



Autonomous Robotics

Research Center

**Beyond the
boundaries of
human capacity**

Pioneering the future of autonomy

The coming decades promise a transformation in autonomous capability with awe-inspiring advantages for everyone. The Technology Innovation Institute (TII) is at the forefront of this global shift, putting innovation that is beneficial for humanity at the heart of its research, and pioneering new systems and technologies to support vital sectors that form the building blocks of the 21st century.

Our new Autonomous Robotics Research Center (ARRC) in Abu Dhabi has been established to investigate and advance this new era of robotics and autonomy. Helping build hybrid societies made up of biological and artificial systems, we apply advanced scientific knowledge to take autonomous systems into new and unknown environments.

Who We Are

The Autonomous Robotics Research Center (ARRC) is leading the advancement of robotics, computer vision, and bio-inspired technologies in the region. Our international team of experts from top-tier academic institutions and research organizations specialize in perception, communication, control and decision making, bio-inspiration, and modular and self-organized autonomous systems. We explore their application across multiple environments: air, land, on-sea and underwater.

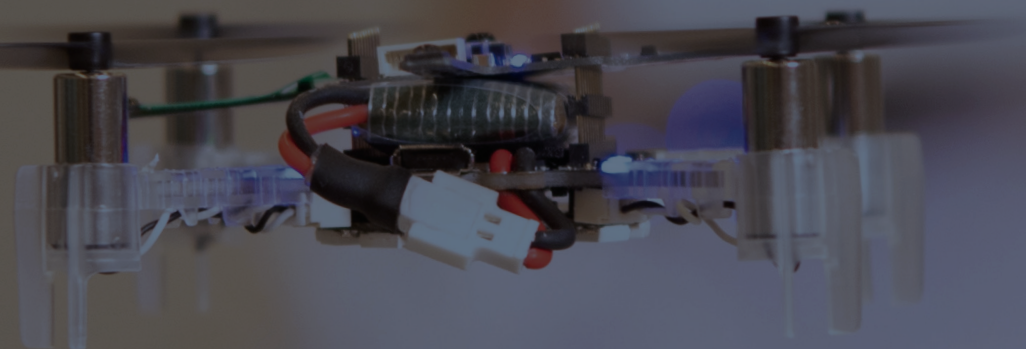
ARRC is part of the Technology Innovation Institute (TII), a global scientific research center attracting the world's foremost scientists and researchers. TII leads worldwide advances in artificial intelligence, autonomous robotics, quantum computing, cryptography and quantum communications, directed energy, secure communication, smart devices, advanced materials, and propulsion and space technologies, and biotechnology fields.

TII belongs to the Abu Dhabi Government's Advanced Technology Research Council (ATRC), which oversees the technology research in the emirate.

What We Do

We research, develop, and apply novel technologies to innovate robotics solutions that are fully independent of human intervention and human infrastructure, while still being able to interact with humans and other biological systems in the environment.

We create breakthrough solutions in areas such as search and rescue, environmental monitoring, shipwreck recovery, oil-spill recovery, surveillance, mapping of confined or large environments, and reconstruction of damaged ecosystems.



Transformational advances

Committed to developing the robotics and autonomous systems of the future, we combine advanced innovation and the latest transformational inventions in perception, communication and control with the power of machine learning.

Our core research areas

ARRC works on multiple research areas in fundamental as well as applied science disciplines.

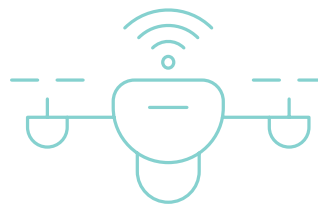


Perception and Computer Vision

We are focused on developing cutting-edge solutions that enable our robots to understand their surroundings by leveraging classical and modern computer vision methods.

Our research domains include:

- Object detection and classification techniques in challenging light conditions
- Object identification and tracking from different perspectives and distances
- Semantic segmentation for areas like autonomous driving, scene understanding and robot manipulation
- Localization in both global and local positioning systems
- Geometric and semantic mapping for aerial and ground vehicles
- Machine learning techniques for underwater computer vision with limited datasets
- Visual-based navigation systems for UAVs

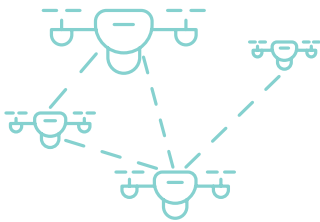


Communication and Networking

We study and develop enabling communications and networking technologies, algorithms, and protocols for cooperation, coordination, and distributed perception, control and decision-making in a group of aerial, terrestrial, marine, and underwater robots.

Our research domains include:

- Wireless communication and PHY layer technologies for networked robotics
- Infrastructure-to-robot and robot-to-robot communication
- 5G/6G-enabled networked robotics
- Communications and networking for swarm coordination and cooperation
- Data link, Network, and Transport protocols for groups of robots
- AI-driven communications for networked robotics
- Quality of service, security, and communications robustness in networked robotics



Swarm and Coordination

We draw inspiration from classical multi-robot systems and biology to develop breakthrough algorithms for cooperative, robust and distributed decision making and task allocation, group navigation, area coverage and scanning, and human swarm interaction for all robotics domains.

Our research domains include:

- Hybrid swarms across aerial, terrestrial, marine, underwater robots
- Cooperative motion and group navigation: flocking and formation
- Task allocation by means of decision trees and auction based approaches
- Distributed online area coverage and scanning
- Human swarm interaction
- Software applications and utilities for swarm generalization



Control and Decision Making

Beginning with existing research in decision-making, trajectory planning, motion planning, control, state estimation, and machine learning, our work employs state-of-the-art technologies in new and challenging domains.

Our research domains include:

- Stabilization, control, and navigation of unmanned aerial vehicles (UAVs), terrestrial and marine vehicles in structured and unstructured domains
- Trajectory and motion planning with constraints originating from either the robot platform used or the environment. On-board version for unknown environments
- Hybridization of decentralized control with swarm robotics principles. Distributed algorithms for synchronization and for task allocation in multi-robot systems
- Machine learning and reinforcement learning for decision-making in unseen environments
- Autonomous driving in unstructured environments, such as the desert
- State estimation methodologies for robot state estimation and for external target tracking
- Control methodologies for high speed and/or agile maneuvering

Sharpest minds, toughest questions

ARRC brings together a fast-growing team of the sharpest minds from across the autonomous and robotics communities to investigate the toughest questions, respond to the greatest challenges and change the world for the better.



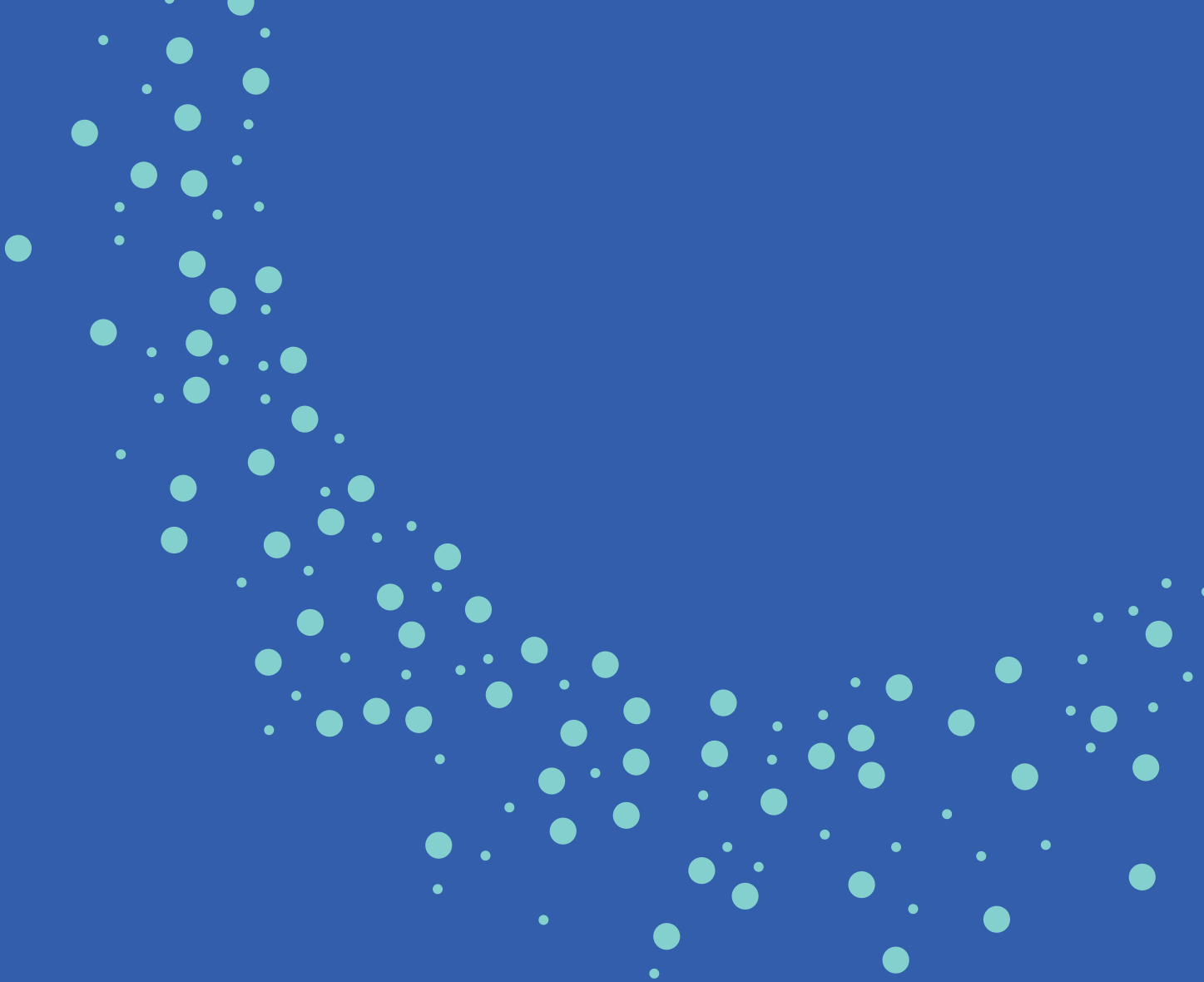
Innovation for a better world

TII helps build a better world by developing the most advanced, transformative technological innovations designed to benefit society. As a key component of the Abu Dhabi Government's Advanced Technology Research Council (ATRC), it promotes a culture of exploration with the aim of establishing Abu Dhabi and the UAE as an R&D hub and one of the next global leaders in breakthrough technology solutions.





One of our key objectives at ARRC is to create autonomous systems that can operate beyond the boundaries of human capacity.



Ahead of the curve, beyond tomorrow

ARRC's market-leading 'full stack' approach to research and development of autonomous systems is built on modular foundations that include hardware platforms, real-time operating systems, computer vision and cognitive AI techniques covering perception, communications, machine learning, path planning, motion control, object identification and distributed decision making. We work on standalone systems architecture as well as coordinated group and swarm architectures.

Working in partnership, our teams of experts study ways to make robots collaborate and communicate with one another, helping build collective autonomy. Meanwhile, we are rapidly advancing robotics research to create working prototypes with their own IP and the potential for transfer to our industrial partners, complete with certification in place.



TII Technology
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Pioneering partnership, inspiring leadership

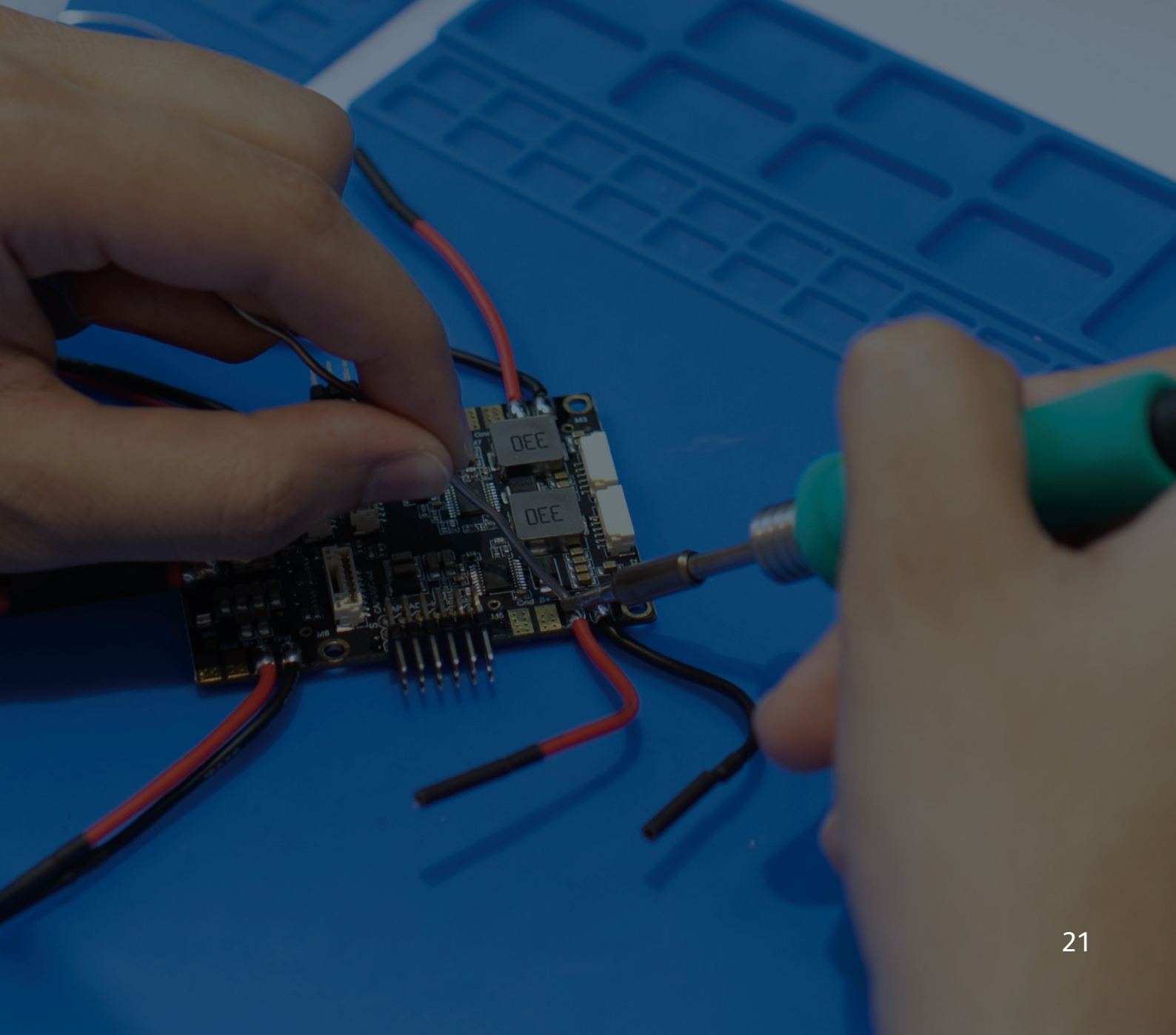
What makes us different? An irresistible combination of scientific approach, inspiring leadership, international collaboration – and a welcoming attitude to new talent from home and abroad.

A unique approach

- Our combination of multiple macro research areas that have never worked with each other, yet whose interaction is necessary for the success of full robotic autonomy
- Our full-stack development model – from fundamental research up to prototyping, technology demonstration and IP realization
- A secure funding model and superb professional research infrastructure

Leading the way

Our expert advisory board helps us establish and maintain our pioneering position. Comprising world-renowned specialists, it offers unique expertise in areas as diverse as autonomous single and multi-drone systems; bio-inspired, soft and underwater robotics; evolutionary computation and evolutionary robotics.

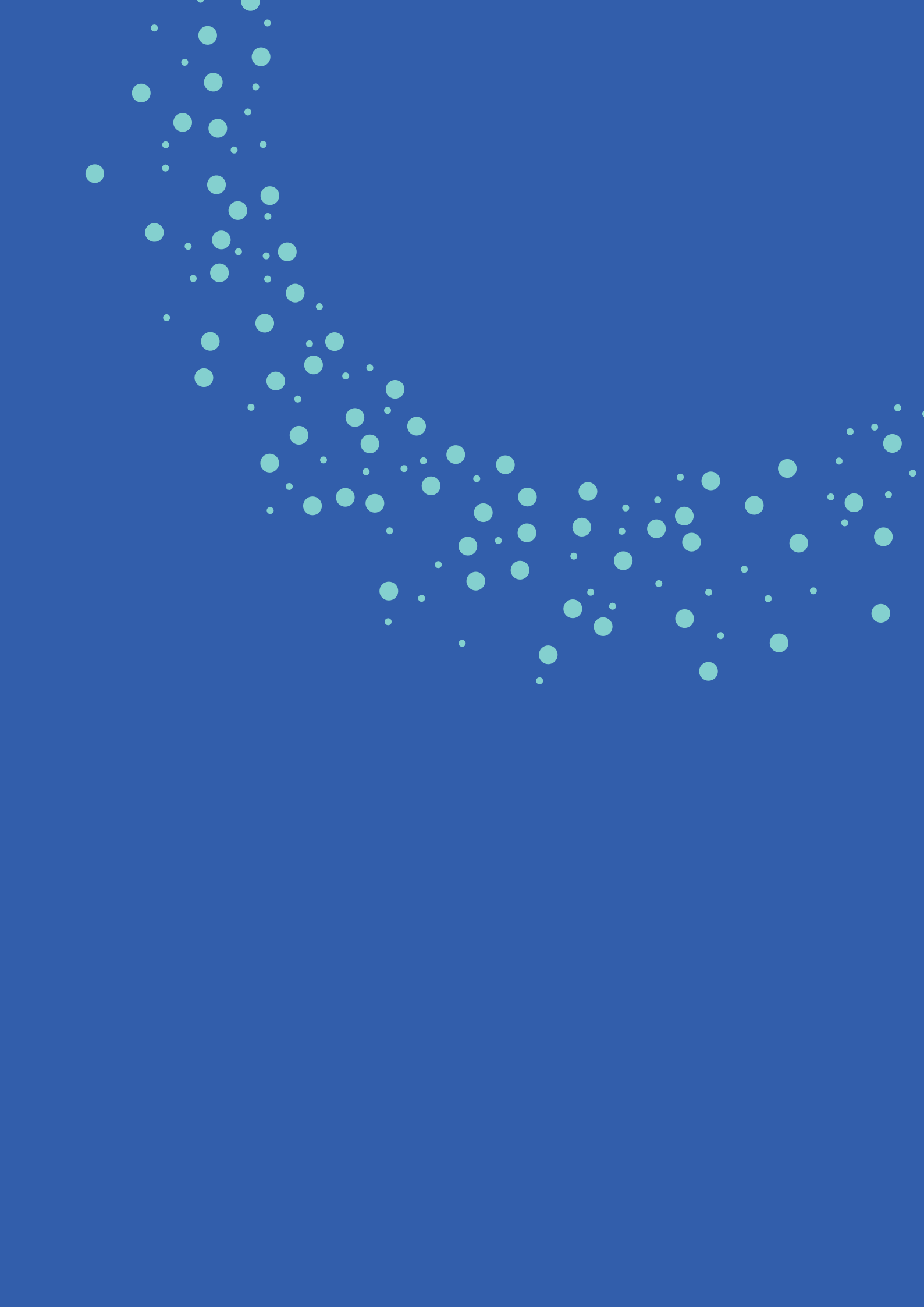


Collaborating globally

At TII, we have established multiple partnerships with leading academic institutions from across North America, Europe and the Middle East. We also conduct individual research with collaborators across Europe and North America. In addition, we welcome skilled researchers to visit our center and meet our team, present talks, host workshops, and work on extended research and collaboration projects with us in Abu Dhabi.

Inspiring the next generation

Here at ARRC, our two to three year postgraduate placement – working with our Principal Investigators – offers potential collaboration with external academic institutions. We also provide one-year and summer internship opportunities for graduate and undergraduate students, in addition to establishing innovative dual-degree programs between UAE universities and European academic institutions.



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