SFI AutoShip Christmas newsletter 2024

Christmas greetings from the Centre Director

As 2024 is coming to an end, I would like to take the opportunity to summarize and reflect on our activities over the last year. SFI AutoShip is now midway through its journey and at the peak of its research capacity, with 21 active researchers and a highly engaged and committed consortium. Our main events included the SFI Days and two researcher workshops, with record attendance and contributions by our partners. In addition, our researchers participated in 3 innovation workshops and co-organized 5 webinars and seminars with our partners.

We are very proud of our 4 researchers, Andreas, Melih, Trym and Taufik, who completed their projects this year and have moved on with their careers. We wish them best of luck and are excited to follow up on their future activities! Several researchers are due to finish in coming months. Among them is Ayoub, who shares insights from his research in this newsletter. At the same time, we are in the process of hiring the Centre's last three researchers on the topics of situational awareness and mission planning, and we are very eager to welcome them in 2025.

Additional highlights for 2024 include: The active usage of some of the Centre's results by our partners; A presentation of SFI AutoShip at the headquarters of the International Maritime Organization (IMO) in London UK on December 3, following an invitation by our partners at the Norwegian Maritime Authority; The initiation of the activities of our internal working group on COLREGS; The completed hardware and software upgrades of milliAmpere1, which is now fully-available to our researchers for full-scale trials; A full scale demo with milliAmpere1 & milliAmpere2 during SFI Days, where over 100 attendants got the opportunity to board the two ferries and experience a fully autonomous operation in action. Last but not least, during Autumn the Centre has undergone an underway evaluation by the Research Council of Norway. This process has already provided us with valuable feedback by our partners, and we look forward to its conclusion during the first months of 2025.

I would like to thank you all for your great contributions and commitment to SFI AutoShip's activities and goals and I look forward to continue the great collaboration during 2025. I wish you all Happy Holidays and a Happy New Year!

Anastasios Lekkas

Registered publications so far in 2024

Journal publications:	*28 (6 co-authored with industry partners)*
Conference presentations:	*40*
Conference papers published:	*12*
Master theses:	*26*

Contents

Recent and upcoming graduates

We are happy to share insights from two of our researchers who will have completed their projects in the SFI during autumn 2024-winter 2025. We thank them very much for their invaluable contributions to the Centre.

Trym Tengesdal

Trym Tengesdal completed his postdoc-project at NTNU's Department of Engineering Cybernetics in September.

What was your project about? The maritime environment is incredibly complex, with lots of perils from winds, currents, waves, grounding hazards, and nearby vessels with uncertain intentions and inclinations toward following the rules of the sea (COLREG). This environment changes over time, and new situations are encountered frequently, making it hard to configure ship collision avoidance systems such that they work over long periods of time, in any kind of situation.

Based on the above, my project was focused on developing adaptable data-driven collision avoidance algorithms and frameworks for developing, training, and testing such planning algorithms that have to consider and tackle these challenges for autonomous ships to become a reality.

What have you achieved during your postdoc? During my postdoc from 2022 to 2024 I have authored two conference papers, two journal papers with one of them still under review, co-authored one conference paper and one journal paper, and have supervised 7 Master`s students to completion. As a stepping stone towards facilitating easy development of new algorithms, I have developed a simulation framework for developing and testing new collision avoidance planning algorithms and machine learning algorithms, which I hope will be utilized by the research community and multiple parties in the future, making it easier to do advanced research on the topic of maritime collision avoidance. A last journal paper on data-driven

collision avoidance is still in progress, utilizing the above-mentioned framework, which I intend to finalize next year.

I want to thank Prof. Tor Arne Johansen for allowing me the freedom to pursue my interests within the field, providing timely feedback when wanted and required. It has been a pleasure over the last 5 years, both during my PhD and my postdoctoral fellowship. I want to thank Anastasios Lekkas and Ingeborg Guldal for steering SFI AutoShip in an excellent manner, the many partners of the centre for good conversations and interest in my work, and lastly all my good colleagues and friends for making the past years a pleasurable ride.

What will you do next? After my period ended as a researcher at SFI AutoShip in September, I have ventured into industry and another domain, now working as an R&D developer within logistics optimization for the norwegian unicorn company AutoStore. Although not focused on marine autonomy anymore, I am using my competence and interest in optimization, estimation, and machine learning to improve their routing system. Exciting work and I will for sure benefit from the knowledge and experiences I have accumulated during my time at NTNU and AutoShip.

Ayoub Tailoussane

PhD candidate at the University of Oslo's Scandinavian Institute for Maritime Law, Ayoub Tailoussane, is due to submit his thesis in early 2025.

What was your PhD project about? Just like road users – car drivers, motorcyclists, and even pedestrians – must follow traffic regulations to ensure the safety of our land-based roads and their users, ships must adhere to the COLREGs (Convention on the International Regulations for Preventing Collisions at Sea). These regulations are a series of conduct rules designed to prevent collisions at sea by requiring, permitting, or prohibiting certain behaviors from vessels. The rules have a broad scope and apply to all types of vessels, regardless of size, type, or technological state. The current expectation is that autonomous ships must follow the same rules if they are to share the same waters. My PhD thesis tests this expectation from a legal perspective.

It is no secret that the COLREGs were not written with autonomous navigation in mind. They assume that a competent crew is onboard each vessel, responsible for the ship's safety and compliance with the collision prevention rules. What happens then if humans are no longer in charge of the collision avoidance function? Can we still claim that a ship is capable of complying with the COLREGs under such circumstances? My thesis seeks to answer these questions.

What have you achieved during your PhD? The past three years have provided numerous opportunities to actively engage in academic discussions concerning autonomy in shipping and its legal future. I have had the honor of presenting at various international conferences and academic gatherings. Notably, in May 2024, I presented to the Comité Maritime International's working group on Maritime Autonomous Surface Ships (MASS) during the CMI's annual colloquium. My presentation focused on the legal challenges associated with applying the COLREGs to autonomous ships. In 2022, I wrote and published an article analyzing one of the central rules of the COLREGs, the crossing rule, and its application to vessels near the entrance of, or within, narrow channels. This year, I contributed a legal perspective to a research project conducted under the umbrella of the SFI's use-case 1 – Deep-sea bulk shipping. Our research group recently produced an article, in which I am a co-author, exploring the use of periodically unmanned bridges. This article has been submitted and is currently awaiting review. As of now, no additional legal articles on the topic of navigation autonomy have been published by me, as the final thesis will comprise a single scholarly monograph. The thesis is scheduled to be completed and published in the course of 2025.

Previous 2024 graduates



Our excellent postdoc and PhD graduates Taufik Sitompul, Andreas Madsen and Melih Akdağ completed their projects earlier in 2024. Read about their findings in the spring newsletter.

Newly hired researchers

We have entered the second phase of recruitment of PhDs and postdocs in the Centre, and are pleased to share that one new postdoc and one new PhD candidate, both in WP4, began their work this autumn. They are already important additions to our researcher community.

Paul Lee

Paul Lee is a new Post Doc at the Department of Marine Technology. He is involved in Work Package 4 “Safety & Assurance” under the supervision of Professor Ingrid B. Utne and Professor Ekaterina Kim. Paul will investigate the concept of risk awareness of AI agents and will develop methodologies that enhance their risk awareness, risk communication, and risk control, especially during the safety-critical operations of autonomous ships. He also plans to closely collaborate with Industry Partners and Use Cases for validation and experimental investigation.

Paul has a PhD in Naval Architecture, Ocean, and Marine Engineering from the University of Strathclyde. His PhD research focuses on developing robust decision-making agents for the reactive collision avoidance of autonomous ships based on deep reinforcement learning, from which his interest for AI agents emerged. His master’s degree in Naval Architecture and Marine Engineering from the National Technical University of Athens focuses on the experimental investigation of microbubble lubrication for the drag reduction of a scaled ship, being inspired by biomimetic engineering.

"I am motivated by the unique opportunities and challenges presented by autonomous ships. Specifically, maritime has been a late adaptor of autonomy considering its domain specific challenges, but the adoption of AI solutions seems inevitable. My interest goes beyond industry domains, and I am thrilled to investigate whether and how the AI agents know the concept of risk and how to communicate and control their risk perception between different stakeholders for a safer and more sustainable autonomous ecosystem."

Jon Estil Krågebakk

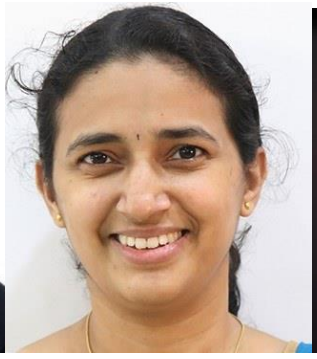
Jon Estil Krågebakk is a PhD candidate at the Department of Marine Technology (IMT) at NTNU in Trondheim. He is part of Work Package 4, focusing on “Fully Explainable AI Using Bayesian Belief Networks” and “Real-Time Wave Estimation.” His work involves leveraging compute shaders to simulate and spatially navigate large waves, aiming to secure cargo more effectively during maritime shipping in harsh environments.

Estil holds an integrated master’s degree in Engineering Cybernetics from NTNU, with a specialization in robotic manipulation and a touch of computer vision. His master’s thesis explored "non-prehensile" manipulation of rigid and semi-rigid bodies to match a desired image, where he developed a closed-loop projection-based visual servoing (PBVS) control law using both dense and sparse feature sets.

"I’ve always loved diving into the full stack of a project, from optimizing simulations with parallel programming to integrating cutting-edge AI methods. This position gives me the chance to do all that and work on computer vision and data visualization problems no one’s tackled before. Plus, applying it all to autonomous ships is the cherry on top—it’s a perfect blend of practical challenges and technical puzzles that excites me."

Researchers hired in spring 2024

Our excellent new PhD researchers Giacomo Melloni, Manju James and Joel Jose were hired earlier this year. Read about their projects in the spring newsletter.



Award to PhD graduate Melih Akdağ

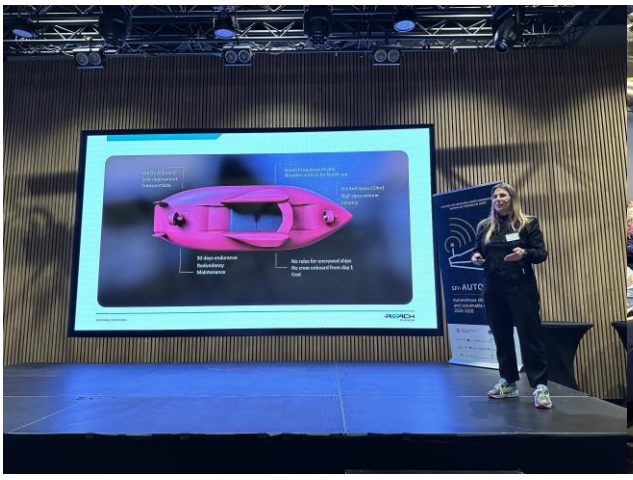
SFI AutoShip researcher Melih Akdağ received the Best Student Presentation Award at the Joint 13th International Conference on Soft Computing and Intelligent Systems and 25th International Symposium on Advanced Intelligent Systems (SCIS&ISIS) which was arranged on 9-12 November in Himeji, Japan.

Melih defended his PhD at NTNU's Department of Engineering Cybernetics in September and has since taken up a position as an AI researcher for DNV. The award-winning presentation was titled "Prioritizing and Ranking Ships in Multi-encounter Scenarios for Autonomous Navigation". SFI AutoShip congratulates Melih on his wonderful achievement!

SFI AutoShip Days 2024

More than 100 participants from our consortium attended our main annual event, the SFI AutoShip Days on 15-16 October, at Quality Hotel Prinsen.

Presentations reflected the wide range of research and innovation activities of the Centre partners, including the Skipsrevyen-awarded "Ship of the Year 2024" Reach Remote 1 by Reach Subsea and Kongsberg Maritime; new DNV class notations for autonomous and remotely operated ships; an overview of the IMO's MASS code by NMA; presentations of results by 4 of our PhDs and PD graduates; the integration of autonomy in offshore operations by Fugro; our internal group on COLREGS; the student competition Njord Challenge; a demo of remote operation and auto-crossing of NTNU's autonomous vessels, milliAmpere 1 & 2; hardware and software on milliAmpere 1; autonomous ships and logistics performance by SINTEF Ocean; a periodically unmanned bridge presentation by IFE; and self-introductions by our 6 newly employed researchers.



Researcher workshops

We welcomed 60 participants from both research and industry to our **Autumn researcher workshop on 16 September**. Fugro's Iurii Kapitaniuk provided an interesting presentation from an industry partner perspective, and we were updated on our Use Cases by Svein Peder Berge from SINTEF. Finally, we enjoyed a live demonstration of milliAmpere 1 being remotely controlled from the conference venue, by researchers from the adjacent Autoteaming project. The day was as usual finished with great discussions in parallel sessions, according to work packages. These sessions focused on next year's annual work plan as well as the 3-year plan for the final phase of the Centre.

The **spring researcher workshop** was held on **18 March** and included presentations on industry-related research challenges from industry partners DNV, Fugro and Kongsberg Maritime, as well as participation by many other consortium partners, with a record 60 people in attendence. Five newly employed PhDs also presented their projects. After lunch, parallel session discussions focused on the involvement of PhDs and postdocs with partner organisations, according to Work Packages.

SFI AutoShip presented at IMO in London

Photo: Håvard Gåseidnes/NMA.

Centre director Anastasios Lekkas presented the SFI at the International Maritime Organisation headquarters in London on 3 December, on the invitation of consortium partner NMA, during the 109th session of the Maritime Safety Committee (MSC 109). In addition to explaining the structure and scope of the SFI, the presentation recounted the focus shift from ship automation to autonomy during the last years, and the added value for Norwegian maritime actors in establishing a research centre like SFI AutoShip as a means to address common challenges. The Centre director also attended the discussions of the International Working Group on development of a code for Maritime Autonomous Surface Ships (MASS).

COLREGs working group

Our internal COLREGs working group had its kick-off meeting in February, with approximately 25 attendees. The group is coordinated by Tom Arne Pedersen from DNV. Starting with 3 subgroups, the group has now merged into one, and meets every Thursday.

Examples of discussion topics:

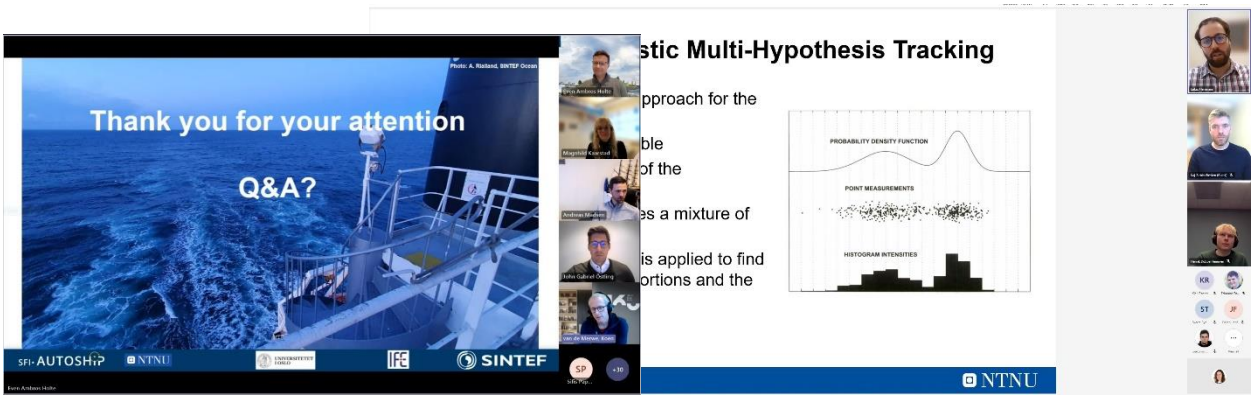
1. The autonomous vessel must understand the intentions of other vessels, other vessels must understand the intentions of the autonomous vessel without knowing whether it is autonomous, and it must behave like other vessels.
2. The vessel must follow the rules for stand-on vessels in COLREGs.
3. The vessel must follow the rules on right of way in COLREGs.

Webinars and seminars

SFI AutoShip webinars have been consistently well attended and have been a great way for researchers and industry/public sector partners to collaborate. Recordings of the webinars are available to the consortium in Teams: 3 Webinars

Overview of webinars and seminars during 2024:

1. WP1: Radar in maritime situational awareness - Beyond point measurement (NTNU, Kongsberg Maritime)
2. WP4: Systems-Theoretic Process Analysis (STPA) tutorial (physical seminar organised by NTNU)
3. WP1: Safe Optimal Control and Multi-Target Tracking Demonstrated with a Digital Twin (NTNU)
4. WP4: Risk assessment and supervisory risk control of autonomous marine systems (NTNU, Kongsberg Maritime and Fugro)
5. WP5: Navigator experiences of periodically unmanned bridge – an empirical study (IFE and SINTEF Ocean)



Innovation workshops for PhDs and PDs


During 2024, our PhDs and postdocs participated in 3 innovation workshops organized by innovation manager Kjell Olav Skjølsvik, focusing on a general introduction to innovation, and guiding our PhDs and postdocs towards investigating commercial potential from their research findings. The first workshop, in May, was arranged at NTNU in Ålesund, and included both PhDs and supervisors based there. In the second workshop in June, most of the PhDs and PDs in the SFI gathered in Trondheim and participated in a dinner marking the end of the spring semester. This was repeated in a December gathering, with participation from Anders Aune, Lodve Berre and Rasmus Rønning from NTNU Technology Transfer and WP6 Use Case leader Svein Peder Berge.

Lodve Berre (NTNU Technology Transfer) introduced the researchers to the KTH Innovation Readiness Level Method, a complete framework for guiding idea development and assessing idea status across six key dimensions, including TRL. In groups, our researchers discussed and tested the method related to individual innovation leads. Svein Peder Berge (SINTEF Ocean) then assessed where we are when looking at the original Use Case specifications. During the workshop all researchers were connected to at least one Use Case, followed by group discussions on how to improve interaction with the use cases next year. We thank our engaged participants for excellent input and discussions. The workshop was followed by a dinner celebrating the end of another successful year for the Centre.


Board meetings and partner meetings

Our in-person board meeting was kindly hosted by DNV at their Høvik headquarters in June, while our November board meeting was held on Teams. As usual the partners have provided invaluable input to the Centre management, not least for the midway evaluation process and planning for the final phase of the SFI. Several individual partner meetings were also arranged, and the Centre was presented by the director and WP leaders to a large number of employees from Kongsberg Maritime in February, and representatives from Fugro visited Trondheim in April. Testing and research activities in collaboration with consortium partners have been carried out, such as the Use Case 1 Bridge simulator studies in Ålesund in April, with NTNU, SINTEF Ocean, IFE and Grieg Star, and more are under planning.

Contact us

Don't hesitate to contact us if you have ideas for topics for the next newsletter or any other suggestions.

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