Multi-Partner Project: Sports Performance and Health Assessment in the DistriMuse Project

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***Abstract*—In our increasingly tech-saturated world, from mobile apps and health sensors to autonomous cars and factory robots, we expect these devices to seamlessly integrate into our lives, enhancing safety and convenience. However, as these devices proliferate and their autonomy grows, ensuring they provide unobtrusive, yet effective support becomes crucial. The Horizon Europe KST multi-partner project "Distributed Multi-Sensor Systems for Human Safety and Health" (DistriMuSe) intends to support human health and safety by improved sensing of human presence, behaviour, and vital signs in a collaborative or common environment by means of multi-sensor systems, distributed processing and Machine/Deep Learning (ML/DL) techniques. In this paper, we focus on the DistriMuSe's approach on sports performance and health assessment, focusing on monitoring the physical activity of non-professional and hobby athletes, people who like sports and care about their health, elderly healthy people, and subjects affected by neurological disability (e.g., Parkinson's disease). The overall goal is to measure activity and exertion, estimating performance levels and determining maximum effort. We discuss the overall system-of-systems architecture, focusing on the adopted technologies.**

***Index Terms*—sensors, Machine Learning, Artificial Intelligence, health assessment, distributed systems**

I. INTRODUCTION

Nowadays, we are generally surrounded by a variety of "intelligent" technical devices, designed to serve us or others in different scenarios. Some examples can be the applications in our mobile phones, the wrist-worn health sensors, autonomous vacuum cleaners, robots on the factory floor and increasingly autonomous cars, all with the aim of easing some tasks and keeping us safe and healthy. The seamless interplay of humans with these devices gains even more importance as they are proliferating with a pervasive presence in our lives. We expect to have continuously available support from the services provided by intelligent devices, and we want them to unobtrusively disappear in the background when not needed. In order to provide support in a collaborative environment with human, physical and digital players, the technology needs to be equipped with sensors able to grasp people presence, to understand their mental and physical states, their activities, and, finally, their intentions. This is required to ensure human safety, safeguard their health, and allow for natural interaction [1]. At the same time, while considering the number of devices required to ensure these aspects, also the ergonomics and wearability of the intended sensors, especially if they are meant to be used in highly dynamic activities, will be addressed.

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The paper is organized as follows. In Section II an overview of the DistriMuSe project and its use cases is provided. In Section III we describe the defined user stories, while in Section IV the possible users and stakeholders of the project finding are highlighted. Section V focuses on the main architecture of the sport performance and health assessment demonstrator and, finally, in Section VI, we draw our conclusions.

II. SPORTS PERFORMANCE AND HEALTH ASSESSMENT IN THE DISTRIMUSE PROJECT

A. The DistriMuSe: Overview

The "Distributed Multi-Sensor Systems for Human Safety and Health" (DistriMuSe) multi-party project [2], funded by Horizon Europe research and innovation program Key Digital Technology Joint Undertaking (KDT JU), intends to improve the sensing of human presence, behaviour and health in a collaborative or common environment by means of multi-sensor systems [3]. The project, being in its initial stage (development

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phase of cycle 1) as it has started in May 2024 and will last three years (to May 2027), aims also at demonstrating results and advancements with respect to the state of the art in three different Use Cases (UCs). These UCs and high-level objectives are described in the following.

- Continuous hybrid health monitoring – aimed at providing means to continuously and unobtrusively monitor a person's health state to enable (i) early detection of adverse health developments in elderly people, (ii) near-clinical sleep monitoring at home to detect sleep-related health issues, and (iii) timely and personalized rehabilitation and coaching services.
- Situational awareness for Vulnerable Road Users (VRU) and driver safety – focused on ensuring safe traffic and especially protecting the VRU by the continuous monitoring of (i) the behaviour and intentions of VRUs when interacting with traffic, and (ii) the drivers' ability to drive and ensuring their attention is appropriate for the given traffic situation including VRUs.
- Safe interaction with robots – dedicated to factory floors shared by human workers and robots, enabling more efficient human-robot cooperation by providing the robots with better monitoring capabilities of the presence and an understanding of the intentions of their human counterparts. Our goal is gradually eliminating the safety fences that separate humans and industrial robots in such environments, permitting an efficient and safe collaboration between them.

B. DistriMuSe UC1 – "Continuous Hybrid Health Monitoring"

In this paper, we describe one of the demos of the first UC, focused on health (namely, UC1). More in detail, UC1 aims at continuous hybrid human health monitoring ensuring both spatial as well as temporal coverage. To achieve this objective, UC1 intends to deepen this potential by presenting person monitoring technologies that work in common, producing coherent and semantically fused data from dynamic sensor networks.

Three demonstrative scenarios have been defined, in the aim of UC1, to cover the objectives of the project. The demonstrators are composed of integrated solutions deployed in different pilots and sites, with the objective of demonstrating DistriMuSe innovations. In the following, a detailed description of different demonstrators is provided.

- Demo 1.1 — "Human life-style monitoring": this demonstrator focuses on human daily activity monitoring considering two main groups of interest: (i) early-stage Mild Cognitive Impairment (MCI) patients, and (ii) elderly people in care facilities and assisted living. The data will be captured using a combination of visual, wearables, radar and other sensors. The developed algorithms and support tools should assist the caregiver in detecting and preventing emergency situations, ensuring better follow-up care and being able to provide predictive care.
- Demo 1.2: — "Sleep Monitoring": this demonstrative scenario aims at developing less obtrusive methods to monitor sleep and assess sleep disorders. By measuring vital signs in a novel and less obtrusive manner, these methods can potentially replace those currently used in gold standard video-polysomnography setups. Additionally, it includes the measurement of vital signs (e.g., blood pressure) that are not part of current gold standard methods due to the obtrusiveness of existing measurement setups.
- Demo 1.3: — "Sports Performance and Health Assessment": this demonstrator focuses on monitoring the physical activity of hobby and non professional athletes, people who like sports and care about their health, elderly healthy people but also subjects affected by neurological disability (e.g., Parkinson's disease). The overall goal of the demonstrator is to measure activity, exertion levels, estimating performance levels, determining maximum effort and monitoring various health parameters. This demonstrator is the focus of our paper.

C. DistriMuSe Demo 1.3 – Sports Performance and Health Assessment

The sports performance and health assessment demonstrative scenario (i.e., Demo 1.3) focuses on monitoring the physical activity of participants with the overall goal of extracting numerous parameters and analyzing their relationships with health parameters such as heart rate, heart rate variability, or glycaemia. This allows to create warnings about potential health problems and produce estimations of performance levels and maximum effort. For completeness, in Table I the high level requirements of Demo 1.3 are summarized.

The integration of wearable sensors based on Inertial Measurements Units (IMU), barometer, PhotoPlethysmoGraphy (PPG), ElectroCardioGraphy (ECG), Continuous Glucose Monitors (CGM), thermometer, and sweat analytic sensors (namely, Perspiration Rate (PR) sensor and salinity sensor), along with the use of Machine Learning (ML)-based processing, will provide parameters for physical health assessment and motion tracking technology. This will revolutionise the landscape of sports performance assessment towards health and provide early warnings when an assessed parameter is out of range. These cutting-edge tools offer a new dimension of insight into an athlete's physical abilities and provide critical data that can prevent a decrease in performance (or even injuries) and also optimize training.

As part of continuous monitoring, the wearable sensors collect data on the body exertion and reactions, providing coaches with tools to personalize and optimize training programs. In addition to performance enhancement, sensors monitoring glycaemia, perspiration rate, salinity, evaluating certain ECG pathologies, and body postural stability are the most important health data for assessing potential health problems. This includes the ability to monitor cardiovascular function and identify exertion levels. Monitoring motor performance and health parameters (e.g., heart rate, blood glucose, oxygen saturation, and blood pressure) is important in the management of neurodegenerative conditions and elderly individuals, with a significant impact in their activities of daily living. In fact, early detection of anomalies in motor performance, gait and posture, and in terms of a few health parameters are important

TABLE I
HIGH-LEVEL REQUIREMENTS FOR DEMO 1.3

ID	Description	Metrics & validation	Owner
UC1_Demo1.3_AI process optimization_001	Benchmarking of integrated platforms for the purpose of distributed data processing optimization	Verification of sufficient real-time computing capacity	BUT
UC1_Demo1.3_Cloud architecture_001	Developement of cloud architecture connected to the edge device to collect data	Checking data presence on cloud storage	BUT
UC1_Demo1.3_Health score_001	Developement of algorithm for health score expression	Health score in range 0-100 wil be validated against personal objective and subjective references	BUT, UNIPR
UC1_Demo1.3_IMU AI-based processing_001	Distribution of AI-based processing to sensors, edge device and cloud	Verification of sufficient real-time computing capacity	BUT
UC1_Demo1.3_On-chip ML processing_001	Integration of on-chip ML core in smartwatch and in edge device to decrease data rate among devices	Verification of on-chip ML processing to parametrize IMU signals	BUT
UC1_Demo1.3_SmartWatch_001	Integration of PR, PPG, IMU, and Thermometer sensors to single wearable device. Minimum battery lifetime 10 Hours.	Real-time data transfer to cloud.	BUT
UC1_Demo1.3_Specification_001	Specification of data fusion algorithms of parameters collected from wearables	Validation on reference data	BUT, UNIPR
UC1_Demo1.3_WBAN _001	Establishing a WBAN for error-free communication between wearable devices.	Network performance verification	BUT, UNIPR

TABLE II
PILOTS OF DISTRIMUSE DEMO 1.3.

Pilot name	Pilot site	Description
P1-BRNO	BUT (Brno, Czechia)	Monitoring athletes to collect enough data to increase their sport performance and physical condition to maximum effort via monitoring the physical activity and exertion levels. In addition, it will allow us to assess the health from several other collected parameters and to warn in time if some pathological phenomena appear.
P1-TOR	UNITO (Torino, Italy)	Monitoring of health parameters, including cardiac rhythm disorders, cardiac arrest, and movement performance in elderly individuals or patients with neurological conditions.

Fig. 1. Pilot P1-BRNO sites.

to promptly adequate and personalize treatments and neurorehabilitation, significantly improving outcomes and reducing risks.

Demo 1.3 is organized with two different pilots, as presented in Table II and described in the following subsections.

1) Pilot P1-BRNO: The first pilot, denoted as “P1-BRNO” is located at the Brno University of Technology (BUT) [4], Brno, Czech Republic, and aims at continuous monitoring of hobby athletes and occasional athletes performance and health status. For this purpose, custom-made smartwatch (equipped with IMU, PPG, temperature, barometer, perspiration rate, and salinity sensors), combined with an ECG/ACC sensor and a CGM sensor will be used. The data will be measured in different scenarios (see Fig. 1), in particular:

- activity protocol (with defined activities) within one hour;
- free-living protocol, with a duration of 10-14 days;
- long-term free-living measurement, considering an observing period of half a year and more;
- graded exercise test in controlled lab environment within one hour.

The participants will be recruited from healthy hobby and occasional athletes.

The glycaemia will be fused with other health features to monitor athletes performance and behavior and to offer them feedback in terms of training optimization (e.g., diet, food/training timing, avoiding hypoglycaemia). In the final application, the overall health score will be assessed to inform the user whether everything is under control or something is going wrong. The user will then be able to see all measured and calculated features and their trends, as the features significantly changing will be highlighted. Activities will be detected, exertion level and burnt calories will be estimated. From ECG, heart pathologies will be detected or even predicted, (an)aerobic thresholds will be estimated, body response will be expressed. The final solution will integrate various sensors whose data will be fused to enable a more complete view on the user.

2) Pilot P1-TOR: The second pilot, denoted as “P1-TOR”, is held by the University of Torino (UNITO) in collaboration with the “Istituto di Ricovero e Cura a Carattere Scientifico”

Fig. 2. Pilot P1-TOR sites.

(IRCCS) Istituto Auxologico Italiano (IAI) [5], located in the San Giuseppe Hospital, Gait and Movement Analysis Lab (in Piancavallo, Verbania, Italy). The pilot aims at creating a multi-domain system for continuously monitoring and assessing movement performance and specific health parameters in elderly healthy people and subjects affected by Parkinson's disease. In particular, the pilot will be conducted taking into consideration several years of expertise in the automated analysis of movement in neurological disabilities, with both cameras and wearable sensors. Participants will be recruited by neurologists among in-patients of San Giuseppe Hospital, and among out-patients. Experiments and simulated real-world settings will be performed in controlled and supervised setting at the Gait and Movement Analysis Lab and at the ward and corridors of the Neurology and Neurorehabilitation Department of San Giuseppe Hospital, as shown in Fig. 2.

Evaluation of usability of the technology and user satisfaction will be obtained using questionnaire and semi structured interview, focusing to the usability in different classes of disease severity.

The set up of the monitoring system will consist of the integration of RGB cameras, wearable sensors based on IMU, PPG, ECG, sweat analytic sensors and other sensors for vital physiologic signals (e.g., blood glucose, oxygen saturation and blood pressure), along with the use of ML/DL-based processing, able to provide parameters for physical health assessment and motion tracking technology. Data will be collected in different daily sessions, for at least 2 weeks (considering 10-20 subjects). Data obtained will also be compared with self-reported questionnaire and clinical evaluation by means of validated scales. Parameters from wearable sensors and cameras will also be used for automated classification of risk conditions of falling, both in elderly and Parkinsonian patients. This aspect is particularly important, as frail people (above all elderly people) and subjects affected by Parkinson's disease are at great and increased risk of falling, with severe consequences such as injuries and hospitalizations. In this context, the efforts will be directed to the classification of motor conditions immediately prior to the fall, for prevention purposes.

III. User Stories

As done for the previous demonstrators, this section presents a set of user stories specifically designed to better understand the utility and real-world usage of Demo 1.3. The user stories are also linked to the different pilots of the demonstrator.

A. User Story for Comprehensive Sport Performance Assessment: Pavel (Pilot P1-BRNO)

Pavel is a hobby athlete who participates in amateur competitions. He is 45 years old and needs to get in shape for races, which occur frequently throughout the season. He cannot afford a personal trainer for financial reasons, but he needs to know whether he is overtraining or undertraining. At the same time, he wants to avoid health consequences or receive early warnings if there is something wrong with his health or performance. There are several wearable devices available on the market that provide different parameters, but they cannot be combined into a single assessment system. Each device has its own application, complicating comprehensive monitoring, and each evaluation only considers a few parameters, making it very rough. Therefore, he would like to have a single app using a minimal number of wearables to obtain the necessary parameters for a comprehensive assessment of athletic performance and health.

B. User Story for Comprehensive Sport Performance Assessment: Alice (Pilots P1-BRNO, P1-TOR)

Alice is another hobby athlete who often practises sports at a university campus featuring various athletic sites, a swimming pool, a golf course, and other sports facilities. She knows that regular sport practice can improve her health and help prevent diseases as much as possible. For these reasons, she buys different wearable devices because she does not want to miss the opportunity to monitor her activities. Unfortunately, she only knows that her activity information is critical for an algorithm that can run during her training sessions, but she is not an expert in technology, so she is not able to select only one wearable to be worn. That is why she prefers to buy multiple devices and check if their joint monitoring would provide interesting advice and suggestions for her health. Her only interest is in practicing several sports activities, thus being unaware that the worn devices would be able to internally perform data analysis, classification, and return feedback without the need for an established network connection to cloud systems.

C. User Story in a Care Facility: Claudio (Pilot P1-TOR)

Claudio is a patient with a multi-year clinical diagnosis of Parkinson's disease. For approximately 1 year he has been experiencing a worsening of motor performance with a reduction in the therapeutic window. He has fallen 3 times in the last month. After an out-patient neurological evaluation, an indication is given for hospitalization in neurology to evaluate the effectiveness of the ongoing dopaminergic therapy. During hospitalization, the neurologist evaluates the status of Claudio according to the Unified Parkinson's Disease Rating Scale (UPDRS) [6]; in parallel, the neurophysiopathology technician implements the monitoring system for the qualitative and quantitative analysis of movement, gait, posture and vital physiological signals. The risk of falling is also evaluated both in terms of clinical scales (by the neurologist) and through an automated system for movement analysis. Subsequently, drug therapy is optimized and UPDRS items are re-evaluated both clinically and with the movement analysis system. By comparing the motor performances during the pharmacological OFF and ON phase, integrated with the measurements of the monitoring system, the clinician can define the current therapy as appropriate or any variations on the type and dosage of the drug in use. The conditions leading to an increased risk of falling are analyzed and managed.

D. User Story for Out-patient: Roberta (Pilot P1-TOR)

Roberta is a patient with Parkinson's disease diagnosed 3 years ago and, at present, the disease is mildly disabling (with a Hoehn & Yahr [7] score of 2). She has bilateral involvement of the limbs and alteration of postural reflexes, but she is still physically independent. After completing a rehabilitation hospitalization of approximately 3 weeks at a regional facility, she would benefit from continuity of rehabilitation treatment at home, a practice that is not feasible due to the presence of architectural barriers and the absence of constant supervision by a caregiver. The patient therefore benefits by being taken care of by the Parkinson Association in the area of residence, where a series of activities are offered, including the performance of motor re-education activities. Monitoring system for the qualitative and quantitative analysis of movement, gait, posture and vital physiological signals will provide information for optimizing the activities and will also provide alert signal when needed. The presence of non-medical personnel able to constantly supervise patients in the facility while they carry out the activities, as well as the possibility of remote interaction with the reference medical personnel who collect and analyze monitored data, may allow for personalized rehabilitation activities to be carried out in relation to the needs of the individual.

E. User Story for Elderly Healthy Subject: Mario (Pilot P1-TOR)

Mario is a frail elderly person, 75 years old, who nevertheless has a good quality of life. He was evaluated by a physician who recommended and planned daily training sessions to practice without the need to go to equipped clinics or gyms, with the aim of increasing psychophysical well-being but also to prevent sarcopenia. He has started several training sessions with different exercises. The physician is interested in monitoring his motor performance to be aware of the correct execution and the profile of vital signs during each exercise. So a single app for an integrated assessment of motor performance and health, with non-invasive minimal set of wearables, could be the ideal solution.

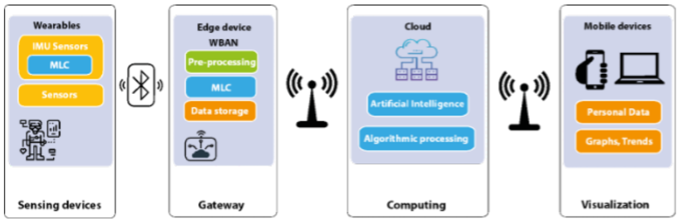

Fig. 3. Pilots P1-TOR and P1-BRNO sites.

IV. Users, Stakeholders, and Potential Customers Analysis

Target users and customers of Demo 1.3 can be characterized as follows.

- For the sport application perspective: athletes, coaches, and hobby athletes who want to monitor or even improve their training, performance, and physical condition.
- For the medical application perspective: doctors who want to monitor patients' important parameters and health trends and detect certain diseases, such as Parkinson's or cardiac disorders, early.

The DistriMuSe project aims at identifying relevant stakeholders' requirements for future products, such as the following.

- Chip Manufacturers: companies interested in enhancing their chips by embedding additional sensing components (e.g., Micro Electro-Mechanical Systems (MEMS)-based sensors) and integrating microcontrollers that support the execution of tiny Artifical Intelligence (AI) models for classifying collected data.
- Wearable Device Producers: manufacturers who will benefit from the insights, remarks, and algorithms designed and developed within the DistriMuSe project, allowing them to improve their wearable devices.
- Research Companies and Academic Entities: organisations that can build upon the algorithms defined in the project, refining their accuracy and expanding their applicability to alternative scenarios and contexts. This includes studying different classes of patients with diseases other than those analysed in the project.

V. High Level Architecture

The high level architecture of Demo 1.3 is illustrated in Fig. 3. More in detail, the demonstrator will be based on several wearable devices connected to a single system using a Wireless Body Area Network (WBAN), which will be managed by an edge device. Partial distributed signal processing will be performed within this network, using on-chip ML/DL cores. Higher-level processing on the server/cloud will evaluate different parameters depending on the pilot, such as physical health, fitness, and calories burned for athletes, and motion and posture analysis for Parkinson's patients.

The wearable sensing devices will include sweat sensors (perspiration rate sensor and salinity sensor) by BUT. Sweat sensors are not usually integrated into wearable devices. A new trend is to integrate such sensors into wearables to obtain more health parameters for evaluation. BUT demonstrated a sweat perspiration rate sensor in bracelets developed in the “Next generation smart Perception sensors and distributed intelligence for proactive human monitoring in health, wellbeing, and automotive systems” (NextPerception) H2020 project [8]. This sensor will be integrated into a smartwatch, along with other sensors, to reduce the number of devices in the network. Other available sensors, such as ECG and IMUs on the chest and a glycaemic sensor on the arm, will be integrated into the wearable monitoring demonstrator. Compared to the NextPerception project, the number of sensors has been reduced, with newly developed smartwatches integrating more sensors in one device. This will be much comfortable than previous solutions, with the user who will be able to choose between two ECG+ACC devices: Bittium Faros 180 and Polar H10. In particular, these devices are selected thanks to their high signal quality even during activities verified by pilot measurements and literature, as well as it is proved by the practical long-term use of both devices in telemedicine. Bittium Faros 180 is more suitable for long-term measurements thanks to its comfort—two Ag/AgCl electrodes are used. The Polar H10, being a chest belt, is better suited for shorter measurements. Finally, although CGM sensors are invasive, they are comfortable as well and bring new perspective especially in sports measurements.

To cover both medical and sport scenarios, the proposed edge device will be designed by two DistriMuSe partners: IMA s.r.o (IMA) Prague, Czech Republic, and the University of Parma (UNIPR), Parma, Italy, in order to be as portable/wearable as possible, while at the same time being equipped with mature and widely adopted communication interfaces to retrieve and collect data from the wearables worn by patients and athletes. To this end, the prototypical edge device will be based on Commercial Off-The-Shelf (COTS) components and provided with a Unix-like operating system (for the convenience of software developers), enabling the execution of software scripts (e.g., developed in Python) featuring AI models and data classification, or using a Reduced Instruction Set Computer (RISC)-based microcontroller environment with an on-chip ML core. This will add a second data processing layer to the proposed architecture and optimise the computing performance/power consumption ratio. This processing will benefit from the ability to be performed not only on the data collected by a single wearable device (like the algorithms possibly embedded inside the worn devices themselves) but also on information gathered from multiple sensing nodes worn by the subjects. Moreover, given the increased computing capabilities of the edge device itself, it will be possible to adopt and define additional algorithms better suited to aggregated data. The edge device will be optimised for multiple Bluetooth Low Energy (BLE) [9] communications with various wearable devices and will upload processed data to the cloud via mobile connectivity.

Regarding AI-based processing, as mentioned before, BUT and UNIPR are working on an architecture allowing the joint provisioning of algorithms to be run directly on wearable devices and mechanisms possibly running on the edge. ML-based chips will be integrated into wearable devices to process the IMU signals and parametrise them. Regarding the first class of algorithms, these should be defined in the most constrained possible way, as they need to be energy-efficient while maintaining high accuracy. This requires the wearable devices to be pre-configured (at the microcontroller level) to support this type of tiny ML/DL algorithms. On the other hand, the second class of AI models, as detailed with reference to the edge device, would feature fewer constraints and would be compatible with data collected (and sent) by multiple sensing systems.

A. Energy efficiency

Some parameters need to be read with a higher sampling rate (e.g., ECG) while others once per minute. We will use such sampling of each parameter to avoid losing the required information necessary for a correct evaluation. This, together with the use of the lowest power sensors, will provide the lowest power consumption that can be achieved. In addition, we use new chips for processing that have very low power consumption compared to standard microcontrollers due to the HW support for processing, since they are chips for battery-powered devices. Further, we will elaborate on energy efficiency of the proposed architecture, since exploring strategies to optimize power consumption will be helpful and open to significantly reduce energy resources while supporting continuous monitoring and processing.

B. Data privacy and security

Finally, a fundamental aspect embracing all the previous aspects is related to the data privacy and security to be handled and granted to the users. This is required as handling sensitive health data necessitates robust safeguards to ensure user trust and compliance with privacy standards, and this is mandatory to be managed in every stage of the communication, i.e., between wearables and edge devices, as well as between these edge nodes and intelligent systems processing the information and returning decisions and suggestions (e.g., on the basis of the specific use story an end user would be involved in). To this end, secure communication channels could be foreseen between the devices collecting data during the activities of the users, as well as exploiting AI-oriented mechanisms training and sharing aggregated models instead of exchanging *raw* information among the interested parties.

VI. Conclusions

The ever growing diffusion of intelligent devices opens new challenges related to innovative services leveraging a collaborative environment between devices and humans. In this paper, we have presented the main objectives of the HE project DistriMuSe, that intends to improve the sensing of human presence, behaviour and health in a collaborative or common environment by means of multi-sensor systems. Our focus has been on the Sports Performance and Health Assessment demonstrative scenario, within which we have described the different goals, pilots, and user stories.

References

[1] L. Mostarda, S. Marinovic, and N. Dulay, "Distributed orchestration of pervasive services," in *2010 24th IEEE International Conference on Advanced Information Networking and Applications*, pp. 166–173, IEEE, 2010.

[2] European Commission, "Distributed Multi-Sensor for Human Safety and Health (DistriMuSe)." https://cordis.europa.eu/project/id/101139769. Accessed on November 1, 2024.

[3] V. Vielzeuf, A. Lechervy, S. Pateux, and F. Jurie, "Multilevel sensor fusion with deep learning," *IEEE sensors letters*, vol. 3, no. 1, pp. 1–4, 2018.

[4] Brno University of Technology, "Brno University of Technology." https://www.vut.cz/en/. Accessed on November 1, 2024.

[5] Istituto di Ricovero e Cura a Carattere Scientifico, "Istituto Auxologico Italiano." https://www.auxologico.com/. Accessed on November 1, 2024.

[6] M. D. S. T. F. on Rating Scales for Parkinson's Disease, "The unified parkinson's disease rating scale (updrs): status and recommendations," *Movement Disorders*, vol. 18, no. 7, pp. 738–750, 2003.

[7] J. Rabey and A. Korczyn, "The hoehn and yahr rating scale for parkinson's disease," in *Instrumental methods and scoring in extrapyramidal disorders*, pp. 7–17, Springer, 1995.

[8] European Commission, "Next generation smart perception sensors and distributed intelligence for proactive human monitoring in health, wellbeing, and automotive systems (NextPerception)." https://cordis.europa.eu/project/id/876487. Accessed on November 1, 2024.

[9] R. Heydon and N. Hunn, "Bluetooth low energy," *CSR Presentation, Bluetooth SIG https://www. bluetooth. org/DocMan/handlers/DownloadDoc. ashx*, 2012.