Lithuania, a leading light in laser technology

Published by Editor Connect on 14/09/2012


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The European Union's innovation scoreboard ranks Lithuania as a modest innovator, but there is one field in which this Baltic country of 3.2 million people shines, literally: lasers. Half of all picosecond lasers sold worldwide are produced by Lithuanian companies, while Lithuanian-made femtosecond parametric light amplifiers, used in generating the ultrashort laser pulses, account for as much as 80 % of the world market. Vilnius University and the Institute of Physics have been carrying out cutting-edge laser research since the 1970s, a decade or so after the first functioning laser was demonstrated. And today their work in the area is continuing apace — especially through collaboration in EU ICT projects.

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Ultrashort pulse lasers, like picosecond and femtosecond lasers, are used for a range of applications from manufacturing to medicine. Half of all picosecond lasers sold worldwide are produced by Lithuanian companies, while Lithuanian-made femtosecond parametric light amplifiers, used in generating the ultrashort laser pulses, account for as much as 80 % of the world market.

Vilnius University and the Institute of Physics have been carrying out cutting-edge laser research since the 1970s, a decade or so after the first functioning laser was demonstrated. And today their work in the area is continuing apace.

A laser-like focus

In the Fast-Dot [2] (1) project, for example, Vilnius University has teamed up with 17 other partners in 12 countries to develop the next generation of lasers for use in biomedical applications. The new lasers are not only much smaller than previous technology (the size of a matchbox instead of a shoebox) but they are also more energy efficient, enabling them to be used in microscopy and nano-surgery, where high-precision cutting, imaging and treatment therapies are required. The Vilnius University research group, led by R.Tomasiunas, says that it's contribution is 'to investigate experimentally the time resolved carrier dynamics in QD material used for mode-locking by means of different techniques, such as pump-probe, four-wave mixing'.

'The objectives of the project are to use a technology called quantum dot materials, probably gallium arsenide, and exploit their lasing characteristics for use in biomedical applications, such as laser tweezing for microsurgery,' says Neil Stewart, the Fast-Dot project manager.

The upshot, Stewart explains, is that surgeons will have access to higher-performance, lower-cost lasers than are currently available, opening up new application areas for lasers in biomedicine.

Quantum dot materials for lasers are also the focus of the LAMP [3] (2) project, involving Lithuanian laser manufacturer Ekspla. The aim of the initiative is to develop new manufacturing technologies for LEDs, using lasers that are considerably cheaper, less wasteful and more efficient than current processes. The resulting LED devices should also be able to emit light more efficiently, potentially improving the quality and efficiency of LED displays.

Another Lithuanian company, Light Conversion, meanwhile, is contributing its laser technology for a very different purpose. In the Cross Trap [4] (3) project, eight international partners are being supported by the European Commission to develop a novel laser-based system for detecting airborne pollutants, such as chemicals, bacterial threats and gases. In grossly simplified terms, the technology is based on exciting molecules with a laser, measuring the reflected light and identifying the molecules based on how they vibrate - but to achieve this requires overcoming several major technological challenges, not least because the backward scattering of light in air under normal atmospheric conditions is extremely weak. Nonetheless, if successful, the project should lead to a range of new systems for environmental monitoring, safety and security - able to detect pollutants and toxins in the local atmosphere.

While lasers are at the forefront of Lithuanian research and innovation, it is by no means the only area that has attracted the attention of the country's scientific community.

Collaborating online

In the VirtualLife [5] (4) project, for example, a research team at Vilnius University joined partners from Germany, Estonia, France, Italy and Romania to develop the underlying technology for creating a new type of virtual world - online environments that are not just entertaining and immersive, but also secure, democratic and adaptable.

'VirtualLife constitutes a new form of virtual organisation, representing the transition from existing virtual worlds' administrator-centricity to a civil organisation ruled by a common law within an immersive, high-quality, 3D virtual-reality environment,' the team says.

The resulting tools for easily creating virtual worlds are designed especially for industry, training, educational, cultural and business scenarios. They include a scalable, reliable peer-to-peer (P2P) architecture for a 3D environment, a secure and trusted infrastructure and a certified authentication system. Validation tests indicate that the P2P architecture, along with the project's tools for

governance and contract-making in virtual worlds, allow users to build richer online environments, better suited for use in training, e-commerce and business.

Also with a focus on collaborative environments, the DEMI [6] (5) initiative is looking to enhance existing product and process design systems with features that will help engineers collaboratively design energy-efficient manufacturing processes. In addition, the team, which includes researchers from the Lithuanian Energy Institute, is working on energy-monitoring and decision-support tools for manufacturing industry, based on ambient intelligence and service-oriented architectures. The project aims to produce a set of computer-aided design systems that would assist engineers in targeting energy savings of at least 15 % compared to current processes.

ICT for health

Using similar underlying technology and a service-oriented architecture, but with a very different aim, the Ponte [7] (6) project is developing a system to help pharmaceutical research. The Ponte approach enables clinical trials - whether of new drugs or existing medications being tested for new uses - to be designed and planned through a flexible authoring tool. This tool allows potential patients eligible to participate in such trials to be identified and selected based on clinical-trial efficacy, patient safety and clinical study cost.

The system couples semantic interoperability of clinical care information systems with clinical research information systems and drug and disease knowledge databases. Advanced data-mining techniques and enhanced learning algorithms are also being worked on. 'Bridging basic science to clinical practice comprises a new scientific challenge that can result in successful clinical applications with low financial cost and increased patient safety,' the project team notes.

Also in the healthcare domain, Kaunas University of Technology is collaborating in the TBIcare [8] (7) project, which is focused on developing an objective and evidence-based solution for managing 'Traumatic brain injury' (TBI) by improving diagnostics and treatment decisions for an individual patient.

Resulting from trauma to the head, TBI is the most common cause of permanent disability in people under the age of 40 and the cost of treating and caring for sufferers exceeds EUR 100 billion annually in Europe. Every year, over 1.6 million people sustain a traumatic brain injury in the European Union, and 100,000 are left disabled, an increase of 21 % over the last five years.

'The project develops a tool that will make the day-to-day clinical work of doctors easier and also revolutionise the treatment of traumatic brain injury. This software tool will enable doctors to match the patient-related variables with the injury-related variables through the combined use of various databases. Using extensive database and system simulation, the software will then form a detailed analysis of the nature of the patient's brain injury, its optimal treatment and predicted outcome,' the team explains.

Kaunas University of Technology has also been working on another health monitoring solution in the Avert-It [9] (8) project, in this case focused on people suffering from low blood pressure. The researchers developed a novel bed-side monitoring system that not only keeps track of blood pressure changes but can predict adverse events before they happen - alerting medical staff in time and greatly improving patient care.

The projects featured in this article have been supported by the Seventh Framework Programme (FP7) for research.

(1) Fast-Dot: Compact ultrafast laser sources based on novel quantum dot structures
(2) LAMP: Laser induced synthesis of polymeric nanocomposite materials and development of micro-patterned hybrid light emitting diodes (LED) and transistors (LET)
(3) Cross Trap: Coherently-enhanced raman one-beam standoff spectroscopic tracing of airborne pollutants
(4) VirtualLife: Secure, trusted and legally ruled collaboration environment in virtual life
(5) DEMI: Product and Process Design for AmI Supported Energy Efficient Manufacturing Installations
(6) Ponte: Efficient Patient Recruitment for Innovative Clinical Trials of Existing Drugs to other Indications
(7) TBIcare: Evidence based Diagnostic and Treatment Planning Solution for Traumatic Brain Injuries
(8) Avert-It: Advanced arterial hypotension adverse event prediction through a novel Bayesian neural network

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- Cross Trap on CORDIS [13]
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