Comparative study of mid-20 th C. Art using THz and X-ray imaging

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***Abstract*—We systematically studied the mid-20th century Italian oil panel painting "After Fishing" by Ausonino Tanda using x-ray transmission and terahertz time-domain transmission and reflection spectroscopic imaging (THz-TDSI).**

I. INTRODUCTION

We systematically studied the mid-20th century Italian oil panel painting "*After Fishing*" by Ausonino Tanda using x-ray transmission and terahertz time-domain transmission and reflection spectroscopic imaging (THz-TDSI). The images were compared to identify the strengths and limitations of each technique, as well as qualitatively and quantitatively ascertain whether terahertz imaging can become a realistic alternative to x-ray imaging as a diagnostic tool for paintings [1].

After Fishing is on an unbleached, multi-ply paperboard substrate. While the paint was determined to have oil as its binder, the exact pigments are unknown. The paint was applied, unusually, using a palette knife, resulting in non-uniform layer thicknesses and coarse blending.

Two THz-TDSI scanners were used to complete this study. The first was a Picometrix T-Ray 4000 (TR4K) system, which was easily adaptable for the transmission and reflection configurations. The second was a Teraview TPI Imaga 2000 (I2K), which had been optimized for measurements in reflection. The x-ray radiograph was obtained using a standard, medical-grade digital x-ray instrument.

The terahertz images were generated from the time-domain (peak amplitude, time-of-flight, and c-scan analysis) and frequency-domain (c-scan) signals. Due in part to the more rigid setup, the pulsewidth and bandwidth of the I2K was superior to the TR4K, such that wavelet-based deconvolution provided enough axial resolution to resolve peaks reflected from fine layers and generate b-scan cross-sections. The x-ray digital image was obtained from the energy transmission density.

The images from each system were imported into proprietary image database software designed by Profilocolore, which registers (i.e., resamples and aligns) the images so that they can be compared and combined. Processes include principal component analysis, cross-correlation and RGB band addition.

II. RESULTS

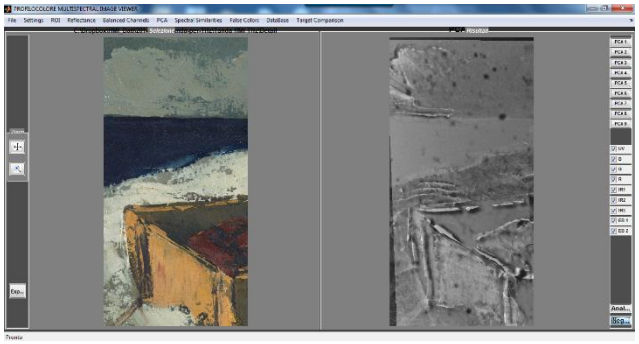

Fig. 1: Screenshot of the image database software, on the left is a photograph of a section of the painting, on the right is a 4th principal component fusion of the THz peak to peak transmission amplitude and the x-ray images.

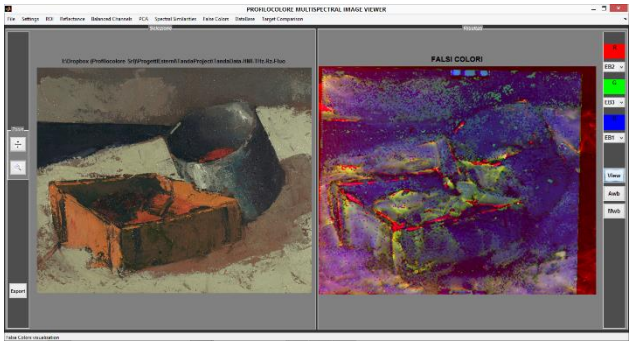

Fig. 2: Screenshot of the image database software, on the left is a photograph of the entire painting, on the right is an RGB false color fusion of the THz reflection time-of-flight, maximum reflected peak amplitude and the x-ray images.

III. SUMMARY

We were able to qualitatively and quantitatively show that THz-TDSI transmission and reflection measurements both produce images with a high degree of correlation to x-ray radiographs—within the limits of diffraction-limited spatial resolution—while also providing information on materials undetectable by x-rays.

REFERENCES

[[1] J. B. Jackson, M. Melis, G. Walker, D. Giovannacci, M. Miccoli, D. Martos-Levif, J. Bowen, and V. Detalle, "Terahertz and multispectral imaging of a Tanda painting," in *Proceedings of SPIE*, 2015, vol. 9527, p. 95270K.