



Robotic CURE

Professor Zoran Vukić explains the background to his laboratory's robotics project, CURE, which is at the forefront of innovation despite difficult conditions

Firstly, what is the overall mission of the CURE project? Could you highlight the reasons behind its establishment?

The project aims at improving Croatian underwater robotics research potential for the benefit of local, regional and European communities. It has reinforced our research potential and mobilised our human and material resources, enabling partnerships with EU research entities and also providing the better dissemination of our research results. The project has also raised awareness among various stakeholders about the use and capabilities of the underwater systems and technologies. Our focus is primarily towards Croatian stakeholders and other stakeholders in the region. Besides revealing the huge potential of underwater robotics, the CURE project also provides momentum for research and development and commercial applications in the region. The reason behind its establishment was to update our expertise in underwater robotics as well as to prepare for the challenges that Croatia will face when it becomes a full Member State of the EU.

How is your research team utilising human and material resources and gaining partnerships in order to achieve your goals?

We are a well-organised group that explores our resources wisely and with clear goals. Everything we do is carefully planned, documented and analysed. We often post-process collected data in order to better extract required information. Of course, when you perform missions at sea, equipment is prone to failure and we do our best to keep it in good condition. In the last three years we have been invited into partnerships for FP7 project proposals, but we also initiated some of our own proposals for various calls. Our accomplishments have produced funding for the FP7 'Cooperative Autonomous Robotic Towing' (CART), the NATO Undersea Research Centre (NATO-NURC), and the FP7 EUOFLEETS2 project, which will be financed from 2013 for end-users and research teams across Europe dealing with marine and maritime activities. This

ensures, at least in the short term, the sustainability of the University of Zagreb's Laboratory for Underwater Systems and Technologies (LABUST). However, we are pushing for greater involvement of SMEs within our projects. There are many reasons for their lack of involvement, including the economic recession and the fact that in Croatia the market for underwater systems and technologies is tiny, with no SMEs producing the relevant technologies. We hope this will change in the future.

What are the objectives of LABUST?

Our goal is to become the foremost centre of excellence on the eastern Adriatic and in the surrounding region. Applications will always be high on our agenda and our R&D will be directed toward the needs of end-users. This formula works well, and I always suggest to my colleagues from other laboratories of similar research interests to keep this in mind. Horizon 2020 stresses this because innovation will inevitably bring research and development closer to the

Swimming against the tide

The University of Zagreb's **CURE** project has received endorsements from the highest levels, but their work to preserve the safety and ecological importance of the Adriatic Sea has been far from plain sailing



market, which is formed by the needs of end-users.

Can you elaborate on LABUST's role in Horizon 2020?

Our role in Horizon 2020 will only intensify, since we now have the expertise, the infrastructure, the experience from various missions at sea, and the knowledge about needs of various stakeholders including end-users, the industrial sector and SMEs. We have already directed our R&D towards various applications, so the invention that is required by Horizon 2020 will become our core objective. We will become more market-orientated and our work will thus increase its profitability. With this, we expect our position will improve and become increasingly sustainable.

What silos must you overcome in order to fulfil your goals?

Our main problem remains how to sustain our capabilities in the long term. Despite all our efforts it is very difficult to achieve market penetration with this technology: not only is it expensive, but at this moment of economic crisis when budgets are being reduced, our efforts end with discussions and a lack of joint projects and financial help. We are working towards correcting this, thereby improving the position of our laboratory and ensuring long-lasting success.

AUV IVER2 DESCENDS FOR LAWNMOWER SURVEY MISSION © MARINO BRZAC

THE WORK OF a robotics team based at the University of Zagreb has recently received an approval quite like no other. Currently involved in the NATO Undersea Research Centre project dealing with mine countermeasures using autonomous marine vehicles, the CURE group has been able to provoke the personal interest of Croatia's President, demonstrating the importance of the work it has been undertaking. Professor Ivo Josipović, who took office in 2010, recently spoke to the project leader, Professor Zoran Vukić, about their efforts to improve safety in the Adriatic region.

Yet the accolades do not end here. Following a publication in the influential *Seapower* journal, which has a readership that spans the globe and has even gained merit in the US Congress, the group has seen a marked boost to its marine research and development profile. Specifically, the article sought to communicate the group's involvement in unmanned mine countermeasures, to which they have been able to contribute a large amount of expertise and technology.

This success is conjoined to a large and challenging task, against which the team has already made its mark. The Adriatic and Baltic are the most polluted seas in Europe, not least due to the impact of UXOs from torpedoes and nervous gas containers. As such, Croatia has signed up to political directives to preserve biodiversity and ecosystems. This will not be possible without underwater technology, and the team at Zagreb envisages its role as an instrumental element of the work that needs to be tackled. Beyond the explosives, the unspoiled eastern coastal areas of the Adriatic must be carefully monitored if they are to maintain

their ecologically important status. This will be increasingly challenging as higher levels of tourist traffic will be matched with direct and indirect human influences, including eutrofication, coastal development and mariculture, leading to more pollution. Because many of the areas in the eastern Adriatic are as yet unsurveyed, there is a drive for the monitoring of ecological and biological conditions to begin soon, so that shifts can be easily detected and dealt with. The project's role in producing underwater robotics could prove influential, providing the opportunity to chart the eastern Adriatic before these delicate ecosystems disappear.

ADDRESSING ISSUES

The members have faced a number of difficulties, not least the procurement of public funds. In efforts to overcome this, they have had to work closely with government officials, inviting individuals from the ministries and other agencies to attend workshops and lectures. While this has required careful planning, the maintenance of a working relationship between the group at Zagreb and the Government has been an important part of the work. Yet this was not the major difficulty for Vukić: "The main challenge was to form a competent team that harmonised in both expertise and character, but I'm happy to say that was in fact my biggest success, and all our achievements were possible because of that". CURE has also faced a number of practical issues within his Faculty, with only limited office and laboratory space available. Despite these problems, the group has been able to drive their work forwards, creating a number of notable successes in their field. It is hoped that, as these early problems fade, they will be able to continue with their research

INTELLIGENCE

CURE

DEVELOPING THE CROATIAN UNDERWATER ROBOTICS RESEARCH POTENTIAL

OBJECTIVES

The ultimate goal is to prepare ground for R&D integration of the Laboratory for Underwater Systems and Technologies into FP7. Integration may find its way in terms of R&D proposals, scientific cooperation or business contacts based on technological innovation. Expected impacts are in upgrading the RTD capacity and capability (ie. the human potential, the number of new researchers and training of research staff, improvement of research management, strengthening the research infrastructure and the quality of research, and enabling better integration in the European Research Area).

KEY COLLABORATORS

Underwater robotics: **Professor Antonio Pascoal** (IST, Lisbon, Portugal), **Professor Giuseppe Conte** (University Marche, Ancona, Italy), **Massimo Caccia** (CNR-ISSIA, Genova, Italy), **Professor Daniel Toal** and **Edin Omerdić**, PhD (University of Limerick, Ireland)

Application: **Professor Tatjana Bakran-Petricoli** (University of Zagreb, Croatia), **Kruno Zubčić** (Croatian Restoration Institute, Zagreb, Croatia), **Duško Kalember** and **Marin Stipanov** (Brodarski Institute, Zagreb, Croatia), **Professor Dario Matika** (Ministry of Defence – Institute for Research and Development of Defence Systems, Zagreb, Croatia)

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and development, pressing forward with the innovations which have provided their success.

PIONEERING HEARING

Conducting research with a firm understanding of the needs of end-users has enabled the team to drive towards practical technologies with instant applicability in their field. An interesting innovation has been through the utilisation of human hearing capabilities in the guidance of remotely-operated underwater vehicles (ROVs). Vukić has led this work: "It is interesting to note that human hearing capabilities were not explored before for guidance purposes, despite the well-known fact that ROV operators are highly burdened with visual information," he comments. By easing the task of operators, the team has been able to significantly improve its product designs. Work has also been done on autonomous underwater vehicles (AUVs), helping them to evade moving and fixed obstacles. This was carried out as part of a PhD study, and involved the use of the virtual potential method for cooperative mission planning of AUV formations. A similar PhD project was able to provide simple and affordable parameter identification method based on self-oscillations which can accommodate situations when sensor suites change – something that happens frequently. These innovations are focused on the potential applications of the new technology.

LAUNCHING PRODUCTS

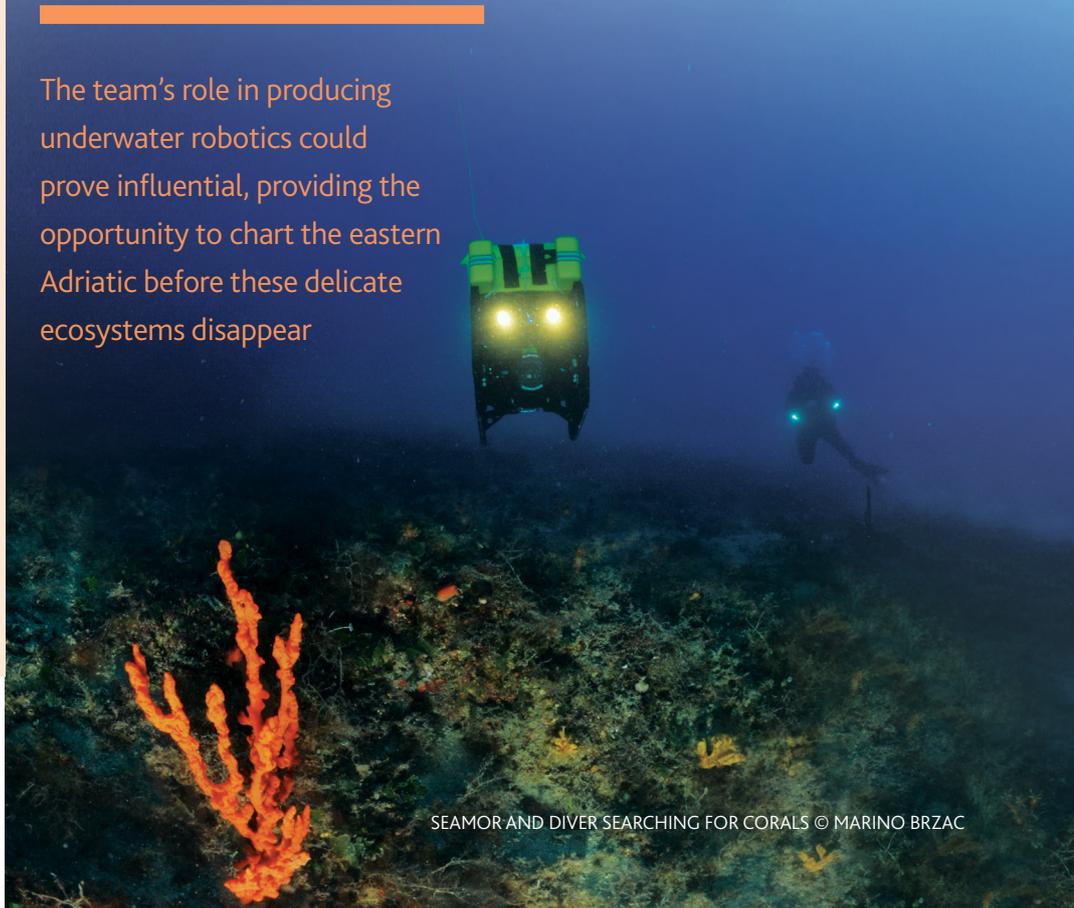
The CURE researchers are now ready to begin the heavy use of the technology in collaboration with numerous stakeholders. In part, the bringing of their investment to fruition has been made

possible because of the specific context in which their investigations have been conducted. Without the necessity for environmental monitoring and the disposal of UXOs, the team would not have had the support, nor the targeted approach, which has shaped their results. They have now reached the point at which they are able to perform numerous tasks at sea, aided by the fact that their research was closely focused on particular applications of the technology. The team is now in a position to monitor, preserve and secure, thus reaching the goals laid down at the beginning of the work.

INCREASING UNDERSTANDING

A major part of the project to date has concentrated on assembling and training individuals to produce the underwater robotics. Vukić has worked hard in the pursuit of this goal: "30 years ago we built submarines, so there is no question that the expertise existed. However, it has dissolved over the years and we have needed a financial stimulus to enable us to regain this knowledge". The ambitious and competent team has also benefited from the involvement of a large number of other experts from Portugal, Italy, Ireland and Croatia. This sharing of knowledge has given the team the boost required in order to press towards their research goals, demonstrating the importance of collaborative work across Europe. At the University of Zagreb, the Department of Control and Computer Engineering is already renowned for its pool of well-trained engineers, and this project has fed into this reputation. The researchers hope that these initial stages will now yield further success, both in the practical application of the robotics, and in the further investigations they are pursuing.

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SEAMOR AND DIVER SEARCHING FOR CORALS © MARINO BRZAC