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RESEARCH NEWS

Dating works of art using infrared light

Watermarks solve the mysteries surrounding Rembrandt's studio

Is it a sketch of historic significance, or a fake from the 19th century? Such questions are difficult even for art experts to answer. A new infrared process developed by Fraunhofer researchers makes watermarks visible on paper to allow for more precise dating.

Is that a genuine Rembrandt or a forgery? Is it a masterpiece, or worthless copy from the 19th century? In many cases, these questions can be answered with the help of watermarks, which provide information about the time period in which the paper, and thus the artwork itself, was produced. Starting around the 12th to 13th century, every paper mill used wire pattern which were fixed on the paper-making sieve to imprint the paper sheets they produced as a type of trademark. Over the years, however, these wire pattern would wear out to the point that the details in the imprinted markings were no longer visible. In some cases, they were reconditioned or replaced by the operators of the paper mills. Because of this, the watermarks can tell us fairly precisely when the paper was made – within the span of a few years. There is already abundant data available for this purpose. To examine the watermark, the typical procedure is to expose it to visible light. Because the paper in the imprinted area allows more light to pass through, it should be easily visible – at least in theory. However, in the real world this is not always the case, as the watermark is often obscured by ink or brushstrokes to the point that it is unrecognizable.

Infrared light sees through paint and ink

Researchers at the Fraunhofer Institute for Wood Research, Wilhelm-Klauditz-Institut, WKI in Braunschweig have come up with a solution to this dilemma. Their findings are the result of a collaboration with colleagues at the Herzog-Anton-Ulrich-Museum and the Institute for Communications Technology (IfN) at the Technical University of Braunschweig. "We didn't scan the papers with visible light, but instead used infrared light, or thermal radiation," says researcher Peter Meinlschmidt at the WKI. "The frequently used iron gall ink is transparent under this light. This means you see only the watermark without the ink or paint getting in the way." Instead of detecting differences in the light, the researchers look for deviations in the thermal radiation, which is a highly accurate method. The cameras can even spot temperature differences of 15 millikelvin – just fifteen thousandths of a degree Celsius.

Editorial Notes
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The team has already successfully dated around 60 sketches associated with Rembrandt using this technique. Here's how it is done: the researchers clamp the paper in a passe-partout, which they position between a heating plate (the infrared heater) and an infrared camera. At this point it is crucial that the heat be evenly distributed. This requires that the paper be kept a suitable distance from the heat source, as direct contact would result in uneven heating.

Does the thermal radiation damage the artworks? "The heat is harmless. The infrared lamp heats the paper to a far lesser degree than fingers do when touching the paper," Meinlschmidt explains. However, speed is of the essence, as the watermark is visible only for a few seconds. This is because the longer the paper is exposed to the heat source, the more intensely the ink-darkened areas heat up, which interferes with the temperature variations brought about by the watermark.

Inspecting manuscript paper for authenticity

The infrared cameras the researchers are currently using are expensive: the entire system costs around 80,000 euros, making it affordable only for large libraries like the state libraries of Bavaria or Berlin. For this reason, researchers are currently working with the Saxon State and University Library (SLUB) in Dresden to lower the system's price down to 20,000-30,000 euros. Researchers will employ a camera with a resolution of only 50 millikelvin, as opposed to 15 millikelvin, which will cost the museums just 5,000 instead of 50,000 euros. "We plan to compensate for the lower resolution through better image processing; for instance through the use of Gaussian filters, which remove noise, or differential images, which eliminate inconsistencies in the paper," Meinlschmidt says. The first version of the software is currently being tested at the Saxon State Library in Dresden using historic manuscript pages, and the system should be ready for use in two to three years.

Automatic synchronization with the database

Once a watermark image has been stored, researchers have to be able to locate this exact same image again in the database. At present, this tedious and difficult task has been performed manually by trained experts. "Soon this classification will be done using search algorithms," says Meinlschmidt. In the future, researchers will be working towards this objective on behalf of the state library in Berlin. The automatic recognition technology should be ready for use in approximately four years. Researchers are also devoting their time to finding out which colors are transparent at which infrared light wavelengths. To put it another way, they want to know which colors are most appropriate for which types of infrared light. Once this is known, it would be possible to find the optimal wavelength for every piece of art, which will improve the visibility of the watermarks still further.

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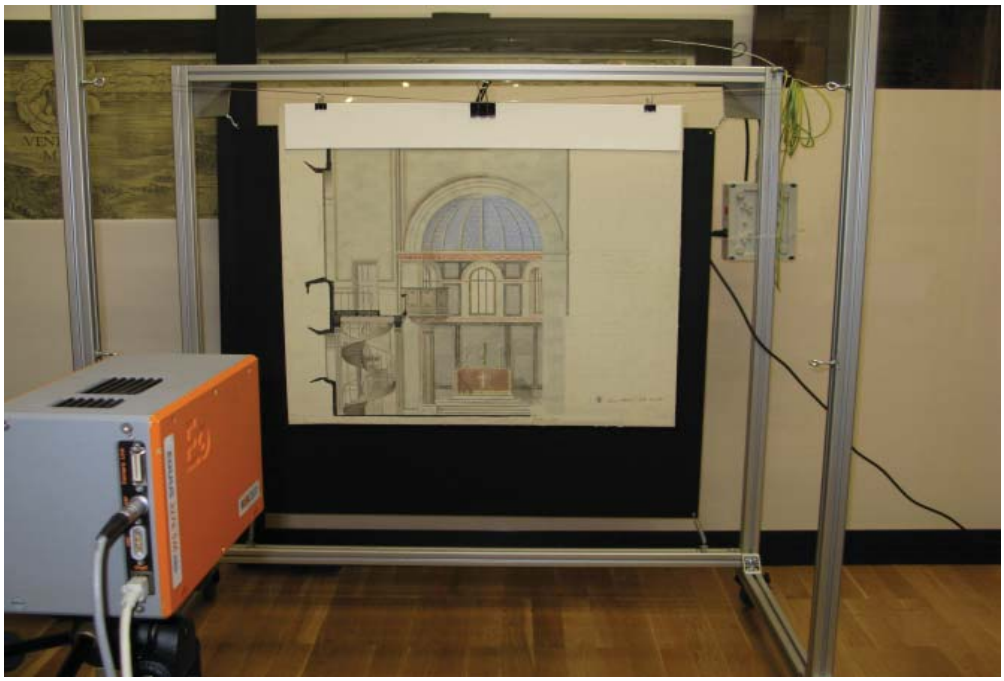
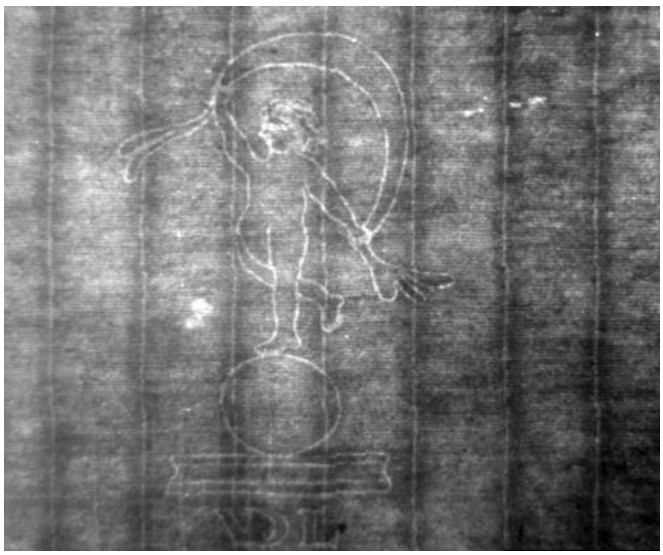


Large-format drawings by architect Karl Friedrich Schinkel are scanned using the infrared camera. © Fraunhofer WKI | Picture in color and printing quality: www.fraunhofer.de/en/press



A typical watermark as it would be found on the paper (thermography).© Fraunhofer WKI | Picture in color and printing quality: www.fraunhofer.de/en/press

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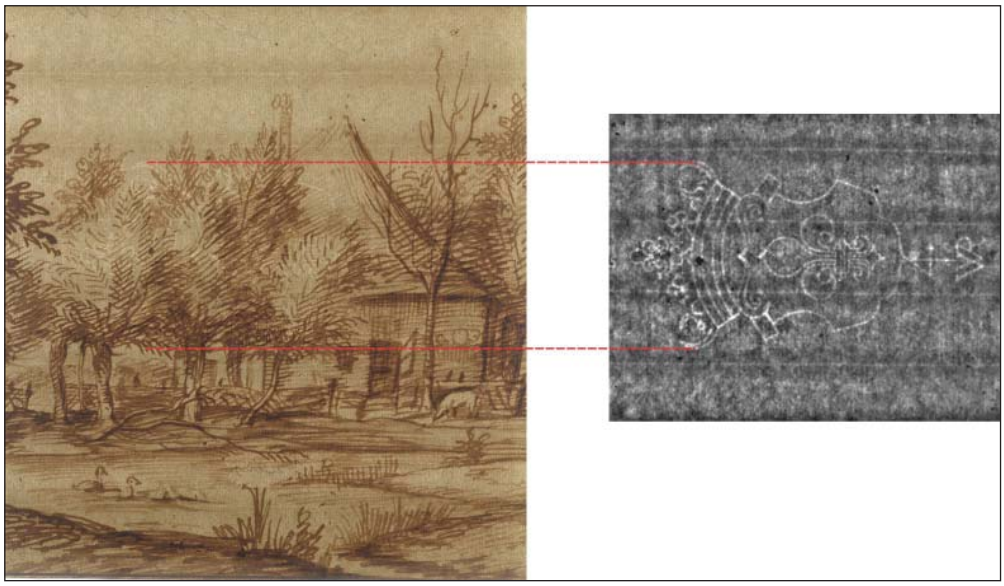

Photo of a drawing by Jan Lievens of the Rembrandt School (left). In this backlit image, the crowned fleur-de-lis watermark is not visible, unlike in the thermographic image on the right. © Herzog Anton Ulrich-Museum, Braunschweig | Picture in color and printing quality: www.fraunhofer.de/en/press

Image of a watermark (above) from a Rembrandt sketch (below) taken by the imaging team: Dr. Volker Märgner of TU Braunschweig; Prof. Thomas Döring, director of the print collection at the Herzog Anton Ulrich-Museum in Braunschweig; and Peter Meinlschmidt of Fraunhofer WKI. © Herzog Anton Ulrich-Museum, Braunschweig | Picture in color and printing quality: www.fraunhofer.de/en/press