CONET Newsletter

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Editorial

Welcome to the 17th issue of the CONET newsletter. CONET is the EU FP7 network of excellence on Cooperating Objects, merging the fields of embedded systems for robotics and control, pervasive computing and wireless sensor networks. CONET focuses on establishing the field of Cooperating Objects within the research and industrial community, thus strengthening the position of Europe in the research landscape.

In this issue we include a conjoint member profile from Bruno Kessler Foundation and the University of Trento, co-located in Trento and partners in several European projects. We also include a report on a collaborative robotic deployment at Spanish Mar Menor and overview the Noptilus project for increasing the autonomy level of multi-robot systems in dealing with critical scenarios. Also in this issue you will find a guest article from João Barros, head of the Instituto de Telecomunicações – Porto institute and a short interview with the two winners of the EWSN 2012 PhD thesis awards, sponsored by CONET.

If you are interested in obtaining up-to-date information about the CONET project please visit our website at: http://www.cooperating-objects.eu

We hope you will enjoy this issue. ■

Member Profile: FBK and UniTN

By Amy L. Murphy and Gian Pietro Picco

The Bruno Kessler Foundation (FBK) and the University of Trento (UniTN) are both located in the hills above the city of Trento, Italy. Both organizations participate in CONET as Associated Members, and bring much of their joint work to the table, specifically in the DMCO cluster on deployment driven research. Here we focus on two applications that have served to motivate our recent work, and present a brief overview of one of the key components at work inside the deployments, namely the TeenyLIME middleware. Notably, the two deployments were presented in at the IPSN conference in 2009 and 2011 respectively, and each received the Best Paper Award. More details are available in those publications.

Road Tunnel Monitoring: The TRITon project

State-of-the-art solutions for road tunnel lighting either use pre-set light levels based on date and time, or adjust the lights based on an open-loop regulator relying on an external sensor. Both solutions disregard the actual lighting conditions inside the tunnel, and diminish safety or consume more power than needed. The solution developed within the TRITon (Trentino Research & Innovation for Tunnel Monitoring) project deployed a WSN along the tunnel walls to measure the light intensity and report it to a controller, which closes the loop by setting the lamps to match the lighting levels mandated by law. Unlike conventional solutions, our system adapts to fine-grained light variations, both in space and time, and dynamically and optimally maintains the legislated light levels. This enables energy savings at the tunnel extremities, where sunlight enters, but it is also useful inside the tunnel to ensure the target light levels even when lamps burn out or are obscured by dirt.

Our WSN-based control system has been installed in an *operational* 630m, 2 carriage way tunnel with approximately 28,000 vehicles per day. It has been running for more than a year without any required intervention. Based on measurements and calculations, the energy con-

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sumption in our tunnel is up to 50% less than a solution with standard technologies.

Figure 1: Tunnel deployment testbed for TRITon

Structural Health Monitoring: Torre Aquila

Torre Aquila, located in Trento (Italy) is a 31 meter-tall medieval tower whose second floor contains "Il ciclo dei mesi" ("The Cycle of the Months"), a series of internationally-renowned frescoes that represent a unique example of non-religious medieval painting. Preservation of the frescoes is a source of concern for the local conservation board as the modern state of the city forces the consideration of a road tunnel to bypass the castle compound. Construction has long been delayed due to fear that the work might cause unwanted settling of the tower foundation. Estimation of the potential risk to the frescoes requires real-time monitoring and appropriate response models to reproduce the structural behavior of the tower.

In collaboration with a group of civil engineers at UniTN, our task was to design a monitoring infrastructure to measure deformation, environmental parameters, and vibrations for a time span of months or years. Our contributions ranged from the hardware to the graphical front-end. Customized hardware deals efficiently with high-volume vibration data, and specially-designed sensors acquire the building's deformation. Dedicated software services provide: *i)* data collection, to efficiently reconcile the diverse data rates and reliability needs of heterogeneous sensors; *ii)* data dissemination, to spread configuration changes and enable remote tasking; *iii)* time synchronization, with low memory demands. The system ran for about two years, collecting data useful for the civil engineers to assess the health of the tower structure.

A middleware for WSNs: TeenyLIME

Programming WSNs is a difficult task with extensive effort spent to develop functionalities related to sharing information among local and distributed components. As the common approach is to implement system services directly on top of the operating system, the developer must implement proper interfaces among components and handle the sharing of information at the level of packets and variables. We took a different approach by designing a programming abstraction, TeenyLIME (http://teenylime.sf.net), which provides the programmer with a data sharing model spanning neighboring nodes. We tested its effectiveness in the aforementioned deployments: the routing service, employed in both Torre Aquila and TRITon, required half the lines of code taken by a comparable TinyOS implementation. Further by grouping access to shared information and common communication primitives behind the same interface, the code footprint was significantly reduced.

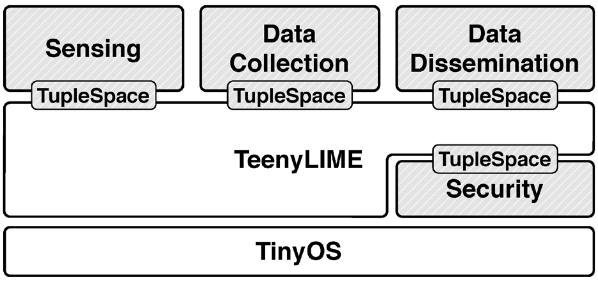

Figure 2: TeenyLIME architecture

Also in Trento

In addition to the work described above, we are working in collaboration with local biologists on deploying a WSN on roe deer to study social contacts and movement behaviors of the animals. We also participate in ACube, a locally funded project in which a WSN will be used to detect the proximity of patients to hazards such as exits in an Alzheimer's day care facility.

Our deployments have also motivated us to study fundamental issues such as a flexible TDMA-like MAC protocol called REINS-MAC, as well as a tool, called Trident, for simplifying in-field deployment by assessing connectivity. These activities are complemented by work on programming abstractions (e.g., Logical Neighborhoods) and their integration with business processes, a topic being investigated in the context of the makeSense EU FP7 project.

The achievements of our joint research groups are possible due to collaborations with a large number of people ranging from talented engineers to PhD students and postdocs. Notably, the work in the tower and tunnel deployments described above is due in large part to the efforts of Luca Mottola and Matteo Ceriotti, who each received the CONET award for their PhD theses in 2009 and 2012 respectively.

Finally, we are always looking for good people. If you're interested in a PhD or postdoc, look us up! ■

- ⓘ http://d3s.disi.unitn.it
- ⓘ http://www.fbk.eu/
- ⓘ http://triton.disi.unitn.it
- ⓘ http://teenylime.sf.net

Multi-robot collaboration towards salinity studies at Mar Menor

By José Pinto (Universidade do Porto)

An experiment with multiple autonomous underwater vehicles (AUVs) was carried out in the Mar Menor Coastal Lagoon in November 2011. The experiment consisted in launching several AUVs at the same time in different zones of the Mediterranean and Mar Menor and use the acquired data to assess the influence of Mar Menor on the adjacent area of the Mediterranean.

The AUVs belong to different institutions which were required to collaborate in near real-time by using common tools and protocols so that surveyed areas were chosen to (im)prove existing water-current models. These models, on the other hand, should integrate new data as soon as it became ready.

Scientific background

The Mar Menor lagoon is located in a semiarid region of Spain with evaporation exceeding precipitation and runoff thus providing its hyper saline character (45-47 PSU) and a range of temperature spanning from 10°C to 32°C seasonally.

It has 135 km^2 with a maximum depth of 6 m and average of 3.5 m. Its water renewal time is of 423 days (1.16 years approximately). The lagoon is separated from the Mediterranean Sea by a sand bar called La Manga. The major forcing factor of water exchange between the Lagoon and the Mediterranean is a horizontal pressure gradient due to difference in the sea levels.

Many species are not allowed to enter into the lagoon because of the strong environmental gradient, mainly imposed by salinity; but others, already adapted to the much more stressed lagoon environment, do leave the lagoon thus providing more resistant populations to changing environmental factors in the Mediterranean (e.g. by global warming trends). The lagoon is, from this point of view, seen as a natural laboratory to understand future changes in larger water masses.

Validation of a 3D model of water mixings requires in situ simultaneous measurements in the area of influence in the three dimensions with the best available technology.

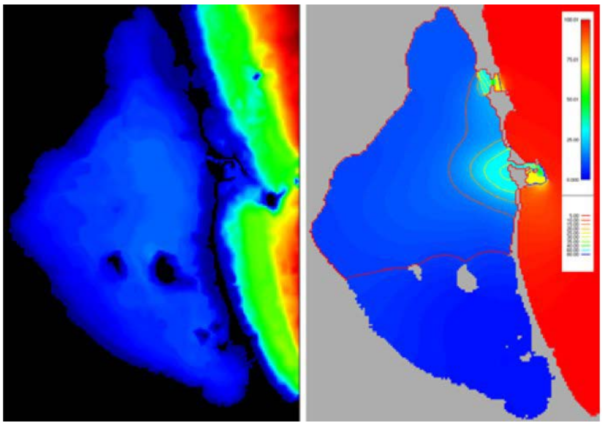

Figure 3: On the left, bathymetry of the lagoon and adjacent Mediterranean Sea. On the right, advection-diffusion model where area of influence is marked in yellow-orange.

Technologies

AUVs are by now the most advanced technology available for salinity measurements that can account for both spatial and temporal variations of water mass given their mobility. They are also cost-effective and adaptable to the changing environment in ways that traditional ship-based observations cannot.

Several institutions were involved in the experiment, some of them contributing with AUV technologies and others bringing tools and support to the operations.

Figure 4: Robots involved in the experiment. Seacon (UP), Guanay II (UPCT), Sparus (UDG) and AEGIR (UPC)

Universidade do Porto contributed with the operation of two Seacon AUVs which are able to do salinity surveys over small-medium areas (due to LBL-navigation limitations). Universidad Politécnica de Catalunya (UPCT) operated Guanay || which dove for the first time in this experiment. Universitat de Girona used Sparus and rented a

CTD sensor so that salinity data could be measured; and Universidad Politécnica de Cartagena (UPC) operated AEGIR, a two-body semi-autonomous vehicle.

Communications between teams and scientists were done through radio and a general overview of the operations was always accessible through MBARI's own Oceanographic Decision Support System (ODSS). All ships were carrying satellite trackers that updated their position periodically on this system and also operational consoles would upload any data coming from the vehicles.

Operations and Results

The operations in the Mediterranean and Mar Menor lagoon were scheduled for several days but it was only possible to sail two days altogether due to problems with weather conditions (rain and strong winds).

Deployment locations from the different teams were discussed and decided according to team experience and robot capabilities. Moreover, the locations of all deployments were chosen to cross the boundaries of the predicted salinity plume.

In order to coordinate all deployments, team locations were uploaded in real-time to ODSS as well as any other data as it became available (AUVs surfaced and transmitted bursts of data). The protocol for uploading data was extremely simplified consisting on emails with attached files with known data formats (NetCDF or comma-separated values) and geo-locations were sent as plain text with latitude/longitude coordinates. Moreover all ships were also uploading their position using satellite trackers. This allowed scientists to get a quick overview of where each teams were and what data were they retrieving.

Conclusions

This experiment has served as a first team collaboration between several institutions which are involved in the development of marine technologies as autonomous underwater vehicles (AUVs). This integration helped each research institute to improve their knowledge in all areas.

The experiment timelines were small (four days in preparation and operations) which proved to be a short time to get a good survey of salinity and to face different issues that may occur during these experiments, as bad weather conditions.

Despite all this, interesting salinity data was retrieved and it will be studied as future work, in order to bring answers to the needs in the community related to the Mar Menor lagoon. ■

ⓘ https://sites.google.com/site/auvexperiment2011/

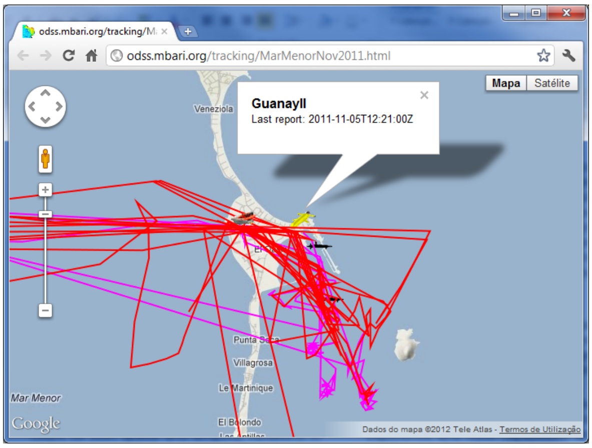

Figure 5: MBARI's ODSS web frontend to the information being uploaded by the vehicles and ship trackers.

Guest article: Breaking the Silos to foster Diverse Thinking

By João Barros (Director of IT Porto)

At the Instituto de Telecomunicações in Porto (IT Porto), Portugal, we strongly believe that diversity is the key towards sparking creative thinking and delivering breakthrough research. This already starts in the way we select our students and post-doctoral researchers. About 43% of more than 90 team members are international and come from 17 different countries, including 27% women. The team combines the expertise not only of computer scientists, mathematicians, and electrical engineers, but also of psychologists, designers and life scientists. To speed up our learning curve in other fields, we collaborate extensively with colleagues in other institutes and departments, always seeking to maximize our impact through inter-disciplinary research. This leads to a wide diversity of research methodologies, as we are constantly confronted with different ways of looking at research problems and finding new solutions. Diversity is also fostered by working closely with industry partners and end user communities, who challenge our assumptions and help us formulate research problems that have real world relevance. In what has become a long-term continued effort, we have learned how to engage in a fruitful dialogue with medical doctors, taxi drivers, firefighters, transportation authorities, and parents of autistic children, to name just a few of the end users we work with on a daily basis.

A good example is the DriveIn project, which is currently deploying the largest vehicular ad-hoc network in the world to understand how vehicle-to-vehicle communication can enhance the experience of drivers and passengers while improving the utilization of vehicles and road infrastructure. At some point, it became clear that the only way to deliver breakthrough results in this class of communication networks was to actually build a test bed with hundreds of vehicles. It was also important to ensure that the vehicles moved a lot, so that we could learn how the network topology varied and test the communication capabilities in as many different urban scenarios as possible. Michel Ferreira, who leads the project, therefore approached RadiTáxis, which coordinates 465 cabs and is the largest taxi fleet in Porto. By combining an equipment grant they received from the Transportation Ministry with our own research grant from the Portuguese Foundation for Science and Technology (FCT), it was possible to deploy an on-board computer in each vehicle. The device provides digital dispatching and navigations services for the taxis (provided by university spin-off Geolink and partner NDRIVE), while allowing us to carry out experiments with separate wireless interfaces using the IEEE 802.11p standard for vehicular communication. Given that the hardware available in the market was too expensive for massive deployment, our colleagues at IT Aveiro developed their own device driver, which greatly lowered the cost of the test bed. Although cab drivers are disheartened whenever they lose connectivity to the main central (a deficiency of the cellular infrastructure that currently supports their main services), the time to dispatch a taxi to a client has decreased 10 times with obvious benefits both to the customers and to the taxi fleet. On the research side, we now have access to complete sets of mobility and connectivity data, which allow us to experiment with different protocols and understand the communication performance that can be achieved using vehicular networking technologies.

The Vital Responder project and the MISC project are two other examples of strong diversity in team composition, methodologies and research outcomes. Both projects investigate how mobile sensing can be used to detect stress phenomena and improve the lives of professional groups who must operate under very high pressure. In the Vital Responder the target population are two corporations of firefighters, who work in urban rescue operations and fight large forest fires during the summer. In the urban scenario, the Vital Responder project is developing a dynamic evacuation system, which uses wireless sensor-actuator networks to guide people out of harms way in an emergency situation. Using real-time information about the temperature in the building, sensor nodes are able to activate one of several possible arrows in a display, which lets people know the right direction to choose. Using wearable technologies developed by the University of Aveiro and their spin-off company BioDevices, it is possible to obtain the complete heartwave of a firefighter in a non-intrusive way. This information can be combined with other sensor data obtained by a mobile device carried by the individual. Once in the forest, these devices form a wireless ad-hoc network to relay the information to a central unit, which is able to monitor the life signs of the firefighters and intervene in case there is eminent danger of heat stroke or suffocation.

A similar set of wearable technologies can be used to monitor the vital signs of public bus drivers as they deal with the daily stress of driving a very large vehicle in the narrow streets of Porto. Together with psychologists at the University of Porto, we developed an inter-disciplinary methodology that combines geo-referenced sensor data collected from the bus with the heart wave signals and the psychological profile of the driver to detect stress events and produce a colored map of the route. This map provides a visualization of the well being of the driver during the trip and assists him in remembering the events that caused the largest variations and triggered the stress detector. Whereas before having this tool psychologists had a great difficult in extracting this type of information using classical inquiry techniques, early experiments with this new methodology indicate that a lot more can be learned once you provide the bus driver with context information obtained by means of advanced sensing and machine learning.

In these examples, and there are many others at IT Porto, the uninhibited exchange of diverse ways of thinking has produced exciting research, offering significant technical depth and undeniable practical relevance. The outcomes of these projects also give evidence to the fact that information and communication technologies are important both as a research field in their own right, but also as key enablers for knowledge creation and technological development in many other disciplines. It is therefore only natural that information and communication technologies should play an important role in breaking the traditional scientific silos and bringing out the kind of diverse thinking that is required to solve the many challenges the world currently faces. ■

ⓘ http://www.it.up.pt/

ⓘ http://www.vitalresponder.pt/

ⓘ http://drive-in.cmuportugal.org/

NOPTILUS Project

By João Borges Sousa (Universidade do Porto)

Current multi-AUV systems are far from being capable of fully autonomously taking over real-life complex situation-awareness operations. As such operations require advanced reasoning and decision-making abilities; current designs have to heavily rely on human operators. The involvement of humans, however, is by no means a guarantee of performance; humans can easily be overwhelmed by the information overload, fatigue can act detrimentally to their performance, properly coordinating vehicles actions is hard, and continuous operation is all but impossible. Within NOPTILUS we take the view that an effective multi-AUV concept/system is a fully autonomous one, and that we are currently able to employ and develop the required technologies to achieve it.

Evaluation of the performance of the overall NOPTILUS system will be done with emphasis on its robustness, dependability, adaptability and flexibility especially when it deals with completely unknown underwater environments and situations “never thought before” as well as its ability to provide with arbitrarily-close-to-optimal performance.

Example scenario: Chemical leakage

To better appreciate the significance and need for an autonomous multi-AUV system, consider the scenario of an ecological disaster due to the sinking of a ship carrying liquid hazardous material (HAZMAT).

During such a critical mission, there is an urgent need to perform, as accurately and as fast as possible, distributed estimation, recognition and situation understanding tasks. It is necessary to locate the shipwreck and inspect its damaged compartments, to map the area around the shipwreck and determine the ship’s stability, determine the locations where chemicals are leaking from and monitor (i.e. locate and track) the spread of the chemicals in the water.

Accomplishing all these tasks accurately and in a timely manner is necessary in order to decide whether nearby coastal areas need to be evacuated, when chemical neutralizers need to be spread and over which area, whether the tanks need to be permanently or temporarily sealed, and whether it’s best to hoist up the sunken ship or pump the content of its leaking tanks into other vessels.

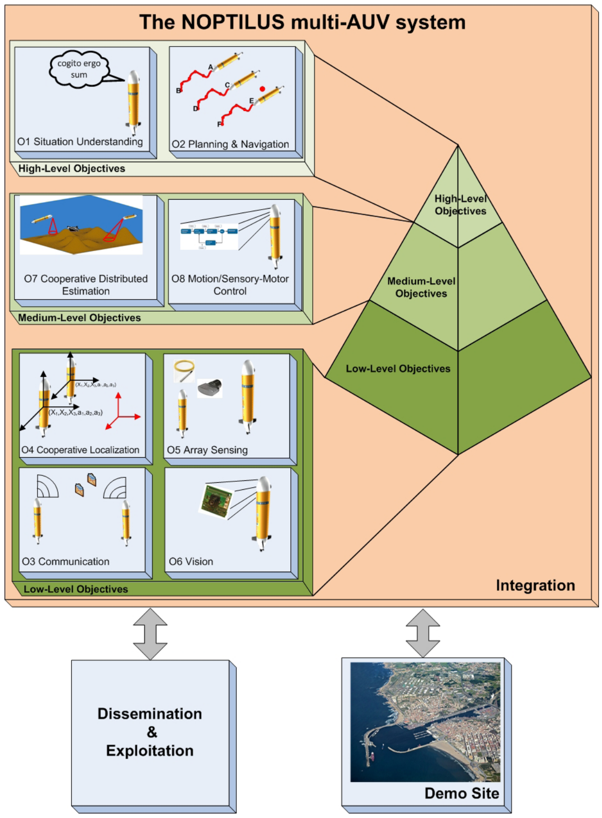

Figure 6: Schematic of the NOPTILUS project

Fully autonomous multi-AUV system

When using existing/planned multi-AUV designs and approaches, most of the critical tasks in the given scenario will have to be performed by human operators: they will have to determine the stability of the shipwreck, detect the damaged areas on the ship, and predict the movement and spread of the chemical spill. Most importantly, the human operators will have to decide, in real-time, the locations the AUVs will need to inspect and to assign different tasks to each AUV.

To achieve a fully-autonomous system, NOPTILUS members will employ machine-learning and reinforcement-learning techniques, combined with a rich set of experimental observation logs from human-operated underwater missions, in order to develop a cognitive-based “Grammar of Underwater Events” and structured prediction designs.

Underwater networking considerations

Underwater network designers find themselves confronted with many challenges. A major difficulty is the latency caused by the relatively low sound speed. Typical travel times between nodes are many orders of magnitude longer than in RF networks.

To cope with this mean’s limitations, we will test multicarrier modulation for underwater acoustic communications. Such systems have the ability to reach high throughputs in an underwater environment, but it is necessary to adapt the system to account for the different Doppler shifts of the different paths of the channel. The throughput and/or reliability of a multicarrier communication system can also be improved by employing a (vertical) hydrophone array. The availability of multiple output channels can also be exploited to tackle the Doppler effects introduced by the underwater channel.

We will also study a C-MAC layer where the interference will be sensed and the transmission of a multicarrier signal will be adapted accordingly by means of power and bit loading. This is very reminiscent of current work carried out in the field of cognitive radio, where every cognitive radio (consisting of a transmitter and a receiver) opportunistically gains wireless access by claiming resources.

Underwater global localization

The current practice in underwater localization is based on sonar, motion sensing, and the occasional GPS fixes when the AUV surfaces. Each AUV uses its own sonar and gyroscope / accelerometer / propeller units to track its position when underwater, possibly aided by one or more surface "anchors" (i.e., emitting sonar beacons). This approach maintains full autonomy of each AUV, yet leaves much to be desired in terms of localization accuracy, early warning capability, fault tolerance and other attributes that are crucial in mission-critical operations.

Unlike mobile phones or sensors, AUVs are equipped with rather sophisticated motion sensing instruments that provide valuable information. We will investigate ways of fusing distance estimates and motion information to improve localization accuracy and track the location of each AUV in a distributed yet collaborative manner. Moreover, we will try using AUVs as anchors to other vehicles, having AUVs re-surface when needed to obtain a GPS fix. A single AUV can take multiple GPS readings while it is moving and others can measure distances to it and compute position estimate improvements.

Situation Understanding

Human operators in current multi-AUV systems contribute not only their maneuvering and recognition skills, but also their high-level cognitive abilities for understanding the situation in the environment the AUVs operate in. Since the main objective of the NOPTILUS project is to offer a fully-autonomous multi-AUV system, it is important to develop methods and techniques for high-level sensor fusion, recognition in timed data, event detection, and event prediction. We use the term "situation understanding" to refer to all these cognitive abilities for inferring high-level representations of the situation at hand. This is perhaps one of the most difficult aspects of the proposed project and the first barrier towards true autonomy compared to the current state-of-the-art. Its importance can be stretched by the fact that high-level decision making for near-optimal planning and task assignment towards successful mission completion cannot be achieved without a high-level understanding of the situation in the surrounding environment.

Each AUV in the system is equipped with a variety of sensors providing continuous low-level data which are filtered and processed to provide information which can then be shared among all vehicles. In that sense, the entire team of the AUVs constitutes a sensor network with a dynamically changing topology. Building on the information provided with respect to the current formation, the AUVs can share measurements with what, where, and when labels; i.e., share each observation, its sampling time and location, as well as its possible attributes. Fusing this stream of information in order to create a "clear and complete picture" is the first step towards realizing the NOPTILUS system; The next step is to recognize sequences of interest in this stream of information which may signal the presence or the initiation of a particular event, for example the approach of a moving obstacle or the extend of a leak. Finally, the last step is to infer possible evolutions of an on-going event and use this prediction to assist decision making, for example estimate the time to a possible collision (and therefore take action to avoid it) or the direction of a spreading oil spill (and therefore indicate where to apply chemical neutralizers). Within NOPTILUS, machine learning methodologies, reinforcement learning tools, and probabilistic context-free grammars will be exploited in innovative ways and will be combined with a rich set of experimental observation logs from human-operated underwater missions, in order to develop all necessary methodological and algorithmic tools for accomplishing the aforementioned steps.

Optimal planning, assignment and navigation

Given the system's limited recourses, the presence of various obstacles, as well as localization and sensing constraints, the problem at hand is to Plan, Assign and Navigate (PAN), in real-time, the AUVs so that the information acquired by their sensors is maximized and the particular situation awareness operation is successfully accomplished as fast as possible. As expected, the problem becomes immensely more complicated when the multi-AUV system operates in highly uncertain and/or rapidly changing environments as is the case in most real-world situations.

The majority of existing approaches employ either heuristic approaches which, suffer from the same drawbacks as humanly-operated multi-robot systems, or optimization-based approaches which are based on relaxations of highly-nonlinear (and often NP-complete) optimization problems. Both methods can lead to very poor overall system performance (e.g. during mapping, several areas of interest may not be visited at all, while in dynamic-process tracking applications the vehicles may lose track of the process/target) which has hindered their applicability to real-world multi-robot systems. An alternative to the aforementioned approaches is the so-called *cognitive-based or learning ones*, where a motion strategy design, with the ability to "recognize its mistakes and learn from them", is repeatedly exposed to situation-awareness examples until it learns to efficiently cope with such operations. Such an iterative learning procedure is time-consuming and often difficult to realize in practice. Thus, in many cases simulated versions of the actual environments are employed to "replicate" the actual ones. Although such cognitive/learning methods conceptually could provide efficient multi-AUV PAN, this unfortunately is not the case: there is no guarantee that the overall approach will perform efficiently when deployed in environments even slightly different than the ones it has been trained for. For all these reasons, cognitive/learning approaches, although have been successfully applied to many robotic applications, have only had limited applicability in AUV situation-awareness operations.

One of the Noptilus partners has developed a design that does not require the time-consuming repetition of simulations or real-world experiments. Instead it efficiently solves a convex optimization problem which can be done very fast and in real-time even when the number of vehicles involved is large. Although is approach can potentially offer an efficient solution for NOPTILUS's motion strategy design, several significant enhancements and improvements are required in order to achieve this objective.

NOPTILUS test case

The NOPTILUS test case is intended to exercise, test, evaluate, and demonstrate, in a realistic environment, the Port of Leixões, the novel algorithms, tools, and technologies developed in this project. The Port of Leixões comprises the largest seaport infrastructure in the North of Portugal and one of the most important in the country.

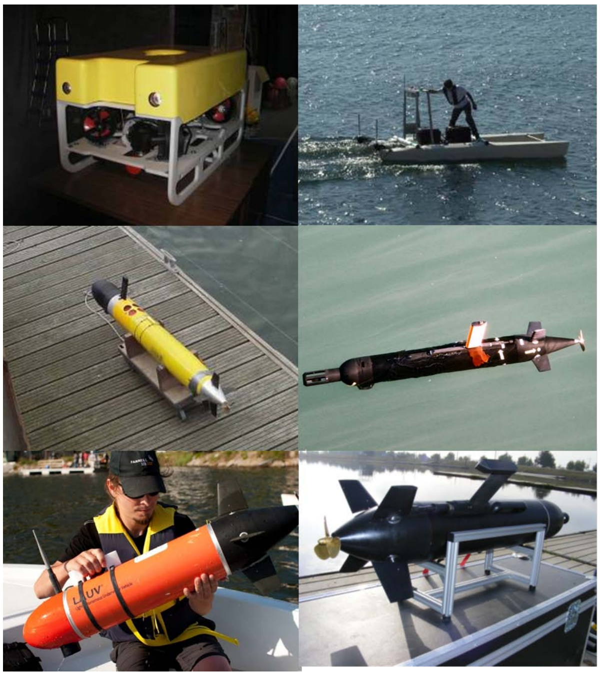

Figure 7: Some hardware to be integrated in the NOPTILUS test case

The test scenario consists of operations (involving a team of 6 AUVs) covering all of these aspects in an integrated fashion. The scenario will be developed in an incremental fashion for each of the aforementioned types of operations. First, sensors and communication devices will be mounted on buoys and other fixed locations to support the operation of autonomous vehicles while providing sensor data for calibration and validation. Second, single vehicle operations, targeted at testing specific developments will take place afterwards. Third, integration tests will be conducted for each system operating in isolation. Fourth, system's level integration tests will be performed to evaluate their joint performance. Fifth, a final demonstration will exercise and demonstrate all the developments in a realistic scenario, and over a statistically significant period of time. This will make the Port of Leixões a case study for other ports in the world.

Existing infrastructure, owned by FEUP, will be appropriately upgraded and integrated for the purposes of NOPTILUS demonstrations. ■

ⓘ http://www.noptilus-fp7.eu/

EWSN 2012 – Trento, Italy

By Gian Pietro Picco and Amy L. Murphy

From 15-17 February, Trento became the center of WSN research in Europe by hosting 9th the European Conference on Wireless Sensor Networks, EWSN'12. Over 130 researchers attended the event, with half the attendees from Europe and the other half from around the world. The technical program consisted of 16 papers, selected from 78 submissions (acceptance rate 20%). The papers were organized into sessions on Communication and Security, System Issues, Reliability, Localization and Smart Cameras, and Hardware and Sensing. The keynote by Peter Corke was titled “Environmental Wireless Sensor Networks: A Decade’s Journey from the Lab to the Field. Two tutorials were presented: “Prototyping the Internet of Things: Creating future embedded devices with Arduino” by Andreas Göransson from Malmö University in Sweden, and “Remote Open Testbed for Cooperating of Wireless Sensor Networks and Mobile Robots” by José Ramiro Martínez de Dios from the University of Seville in Spain. The poster and research demo session this year was exceptional due to its size: nearly 40 posters and demos filled the atrium; the proceedings are also available online.

The conference attendees also soaked up the local atmosphere with a reception at the Castello di Buonconsiglio in downtown Trento and the banquet at the nearby Castel Toblino.

Interview with EWSN thesis awards winners

The European Wireless Sensor Networks conference also had a thesis award session, sponsored by CONET. The winners were Matteo Ceriotti (Bruno Kessler Foundation) and Panayiotis Andreou (University of Cyprus). Following there is a short interview with both.

Matteo Ceriotti

CN: *Could you briefly describe the focus of this research to the readers?*

MC: What is my thesis about? It presents a journey started with the deployment of two operational systems for structural health monitoring in a medieval tower and adaptive lighting in road tunnels, undertaken by my former research group in Trento. Our major contribution, among others, covers the definition and implementation of the system services that guarantee the quality required by the end user. The resulting unique design and reliability provide concrete support to the vision of wireless sensor networks as dependable monitoring infrastructure.

Real world deployments are an unbelievable source of new research challenges. Motivated by our experience in the aforementioned deployments, we designed Reins-MAC, core contribution of the thesis. Reins-MAC is a versatile TDMA communication scheduler that coordinates access to the medium in a fully decentralized fashion. It employs an online scheduling mechanism that forms and reserves slots of variable size, tailoring medium access both to network conditions that vary in time and space, and to the explicit communication quality needs of nodes. The resulting quality and anarchy in accessing the communication resource affect the design and implementation of wireless sensor networks, opening new horizons where the application regains control of communication.

CN: *Will you stay as a postdoc at FBK, maintaining this line of research or are you already planning for new projects?*

MC: I recently left Trento to move to the group of prof. Klaus Wehrle at RWTH Aachen University, in Germany. It is both exciting and challenging to test myself in a completely different environment, in particular in a group where communication systems are tackled from a broader perspective; apparently there is more than just wireless sensor networks! Nonetheless, I received a fellowship to continue working on real world deployments of resource constrained devices. I want to see wireless sensor networks enabling other scientists to acquire knowledge about the world in which we live, and smart objects improving everyday quality of life.

CN: *What would you recommend to new students starting their PhD in fields related to Wireless Sensor Networks and Cooperating Objects?*

MC: It feels strange to be asked for advice. For what concerns my own experience, somebody invited me to participate in a real world deployment in a medieval tower; it was a great opportunity that taught me, not without temporary regrets along the way, the beauty of a kind of research that has concrete impact. Another key ingredient in my journey was a great motivating crew; deploying WSNs is not a task for an individual person, not only because you should not be alone debugging in a road tunnel, but also because there are very different competencies required to make a successful deployment. So, I would be tempted to say: start from a real application and a good team. However, I am certain that a Ph.D. is an intensive experience, different for each and every person, and I do not have a magic formula to make those red blinking devices work. Keep trying and, seriously, have fun!

Panayiotis Andreou

CN: *Could you briefly describe the focus of this research to the readers?*

PA: My research advocates an alternative framework design that looks upon the network characteristics as well as the intrinsic properties of the data dissemination/acquisition process in wireless sensor networks. In this context, we developed three novel techniques that optimize the network topology and decrease the energy cost of query execution. Finally, we have shown that these techniques have opportunities of applications that go beyond the current problem settings (e.g., smartphone networks, People-centric sensing, etc.).

CN: *Will you stay as a postdoc at Cyprus, maintaining this line of research or are you already planning for new projects?*

PA: I'm currently a post-doc at the University of Cyprus involved in several projects in my line of research.

CN: *What would you recommend to new students starting their PhD in fields related to Wireless Sensor Networks and Cooperating Objects?*

PA: I would recommend that they study really hard to gain sufficient insight on what the current trends and open challenges are in the aforementioned areas. Personally, I believe that interdisciplinary research (e.g., opportunistic sensor/smartphone networks) has much more to offer than supplementary approaches in already established areas. Finally, I would recommend that new students should, at the end, follow their heart so as to really commit to the field they are going to pursue.

CN: *Any final words?*

PA: I would again like to thank the EWSN 2012 and CONET committee for awarding me with this award. This is a true honour to myself, my family, my advisors and the Department of Computer Science at the University of Cyprus. ■

Announcements

7th IEEE International Workshop on Practical Issues in Building Sensor Network Applications (SenseApp 2012)

October 22-25, 2012, Clearwater, Florida, USA

ⓘ http://www.senseapp.org/

Paper Submission Deadline: May 12, 2012
Notification of Acceptance: June 30, 2012
Camera Ready Copy Due: July 28, 2012

33rd IEEE Real-Time Systems Symposium (RTSS 2012)

Dec 5-7, 2012, San Juan, Puerto Rico

ⓘ http://www.rtss.org/

Paper submission deadline: May 15, 2012
Notification of acceptance: August 1, 2012
Camera-ready deadline: September 15, 2012

PLANET Summer School on Cooperating Objects and Wireless Sensor Networks

July 15-21, 2012, Bertinoro, Italy

ⓘ http://sites.google.com/site/planetsummerschool/

Application deadline: June 7, 2012

GKmM Summer School 2012 – Cooperation of Robots and Sensor Networks

July 22-27, 2012, Castle Ebernburg, Germany

ⓘ http://www.gkmm.tu-darmstadt.de/summerschool/

Application deadline: May 27, 2012

Resource-aware Machine Learning – International Summer School 2012

September 4-7, 2012, TU Dortmund University, Germany

ⓘ http://sfb876.tu-dortmund.de/SummerSchool2012

Registration deadline: June 1, 2012

SpringerBriefs in Cooperating Objects

The first book in our SpringerBrief series has been published, titled "**The Emerging Domain of Cooperating Objects: Definition and Concepts**". It provides an in-depth explanation of the Cooperating Objects definition and shows its relation to other concepts. Subsequent books will detail the enabling technologies for Cooperating Objects, will show concrete applications and will present an updated research roadmap.

ⓘ http://www.springer.com/engineering/signals/book/978-3-642-28468-7