Winners of the Inaugural IEEE RAS Start-Up Competition Announced!

By Raj Madhavan, Erwin Prassler, and Oliver Brock

French poet and novelist Victor Hugo is attributed with the quote "Nothing is more powerful than an idea whose time has come." The saying is especially true as it applies to robotics and automation. In the last few years, entrepreneurship in robotics and automation has received renewed interest due to several high-profile acquisitions, for example, Amazon's US$775 million acquisition of Kiva Systems in early 2012 and Google's acquisition of eight robotics companies in late 2013. In addition, companies like Da-Jiang Innovations Science and Technology Co., Ltd., a Chinese technology company that produces unmanned aerial vehicles, are currently valued at US$8 billion, indicating the market's belief in the commercial impact of robotic technology. However, a powerful idea alone is not enough for a successful transition of a concept to a commercializable product, as anyone who has attempted to make their dream a reality would attest.

To foster the entrepreneurial spirit and to provide a platform to encourage researchers and practitioners to transition ideas and prototypes to commercializable products, the IEEE Robotics and Automation Society's (RAS's) Industrial Activities Board invited the robotics and automation community to participate in an Entrepreneurship Forum and Start-Up Competition at the 2015 IEEE/Robotics Society of Japan International Conference on Intelligent Robots and Systems (IROS) held in Hamburg, Germany, on 1 October 2015. The event was intended to inspire, educate, enable, and empower researchers, students, young professionals, and anyone else who has the start-up bug and wants to launch companies but is not sure of how to go about it. It is our belief that such efforts will create an ecosystem that will provide much-needed support for start-ups to launch their initiatives while being realistic about their envisioned ideas and products.

Figure 1. (From left) Erwin Prassler; Raj Madhavan; competition winners Alvin Chen and Max Balter (of VascuLogic); and Oliver Brock.

In a rigorous review process, a panel of experts from industry selected 12 finalists from 55 submissions. The finalists were invited to IROS in Hamburg to make their final pitches. In an interim coaching stage, the finalists were paired with an expert to fine-tune their presentations and ideas to present at the finals, where they made a 5-min presentation (followed by a 5-min question and answer session) to a distinguished judging panel from industry and academia.

The presentations were judged based on the following seven criteria: business idea, customer benefit, competitive advantage, market analysis, management, traction, and financial concept. The judges were Dominik Boesl, corporate innovation manager, KUKA AG, Germany; Francois Boucher, chief business development officer, Kinova, Canada; Ryan Gariepy, chief technology officer, Clearpath Robotics, Canada; Nikolaos Papanikolopoulos, Distinguished McKnight University Professor, University of Minnesota; Slawomir Sander, Bosch Robotics, Germany; and Alin Albu-Schaeffer, head of the Institute of Robotics and Mechatronics, German Aerospace Center (DLR).

The top three prize winners of the first IEEE RAS Start-Up Competition were as follows (Figure 1):

- **Grand prize winner:** Alvin Chen of VascuLogic, LLC, whose business idea was a portable, image-guided

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medical robot that improves the accuracy, safety, and cost-effectiveness of venipuncture by drawing blood and performing intravenous procedures in an automated fashion.

- **Second place:** Kenji Suzuki of PLIMES Ltd., whose business idea was social problem solving by dramatically enhancing the quality of life of people with lower-body paralysis or elderly people through the use of passive exoskeletons with smart mechatronics in personal mobility.
- **Third place:** Francesco Maria Petrini and Stanisa Raspopovic of SensArs Neuroprosthetics Sàrl, whose business idea was SENSY, a unique device enabling amputees who do not have feelings from their prosthesis to feel skin softness or a stone trampled during walking.

The three winners took home US$15,000, US$10,000, and US$5,000, respectively. All finalists were provided travel support of up to US$1,250. Financial sponsorship provided by RAS, the IEEE, and KUKA is gratefully acknowledged. More information on the Start-Up Competition, the 12 finalists, and their business ideas is available at http://iros2015.org/index.php/program/entrepreneurship-forum-start-up-competition/.

In the following articles, the three winners describe their inventions in detail and their path to success.

Developing the World's First Portable Medical Robot for Autonomous Venipuncture

By Alvin I. Chen, Max L. Balter, and Timothy J. Maguire

In the past decade, robotic technology has slowly made its push into the medical field. Advanced surgical robots, in particular, have become technological icons in today's hospitals. However, the use of robotics for everyday medicine remains a major challenge due to the cost and size of current systems—the da Vinci Surgical System, for example, can cost several million dollars and requires a dedicated operating room.

In 2010, our team of biomedical engineers in New Jersey founded VascuLogic to commercialize imaging and robotic technologies designed specifically for compact, portable, and low-cost medical devices. Our primary technology, the VenousPro, is the world's first robotic venipuncture device. The device is about the size of a soccer ball and the weight of a few engineering textbooks, and yet it is capable of drawing blood or placing an intravenous (IV) catheter in a fully autonomous fashion. The core idea behind the device was that the precision and imaging capabilities of a robot would allow it to find veins and insert the needle better than a human.

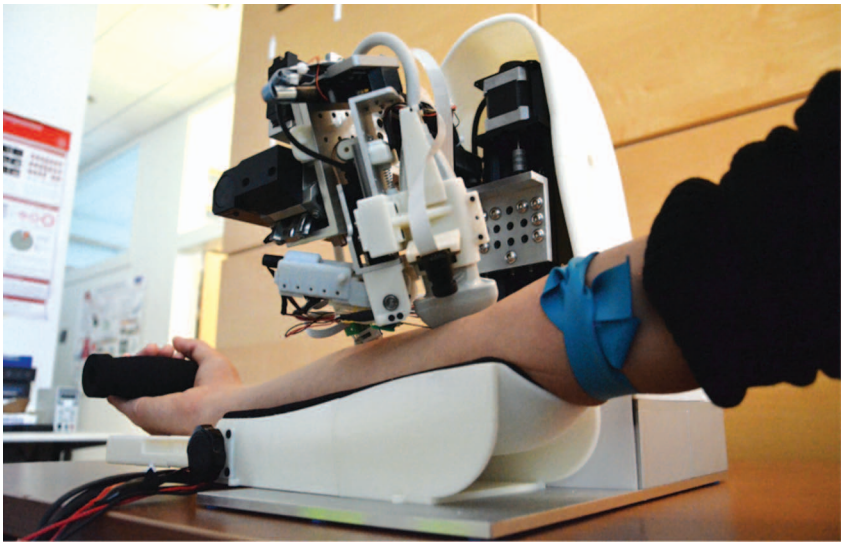

Figure 1. VascuLogic's VenousPro is the world's first image-guided robotic venipuncture device. VenousPro is designed for use in hospitals and labs to quickly and safely draw blood and perform other intravenous procedures in a fully autonomous fashion. (Photo courtesy of Alvin Chen, VascuLogic L.L.C.)

In 2012, we conducted a survey of U.S.-based hospitals, diagnostic labs, and phlebotomists, and in this process, we identified difficult venous access as a particularly significant problem in children and elderly patients. These patients tend to have very small and fragile veins that roll to the side when the needle makes contact. It can also be challenging

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to visually identify a suitable venipuncture site, particularly in patients with dark skin or high body mass index.

Even after the phlebotomist has identified a vein, accurately inserting the needle can also prove to be difficult because there is no way to sense the depth of the needle. In many cases, the needle will be pushed too far and pierce through the back of the vein wall, which causes sharp pain, bruising, internal bleeding, nerve injury, and a number of other possible complications. Our goal was to develop the VenousPro to overcome all of these problems and, thereby, enable blood draws and IV procedures to be completed at the first stick and without complication.

One of the early challenges to the design of the VenousPro was to meet the precision requirements of venipuncture. Blood vessels in the human arm can be as small as 1 mm in diameter, especially in children. We iterated through five prototypes to minimize errors due to backlash in the motors, manufacturing imprecision, and latency.

Another challenge was developing the vein imaging technology and coupling it seamlessly with the robot. VenousPro relies on detailed images of the vein and its surrounding area, and in recent designs, the imaging has been further improved with ultrasound and real-time three-dimensional vessel reconstruction software.

Our third focus has been to develop comprehensive safety features for the device. Such features include electronic, mechanical, and software-based monitoring systems; real-time tracking of the vein and needle; and sterile disposables to prevent contamination between patients.

In both phantom and animal validation studies completed using the latest generation of the device, VenousPro has demonstrated greater than 95% first-stick accuracy and additionally has outperformed human phlebotomist controls. We will be conducting our first human clinical studies in the coming months to demonstrate the safety and accuracy of the device.

We have also begun working with an industrial design firm to make sure that the VenousPro meets the needs of the patient and the practitioner and fits in the current hospital and lab workflow. This past year, VascuLogic was awarded a number of large grants, including a Small Business Innovation Research grant from the U.S. National Science Foundation. We will also be working with Rutgers University to integrate the VenousPro with miniaturized diagnostic blood tests that can be performed rapidly, on the device, and with small samples of blood. Finally, we are continuing to pitch at events such as the IEEE/International Conference on Intelligent Robots and Systems Entrepreneurship Forum and Start-up Competition as we seek continued funding. Our ultimate goal is to see VenousPro in hospitals and labs by 2019 (Figure 1).