Futuristic look at artworks of the past

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Anyone interested in art conservation knows very well how the devil is in the details. Restoring or preserving paintings, ceramics or sculptures has become an art in itself, one that requires knowledge, patience and advanced technologies. The INSIDDE project focuses on the latter with a scanning technology that is on track to taking art analysis and observation to the next level.

Since our ancestors drew their first cave paintings, art has always been part of how humans define themselves and perceive the world around them. Each work of art is a treasure for anyone willing to read between the lines, as it tells much about the artist, his personality and the world he lived in. But when it comes to analysing and understanding art, experts thus far have only been able to scratch the surface.

As they struggle against the ravages of time, curators and restorers need advanced technologies to avoid damaging the artwork. Solvents and their potential side effects are progressively being replaced by the likes of lasers and limestone-producing bacteria. But the EU-funded project INSIDDE ('INtegration of technological Solutions for Imaging, Detection, and Digitisation of hidden Elements in artworks') is willing to take a step further in this direction. The project is developing a new technology relying on graphene-based terahertz scanner devices, which is expected to reveal the hidden secrets in paintings and ceramics. All details invisible to the naked eye - such as underdrawings, underpaintings, pigments (or contents in sealed vessels) - will now be observable and may notably allow for determining the authorship or the period in which the work of art was painted or made. Far from limiting its access to experts, the project aims at making the technology available to the broader public through smartphone and tablet applications to be exploited by local and regional museums.

INSIDDE was kicked off in January 2013. Javier Gutiérrez Meana, project coordinator and R&D Program Manager at Treelogic in Spain, explains how the project has already performed various experiments whose results show promise for a large range of potential applications.

What are the main objectives of the project?

We are developing a terahertz (THz) scanner - a non-invasive technology lying in between microwave and infrared bands in the electromagnetic spectrum - which will be used for image acquisition and complemented with a commercial scanner for a high-resolution characterisation of the work of art's upper layers. The raw data obtained will then be processed with different techniques to extract and interpret those unknown features.

Apart from curators and restorers, this technology will also benefit the

broader public: on the one hand, the digital models (2D and 3D) will be uploaded to the European network Europeana (europeana.eu/) - meaning that everyone will have free access to these models through the internet. On the other hand, an application for smartphones and tablets will be designed and implemented. It will be available at the participating museums and will display, when pointed at the artwork and thanks to the augmented reality, the different layers of the painting, a scheme of overlapping brushstrokes, metadata and other interesting representations.

What is new or innovative about the project's approach to art understanding and analysis?

Although there are currently multiple techniques to carry out this type of study and some of them are also non-invasive, terahertz technologies can complete the information obtained by means of X-rays or infrared reflectography because, in general terms, their penetration depth is lower than the former but higher than the latter. Therefore, we can say the project concentrates on the intermediate layers between the gesso and the varnish in paintings as well as on the clay and the characterisation of contents in ceramics.

We expect - and the preliminary results are very promising - to be able to distinguish among materials with different widths and thus to be capable of analysing each layer independently. This will give an idea of the original sketches, how they were modified by the artist or the order in which the paint or brushstrokes were applied. It could also magnify the visualisation of pentimenti or uncover underlying works.

Regarding the characterisation of materials, nowadays it is still quite difficult to determine which pigments were employed by the artist without taking samples under strict supervision. The behaviour in the terahertz bands may enable this by comparing some predefined patterns

with the measured response. Likewise, the contents in sealed ancient vessels may be discovered.

What drew you to research in this area?

When the call (ICT for access to cultural resources) opened, three partners of the consortium (Treelogic, Universidad de Oviedo and ITMA Materials Technology) were already working together on the development of graphene-based devices for the terahertz band, but focused on other fields. One day, during a follow-up meeting, Dr David Gómez talked about this action because his department had previous experience in the field of cultural heritage and had collaborated with renowned Spanish museums. We all agreed that this was a great opportunity to test the technology in other scenarios and, at the same time, we were sure our team was ready to offer an almost completely new perspective - far from the massive digitisation proposed by other projects.

Then we drafted the main idea. Obviously we considered different approaches until one of them was consolidated, and the other partners - Technical University of Delft (Netherlands), 3D Dynamics (Belgium), Istituto Nazionale di Ottica (Italy), Regionalen Istoricheski Muzei Stara Zagora (Bulgaria) - joined the consortium motivated by its attractiveness and innovation. The last to enter was Centro Regional de Bellas Artes de Asturias (Spain) last June when the project was already running.

What were the main difficulties you faced and how did you solve them?

With most leading museums already preparing their own projects in collaboration with other centres, universities and companies, INSIDDE decided to aim for a cost-effective solution for regional or local entities.

It may seem an easy task to find such end users but, although we got in touch with many people from multiple European countries who all liked the challenge we were proposing, they could not get involved in such a venture due to the long bureaucratic and administrative processes required to obtain the corresponding permissions from the public institutions. Fortunately, the Enterprise Europe Network - through its regional contact points Ficyt in Spain and the Chamber of Commerce and Industry Stara Zagora - helped us.

From a technical point of view, the major complications we faced were related to the generation (and integration) of graphene - the so called 'wonder material' - with the specific characteristics to be used in this application, as well as how to design a focusing system in which each millimetre in the path from the transmitter to the target and back to the receiver really counts because the propagation losses in the air at these frequencies are very high. The designs as well as the recipe to generate graphene were modified many times until a very good efficiency was achieved, and we also managed to optimise the available resources - lenses, sources, connections and space.

Generally, in this type of project, the essence of research is present every day: no one can be 100% sure that your idea will work. You can sometimes think of other options, partners or investment, but then again success cannot be guaranteed.

What are the next steps for the project?

While over the past year most of the efforts were dedicated to building the scanner, in 2014 the consortium will focus on performing several experiments with samples of clay, pigments and other materials, fake paintings reproducing the original artworks, etc. This will allow us to calibrate, fine tune and assess the performance of the transmitter, receiver and focusing system. We expect to be able to release some

results during the final quarter, even though they will be based on preliminary studies and not on famous pieces of art.

In parallel, we will also start working on the application for smartphones and tablets. We are planning to design the interface and functionalities using X-ray images from a Goya masterpiece that is permanently exhibited at Museo de Bellas Artes de Asturias - you can see them on our website. In a second phase, we will replace these radiographies with the acquired THz images. The application may then be exploited by other museums to attract new visitors and INSIDDE will make the results public in an innovative manner.

How do you expect this technology to benefit EU citizens?

The immediate benefit can be found in cultural heritage. We think INSIDDE can contribute to generating enthusiasm when visiting a museum, since we are intertwining artworks and new technologies and most people really like this combination. Although we will concentrate on two approaches - the integration into Europeana and the augmented-reality based applications - within the framework of the project, others like animations or interactive games are also feasible.

One of the keys of INSIDDE, in terms of being useful for the European citizens, is the fact that even though the technology is being developed to fulfil some concrete objectives, it may be adapted to other scenarios: security purposes (body scanners), non-destructive tests (food), health (burns, skin cancer). Our intention is to take advantage of these capabilities in order to maximise the impact on society and the economy.

When do you expect the INSIDDE technology to be commercialised?

We believe our prototype will be validated with real artworks in 2015. However, since INSIDDE is basically an R&D project, some adaptations will be required before it can be commercialised. For example, the experiments are being carried out using a general purpose 3D positioning system that cannot be easily transported to other facilities. This is one of the reasons why, from now on, we will intensify our efforts to contact potential end-users and evaluate the conditions under which the THz scanner would be of interest for them. If these are aligned with ours, the consortium will continue working together once the project finishes. We have not decided yet whether the best approach would be to offer a service, selling the equipment or both, so we are completely open to almost any proposition.

We strongly believe that other outputs - not only devices but also techniques or processes - may be exploited. At this point we have earmarked up to ten and our strategy consists of analysing how these can be transferred to other sectors. We will look for solutions that are not available yet before releasing guidelines detailing whether further exploration makes sense or not.

More information: www.insidde-fp7.eu/

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