The increasing use of composites, sandwich and lightweight structures and parts in new airplanes means that testing techniques that do not compromise the integrity of these components are needed. Holograms and thermal imaging are often used in this way, but the FANTOM project led by coordinator **Marc Georges** has designed an ingenious way to combine these two methods.

Using holography to reduce aircraft costs

In industries such as aeronautics, holography is used to detect micro-deformations in structures caused by hidden defects. An image of the structure at rest is taken and then compared with one that has been stressed by heating or mechanical loads, revealing fringes that will alert to the presence of defects. Local defects react differently compared to the global behaviour of a structure, so it is important to evaluate this during the testing of components.

"We have been working for around 20 years in the field of optical non-destructive testing with laser techniques such as holography," begins Marc Georges, coordinator of the FANTOM project. "Working with aeronautical companies, we found that there were some problems with the way things were being done.

"For instance, back then we were using visible lasers which require an incredibly stable setup to be effective. My reaction to this was to think that if we were to use infrared, which has a much longer wavelength than visible light, we would be able to solve this stability problem."

Unlike visible light holography, infrared holography requires specific cameras to capture an image, and up until recently these thermographic cameras were very expensive.

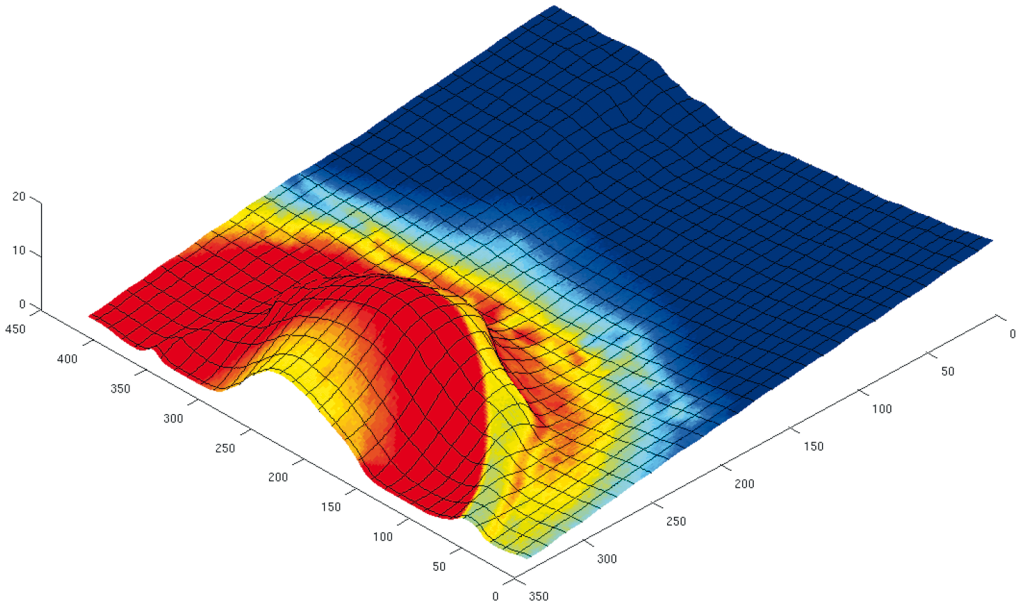
However, in recent years, they have become more ubiquitous and thus cheap due to use in areas such as civil engineering, which utilises them to capture thermal flows in buildings to test insulation efficiency.

"The real beauty of using holography in the infrared spectrum," continues Georges, "is that it allows you to capture a thermal image of the object as well as a spatial image. This is the basis of our project, FANTOM: creating a system that uses infrared lasers with thermographic cameras to allow the simultaneous capture of temperature and deformation."

At present, companies such as Airbus use two separate measurement devices to gather this data.

After suggesting to some of these companies that it could be done with just one, Georges received a lot of interest in his idea, and so after the first call of the FP7 was announced a consortium was put together and FANTOM was born.

"When we talked to Airbus," says Georges, "they explained that this product will be particularly useful for the testing of new aircraft parts (rather than for



A 3D profile of the deformation of a helicopter part with a defect that reacts differently to the remaining part of the piece. In every point of the deformation map, a color represents the temperature elevation (blue are colder zones, red are hotter). This plot shows that the structures underwent a larger deformation where the temperature elevation was more important.

maintenance or production.) The FP7 call asked us to 'decrease aircraft development costs', and by combining two instruments into one, we hope it can do exactly that."

The project is divided into a number of packages, which have been collaborated on together by the six partners involved.

These include the Centre Spatial de Liege, which is a specialist centre for non-destructive optical measuring methods, ITO from the University of Stuttgart who are also holography specialists, and InfraTec, a company from Dresden who make thermal imaging systems.

Georges explains about some of the work involved in the project: "We started out with what we call the specification package, which involved bringing together everyone involved in the project and evaluating what the state of the art components at the time were, what everyone wanted to get out of the project and how we could achieve this using the resources and people available.

"We then moved on to the second work package, which involved the conceptual design of the system.

We tried to imagine all the possible scenarios in which the product might be used, and then created a number of different potential systems utilising the different lasers, cameras and optical components available to us."

After the initial ideas had been whittled down to a final basic design, a preliminary system was created under laboratory conditions.

InfraTec, the thermal imaging company (and partner in the project), were commissioned to create a new infrared camera with a high resolution – 640 x 512 pixels - specifically for the project. As well as this, a system that was able to separate the temperature and spatial information from the signal had to be designed.

"Once we had the basic system designed, we needed to be able to test how well it worked," continues Georges. "CTA, a testing centre based in Spain, created a multitude of samples for us that mimicked the sort of composite materials such as CFRP that are used in aeronautics, and inserted calibrated flaws into them so as to test the performance of the system."

The project is now at the stage of testing, and as well as assessing the performance of the technique through a transportable instrument built by Optrion company ; it is vital that the latter is fully functional.

Once this testing stage is over and the whole system has been finely tuned, Georges will be demonstrating the finished product to a number of potential end-users.

"We will be taking the instrument to Airbus to test-drive the system, and a number of other potential customers will be there to see how it works," says Georges. "I believe that this will not only help reduce the costs of aircraft testing, but also be a great way to show the world what the non-destructive testing community is capable of." ★

At a glance

Project Information

Project Title:
FANTOM :
Full Field Advanced Non-Destructive Technique For Online Thermo-Mechanical Measurements On Aeronautical Structures

Project Objective:
The objective of FANTOM is to develop an innovative Non Destructive Testing technique combining holography for deformation and thermography for temperature measurements. The concept is to perform holography with thermal infrared lasers and cameras, where this association is made feasible in a single sensor with simultaneous capture of both sets of information.

Project Duration and Timing:
42 months

Project Funding:
European Union FP7 - 1.7 M€ EC Funding

Project Partners:
Centre Spatial de Liège - Université de Liège
Institut für Technische Optik - Universität Stuttgart
InfraTec GmbH
Centro de Tecnologias Aeronauticas
Optrion S.A.
InnovSupport

Marc Georges

Marc Georges holds a PhD in physics from University of Liege. He has been a researcher at the Space Center of Liege for 20 years, where he now heads the Non-Destructive Testing and Laser lab. He is author of numerous publications in peer-reviewed journals and conferences and has received several awards.

FANTOM

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