PORTABLE X-RAY IN THE SERVICE OF ART

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ABSTRACT

Digital Radiography is becoming increasingly popular in the service of art. Museums, antique dealers, restorers, experts, auction houses and galleries, and institutions all use the information that an X-ray image can reveal about pieces of art, antiques and archeological artifacts.

X-ray assists in the authentication of artifacts; determination of their original period and detection of fraud. X-ray also helps learn about drawing techniques and reveals the scope of restorations – thus assisting in valuating artifacts. X-ray exposes internal mechanisms to help determine manufacturing techniques of antiques and their time, and also reveals changes made in pictures by exposing all the layers, and detects corrosion and erosion of artifacts.

Vidisco's portable flat panel X-ray inspection systems Flat foX-17 and foX-Rayzor add more benefits as their small size and their portability allows for efficient inspections in any conditions, whether in a museum cellar or out in an archeological site. Images are created upon request and results are generated on the computer screen on site for immediate analysis. The system is handy and allows the inspection of items to take place with minimum movement of the item and maximum discretion and security. Fragile items and items of all sizes can also be efficiently inspected. Our Dual Energy Organic Discrimination Package can also help reveal new insights into the artifacts inspected and restoration techniques used on them.

The article will show images taken in museums all around the world, demonstrating X-ray of original works of art as well as other artifacts from Europe and the USA, and detailing all types of inspections that can be conducted with the Vidisco systems, while emphasizing the enhanced efficiency and special benefits of conducting such inspections with our systems.

GENERAL

Non destructive testing is becoming more and more prominent in the world of art analysis and inspection. As the phenomenon of fraud expands, testing and authentication become more important to museums and to private collectors alike. Restoring labs also enjoy the benefit of NDT when they look to conserve priceless objects. X-ray inspections allow us to see the invisible. We can learn about the structure of an object in order to better understand how to prevent its further deterioration and conserve it, or in order to place it in the correct historical art context and evaluate it. The use of X-ray in the inspection of art and artifacts is not new. The use of portable DR inspection systems is new in this field, and it brings with it many simplifications to the inspection process shortening the time to results.

Vidisco Ltd. produces portable DR inspection systems for over 20 years. We are however relatively new in the art market and in our quest to learn more about the needs of museums, institutes and restoration firms we visit these regularly. This article will describe the main principle of our portable DR systems and will show results from our visits to the Tel-Aviv Museum of Art, the Brooklyn Museum, the National Gallery in Washington and CIRAM - the Laboratory for Art's Sciences, located in France. We will demonstrate X-ray images taken wit the Vidisco Flat *f*oX-17 and *f*oX-Rayzor systems, along side pictures of original works of art and artifacts while sharing the discoveries made during these visits.

HOW DO AMORPHOUS SILICONE FLAT PANELS WORK

The Amorphous Silicone Digital flat panel is composed of a Gadox scintillator and an array of Amorphous Silicon (a-Si) photodiodes. The X-Ray tube sends a beam of X-Ray photons through a target. The photons that were not absorbed by the target reach the a-Si flat panel and strike the layer of scintillating material that converts them into visible light photons. The light photons reach the photodiodes which convert them into electrons that activate the pixels in the amorphous silicone. The electronic data that is generated from this process is converted to a digital signal that is received by the computer and the software converts this information into a high quality image. See Figure 1.

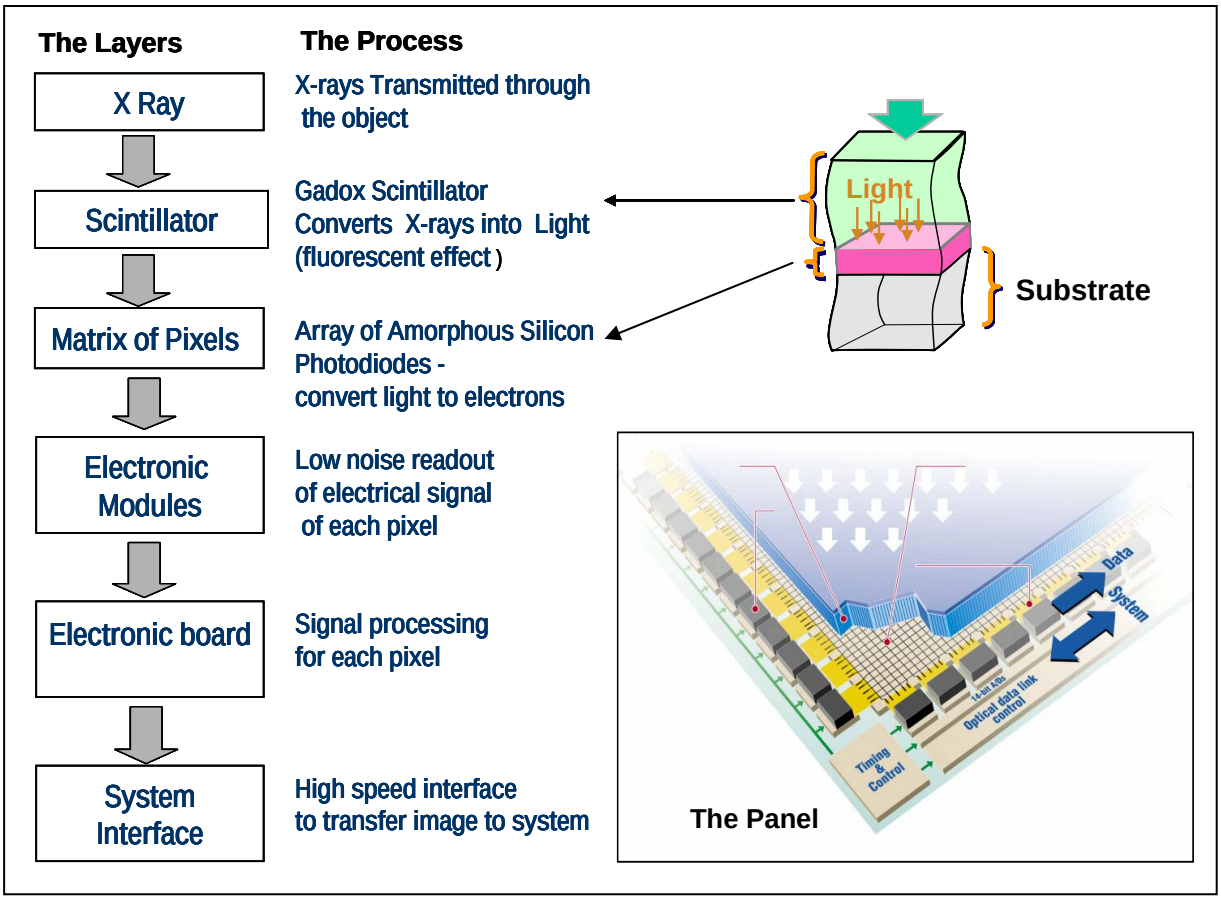

Figure 1: Amorphous Silicone Flat Panel Structure

TEL AVIV MUSEUM OF ART

The restoration department of the Tel-Aviv Museum of Art is faced daily with the concerns of art evaluation, authentication and conservation. NDT has become an important tool to learn the details of each new object that comes into the lab. Authentication criteria and manufacturing techniques are researched on a continual basis. We met with the Oil Painting and Paper restoration specialists in the museum's lab. They explained their major concerns to us: Consolidation and restoration efforts must be differed from Pentimenti and intended corrections. Reconstructions must be examined to discover deceitful assemblies and fraud. Painting characteristics and layers must be exposed in order to learn more about a painting before its restoration. Paper making methods and details of paper fibers can determine origin and authenticity of a parchment. X-ray is an inspection method that can help study all these aspects in an art object and provide the knowledge that the restoration team needs to reveal for their work [1].

Different Pigment Materials

We reviewed a painting by Ziona Tagar. The portrait of the poet Shlonski which was painted in 1924, oil on canvas. The canvas was lined and the team at the museum wanted to know if the original canvas had entailed any writings or information about the painting. Our X-ray of this painting did not reveal that such writing had been done. We were able to learn about the content of the pigments used to paint different areas. The forehead of the portrait was darker in the X-ray, indicating the use of pigments that have low content of unpenetratable materials.

We also reviewed a Jan Lievens 1626 oil paining on canvas "The Angel Releases Peter from Confinement" to ensure it is indeed a work from this esteemed artist. The painting is known to have been smuggled by a Russian Kozak in the Second World War, so it was necessary to verify that it is indeed Lieven's work.

We used a portable 200kV x-Ray source and shot an X-ray of 40 pulses (≈2.8 seconds). The levels of White Led paint used to create light on the faces of the characters in the painting were corresponding to the usual method of the artist, thus enabling to remove the initial fear of fraud. In addition a paint scratching effect in the beard of the older man could be clearly seen in the X-Ray. This technique too is typical for Jan Lievens (see Figure 2).

Figure 2: Jan Lievens Oil on Canvas 16th Century; Painting and Corresponding X-Ray Image

Various Exposure Levels

Exposure levels can be adjusted from the software by changing the time/ number of pulses of the X-Ray or alternatively the distance of the source. Different exposure levels reveal different information. One can combine the layers of information immediately in order to learn more about the inspected object by using an overlaying function in the Flat*f*ox software. Graphic enhancement tools such as Adaptive Histogram and 3D embossing effect are also available for immediate use to shed more light on the information in the X-ray image. We examined a 1515 painting by Benvenuto Di Garofalo. "The Circumcision of Jesus", oil on wood. We took X-ray shots of this picture in different levels of exposure and then overlaid them on top of one another to expose more delicate details of the structure and layering of the paint.

Layers of Painting and Sub-Paintings

Our major contribution on the visit to the Tel-Aviv Art Museum was in conducting an X-Ray of oil on canvas painting by Moshe Castel. "Synagogue on Saturday" from the beginning of the twentieth century. The restoration team at the museum had already examined the layer structure of the paint and came to the conclusion that there is more than one layer to this painting. They wanted to know what was hiding behind the external layer and we were only to happy to comply with their wish.

Using the Vidisco Flat *f*oX-17 Amorphous Silicone DR system, we took 6 images of this painting in the form of a grid with overlapping parts (see Figure 3). The darkened frame indicates the size of each image taken (28cmX40cm). The overlapping areas are indicated with stripes. The numbers show the order of taking the images. Each image was taken using the same level of exposure. We used a 270kV portable, pulsed X-Ray source and shot image using 40 pulses (≈2.8 seconds). The source was located at about 1.20m away from the painting. The flat panel was directly behind the painting.

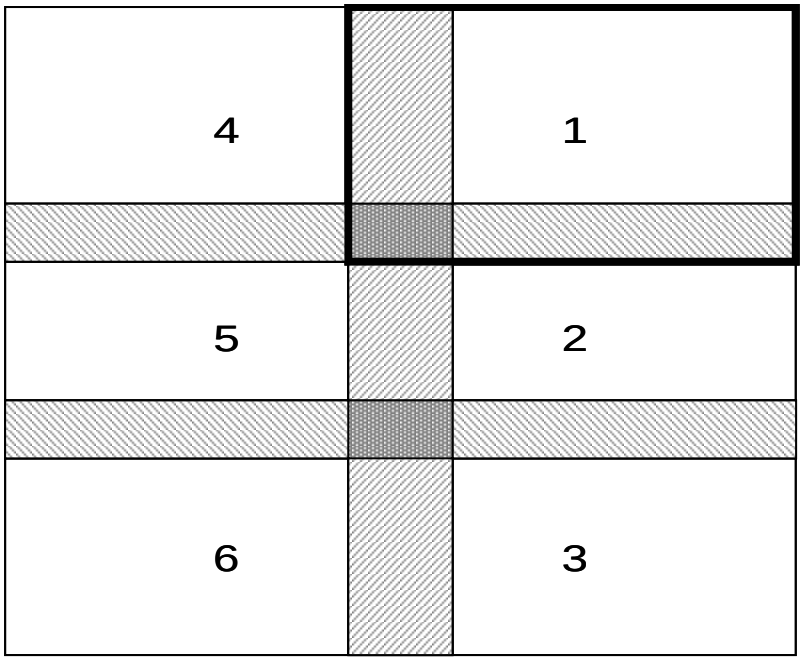

Figure 3: Image Grid Map

This Image grid map was important for the assembly of the X-Ray of the entire image. Using our professional NDT Flat*f*oX software, we stitched a complete image out of the six parts. The stitching was done automatically by the software, first stitching together the three images on the right (images 1-3), then the three images on the left (images 4-6) and then stitching together the two combined images. The result revealed a portrait of a lady under the scenery painting (see Figure 4).

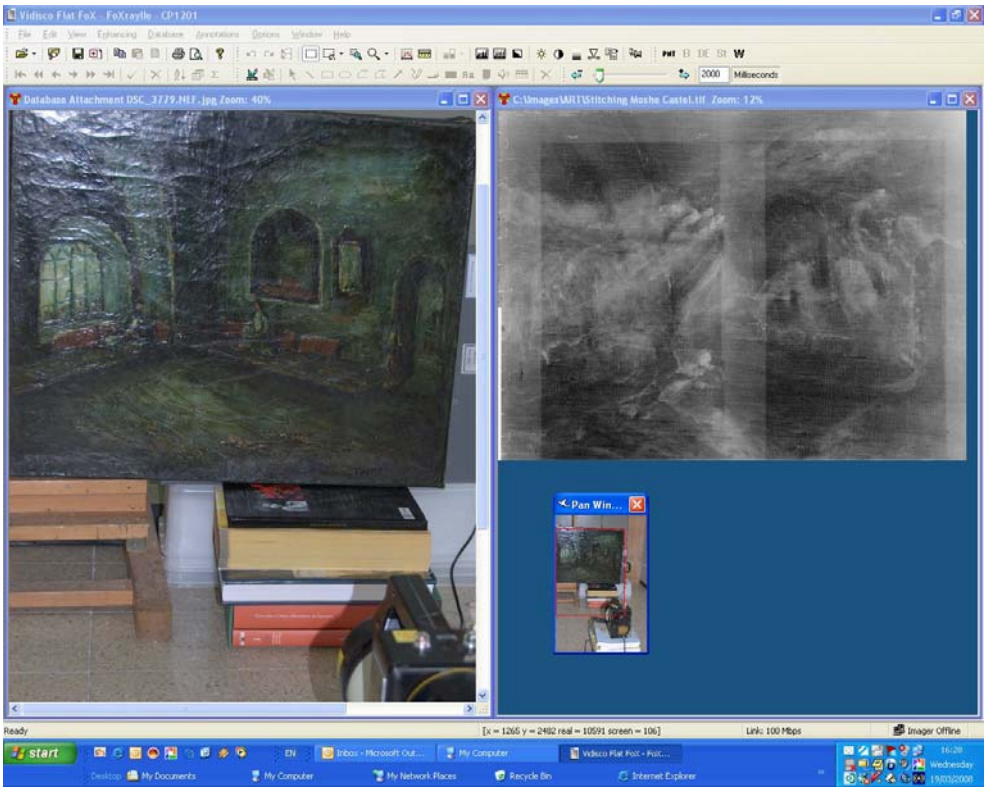

Figure 4: Castel Painting and Corresponding X-Ray Images in the FlatfoX Software Screen

The entire process of taking the images and assembling them together took less than 15 minutes. Most of this time was required to set the picture in place for each image.

Vidisco Ltd. has been producing portable X-ray inspection systems for over 20 years. Our expertise has enabled us to develop a fully portable battery operated DR system. We offer a cost effective system that enables X-ray inspection of art objects in any location. Whether in a museum cellar or out in an archeological site, our systems can be placed anywhere and results are obtained immediately. Analysis on site allows for efficient testing and confidentiality.

Vidisco DR systems provide X-ray images on a laptop screen within seconds. Each image is stored in a data base and one can document the time and place it was taken and for what project/ purpose. External video and still images can also be taken using a video camera that can be provided with the DR system as an accessory. The external images can then be saved together with the corresponding X-Ray images for comprehensive documentation.

THE BROOKLYN MUSEUM

The Brooklyn Museum in New York [2] owns a Vidisco *fo*X-Rayzor portable DR system and they use it in combination with a Seifert X-Ray source. Using a portable X-Ray system to examine a mummy is especially efficient, as the system can be set up around the examined artifact, allowing for minimum moving of the object. Figure 5 shows an X-Ray image that was taken using a 270kV portable pulsed X-Ray source with an exposure of 10 pulses (≈0.7 seconds).

The dog mummy X-Ray image reveals a break in its neck. It is assumed this was done intentionally when the owner of the dog died, so that the canine could be buried with its master.

Figure 5: Dog Mummy X-Ray

THE NATIONAL GALLERY IN WASHINGTON D.C.

In a visit to the National Gallery in Washington D.C we were confronted with a small Lead Bronze Statue, a Renaissance masterpiece, by Antico. Despite the hard to penetrate material, we were able to discern the exact inner structure of the statue with X-Ray images taken with a Flat *f*oX-17 panel (see Figure 6). We used a Balteau 320kV X-Ray source and exposed the statue to an X-Ray for 3.5 seconds. This Status is of vital importance because the artist who made it, Antico, is known to have brought back antique Bronze casting methods (Indirect Casting) again into use in the Renaissance period.

Figure 6: Antico Lead Bronze Sculpture, X-Ray Image

CIRAM

We visited CIRAM, the Laboratory for Art's Sciences, in France. They specialize in analysis, datation, tracing and securing of works of art and archeology. We used the *f*oX-Rayzor system and inspected Ivory statuettes in order to create an X-ray "fingerprint" of the artifacts for their future identification (see Figure 7).

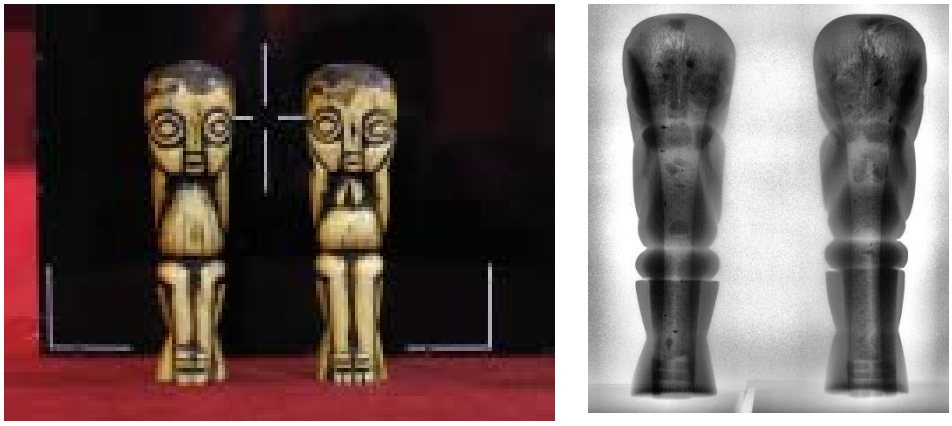

Figure 7: Unique Finger Print of Ivory Statuettes

An X-ray of an antique rifle enabled the CIRAM specialists to see the mechanism of the object (see). This helped understand its manufacturing technique and from this its antiquity could be determined. Placing artifacts in the correct context of time and iconography is an important part of documentation and evaluation of such objects.

Figure 8: Rifle and the X-Ray Image of its Mechanism

PORTABLE DR INSPECTION SETUP

The Vidisco portable DR system basic setup is similar to that of any X-ray inspection system in that the inspected object must be placed between the X-ray source and the a-Si panel, which receives the X-Rays and turns them into an image (see Figure 9). An image is acquired within seconds for immediate analysis.

Our digital flat panels enable 16,384 gray levels. This means the amount of detail and information that is produced by these super sensitive panels is very high. With our special Window Leveling tool one can change the spectrum of grey levels that is viewed on screen and thus extract different layers of information while taking only one X-Ray shot. With film one would have to take more than one image, develop it and then compare the results manually. Using our professional NDT FlatfoX software, the digital image can be enhanced with graphic tools such as adaptive histogram and 3D embossing effect along with the already mentioned Window Leveling, in order to maximize the information that can be extracted from an image for immediate and detailed analysis.

Vidisco systems can work with any industrial continuous X-Ray source, but we supply the systems with a portable pulsed X-ray source (Golden). The energy levels of the X-Ray is therefore constant (we have sources with voltage of 150kV and 270kV) and we can control the overall exposure level by changing the number of pulses/ the time of exposure and the distance between the X-Ray source and the inspected object. Shorter distance increases overall exposure level as does longer "shooting time" of the X-Ray source.

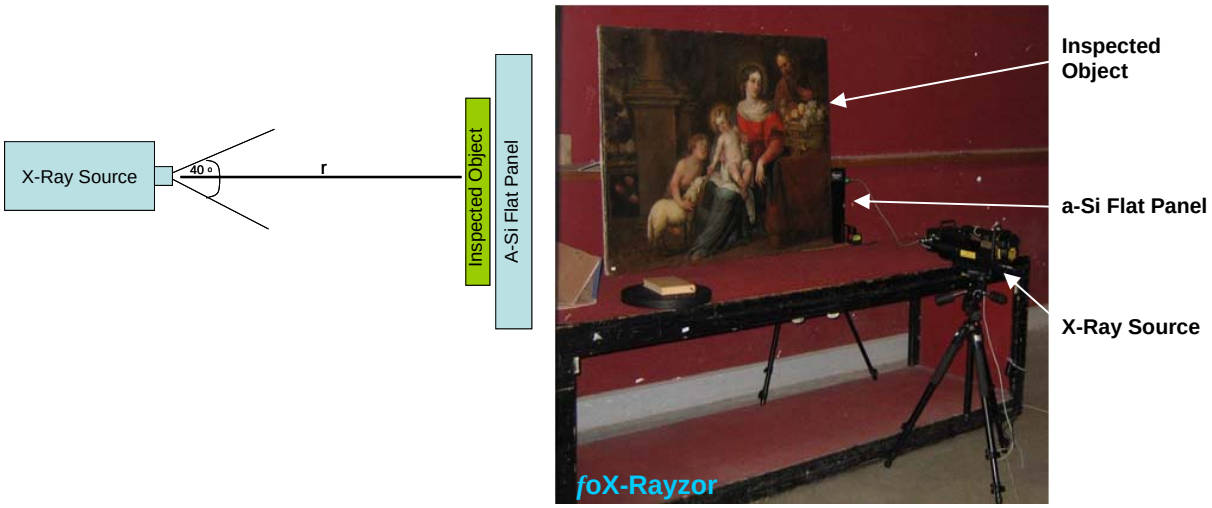

Figure 9: Setup for DR Inspection

With Vidisco DR systems only a few seconds of exposure are required in order to penetrate oil paintings. This maximizes the safety of the operator and that of the environment. With film it would take about ten times longer and require using a higher kV to reach the same level of saturation (equivalent to film density).

The safety distances required for working with the Vidisco systems are 3-5 meters only behind the X-Ray source and 30meters only in front of it (according to the recommendation of the manufacturer of the pulsed X-Ray source). This is considerably less than continuous X-Ray sources necessary for producing an X-Ray image using film. This allows for flexible inspection on site without having to clear the inspection area in a wide radius. This enables inspection of artifacts where they are located, and reduces the need to move artifacts to a minimum. The system can be placed "around" the inspected object and sometimes the object need not be moved at all.

CONCLUSION

Even when a restoration laboratory has limited means it can reach maximum results with a portable DR system. These systems are smaller than and not as costly as X-Ray laboratories and yet they offer high quality imaging that allows for effective inspection without compromise.

The mobility of the systems allows the flexibility of conducting efficient and effective X-Ray inspection anywhere (in a lab or outside). The systems provide images upon request and results on site, enabling immediate analysis. There is no longer a need to work "in the dark" while waiting for the development or scanning of film or film replacement. The image is available immediately on screen and the inspector can continue to work already knowing what the image entails.

The Vidisco Flat *f*oX-17 and *f*oX-Rayzor portable DR systems are safe to work with for the operator and require minimum evacuation of the location when conducting an inspection. The fact that images are gained digitally also spares the need for film development and is hence environmentally friendly, as no chemicals are used.

Due to the many advantages of the Vidisco Systems for Art inspection, as presented above, we believe that our systems will emerge in this market as a useful inspection tool.

ACKNOWLEDGEMENTS

Special thanks to the restoring team at the Tel-Aviv Museum of Arts for opening their doors to us and having an open mind toward innovation in the field of inspection.
To Sharon, Dafna, Chasia and Dr. Doron, your cooperation is highly valued.
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