ILLINOIS AUV

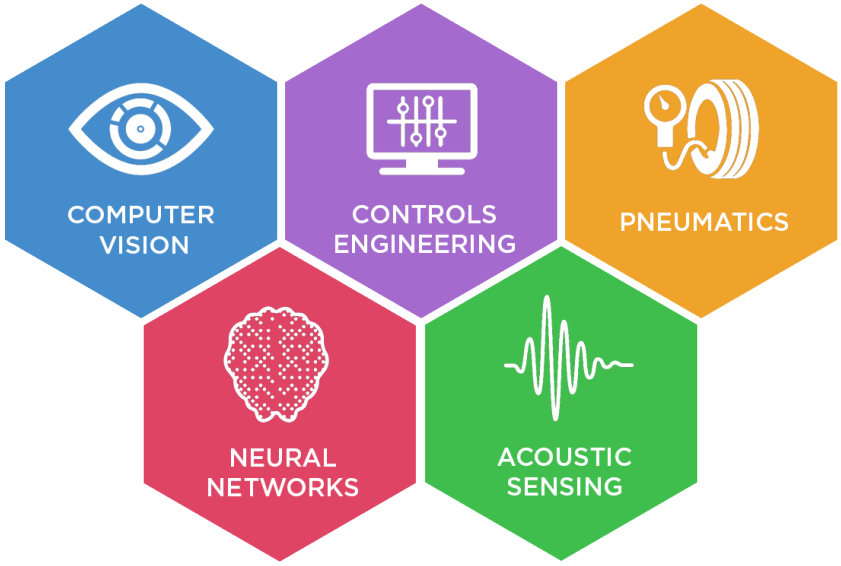
SPONSORSHIP PROSPECTUS

contents

overview

We are a student-run organization with an aim to build an **autonomous underwater vehicle** to compete at the international **RoboSub competition** organized by the Association for Unmanned Vehicle Systems Internation (**AUVSI**), which is held at the Space and Naval Warface Command Research facility in San Diego, California. The main goals of the organization are:

- Build creative solutions through relentless innovation instead of using expensive industry-level hardware
- Implementing cutting-edge technologies such as deep learning, computer vision and artificial intelligence
- Conducting thorough research to investigate different ways to build autonomous robots and find best practices
- Bringing people with different skillsets from different backgrounds to pursue a common goal
- Create a collaborative learning environment and knowledge base for improving resources to learn and skills relating to Artificial Intelligence and Robotics
- Build a submarine that is worthy of achieving our ambitious goals and putting the University of Illinois in the RoboSub pool



about the competition

The international Robosub competition is organized by the Association for Unmanned Vehicle Systems International (AUVSI) Foundation and the Office of Naval Research (ONR). The competition is held at SPAWAR Transdec in San Diego. This summer, in 2017, we will be competing at the 20th iteration of the competition.

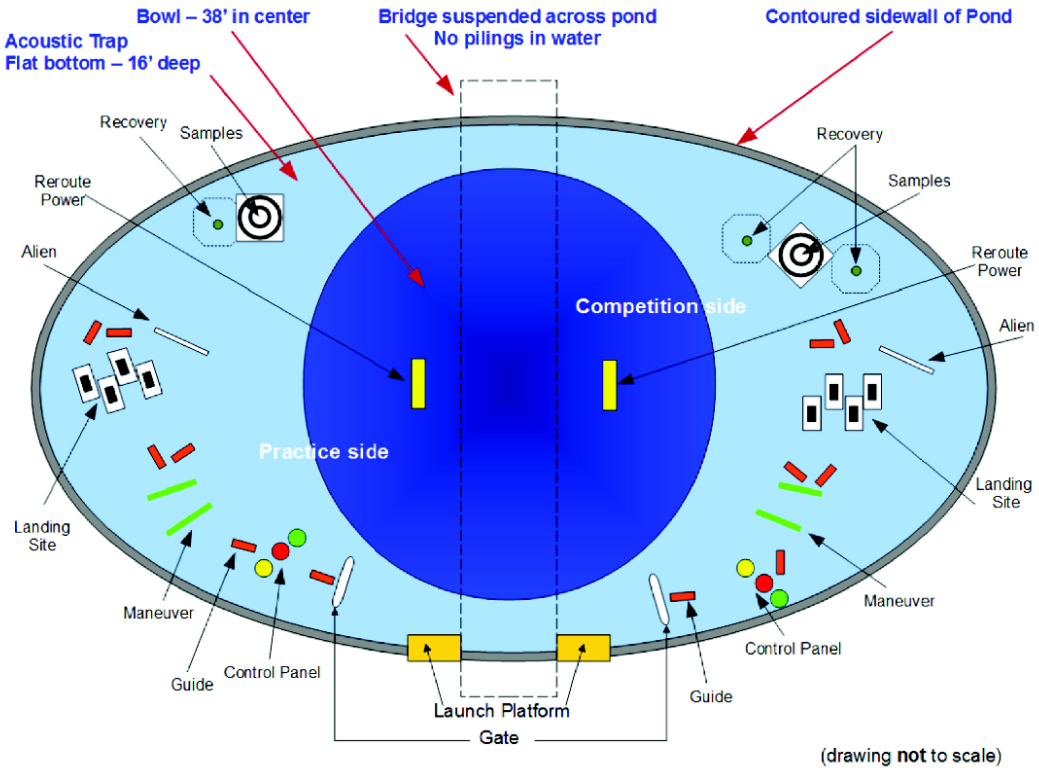
The competition draws participants from 50 teams from around the world. All participating teams have to make an autonomous submarine from scratch to perform a variety of visual and acoustic-based challenges designed by competition judges. The course design and tasks are subject to change each year. The competition design and rules are released one month before the competition.

The SSC Pacific TRANSDEC (Source: BlueRobotics)

objective

The objective of the competition is for the submarine to autonomously navigate the underwater course. This involves recognizing objects such as buoys, dropping markers, shooting torpedos at targets, following pipelines and a variety of other complex tasks.

- To begin the course, the vehicle must pass through a validation gate.
- Then, the vehicle must past three colored buoys in a pre-defined sequence.
- The vehicle must then pass through a gate marked by a horizontal pipe capped by risers on either side.
- After this, the vehicle is required to drop up to two markers in specific bins from a set of bins arranged in order.
- The vehicle must then fire torpedoes through designated holes marked by various numbers after removing their covers.
- An acoustic pinger leads the vehicle to an object that must be captured by the vehicle when it surfaces. The vehicle must surface fully inside an octagon recovery zone.



faculty

Dr. David Forsyth
Professor David Forsyth currently occupies the Fulton-Watson-Copp chair at the Computer Science department here at Illinois. Prior to UIUC, he was a full professor at UC Berkeley. He has published over 130 papers on computer vision, computer graphics and machine learning. He has also served as program co-chair for IEEE Computer Vision and Pattern Recognition in 2000, 2011, and 2018, general co-chair for CVPR 2006 and 2015, program co-chair for the European Conference on Computer Vision 2008, and is a regular member of the program committee of all major international conferences on computer vision. Professor Forsyth has served six years on the SIGGRAPH program committee.

Dr. Volodymyr Kindratenko
Professor Volodymyr Kindratenko is a Senior Research Scientist at the National Center for Supercomputing Applications (NCSA) - home of Blue Waters supercomputer - one of the largest high-performance computing (HPC) resources available for open academic research. He is also an Adjunct Associate Professor in the department of Electrical and Computer Engineering. At NCSA, he works on the development and deployment of next-generation HPC systems based on computational accelerators and on the design and implementation of scientific applications for such systems.

Dr. Tim Bretl
Professor Tim Bretl received his B.S. in Engineering and B.A. in Mathematics from Swarthmore College in 1999, and his M.S. in 2000 and Ph.D. in 2005 both in Aeronautics and Astronautics from Stanford University. Since 2006, he is an Associate Professor of Aerospace Engineering and a Research Associate Professor in the Coordinated Science Laboratory. He received the National Science Foundation Faculty Early Career Development Award in 2010. Professor Bretl heads the Bretl Robotics Group, which works on many innovative robots.

Dr. Naira Hovakimyan
Professor Naira Hovakimyan received her MS degree in Theoretical Mechanics and Applied Mathematics in 1988 from Yerevan State University in Armenia. She got her Ph.D. in Physics and Mathematics in 1992, from the Institute of Applied Mathematics of Russian Academy of Sciences. She is currently W. Grafton and Lillian B. Wilkins Professor of Mechanical Science and Engineering at UIUC. In 2015 she was named as inaugural director for Intelligent Robotics Lab of CSL at UIUC. She has co-authored a book and more than 300 refereed publications. In 2014, she was recognized as Hans Fischer senior fellow of Technical University of Munich. Her research interests are in control and optimization, autonomous systems, neural networks, game theory and applications of those in aerospace, mechanical, agricultural, electrical, petroleum and biomedical engineering.

team

The team is comprised of driven students from diverse backgrounds and disciplines, who aim to explore the applications of cutting-edge technology and engineering in building an autonomous underwater vehicle. As a team, we aim to develop a platform for the exchange of ideas, fostering team spirit and cultivating a strong work ethic.

Shubhankar A.
Computer Engineering
President

Mohammad S.
Electrical Engineering
Electrical/Software

Krishna D.
Computer Science
Software

Raimi S.
Computer Engineering
Software

Tanay V.
Aerospace Engineering
Mechanical/Software

Adrian B.
Computer Engineering
Electrical

Aneesh D.
Computer Science
Software

Rob A.
Electrical Engineering
Electrical

Saleh A.
Electrical Engineering
Mechanical

Indraneel B.
Mechanical Engineering
Mechanical

Wale A.
Nuclear Engineering
Partner Relations

Harshit
Computer Engineering
Software

innovation

Cost-effective GPU instead of i5 processor
An autonomous submarine requires immense computing power, which is why many teams opt to use i3 or i5 processors. Consequently, placing these multi-core processors in a compact (to meet competition specifications on size) and watertight arrangement becomes a key challenge. Their processors also need to be powered underwater, and hence, high capacity batteries must also be used. Additionally, these processors require intricate cooling and pressure-stabilizing mechanisms. All of these considerations work towards drastically increasing costs.

Therefore, we have decided to use an NVIDIA Jetson TX1, an affordabe ($600) GPU, that runs Linux out of the box. The GPU consumes less power; it takes only 10W as compared to the ~250W the aforementioned processors take. Furthermore, overheating is also not a major concern, and hence, without any losses in computing power, while reducing costs significantly.

SLAM (Simultaneous Localization and Mapping) in place of DVL
One of the big challenges faced by teams in this competition is making their submarines aware of their position in the pool. With most basic sensors such as gyroscopes, accelerometers, or depth sensors, there is no way to accurately determine the velocity of the submarine. Many teams use a Doppler Velocity Logger, a $18k piece of hardware which is used to obtain accurate measurements of velocity underwater. We believe that this large amount of $18k can be spent in better ways, and hence, we're developing a more cost-effective solution for this problem.

Our solution incorporates Real-time SLAM (Simultaneous Localization and Mapping) to determine velocity. SLAM will help us create a point cloud of the pool and give our submarine a global sense of its surroundings. Over the course of a few runs, we can construct a fairly accurate estimation for the layout of the pool. This enables our submarine to make more intelligent decisions in lesser time. SLAM algorithms are being constantly created and improved by open-source developers and researchers around the world. and we hope to implement them to develop our submarine's self-awareness. Moreover, our GPU provides us with the computing power to run those algorithms in a real-time setting.

roadmap

Fall 2016

Build Working Submarine

- Completely waterproof
- PID calibrated

Spring 2017

Improve Submarine

- Implement Vision
- Torpedo Launcher
- Bomb Dropper
- Acoustics

Summer 2017

Compete at the RoboSub Competition

- Reach Finals

Fall 2017

Expand organization

- Recruitment
- Workshops/Seminars
- Community Outreach

requirements

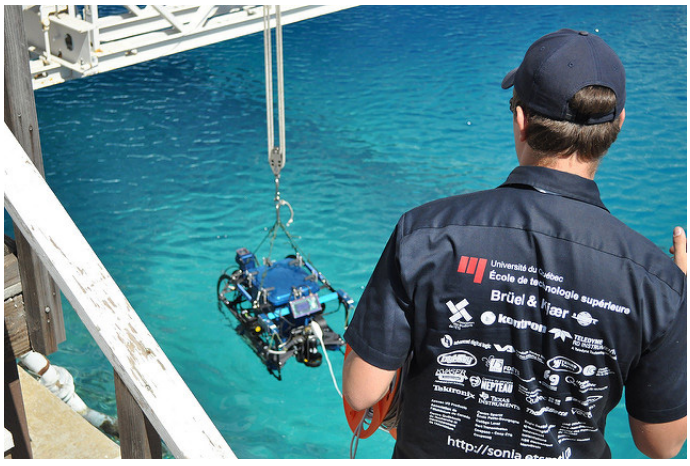
Expenditure
In addition to the guidance from our esteemed faculty advisors, we're dependent on partnerships with generous sponsors to embark on this journey. We aim to build a submarine capable of navigating an underwater course, and reaching the finals of an international competition. This will require significant, but intelligent expenditure.

A significant fraction of our expenditure will be utilized in **buying parts**, such as sensors, hydrophones, GPUs, depth sensors and batteries. In addition to using the software for analysis and CAD available in engineering labs, we anticipate the need for **purchasing licenses for key softwares** when we are out pool testing or at competition.

After building the submarine, we'll also incur expenses relating to **logistics, such as travel, lodging and transportation costs**. Furthermore, there will always be things breaking, as we strive to build a submarine to navigate complex challenges through an underwater course. Hence, we must also take into consideration **contingencies and miscellaneous costs**.

Opportunities
Building an autonomous underwater vehicle is not for the faint-hearted. A partnership will provide access to driven STEM students working with world-class faculty on exploring cutting-edge technology and applying it to solve a real-life challenge. In addition, there are numerous opportunities for representation of your company's name and logo on team apparel, the website, posters, and even the submarine. In addition, we plan to host testing at the **Urbana community pool**, and reach out to interested high-school students and engage them. Before the competition, the team also publishes and submits a r**esearch paper**, outlining the research and innovation that went into building the submarine. As a sponsor, your company's name will be included on that paper. We are also open to **non-monetary sponsorships**, through which donations of parts, software licenses and airfare waivers can be made.

(Source: AUVSI)



(Source: Sonia AUV)

sponsorship bundles

Gold
($5000 <)

1. Priority representation on submarine
2. Priority representation on team apparel
3. Priority representation on team website
3. Company name on journal paper
4. Priority representation on team poster
5. Access to resume book
6. Assistance with setting up info sessions on campus

Silver
($2500-5000)

1. Representation on submarine
2. Representation on team apparel
3. Representation on team website
5. Representation on team poster
6. Access to resume book

Bronze
(< $2500)

1. Representation on team apparel
2. Representation on team website
3. Representation on team poster
4. Access to resume book

Aqua

Not what you had in mind? Get in touch and we can work together to build a custom sponsorship bundle. Please look for contact information on the next page!

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