

Research options available for topic B

Research topics a) and b) offered by every Doctoral Course involved in UNIPhD are frameworks within which every applicant has to present an original research project in collaboration with a Supervisor at the University of Padua.

Potential Supervisors at Unipd have proposed the following detailed research options, which are related to the research topic. They are offered as a guideline and should facilitate your contact with potential Supervisors. Supervisors' e-mail is specified in every research option table. You are welcome to contact them directly.

Note that this research option list is not at all exhaustive and, within the topic you have chosen, you are free to propose a different research project.

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| Doctoral Course | INFORMATION ENGINEERING |
| Macro-area | Physical Sciences and Engineering |
| Department name | Department of Information Engineering |
| Webpage | https://phd.dei.unipd.it/ |
| Research topic B | <p>Environmental sensing through millimeter wave radars</p> <p>The objective of this research project is the design and implementation of a mm-wave radar system to track and analyze human motion. This entails the design of advanced signal processing and deep learning based algorithms that extract fine-grained information on human movements from radars irradiating the indoor environment of interest. Such system enables new applications for assisted living and healthcare and, in the medium term, replace standard camera systems for motion analysis in the clinical field.</p> |
| Link to the UNIPhD Call (Academic Year 2022/2023) | https://www.unipd.it/en/uniphd |
| Latest Update | 11.01.2022 |
| #Number of available Research Options | 1 <i>Scroll down to see all the Research Options</i> |

#1 Research Option Description

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| Doctoral Course | Information Engineering |
| Department name | Department of Information Engineering |
| Research topic B | Environmental sensing through millimeter wave radios |
| Research option | Human motion tracking and analysis by applying signal processing and deep learning imaging techniques to mm-wave radar data |
| Supervisor | Michele ROSSI (michele.rossi@unipd.it) |
| Webpage | http://www.dei.unipd.it/~rossi/ |
| Context of the research activity and objectives | <p>The objective of this research project is the design and implementation of a mm-wave radar system to track and analyze human motion (movements, poses, activities, etc.). This entails the design of advanced signal processing and deep learning based algorithms that extract fine grained information on humans movements from radars irradiating the indoor environment of interest.</p> <p>The availability of such type of sensing system enables a number of new applications for assisted living and healthcare that help elderly and people affected by pathological diseases or physically impaired ones to conduct their daily activities. Also, in the medium term this technology may replace standard camera systems for motion analysis within the clinical field. mm-wave radars are rapidly emerging as an alternative to camera systems, which pose several privacy issues and may fail to work in low-light conditions or in the presence of dust or smoke. On the contrary, mm-wave radar signals are naturally unaffected by illumination conditions and provide high spatial resolution and accurate velocity estimation of moving objects (including humans), which are appealing properties for the in-depth analysis of human motion.</p> <p>The student is required to design and implement the sensing system exploiting 2D and especially <i>3D MIMO radars data and advanced signal processing algorithms</i>. This integration is expected to lead to a robust and accurate system for the fine grained analysis of human motion. Specifically, the high resolution of mm-wave signals allows localizing the different body parts of a subject and reliably tracking them in real time, whereas signal processing and deep learning techniques allow coping with the disturbances and the randomness of the radio signals. The final goal of the research activity is the implementation of the developed system on edge computing hardware (e.g., NVIDIA Jetson), providing an integrated motion tracking system that can be easily deployed in indoor spaces.</p> <p>The candidate will be part of a research team that is actively working on these topics and will have access to computing and testbed facilities.</p> |

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| Infrastructures | <p>The Ph.D. student will be provided with a high-quality workstation empowered with GPU to effectively implement deep learning algorithms. In addition, she/he will be given access to the computing cluster hosted by the Department of Information engineering.</p> <p>The candidate will have full access to the laboratories of the telecommunication group where hands-on activity is carried out, including mm-wave radar measurements for people tracking, identification and motion analysis.</p> <p>The hardware facilities that will be made available to the student include (to date) 7 Texas Instrument radars operating on the 60-64 GHz and 77-81 GHz bands, one Infineon 24 GHz radar, advanced Texas Instruments 3D MIMO radars at 76-81 GHz, a high precision Vicon motion capture system (RGB camera and infrared marker-based motion tracking) for ground truth measurements, an infra-red thermal camera, a ToF camera for depth estimation, and several RGB cameras.</p> <p>Several NVIDIA Jetson boards (3 TX2, 2 Xavier NX, 1 AGX Xavier and 1 Nano 4GB) are available for the implementation and testing of the developed sensing applications on edge computers.</p> |
| Skills and competencies for the development of the activity | <p>TO successfully tackle the aforementioned objects, the candidate must have a degree in Telecommunications Engineering, Computer Science, Data Science or equivalent. Highly welcome and recommended skills are: MS-level training in advanced signal processing and machine/deep learning techniques; MS-level training in mathematics, probability and optimization theory; strong programming skills (preferred Python with TensorFlow, Scikit-learn, NumPy, Pandas libraries).</p> <p>Open-mindedness, strong integration skills, team spirit and good communication skills in oral and written English complete the profile.</p> |
| Training offer | <p>The PhD Program courses and seminars are available at the following link: https://phd.dei.unipd.it/courses/</p> <p>The following courses are of particular relevance:</p> <ul style="list-style-type: none"> • Elements of Deep Learning (24 hours) • Bayesian Machine Learning (20 hours) • Machine Learning for Wireless Communication Systems (20 hours) • Introduction to Reinforcement Learning (15 hours) • Information Theoretic Models in Security (20 hours) • Advanced Topics in Scientific and Parallel Programming with Practical Application to the CAPRI HPC Infrastructure (20 hours) |
| Possible Secondments | <p>Academic partner (secondment duration 4 months, mandatory): IMDEA Networks (research center located in Madrid, Spain)</p> <ul style="list-style-type: none"> • https://networks.imdea.org/ <p>Non-academic partner (secondment duration 3 months, optional): Worldsensing (SME located in Barcelona, Spain)</p> <ul style="list-style-type: none"> • http://worldsensing.com |