GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Human Robot Interaction, PG_00068198		
Field of study	Automatic Control, Cybernetics and Robotics		
Date of commencement of studies	October 2025	Academic year of realisation of subject	2028/2029
Education level	first-cycle studies	Subject group	Optional subject group Subject group related to scientific research in the field of study
Mode of study	Full-time studies	Mode of delivery	at the university
Year of study	4	Language of instruction	Polish
Semester of study	7	ECTS credits	2.0
Learning profile	general academic profile	Assessment form	assessment
Conducting unit	Department of Decision Systems and Robotics -> Faculty of Electronics Telecommunications and Informatics -> Wydziały Politechniki Gdańskiej		
Name and surname of lecturer (lecturers)	Subject supervisor	dr hab. inż. Michał Czubenko	
	Teachers	dr hab. inż. Michał Czubenko	

Lesson types and methods of instruction	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	15.0	0.0	0.0	15.0	0.0	30
	E-learning hours included: 0.0						

Learning activity and number of study hours	Learning activity	Participation in didactic classes included in study plan	Participation in consultation hours	Self-study	SUM
	Number of study hours	30	2.0	18.0	50

Subject objectives
The aim of the subject "Human-Robot Interface" is to prepare students to design, analyze and evaluate communication systems between humans and robots. The subject will take into account both technical, psychological and ethical aspects. It aims to develop skills in creating intuitive, safe and effective interfaces that enable natural cooperation with robots in various environments. Students will gain knowledge in the field of multimodal communication, principles of designing user-friendly interfaces, as well as mechanisms of perception and trust in robots. Additionally, they will learn to identify and solve problems related to adaptability, anthropomorphism and technological responsibility. The subject develops competences needed to create modern solutions in the field of human-centered robotics.

Learning outcomes	Course outcome	Subject outcome	Method of verification
	[K6_U02] can perform tasks related to the field of study in an innovative way as well as solve complex and nontypical problems, applying knowledge of physics, in changing and not fully predictable conditions	Is able to design human-robot interfaces taking into account the principles of ergonomics, sensory perception and human physiological limitations, using knowledge of physics and mechanics. Is able to creatively and innovatively solve problems related to the interpretation of gestures, speech, touch and other interaction modalities, including combining different methods to increase the reliability of communication. Understands the impact of anthropomorphism and user behavior on the design of physical and digital forms of the interface and is able to select appropriate technological solutions depending on the application context.	[SU1] Assessment of task fulfilment
	[K6_U12] can analyze the operation of components, circuits and systems related to the field of study, as well as measure their parameters and examine technical specifications, and plan and conduct experiments related to the field of study, including computer simulations and measurements, and interpret obtained results and draw conclusions	Is able to analyze the structure and operation of user interfaces in human-robot interaction systems, including their physical components (sensors, manipulators) and software components (control algorithms, dialogue systems). Is able to plan and conduct experiments involving the user and the robot, e.g. tests of intuitiveness, response delay, gesture reading accuracy, or multimodal communication effectiveness.	[SU3] Assessment of ability to use knowledge gained from the subject
	[K6_W21] knows and understands the basic methods of decision making as well as methods and techniques of design and operation of automatic regulation and control systems, computer applications for controlling and monitoring dynamic systems.	Knows techniques for monitoring user and robotic system behavior, as well as integrating sensory data (e.g. cameras, microphones, force sensors) to make control decisions. Understands the challenges of designing HRI systems as dynamic systems whose behavior depends on variable and difficult to predict human responses, and is able to select appropriate control and adaptation methods.	[SW1] Assessment of factual knowledge

Subject contents	The Human-Robot Interface (HRI) course focuses on the design and analysis of user interfaces in systems where there is direct interaction between humans and robots. The course aims to provide students with theoretical and practical knowledge on how to create interfaces that are intuitive, safe and effective in the context of human-machine cooperation. The principles of designing user-friendly interfaces are discussed, including good engineering practices, ergonomics, accessibility and clarity of messages. Particular emphasis is placed on multimodal communication including speech, gestures, touch, facial expressions and visualization, and on the integration of different perceptual channels that allow robots to better understand human intentions and respond to them appropriately. Challenges related to the intuitiveness and adaptability of interfaces are also addressed, including the robot's dynamic adaptation to changing conditions and the user's level of experience. The course covers issues from the psychology and ethics of HRI, such as human perception of robots, trust, acceptance, prejudices or stereotypes towards technology, as well as the phenomenon of anthropomorphism, giving robots human characteristics and its impact on reception and interaction. Particular emphasis is placed on the ethical aspects of designing robotic systems, including privacy, responsibility for algorithmic decisions, user safety and the impact of technology on society. Lecture The theoretical part will introduce basic concepts from the field of human-robot interaction, with particular emphasis on types of interfaces (physical, linguistic, gestural, tactile) and communication models. The principles of designing user-friendly interfaces, good engineering practices, ergonomics and the importance of multimodality, including speech, gestures, touch and visualization, along with techniques for their integration and processing, will be discussed. Then, students will become familiar with the impact of psychological and social aspects on the reception of robots, such as trust, anthropomorphism, the uncanny valley effect and user acceptance. A significant part of the lectures will be devoted to the ethics of designing HRI interfaces, taking into account the issues of privacy, responsibility and security. The topics of adaptive algorithms and system architectures enabling dynamic human-robot collaboration will also be discussed. Finally, case studies and real applications of HRI technology in industry and social robotics will be presented. Project The practical part allows students to apply the acquired knowledge by implementing projects in large teams. In the first stage, students familiarize themselves with available tools (e.g. Gazebo, V-REP, Webots) and choose a project topic. Then, they conduct an analysis of user requirements, design an interface (graphical or physical) and plan ways of communicating with the robot. The next classes are devoted to the construction or configuration of a simulation environment and the integration of sensors and control systems. Students implement a prototype of the interface, test its operation in various scenarios, analyze delays, reliability and intuitiveness, and then introduce improvements. The project ends with a presentation of the working HRI system, a discussion of the results and reflection on the ethical and technological aspects of the solution. The end result is also documentation describing the entire design process.
Prerequisites and co-requisites	Detailed knowledge of robotics, especially sensors and actuators. Knowledge of human perception. Ability to use robot simulators (Gazebo, V-REP, Webots).

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
colloquium	60.0%	30.0%
project	60.0%	70.0%

Recommended reading

Basic literature	Mårell-Olsson, E., Bensch, S., Hellström, T., Alm, H., Hyllbrant, A., Leonardson, M., & Westberg, S. (2025). Navigating the HumanRobot InterfaceExploring Human Interactions and Perceptions with Social and Telepresence Robots. *Applied Sciences*, *15*(3), 1127-. https://doi.org/10.3390/app15031127 Sumithra, M. G. (Ed.). (2023). *Brain-computer interface: using deep learning applications / edited by M. G. Sumithra [and four others].* John Wiley & Sons. SHIOMI, M., & Sumioka, H. (2024). *Social Touch in Human-Robot Interaction: Symbiotic Touch Interaction between Human and Robot* (1st ed.). CRC Press. https://doi.org/10.1201/9781003384274
Supplementary literature	Zhang, J., Li, S., Zhang, J. Y., Du, F., Qi, Y., & Liu, X. (2020). A literature review of the research on the uncanny valley. In *Cross-Cultural Design. User Experience of Products, Services, and Intelligent Environments: 12th International Conference, CCD 2020, Held as Part of the 22nd HCI International Conference, HCII 2020, Copenhagen, Denmark, July 1924, 2020, Proceedings, Part I 22* (pp. 255-268). Springer International Publishing.
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Example issues/ example questions/ tasks being completed	Sample Questions 1. What is multimodal communication in human-robot interfaces? Provide examples and discuss integration challenges. 2. What are the main principles of designing human-friendly user interfaces in the context of HRI? 3. What is the Uncanny Valley effect and how does it affect the design of humanoid robots? 4. Discuss the role of trust and acceptance in human-robot interaction. How can it be built? 5. How can vision systems be used to monitor the user in real time? 6. Explain the adaptiveness of HRI interfaces and how can it be implemented. 7. How is anthropomorphizing a robot different from designing it functionally? How does it affect user behavior? 8. What are the ethical concerns associated with implementing robots in social environments? 9. Describe the architecture of a ROS-based HRI system. What are the key modules? 10. How can reinforcement learning algorithms be applied in the context of human-robot interaction? Example projects: 1. Controlling a mobile robot using hand gestures detected by an RGB-D camera (e.g. Kinect, Intel RealSense) the project includes gesture detection and mapping them to commands controlling the robot's movement. 2. Voice interaction system with an assisting robot in an office space analysis of voice commands, robot responses, integration with the TTS/STT engine. 3. Interactive GUI for controlling a cobot in human-machine cooperation mode design and implementation of a graphical interface with trajectory preview and control. 4. Recognition of user emotions based on facial expressions and adaptation of the robot's behavior integration with emotion recognition libraries (e.g. OpenFace, Affectiva). 5. Touch interface for a rehabilitation robot supporting limb movements design and testing of the physical interface, force and resistance monitoring. 6. HRI safety system: detection of undesirable events in the robot's work area use of cameras and proximity sensors, analysis of scenes and critical events. Creating a social robot avatar in a virtual environment (Unity + ROS) a VR robot responding to user speech and gestures, with contextual responses. 7. Controlling a robot simulator game using punches, steps and body movements integration with a skeleton tracking system, e.g. Kinect, and simple game logic. 8. An interface for teaching school children to cooperate with a robot adapting the language, graphics and behavior of the robot to the childs level of perception. 9. Analysis of the impact of different forms of robot anthropomorphism on user behavior comparison of interfaces with synthetic and natural voice, facial expressions, gestures, etc.
Work placement	Not applicable

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