Impact of SAC

By Tamas Haidegger

The first year of our term has passed, and the Student Activities Committee (SAC) has been trying to make an impact: boosting your conference experience at the IEEE International Conference on Robotics and Automation (ICRA) and the IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS) and providing alternative ways to develop your professional career to network and improve your professional skills. You can read a short report on the activities of the IROS below from Michel Franken (see "Sneak Peek into Our Upcoming ICRA 2011 Events"). Michel was one of my cochairs in 2010, and he did an amazing job, pulling together SAC activities. I am happy to announce here that for his service he has been awarded the IEEE Robotics Automation Society (RAS) Outstanding Student Volunteer Award. Congratulations!

Meanwhile, we are eagerly looking forward to the next year, focusing on enlarging the scope and attendance of our programs and reaching out to a larger number of students.

Back in December, we started our preparation for ICRA 2011 to make it an even larger event. We hope to see most of you at the conference and at our programs. You can find more details about the tentative program in "Sneak Peek into Our Upcoming ICRA 2011 Events," but please follow the official Web site for updates.

In addition, you can read a short notice from Alejandro, my other hard-working cochair, on academic career development (see "Academic Career Advice from Your Future Self"), an inspiring edited interview with a couple of the recent best student paper award winners, and finally, the first article in a new series from SAC on the brand new Student Reviewing Program (see "The Reviewing Process: An Introduction for New Reviewers"), coordinated by Ludo. Do not miss it.

Finally, you are most welcome to join our team. For more details, check out our Web site: http://wiki.ieee-ras.org/mab/sac or e-mail me at ras_sac@ieee.org.

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What's Behind the Best Papers

By Alejandro Perez and Tamas Haidegger

Interview with the Recent Recipients of Best Awards

Without a doubt, research publications are one of the major driving forces behind the scientific progress in our field. Conducting research that provides significant results and leads to materials worthy of publication and presentation is a challenging, but widely known and understood process. However, we can always learn from good examples, analyzing what makes certain papers outstanding in their research area, recognized by awards. In this article, you can read an edited interview with young professionals who were recently honored for their excellent papers. They tell us about the background on how they achieved it.

Three articles are featured:

- *Best Medical Robotics Paper, ICRA 2010*: "Superhuman Performance of Surgical Tasks by Robots Using Iterative Learning from Human-Guided Demonstrations" by Jur van den Berg et al.
- *Best Conference Paper, RSS 2010*: "Biophysically Inspired Development of a Sand-Swimming Robot" by Daniel I. Goldman et al.
- *Best Student Paper, RSS 2010*: "Passive Torque Regulation in an Underactuated Flapping Wing Robotic Insect" by Pratheev Sreetharan et al.

How did the research group work together? What were the main contributions of each author?

van den Berg: We worked on this project with a large group. The runup to the final result was a long process, which started with getting back into operation a 13-year-old laparoscopic robotic platform. Getting it to work can mainly be attributed to Andrew Wan, Humphrey Hu, and Xiao-Yu Fu.

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Sneak Peek into Our Upcoming ICRA 2011 Events

Fostering Interaction Between Roboticists and Students

Student/Chair Mentorship Program

At ICRA 2011, students can get involved in a fun way again. Get the behind-the-scenes experience of a conference. This program will give you a chance to interact with key researchers in your field. Students will be paired with a session chair, where you will learn how to run a session. Students who are interested should first find out who they would like to work with by reading the session guide and selecting a chair that they would like to be their mentor. Please e-mail the name of the session, the date, and your relevant contact information to fibrs@ieee.org. Keep in mind that the people are occasionally very busy, so you may also wish to provide alternative mentor names. Pick topics you are interested in rather than focusing on famous names.

Student Photo Contest

You are welcome to submit your photographs taken during any professional event. This is a seasonal amateur photography competition, which is open to undergraduate and graduate student members. The judging of the submitted photographs will be made by the IEEE RAS SAC, involving independent judges. Three winners will be announced and awarded after the conference. The submitted photos will be used for archival purposes.

Student Reporters Program

You are given a chance to become famous with your writing skills: we are calling for entertaining, yet professionally relevant reports on different workshops and conferences. Specifically for ICRA reporters, you can register yourself to a session via SAC Web site (http://wiki.ieee-ras.org/mab/sac). The best reports will be awarded and published on the RAS Web site and/or in an upcoming issue of *IEEE Robotics & Automation Magazine*. Contact RAS_student_reporters@ieee.org for more details.

Explore Shanghai Beyond Pudong

SAC is organizing tours in the free timeslots at ICRA to explore Shanghai's day and night. We will have local student guides to show us the most interesting places, traditional food, and local drinks.

Tamas Haidegger

Once operational, the focused research on learning knot ties and other procedures through human demonstrations was mainly carried out by Jur van den Berg, Stephen Miller, and Daniel Duckworth. Jur, as a postdoctoral researcher, led the project on a daily basis. He wrote the paper and the algorithms for learning trajectories from demonstrations. Stephen and Daniel, undergraduate students, worked in the laboratory on implementing these algorithms to work on the robots. Humphrey Hu was never far away to resolve hardware issues with the robots in case they appeared. Ken Goldberg and Pieter Abbeel supervised the project on a higher level. They provided global directions and feedback on the progress.

Goldman: The research group was composed of two of my graduate students, Ryan Maladen (a bioengineering Ph.D. student) and Yang Ding (a physics Ph.D. student), an undergraduate student (Adam Kamor), and a collaborator of mine, Dr. Paul Umbanhowar. Ryan and Paul developed the robot, while Ryan, Yang, and Adam developed the experimentally validated numerical

SAC Report from IROS 2010

The IROS was held in Taipei, Taiwan, 18–22 October. The conference itself was quite interesting, with even more presentations and exhibitors than usual; the program featured a lot of technical sessions piled with innovative research and three excellent keynote speakers, Prof. Pfeiffer, Dr. Cousins, and Prof. Sankai.

As we are responsible for the student programs, SAC tried to offer some alternatives running in between the official conference schedule. Primarily, RAS students were provided with the opportunity to get to know each other. We visited Taipei 101 together (the second tallest building the world) and were pleasantly surprised by the amazing view of the city from above when the weather all of a sudden decided to clear up. We also explored the night life of Taipei and toured the famous Shilin Night Market where all kinds of foods, mostly clothes and toys were for sale. A spectacular ending of the conference was provided with a "sing along" session for three hours in a local karaoke bar. This was great fun, and there are actually some nightingales hidden amongst us, roboticists. Some of the people who were still in Taipei on Saturday joined us on a visit to the National Palace Museum, where we saw a lot of pottery, books (that unfortunately nobody there could read), and an amazing garden. In the afternoon, we explored the downtown area (Longshan temple, snake market, Peace park) and finally enjoyed the sunset at the magnificent Chiang Kai-Shek Memorial.

A new event for SAC was the Lunch with Leaders. During this special meal, the students could have a casual discussion with well-recognized professionals, including Dr. Kosuge, Dr. Pfeiffer, Dr. Cousins, Dr. Ng-Thow-Hing, Dr. Ryu, Dr. Ferre, Dr. Niemeyer, Dr. Khatib, Dr. Corke, Dr. Du Pont, Dr. Stramigioli, and many others. Based on the feedback we got, the Lunch with Leaders will definitely be continued. Do not miss it next time at ICRA 2011.

We have the winner of the IROS student photo contest, William Morris, from City College of New York. Congratulations! You can see the winning entry at http://wiki.ieee-ras.org/mab/sac/iros2010.

We also tried to run the Fostering Interaction Between Roboticists and Students (FIBRS) Program at IROS in which the students can cochair a technical session to learn more about how the major conferences are organized and to interact with a session chair of their choice. Unfortunately, there were not many student requests, and the requests eventually could not get fulfilled. To those students who we could not help, our apologies, and we expect to do better again at the next ICRA.

This was a small overview of the events SAC organized during IROS. It is great fun to interact with fellow students outside of the technical sessions, so make sure you do not miss these events the next time.

Hope to see most of you in Shanghai.

Michel Franken

PS: Should you have any feedback on our activities, do not hesitate to contact us at ras_sac@ieee.org.

simulation of the robot and granular medium. I supervised and guided the project.

Sreetharan: Our smart composite microstructure fabrication techniques enable many of the interesting millimeter-scale robotic structures produced by our research group. Progress in these techniques is highly collaborative, with improvements and refinements quickly advancing from individual experimentation to laboratory standard.

This article considers the problem of underactuated robotics in an atypical framework.

For this paper, Pratheev conceived of the PARITy methodology for control, designed the roll-torque balancing PARITy drivetrain and created the theoretical dynamic model. He also leveraged the group's existing fabrication techniques to build the experimental structures, and he conducted the experimental trials described in the paper. Prof. Robert Wood assisted with helpful discussions, material support, and with mechanical assembly.

What do you think made the paper strong and ultimately worthy of the award?

van den Berg: I think the answer to this question is a combination of factors. First, we studied a problem of high practical relevance, given the enormous growth of robotic surgery platforms over the past couple of years. Second, the algorithms at the basis of our approach to learn optimized trajectories from demonstrations and speed them up are elegant and based on strong theoretical foundations. Third, we made it work, and showed the results that are promising for future developments in this direction. In short, our paper bridged the strong theory with relevant practice, and made it work on real robots.

Goldman: The paper builds upon our biological studies (also led by Ryan Maladen) of the sand-swimming of the sandfish lizard, results reported in *Science* ("Undulatory Swimming in Sand: Subsurface Locomotion of the Sandfish Lizard" by Ryan Maladen, Yang Ding, Chen Li, and Daniel I. Goldman, *Science*, vol. 325, p. 314, 2009). In this study, we discovered how the lizard propels itself within the sand by using an undulation of its body. The robot serves as a physical model of the organism and allows us to test hypotheses about movement patterns, for example, why does the animal always use a particular amplitude of body undulation to dive into the sand? We find that the robot swims fastest when it uses this amplitude. The other merit of this work is that we were able to develop an accurate computer model of the robot—the challenge here was to create a model of the granular medium. While such models (partial differential equations called Navier-Stokes equations) are well known in fluids like air and water, the equations at this level do not exist for granular media. Therefore, we used what is called discrete element simulation to simulate the movement of hundreds of thousands of colliding spheres in the computer and validated this simulation against the experiment (measuring drag forces in experiment and simulation). The simulation agreed quite well with robot-experimental measurements (for example, the speed of robot as we varied its wave frequency, amplitude, etc.). This provides us (and future researchers) a tool that allows accurate simulation modeling of devices that must interact with sand.

Sreetharan: This paper introduces a novel control methodology for microrobotic air vehicles that breaks from conventional wing trajectory control espoused by the related work in the field. Mechanically intelligent structures, such as the one described in this article, have the potential to greatly simplify active control systems for severely mass- and power-limited airborne robotic insects, while also providing insight into passive mechanisms potentially available to biological insects.

In a broader sense, this article considers the problem of underactuated robotics in an atypical framework. Whereas traditional underactuated robotics seeks to control the state of systems with more degrees of freedom than actuators, this article analyzes how adding the degrees of freedom can actually increase the performance of an underactuated robotic system by introducing beneficial passive dynamics.

What do you consider to be the major lesson learned while working on this project?

van den Berg: One of the main lesson is, although known by everybody, that working with hardware always presents (un)pleasant surprises during experimentation. Either the behavior of the robot is suddenly unpredictable or it breaks down for no apparent reason. Dealing with these issues makes it hard to predict how much time each step in the process takes.

Goldman: The major lesson is that physical robot models and simulation models can have predictive power for biological performance once the interaction models with the environment are established.

Sreetharan: We learned the importance of exacting and methodical design. In a first prototype, an oversight led to one of the mechanical joints exceeding its maximum force rating and buckling once the device began flapping its wings at 110 Hz. In addition to addressing these concerns about device strength, we took care to control the dynamics of individual elements of the experimental structure to tight tolerances. This allowed our classical theoretical model to accurately predict the behavior of the greatly underactuated robotic system without resorting to parameter fitting.

What was the writing process like? Does the group have any particular modus operandi that is used while redacting the material to be published?

van den Berg: The writing was the main responsibility of the first author, and drafts of the final version were ready about two weeks ahead of the deadline. This gave every member of the team the chance to review the paper at a time of their convenience and suggest changes, which were then incorporated by the first author. This cycle repeated a few times, such

that the end result was carefully internally reviewed and approved by every member of the team before submission.

Goldman: The writing process was pretty smooth on this paper. The student, Ryan Maladen, did a fantastic job of producing a first draft.

Sreetharan: We follow the standard procedures of ensuring that any intellectual property is adequately protected before publication. We also believe that clear and appealing imagery is at least as important to conveying a scientific work as is clear writing; thus, much care was taken to ensure that the figures were clear, informative, appealing, and polished.

Has the group continued to work on this project? What can we expect from future publications coming out of your laboratory?

van den Berg: Yes, we are continuing research in this direction. A major shortcoming of our paper was that the robots essentially operated blindly and assumed knowledge of the state of the suture if it needed to grasp it. The main questions we are working on now is how to model the behavior of the suture during manipulation by the robot and take that into account in the process of learning from demonstrations as well as incorporating the visual feedback in the process of tying the knot. This should greatly improve the robustness and applicability of our approach.

Goldman: Yes, we continue to explore the biological features of sand swimming, the physics of intrusion into granular media, as well as ways to improve robot performance. For example, expect papers on how the back muscles in the lizard are used during sand swimming, papers on lift control during sand swimming and papers on the physics of lift in granular media.

Sreetharan: This paper demonstrated the passive regulation of body-roll torques of an airborne robotic insect, largely resulting from aerodynamic drag. We expect to continue this research, demonstrating intelligent passive mechanisms that regulate a greater subset of forces and torques during flight. For example, a current project seeks to passively regulate yaw torques resulting from aerodynamic lift.

Furthermore, we plan to demonstrate active control under the PARITy methodology. Control inputs of this type do not alter wing trajectories, as per the conventional approach; rather, they bias the passive systems that regulate body forces and torques.

Did the group encounter any difficulties with team work? If so, how were these solved?

van den Berg: No, not really. The roles were clearly divided, and everyone was highly committed to the success of the project. Without this, it could not have succeeded.

Goldman: No, our team works great. My laboratory (we call it the CRAB Laboratory for Complex Rheology and Biomechanics) has a number of projects like this, in which physicists, biologists, and bioengineers work to gether to solve problems—such solutions in fact require the collaboration and skills from these different disciplines.

Sreetharan: Since this research was largely the result of individual effort, we had no major difficulties.

Thank you for the interview!

Academic Career Advice from Your Future Self

By Alejandro Perez

In robotics, real-time knowledge acquisition with no a priori data or "learning as you go" is very common, and it can be considered the norm. Similarly, as we develop our careers and grow as members of the academic community, we often find ourselves saying "If only I had known x two years ago?" Our field is rapidly growing, its rate of advancement is hastening, and it is slowly moving toward the spotlight of the entire scientific community. In the same way, joining top academic institutions or getting involved with cutting-edge research projects is getting more competitive each year. Below, you will find a short list of the most common "If only I had known's" I have heard from graduate students. Hopefully, they will help you through your career. Just consider it as advice from your future self.

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Academic Research

A good transcript, graduate record examination score, and a statement of purpose are simply not enough anymore. Research is what will truly make you stand out and also what the bigger part of your graduate career will consist of. Many regret not getting involved with research from the very beginning.

Diversity

Most students get their first research experience at their own institution. However, getting results and good progress can tempt you to solely work with a certain laboratory. Working at just one place means meeting only a limited number of faculty members and having only one reference source and possibly a stale resume/CV. Consider working at your institution during the semester and applying for research internships or jobs at a different institution every summer. Some