



Robotics Research Technology and Methods (RRTM)

Portfolio: Critical Evaluation of Robotics Research

Prepared by: Pruthvi Omkar Geedh

Contents

1	Week 1	4
1.1	Seminar 1: Monday 28 th September 2023. Dexterous Robotics by Prof. Nathan Lepora.(UOB).	4
1.2	Seminar 8: Thursday 12 th October 2023. Bio-Inspired Aerial Robotics by Prof. Shane Windsor. (UOB).	4
2	Week 2	4
2.1	Seminar 2: Monday 2 nd September 2023. Research talk by Prof. Arthur Richards.(BRL).	4
2.2	Seminar 3: Thursday 5 th October 2023. Robot Learning for Dexterous Manipulation by Prof. Dandan Zhang.	5
3	Week 3	5
3.1	Seminar 4: Monday 9 th October 2023. Morphological Computation - The hidden superpower of soft robots Prof. Helmut Hauser (UOB).	5
3.2	Seminar 5: Thursday 12 th October 2023. Microrobotics, biological soft-robotics and artificial muscles Prof. Hermes Gadelha (UOB).	6
3.3	Reading Group Session 1: Tuesday 10 th October 2023. Development of Hydraulically-driven Soft Hand for Handling Heavy Vegetables and its Experimental Evaluation. Presenter: Yazan Adi	6
3.4	Reading Group Research Paper 1 : Tuesday 10 th October 2023. Mono-STAR: Mono-camera Scene-level Tracking and Reconstruction Topic: ICRA 2023	6
4	Week 4	7
4.1	Seminar 6: Monday 16 th October 2023. Neuromorphic touch for prosthetics by Prof. Ben Ward-Cherrier (UOB).	7
4.2	Seminar 7: Thursday 19 th October 2023. Assistive and Rehabilitation Robotics by Prof. Marcela Munera (UWE).	7
4.3	Reading Group Session 2: Tuesday 17 th October 2023. A Comprehensive Review Of Shepherding A Bio-Inspired Swarm-Robotics Approach. Presenter: Cosmo Boyd Esposito	8
4.4	Reading Group Research Paper 2 : Tuesday 17 th October 2023. Development and Control of Underwater Gliding Robots A Review. Topic: Journal Paper	8
5	Week 5	8
5.1	Seminar 9: Monday 23 rd October 2023. Multi-Robot Systems in the Wild by Prof. Edmund Hunt (UOB).	8
5.2	Seminar 10: Thursday 26 th October 2023. Human-centric robot learning, NLP and Autonomous driving by Prof. Ning Wang (UWE).	9
5.3	Reading Group Session 3: Tuesday 24 th October 2023. Vision for Mobile Robot Navigation: A Survey Presenter Pruthvi Omkar Geedh	9
5.4	Reading Group Research Paper 3 : Tuesday 24 th October 2023. A Survey on Swarm Microrobotics. Topic: Survey Paper.	10
6	Week 6	10

7	Week 7	10
7.1	Seminar 11: Monday 6 th November 2023. Dexterous manipulation and wearable robotics by Prof. Antonia Tzemanaki (UOB).	10
7.2	Seminar 12: Monday 6 th November 2023. Computer vision in the carbon fibre composites industry Prof. Gary Atkinson (UWE).	11
7.3	Reading Group Session 4: Tuesday 7 th November 2023. S-Sacrr: A Staircase and Slope Accessing Reconfigurable Cleaning Robot and its Validation. Presenter: Yixuan Jin	11
7.4	Reading Group Research Paper 4 : Tuesday 7 th November 2023. Using advanced industrial robotics for spacecraft Rendezvous and Docking simulation. Topic: Hardware Paper	11
8	Week 8	12
8.1	Seminar 13: Monday 13 th November 2023. Independence after tetraplegia: Eye-gaze control for complex systems Prof. Emanuel Nunez Sardinha (UWE).	12
8.2	Seminar 14: Monday 13 th November 2023. Ultraleap by Prof. Noor Alakhawand (UOB).	12
8.3	Reading Group Session 5: Tuesday 14 th November 2023. Phenotypic Plasticity Provides a Bioinspiration Framework for Minimal Field Swarm Robotics. Presenter: Morris Man	12
8.4	Reading Group Research Paper 5 : Tuesday 14 th November 2023. A Compact and Reliable Software Architecture for Robotics Control Topic: Software Paper	13
9	Week 9	13
9.1	Seminar 15: Monday 20 th November 2023. Smarter Materials for Simpler Robots. by Prof Andrew Conn (UOB).	13
9.2	Seminar 16: Monday 20 th November. Physically Interactive Robots. by Prof. Efi Psomopoulou (UOB).	14
9.3	Reading Group Session 6: Tuesday 21 th November 2023. Challenges of continuum robots in clinical context: a review. Presenter: Boyu Qin . . .	14
9.4	Reading Group Research Paper 6 : Tuesday 14 th November 2023. Context-Awareness in Human-Robot Interaction: Approaches and Challenges Topic: Robot Context	14
10	Week 10	15
10.1	Seminar 17: Monday 27 rd November 2023. Robots for Nuclear Environments. by Prof. Paul Bremner (UWE).	15
10.2	Seminar 18: Thursday 30 rd November 2023. Collaborative robots and precision welding - developing performance and inspection capabilities. by Prof. Carwyn Ward (UWE).	15
10.3	Reading Group Session 7: Tuesday 14 th November 2023. A Brief History of Industrial Robotics in the 20th Century. Presenter: Qiushi Wang . . .	16
10.4	Reading Group Research Paper 7 : Tuesday 14 th November 2023. Artificial Intelligence and Robotics. Topic: Pre-1990	16
11	Week 11	17

11.1	Reading Group Session 8: Tuesday 12 th December 2023. MFF-Net: Towards Efficient Monocular Depth Completion With Multi-Modal Feature Fusion. Presenter: Yu Xiang	17
11.2	Reading Group Research Paper 8 : Tuesday 12 th December 2023. Applications of Hybrid Conditional Planning in Service Robotics Topic: Free choice	17

1 Week 1

1.1 Seminar 1: Monday 28th September 2023. Dexterous Robotics by Prof. Nathan Lepora.(UOB).

The session dives into recreating human hand functions using robotic counterparts, a potential marvel. It explores merging tactile sensors, CV and AI, Examples like Gelsight and Tactip. Transition from simulation to real-world scenarios, currently use Pneumatic actuators may limit precision in intricate functions. Opting for electric actuators and soft grippers enhances control, advancing robotic innovation.

Research challenges:Robotics future relies heavily on scalability, merging theoretical concepts with industry. discussion lacks of real-time AI as it is crucial for dynamic tactile control. Tackling softness issues requires research on materials and hybrid systems and adaptive algorithms. Industry collaboration and open-source initiatives drive cost-effectiveness. Navigating ethical implications and soft material limitations propels innovative robotic solutions.

Reference: <https://lepora.com/>

1.2 Seminar 8: Thursday 12th October 2023. Bio-Inspired Aerial Robotics by Prof. Shane Windsor. (UOB).

Obstacles encountered by Unmanned Aerial Vehicles (UAVs)in turbulent environments drive bio-inspired solutions from strategies employed by birds for gust-navigating. The session intricately examines aspects like wing morphing, flow distribution, and form sensing. Notably, a strain-sensing aircraft pioneers open-loop flight with gusts, integrating neural network-based control, showcasing promising aeroelasticity.

Research challenges:The Z-hinge wing, mirroring birds' wind control, lacks active stabilization however Testing the articulated wing joint may lead to a potential solution. Reliability concerns arise in establishing suspension systems for small-scale aerial robots and manned flights. A crucial hardware advancement is developing lightweight sensors and local computation without compromising wing weight and flight dynamics.

Reference: <https://shorturl.at/jABHI>

2 Week 2

2.1 Seminar 2: Monday 2nd September 2023. Research talk by Prof. Arthur Richards.(BRL).

In today's tech scene, multi-agency systems aim for autonomy under human supervision, assuring reliability with predictive control and simulations merging digital and real realms. Exploring tasks like the dull, dirty, and dangerous, the discussion delves into human-like intricacies in robotics. Reflecting on a robot's apology and the fate of task-oriented creations infuses a human touch into the session.

Research challenges: Exclusion of real-world testing and simulation bridge methods neglects deployment effectiveness. Overlooking collision avoidance integration with air

traffic management diminishes safety insights. Divergent views on a robot's apology highlight varying perceptions, tied to individual perspectives and emotional attachments. The modern "D" in robotics introduces creative disruptions to traditional methodologies.

Reference: <https://shorturl.at/bgiDP>

2.2 Seminar 3: Thursday 5th October 2023. Robot Learning for Dexterous Manipulation by Prof. Dandan Zhang.

We explore definition of intelligent robots, emphasising the intricate difference between autonomy and automation. It highlights perception, environment understanding, and navigating uncertainties for success. Resolving the human versus robot task debate, human-robot shared control is highlighted. Despite potential cost reduction through simulations and reinforcement learning, the time-consuming training of large hierarchical datasets presents a significant challenge.

Research challenges: Learning from virtual models faces hurdles when applied in the real world. Transfer learning, adapting knowledge across environments, improves generalization and overcomes the black-box effect. This aids in action recreation, enhancing the performance of 3D depth cameras and LIDAR. Adding interpretable machine learning models resolves transparency issues, providing a clearer understanding of AI actions.

Reference: <https://www.imperial.ac.uk/people/d.zhang17>

3 Week 3

3.1 Seminar 4: Monday 9th October 2023. Morphological Computation - The hidden superpower of soft robots Prof. Helmut Hauser (UOB).

This research draws inspiration from nature, infusing adaptability into robotics through soft body parts and multiple degrees of freedom. The intriguing "Learn and Grow in Robotics" concept, centered on studying frog stages, delves in intricate link between morphology and computation. Discussing real-world deployability in multi-terrain by Discovering how transfer learning boosts adaptability.

Research challenges: Mimicking nature's soft body features in robots poses challenge. Discussing insights into physical structures like the frog's skeletal structure and kinematics, along with details on materials, such as PLA—crucial for advancing this transformative endeavor. Requires a delicate balance between structure and computation, this has the potential to revolutionize robot design for efficient locomotion in diverse terrains.

Reference: <https://www.morphologicalcomputation.org/>
https://link.springer.com/chapter/10.1007/978-3-030-24741-6_42

3.2 Seminar 5: Thursday 12th October 2023. Microrobotics, biological soft-robotics and artificial muscles Prof. Hermes Gadelha (UOB).

Drawing parallels with patterns in sperm decision-making and replicating nature's patterns for artificial robots and IVF, a groundbreaking motor-exclusive approach is introduced for artificial muscles. The Lab's focus on octopus-inspired suction cups, using microfluidic chips, displays precision and multiple analyses. Real-world deployability beyond robotics and IVF is crucial for a comprehensive understanding and practical applications.

Research challenges: Hardware challenges includes replicating intricate micro-level patterns, microfluidic chip usage raises aging concerns due to poor chemical compatibility with many solvents. Insights on overcoming these challenges could shed light however utmost need for detailed discussions over medical concerns of robots in the bloodstream and its ethical implications to deployability for practical applications in the field.

Reference: <http://www.polymaths-lab.com/>

3.3 Reading Group Session 1: Tuesday 10th October 2023. Development of Hydraulically-driven Soft Hand for Handling Heavy Vegetables and its Experimental Evaluation. Presenter: Yazan Adi

Highlighting robotic automation's significance in cabbage processing, the soft robotic hand excels in flexibility and grasping force. Critical gaps, including the absence of real-world failure scenarios and limited hand variability testing (4-finger only), raise concerns. Uncertainty about its application to diverse vegetables like tomatoes hinders clarity on success rates, especially with the vague statement "Picked up cabbages successfully."

Research challenges: Addressing real-world agricultural challenges involves introducing diverse failure scenarios, testing variable hand configurations, and extending applicability to various vegetables. Quantifying success demands specific grasp details. The hybrid approach, combining Strategy 1 and Strategy 2, may optimize success rates across diverse agricultural settings and containers, showcasing adaptability and refinement for practical applications.

Reference: <https://ieeexplore.ieee.org/document/10160629>

3.4 Reading Group Research Paper 1 : Tuesday 10th October 2023. Mono-STAR: Mono-camera Scene-level Tracking and Reconstruction Topic: ICRA 2023

The Mono-STAR system transforms real-time 3D reconstruction, addressing non-rigid deformations and topological changes. Shifting to a mono-camera benefits mobile robots, but we must cautiously weigh limitations. Cleverly employing optical-flow-based 2D constraints for swift motion tracking is smart and builds structure, yet thorough validation across diverse scenarios is crucial for its success.

Research challenges: Research impresses in nonrigid object reconstruction and fast motion capture, yet lacks crucial quantitative metrics, raising generalisability concerns. Qualitative outcomes are impressive, but additionally credibility would soar with added concrete numbers. Acknowledging limitations is commendable, yet a deeper dive into future improvements is vital. Its success propels field advancements.

Reference: <https://ieeexplore.ieee.org/document/10160778>

4 Week 4

4.1 Seminar 6: Monday 16th October 2023. Neuromorphic touch for prosthetics by Prof. Ben Ward-Cherrier (UOB).

Research aims an enhanced prosthetic experience through spike encoding, and neural relaying mirroring brain processing. NeuroTac sensor exploration and a pending sensor patent show promise. Commendable use of spike neural networks for perception, coupled with machine learning aiding texture classification, and real-time adaptation with personalized feedback, constitutes a strategic advancement in prosthetic.

Research challenges: Developing cost-effective neural network for NeuroTac sensor data aligns with the ambitious goal of achieving shared autonomy in neurographic prosthetics. Future integration into micro-neurography for simulating a single afferent adds complexity. The neural network struggles with backpropagation challenges. Hybrid approaches, fusing conventional haptics, advanced ML, and emerging sensors, present a comprehensive solution to current prosthetic challenges.

Reference: <https://arxiv.org/abs/2003.00467>

4.2 Seminar 7: Thursday 19th October 2023. Assistive and Rehabilitation Robotics by Prof. Marcela Munera (UWE).

The scarcity of healthcare specialists leads to costly and less adaptable products like the Castor robot. While suitable for children, its limited adaptability poses challenges for adults with cardiovascular issues. Community research on social assistance with human-like robots enhances interactive feedback, showing promising metrics. The intriguing discussion on ankle and hand exoskeletons hints at potential advancements in healthcare technology.

Research challenges: Development concerns focus on seamlessly integrating adaptive AI into a specialized digital GUI, bypassing physical robot complexities. Coordinating HRM and CV demands precision. This approach tackles adaptability concerns, enhancing practicality for a motivating user experience. Pros include community involvement, metric testing, human-like features, and cardiovascular support.

Reference: <https://people.uwe.ac.uk/Person/MarcelaMunera>

4.3 Reading Group Session 2: Tuesday 17th October 2023. A Comprehensive Review Of Shepherding A Bio-Inspired Swarm-Robotics Approach. Presenter: Cosmo Boyd Esposito

Shepherding-inspired swarm robotics, influenced by sheep herding, provide a distributed approach for robust collective behavior. Emulating guidance from sheep herding dogs and exploring V formations, these multi-agent systems offer distributed formations and real-world adaptability. Integrating machine learning for autonomous learning addresses human bias, ensuring a more sophisticated and efficient system.

Research challenges Addressing centralisation concerns, the investigation into multiple shepherds is urged to enhance robustness. Early-stage machine learning integration grapples with human bias and efficiency issues. Limited practical applications underscore the need to overcome challenges for real-world viability, addressing local knowledge impact, scalability, field validation, communication overhead, energy efficiency, and ethical considerations for responsible deployment.

Reference: <https://ieeexplore.ieee.org/document/9099485>

4.4 Reading Group Research Paper 2 : Tuesday 17th October 2023. Development and Control of Underwater Gliding Robots A Review. Topic: Journal Paper

This paper navigates the evolution of underwater gliding robots (UGRs), spanning traditional, hybrid-driven, and bio-inspired prototypes. The global perspective highlights collaborative underwater robotics research. The meticulous analysis of buoyancy-driven systems and dynamic models showcases a commendable commitment. However, a deeper exploration of bio-inspired approaches is needed to tackle challenges in environmental adaptability and disturbance handling.

Research challenges: This exploration skips a crucial look at limitations, especially in lightweight hardware and on-board computation. Future research needs to tackle these challenges, delving into inventive bio-inspired approaches and practical implementations. This ensures a nuanced understanding of underwater gliding robotics, making them not just theoretically sound but genuinely feasible and efficient in the real world.

Reference: <https://ieeexplore.ieee.org/document/9865035>

5 Week 5

5.1 Seminar 9: Monday 23rd October 2023. Multi-Robot Systems in the Wild by Prof. Edmund Hunt (UOB).

This session precisely differentiates between swarm robotics and multi-robot systems, connecting theories to real-world applications. Highlighting the adaptability of swarm behaviors in transitioning multi-agent robot systems. The inventive exploration of electrostatic measurements demonstrates creativity. However, the use of copper tape for grounding raises concerns, especially in extraterrestrial environments like Mars.

Research challenges: Navigating challenges of extreme temperatures, low pressure, and unknown terrain, adapting swarm robotics to Mars requires resilient grounding solutions. Essential for long-term reliability, addressing implications, limitations, and challenges is crucial. Ongoing discussion on alternative solutions, especially considering potential degradation over time and in extreme conditions, ensures adaptability and sustained performance.

Reference: <https://www.huntlab.uk/>

5.2 Seminar 10: Thursday 26th October 2023. Human-centric robot learning, NLP and Autonomous driving by Prof. Ning Wang (UWE).

This research in human-centric robot learning seamlessly connects theory with practice, Enriching the analysis, the inclusion of "What if?" scenarios adds depth. Ethical considerations and bias awareness provide a comprehensive perspective. The user-centric design for aging populations deserves commendation, stressing the crucial vigilance needed to mitigate biases in personalized driving models for fair and safe autonomous system deployment.

Research challenges: Imitation learning faces limitations due to training data, hindering adaptability and introducing bias. Sim-to-real transfer faces challenges with varying dynamics. Solutions include advancing transfer learning, boosting adaptability, and addressing ethical concerns. A hybrid approach, integrating imitation and reinforcement learning with perception systems, offers a robust autonomy solution, tackling collaboration challenges, sim-to-real transfer, and adaptive control.

Reference: <https://people.uwe.ac.uk/Person/Ning2Wang>

5.3 Reading Group Session 3: Tuesday 24th October 2023. Vision for Mobile Robot Navigation: A Survey Presenter Pruthvi Omkar Geedh

The paper extensively reviews computer vision in mobile robot navigation, spotlighting road-following innovations like ALVINN and VITS. However, it lacks recent advancements and generalisability discussions. Examining machine learning, especially deep learning challenges, can enhance perception and decision-making. Deeper insights into sensor fusion, real-time adaptability, and human-robot collaboration, including natural language processing, are crucial for comprehensive navigation.

Research challenges: Include real-world generalization, deep learning integration hurdles, multi-sensor fusion complexities, and the need for adaptive algorithms. Improving human-robot collaboration, optimizing edge computing for real-time processing, and addressing ethical considerations are vital for enhancing mobile robot navigation's robustness and adaptability. Addressing these challenges will drive advancements for seamless interactions in dynamic real-world environments.

Reference: <https://ieeexplore.ieee.org/document/982903>

5.4 Reading Group Research Paper 3 : Tuesday 24th October 2023. A Survey on Swarm Microrobotics. Topic: Survey Paper.

Swarm microrobotics in biomedicine unfolds as a captivating maze of challenges and innovations. The paper delves into enhanced control systems, integration with medical tools, and the intricate realm of in-vivo procedures. Yet, there's room for expansion, shedding light on obstacles like achieving high-resolution imaging in deep tissues and seamlessly integrating multiple modalities for enhanced clarity.

Research challenges: Miniaturization while maintaining payload capacity, ensuring biocompatibility, and achieving autonomous navigation takes center stage. Creative solutions emerge through the realms of biomimicry and advanced control algorithms. The article underscores the significance of long-term monitoring, fervently urging research into not only energy-efficient mechanisms but also cutting-edge tracking technologies, forming the backbone for sustained in-vivo applications.

Reference: <https://ieeexplore.ieee.org/document/9559732>

6 Week 6

Reading Week

Reading week - no seminars

7 Week 7

7.1 Seminar 11: Monday 6th November 2023. Dexterous manipulation and wearable robotics by Prof. Antonia Tzemanaki (UOB).

Surgical robots offer transformative medical potential. Soft tissue robot-assisted surgery exposes feature limitations, awaiting efficacy testing for a 3-finger system. Breast cancer screening automation disrupts norms, emphasizing reduced monitoring time and emphasising awareness. Emphasizing the need for efficiency, the soft robotic hand in pleural aspiration shows promise, underscoring the necessity to optimize the 30-minute procedure time.

Research challenges: It's vital to conduct thorough clinical trials to ensure the safety and effectiveness of healthcare robotic systems. While broadening access is essential, cost considerations should never sacrifice accuracy. The exploration of collaborative human-robot approaches enhances safety. Prioritizing user-friendly interfaces is key for widespread acceptance and trust in successfully implementing robotic technologies in healthcare.

Reference: <https://www.dexterousrobotlab.com/projects>

7.2 Seminar 12: Monday 6th November 2023. Computer vision in the carbon fibre composites industry Prof. Gary Atkinson (UWE).

Carbon fiber computer vision excels in defect detection. Automating welding inspection, with robotic arms and LIDAR in the mix, meets industry demands. Heritage building weathering assessment is crucial. Predicting hospital cleanliness via computer vision, with sensor fusion, is practical. Health blood monitoring streamlines with CNN's. Futuristic pet behavior analysis using deep learning shows promise.

Research challenges: Carbon fiber computer vision faces challenges in optimizing multispectral imaging for scarf repair defect detection and integrating image-LiDAR fusion for accurate heritage building assessments. Automating immunofluorescence analysis for unbiased health blood monitoring requires diverse labeled datasets. Defining precise hospital cleanliness parameters and exploring alternative sensing technologies remain ongoing challenges for success in demanding manufacturing environments.

Reference: <https://www.uwe.ac.uk/research/centres-and-groups/machine-vision>

7.3 Reading Group Session 4: Tuesday 7th November 2023. S-Sacrr: A Staircase and Slope Accessing Reconfigurable Cleaning Robot and its Validation. Presenter: Yixuan Jin

The S-Sacrr robot's innovative reconfigurable design for stairs and slopes has maintenance advantages but limits versatility for high-speed applications. Emphasizing stability poses challenges in extreme surfaces. An alternative hardware solution involves integrating advanced sensors for terrain recognition and a versatile locomotion mechanism, like articulated legs or omnidirectional wheels, to enhance functionality.

Research challenges: Developing algorithms for real-time decision-making with advanced sensors is crucial. Rigorous testing, including simulations and controlled experiments, is vital to ensure the robot's reliability in dynamic environments. Adequate testing on various staircase shapes is essential to guarantee robust performance when the robot needs to make decisions on the fly in various situations.

Reference: <https://ieeexplore.ieee.org/document/9714003>

7.4 Reading Group Research Paper 4 : Tuesday 7th November 2023. Using advanced industrial robotics for spacecraft Rendezvous and Docking simulation. Topic: Hardware Paper

Introducing a hardware-in-the-loop (HIL) simulation for Rendezvous and Docking (RvD) in space, the paper utilizes two industrial robots, promising enhanced practicality. It confronts testing of 6-DOF contact dynamics, prioritizing cost-effectiveness. To mitigate biases from assuming consistently low docking speeds, the study could incorporate a more varied and realistic range of space scenarios, ensuring a comprehensive evaluation.

Research Challenges: Acknowledging industrial robots response time and stiffness, proposed solutions like energy balancing and admittance control showcase innova-

tive problem-solving. Further exploration of alternative control strategies and assessing adaptability to diverse space system complexities is crucial. This ensures a comprehensive approach to advancing autonomous RvD simulations, addressing the nuances of space exploration.

Reference: <https://ieeexplore.ieee.org/document/5980583>

8 Week 8

8.1 Seminar 13: Monday 13th November 2023. Independence after tetraplegia: Eye-gaze control for complex systems Prof. Emanuel Nunez Sardinha (UWE).

Exploring assistive tech for tetraplegics, the review highlights an eye-tracking system with a single camera and stickers. Although comfortable for extended use, reliance on monocular gaze affects depth precision, and imperfections in pupil data challenge reliability. Concerns arise regarding the system's limitations and sticker dependency, raising feasibility questions. Ongoing discrete research aims to enhance the proposed solution.

Research challenges: Highlighting the need to integrate binocular vision for better depth perception. Collecting comprehensive pupil datasets is crucial to address precision issues in gaze tracking. Solutions must ensure adaptability to diverse environments and seamless integration with interfaces. Improving depth measurements, possibly through advanced technologies, is essential for practical effectiveness and usability.

Reference: <https://people.uwe.ac.uk/Person/EmanuelNunezSardinha>

8.2 Seminar 14: Monday 13th November 2023. Ultraleap by Prof. Noor Alakhawand (UOB).

Ultra Leap's mid-air haptics, using ultrasound for touch feedback, struggles to accurately simulate touch sensations. Considering neuroscientific principles as an alternative might be fruitful. The flat Tac Tip could limit nuanced feelings; opting for an advanced tactile sensor inspired by human skin could boost accuracy. While autonomous haptic exploration is innovative, adding real-time data processing could reduce delays.

Research challenges: Boosting real-time sensing, and advancing tactile sensors are challenges. Collaborating with neuroscientists, delving into how we feel things, and integrating cutting-edge sensors for super sensitivity can make mid-air haptic and tactile robotics more accurate and effective. It's about understanding touch and using top-notch sensors for a more human-like experience.

Reference: <https://www.ultraleap.com/>

8.3 Reading Group Session 5: Tuesday 14th November 2023. Phenotypic Plasticity Provides a Bioinspiration Framework for Minimal Field Swarm Robotics. Presenter: Morris Man

In swarm robotics, borrowing from nature's phenotypic plasticity emphasizes adapt-

ability, treating diversity as a shield for robustness. Infusing "personalities" into swarms enhances subtle adaptability, understanding the genotype-phenotype link is crucial. Employing Reinforcement Learning with Neural Networks (RLNN) can boost adaptability and precision, but emulating nature's repeatability challenge may require mechanisms for controlled variability.

Research challenges: Promising as it is, challenges in phenotypic plasticity for swarm robotics include deciphering the genotype-phenotype link and tackling complexity in translating genetic instructions. Striking the right balance between adaptability and consistency is a crucial hurdle. Exploring alternative solutions, like incorporating hierarchical control structures and refining genetic encoding, could further advance the efficacy of this approach.

Reference: <https://shorturl.at/iPUW7>

8.4 Reading Group Research Paper 5 : Tuesday 14th November 2023. A Compact and Reliable Software Architecture for Robotics Control Topic: Software Paper

The paper emphasizes a compact robotics control software architecture, prioritizing simplicity, modularity, and fault tolerance. Validated through quadruped robot deployment, it showcases potential for robotics advancement. Existing frameworks, established over years, boast complexity, scalability, and adaptability. The proposed architecture aims to establish reliability and performance, acknowledging current architectures' maturity.

Research challenges: Include evaluating the proposed architecture's adaptability to diverse robots with varying complexities, addressing dynamic deployment challenges in rapidly changing real-world environments, and investigating security and reliability in scenarios prone to intentional or unintentional disruptions. Additionally, assessing how the architecture facilitates human-robot interaction and usability in collaborative settings presents crucial considerations.

Reference: <https://ieeexplore.ieee.org/document/9404085>

9 Week 9

9.1 Seminar 15: Monday 20th November 2023. Smarter Materials for Simpler Robots. by Prof Andrew Conn (UOB).

Soft robotics and smart materials show immense potential, yet challenges exist. Electroelastomers relying on static charge may face reliability issues; alternative stimuli like magnetic fields could enhance reliability. Liquid metal's temperature dependency poses challenges; a more adaptable solution involves materials with tunable mechanical properties, reducing reliance on controlled temperatures in dynamic scenarios.

Research challenges: Material durability challenges in soft robotics emphasize the need for robust, long-lasting smart materials. Existing soft robotic materials often face degradation, presenting real-world application challenges. Exploring advanced polymers

and self-healing materials aims to enhance durability. The complexity extends to integrating multiple functionalities seamlessly, ensuring performance isn't compromised. Proactively addressing ethical concerns, including privacy and autonomy, is essential.

Reference: <https://shorturl.at/tCFR8>

9.2 Seminar 16: Monday 20th November. Physically Interactive Robots. by Prof. Efi Psomopoulou (UOB).

Disagreeing with the sole reliance on tactile feedback, limited object knowledge, and high costs in physically interactive robots, alternatives include integrating computer vision, exploring diverse manipulation techniques, combining tactile with visual input, focusing on cost-effective solutions, employing adaptive handover algorithms, implementing dynamic safety protocols, and advancing haptic feedback for more precise teleoperation.

Research challenges: Challenges in robotics include adapting to unstructured environments, integrating multisensory information effectively, ensuring scalable and affordable systems, addressing ethical concerns, fostering human-robot collaboration, enhancing autonomy and decision-making, ensuring long-term reliability, establishing interoperability standards, managing public perception, adapting to dynamic environments, developing regulatory frameworks, and optimizing energy efficiency.

Reference: <https://shorturl.at/ft024>

9.3 Reading Group Session 6: Tuesday 21th November 2023. Challenges of continuum robots in clinical context: a review. Presenter: Boyu Qin

Continuum robots offer promise in Minimally Invasive Surgeries, but gaps in fluidic and magnetic robot fabrication persist. Limited consensus on modeling and control poses challenges, with only 9 percent of researchers focusing on control aspects. Standardized modeling and interdisciplinary collaboration are crucial for effective integration of continuum robots in medical applications.

Research challenges: Revolutionizing medical robotics demands accurate modeling for control and safety in continuum robots. Overcoming challenges in controllable and actuation, real-time shape sensing navigates adaptive motion in intricate anatomies. Perfecting actuation ensures smoother movements, while tackling fabrication hurdles through digital manufacturing is vital. Dedicated research paves the way to seamlessly integrate continuum robots into mainstream medical practice, unlocking transformative healthcare benefits.

Reference: <https://iopscience.iop.org/article/10.1088/2516-1091/ab9f41>

9.4 Reading Group Research Paper 6 : Tuesday 14th November 2023. Context-Awareness in Human-Robot Interaction: Approaches and Challenges Topic: Robot Context

Highlighting intelligent social capabilities and context-awareness, emphasizing decision-

making research aligns with HRI trends, underscoring the need for responsive robotic systems. Hypothesis promises a comprehensive exploration, and the hybrid format excels in global accessibility, mirroring the industry's shift toward intelligent robotic systems—a glimpse into a future where human-robot synergy becomes a societal necessity.

Research challenges: Intelligent social robotics, tackling biases in AI algorithms is vital for healthcare. Ensuring ethics in sensitive healthcare settings is crucial, and delving into the long-term societal impact is essential. These challenges enrich the HRI discourse. Personally, Strengthening the bond between robots and humans in healthcare requires advancements like explainable AI and continual learning, fostering empathy and ethical connections.

Reference: <https://ieeexplore.ieee.org/document/9889584>

10 Week 10

10.1 Seminar 17: Monday 27rd November 2023. Robots for Nuclear Environments. by Prof. Paul Bremner (UWE).

The integration of diverse robot teams and advanced technologies like virtual reality in nuclear decommissioning offers enhanced mapping accuracy and reduces the risk on human life. Effective communication among robots and teleoperators is pivotal, utilizing layered cost maps for risk-aware control. Incorporating virtual reality aids data rendering and teleoperation, emphasizing human-robot shared control.

Research challenges: Creating seamless sensor integration and high-speed processing is key in nuclear decommissioning and can reduce risk on human life. Efficient data management, adaptive communication protocols, and user-friendly interfaces enhance human-robot interaction and . Studying radiation effects on sensors and communication to develop robust fault tolerance and safe manipulation techniques for reliable and secure decommissioning processes.

Reference: <https://people.uwe.ac.uk/Person/Paul2Bremner>

10.2 Seminar 18: Thursday 30rd November 2023. Collaborative robots and precision welding - developing performance and inspection capabilities. by Prof. Carwyn Ward (UWE).

Research spans aerospace and renewable industries, delving into Design for Manufacturing, Automated Layup, and welding. Silicon tips and print path optimization promise enhanced precision. Innovatively using silicon tips and rollers exhibits versatility for different surfaces. Prioritizing print path optimization and adaptive algorithms enhanced overall efficiency. Addressing semi-automated welding limitations opens avenues for future advancements.

Research challenges: Addressing geometry challenges requires adaptive solutions. Implement machine learning models to predict layup times, ensuring efficiency through parameter adaptation. Consistent quality across geometries demands adaptive tools dynamically adjusting to shapes. Enhance weld quality insights by integrating advanced

machine vision, CNN for visual analysis with FEA for structural insights to predict weld quality effectively.

Reference: <https://people.uwe.ac.uk/Person/CarwynWard>

10.3 Reading Group Session 7: Tuesday 14th November 2023. A Brief History of Industrial Robotics in the 20th Century. Presenter: Qiushi Wang

The 20th-century evolution of industrial robotics, spanning three generations, reveals a progressive journey. The First, inaugurated by George Devol's Unimate, introduced programmable machines. The Second, employing servo-controllers, enhanced complexity despite application specificity. The Third generation exhibited heightened interaction and self-programming, embracing innovations like direct drive actuated robots and the Delta robot, elevating speed and accuracy.

Research challenges: Second Generation robots faced hardware challenges due to microchip constraints. In the Third Generation, evolving microchips addressed issues, but lagging algorithms hindered self-programming. Overcoming this, algorithmic advancements emerged, crucial for versatile industrial robots. Bridging hardware and algorithmic gaps propelled the industry's evolution.

Reference: <https://www.scirp.org/journal/paperinformation?paperid=90517>

10.4 Reading Group Research Paper 7 : Tuesday 14th November 2023. Artificial Intelligence and Robotics. Topic: Pre-1990

The 1988 paper laid foundations for AI-robotics integration. While its vision aligns with current achievements in real-time perception and integration, modern approaches leverage advanced algorithms, edge computing, and machine learning, reflecting a paradigm shift. Core principles endure, but the evolution since 1988 underscores the dynamic nature of AI and robotics progress.

Research challenges: In the early AI and robotics era discussed, challenges included computational inefficiency, dynamic planning, sensory integration, belief revision, learning in noise, articulating human knowledge, achieving psychologically plausible planning, and efficient model-based vision. These shaped foundational research, advancing intelligent agents and setting the stage for subsequent progress.

Reference: <https://ieeexplore.ieee.org/document/60933>

11 Week 11

11.1 Reading Group Session 8: Tuesday 12th December 2023. **MFF-Net: Towards Efficient Monocular Depth Completion With Multi-Modal Feature Fusion. Presenter: Yu Xiang**

MFF-Net's monocular depth completion shows promise but raises concerns about relying solely on LiDAR, impacting robustness in adverse conditions. Efficient processing is highlighted, but a comprehensive analysis of computational requirements is lacking. Generalization capabilities, adaptability to sensor noise, and interpretability need deeper exploration. Future research should prioritize robustness, reduced complexity, and sensor fusion for real-world deployment.

Research challenges: Research challenges in monocular depth completion include robustness to adverse conditions, generalization across diverse environments, real-time processing efficiency, effective sensor fusion, interpretable deep learning models, real-world deployment complexities, handling dynamic objects, data annotation efficiency, ethical considerations, and optimizing human-centric interactions for augmented reality applications.

Reference: <https://arxiv.org/abs/2307.12761>

11.2 Reading Group Research Paper 8 : Tuesday 12th December 2023. Applications of Hybrid Conditional Planning in Service Robotics Topic: Free choice

The paper introduces HCPLAN, a robust hybrid conditional planning framework, showcasing strengths in integrating deterministic and non-deterministic actions, and parallelization for scalability. The Baxter robot's application in a kitchen setting demonstrates practicality. However, addressing human-centric factors and conducting a thorough feasibility analysis will be crucial for broader adaptability in complex real-world scenarios, ensuring the framework's success.

Research challenges: Feasibility checks hints for a deeper analysis, especially in dynamic settings. The framework's adaptation to human responses and sensitivity to initial conditions lack detailed exploration. Improvements could dive into feasibility, focusing human-robot interactions for wider use, and analyze sensitivity for robust performance in diverse conditions. This enriches understanding of real-world constraints, boosting the framework's practicality.

Reference: <https://ieeexplore.ieee.org/document/10089569>