, natural disaster, heist and other catastrophes."

Making OCT useful for art analysis

OCT is a laser-based non-invasive imaging technique that can capture images with micrometer resolution. Although it is commonly used for biomedical applications, the imaging technique is useful for art analysis because it can simultaneously capture both topographical information from a painting's surface and the structure of underlying layers.

"Because today's OCT systems are optimized for biomedical applications, they have a limited scanning range that severely limits the

speed of collecting data from large areas," said Yang. "We integrated a robotic scanning platform with an advanced OCT system and image processing software to capture the OCT data of paintings beyond the scanning range of typical commercial OCT systems."

To increase the field of view, individual OCT images captured using the robotic scanner are digitally stitched together to form a larger image. To improve this process, the team developed software that removes distortions and other image artifacts that commonly arise during this type of digital stitching.

The researchers demonstrated their new technique by acquiring OCT images of a portion of an oil painting that mimics the unique impressionist style brushstrokes and measured 10 by 10 centimeters. They also produced a digital 3-D model of the scanned area of the painting.

Now that the researchers have proved the new concept, they plan to optimize their system by making improvements in both the hardware and software.

More information: Xingyu Zhou et al, Spectral 3D reconstruction of impressionist oil paintings based on macroscopic OCT imaging, *Applied Optics* (2020). DOI: 10.1364/AO.390326

Provided by The Optical Society