NEWSLETTER #03

MAY 2024

> “The right to privacy was first established as a core human right in the 1948 Universal Declaration of Human Rights”

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Unlocking Opportunities and Addressing Challenges in XR-based Health and Work Solutions

Rehabilitation is a crucial aspect of healthcare, but its accessibility and affordability remain significant challenges. With limited access to quality care and soaring costs, many individuals are left without adequate support. In the meantime, from the industry 5.0 perspective, complex shopfloors are facing new issues related to worker safety and the request of increased efficiency. However, a beacon of hope emerges with the integration of Extended Reality (XR) technology into those practices.

Addressing the Challenges

The current landscape of rehabilitation is marred by high costs and restricted access, particularly for orthopaedic impairments and neurological disorders. The traditional model often entails lengthy sessions and significant healthcare burdens. Moreover, remote options are scarce, exacerbating the accessibility issue.

Enter XR: A Game-Changer in Rehabilitation

By leveraging XR in rehabilitation, SUN project unlocks a

realm of possibilities:

● Cost Reduction: Implementing XR in rehabilitation scenarios holds the promise of slashing costs. By reducing the need for extensive in-person sessions, XR can streamline the rehabilitation process, making it more financially viable.

● Enhanced Accessibility: XR opens doors to improved access and care for a broader population. Through innovative health education content delivered via XR platforms, patients can better understand their conditions and engage in self-care, regardless of geographical constraints.

● Stakeholder Collaboration: Engaging stakeholders through comprehensive mapping and advisory board collaboration fosters a supportive ecosystem. Professionals from diverse backgrounds contribute expertise, ensuring the efficacy and relevance of XR-enabled rehabilitation solutions.

Real-World Applications

Several initiatives within the SUN project highlight the tangible benefits of XR in healthcare:

● SUN XR Platform: Utilizing the SUN XR platform, patients with orthopaedic impairments undergo XR-assisted rehabilitation, leading to accelerated recovery and reduced healthcare burdens.

● Multimodal Fusion: Integrating hand gesture recognition, activity recognition, and emotion recognition modules enhances the rehabilitation experience, providing personalized feedback and support.

● Remote Monitoring: Sensor-based monitoring and machine learning algorithms enable remote rehabilitation exercises, empowering patients to take charge of their recovery journey.

Overcoming Challenges

While the potential of XR in rehabilitation is immense, challenges persist. Adoption barriers, initial implementation costs, and technological complexities require strategic navigation. However, concerted efforts to address these hurdles pave the way for widespread acceptance and utilization of XR solutions in healthcare.

A Future of Inclusive Healthcare

As XR continues to evolve, its integration into rehabilitation practices holds the promise of a more inclusive and cost-effective healthcare landscape.

By harnessing technology to empower patients and optimize care delivery, we embark on a journey towards a healthier, more accessible future for all.

In the realm of healthcare, the integration of Extended Reality (XR) technologies offers a promising avenue for innovation, enabling novel approaches to education, training, and rehabilitation. As initiatives like the SUN project demonstrate, leveraging XR platforms can revolutionize traditional practices, making them more cost-effective, accessible, and ultimately, more impactful.

One of the key opportunities highlighted within the SUN project is the potential for collaboration with stakeholders. By engaging with a diverse array of partners, including advisory boards and healthcare professionals, initiatives like SUN can tap into a wealth of expertise. This collaboration fosters continuous improvement and ensures that XR solutions are strategically guided, maximizing their effectiveness and long-term sustainability.

Moreover, the SUN project emphasizes the importance of measurability, particularly in terms of health outcomes and accessibility. Through pre and post-assessment tests, as well as the tracking of usage statistics on XR platforms, the project aims to quantify the impact of XR-based interventions. This data-driven approach not only provides valuable insights into the efficacy of these solutions but also facilitates ongoing refinement and optimization.

However, amidst these opportunities lie several notable challenges and threats. Rapid technological obsolescence poses a significant risk, potentially undermining the longevity of XR solutions. Moreover, resistance from traditional healthcare practices underscores the importance of addressing scepticism and promoting the adoption of innovative approaches.

Revolutionizing Shopfloor Safety with XR Technology

In the heart of innovative Industries lies a vision: to transform the shopfloor experience, ensuring both efficiency and safety are paramount. Entering SUN project cases in industry 5.0 perspective, poised to revolutionize shopfloor operations through the strategic integration of Extended Reality (XR) technology.

Picture this: a bustling shopfloor where workers meticulously carry out their tasks amidst

the hum of machinery. Yet, amidst the productivity, lies a challenge – the manual supervision of Personal Protective Equipment (PPE) adherence and the detection of anomalous situations remain a labour-intensive task.

The as is analysis recognizes this bottleneck and sees XR technology as the catalyst for change. Through collaborative efforts within the SUN consortium the aim is to develop and implement XR solutions tailored to address these critical issues.

In the area of industry 5.0 focuses on enhancing PPE compliance monitoring. Currently, supervision falls primarily on the shoulders of HR and manufacturing managers, diverting their attention from core responsibilities. With XR technology, Factor aims to automate this process, leveraging immersive simulations and real-time alerts to ensure every worker is equipped with the necessary safety gear.

Meanwhile, the pilot targets the detection of anomalous situations within the shopfloor environment. From spills to container stock levels, manual supervision is prone to oversight and delays in response. By harnessing XR technology, SUN seeks to empower shopfloor operators with augmented insights, enabling proactive identification and swift resolution of potential hazards.

The significance of this innovation extends beyond pilot's walls. It aligns with industry-wide aspirations for safer and more efficient shopfloor operations. By achieving a high Technology Readiness Level (TRL), Factor aims to deliver a solution that not only meets industry standards but sets a new benchmark for XR integration in manufacturing environments.

While many entities worldwide are exploring similar solutions, SUN project commitment to research and development positions it at the forefront of this transformative journey.

In conclusion, SUN industry 5.0 initiatives represent more than just technological advancements. They embody a commitment to excellence, safety, and innovation within the manufacturing industry. With XR technology as their ally, SUN project paves the way for a future where shopfloor operations are not just efficient but inherently safer, setting a new standard for industrial excellence.

Additionally, the SUN project acknowledges the role of external actors, such as advi-

sory boards and stakeholders, in shaping the success of XR initiatives. By actively involving these stakeholders and leveraging their expertise, initiatives like SUN can ensure that their solutions have a meaningful and sustainable impact.

Despite these challenges, the SUN project remains committed to pushing the boundaries of XR innovation in healthcare. By focusing on collaboration, measurability, and stakeholder engagement, initiatives like SUN are paving the way for a future where XR technologies play a central role in transforming healthcare delivery and improving patient outcomes. Through strategic partnerships and a relentless pursuit of excellence, the SUN project stands poised to drive meaningful change in the field of healthcare rehabilitation and industry 5.0 improved safety.

The Role of Stakeholders in Driving Innovation: The SUN Project

The success of any innovative project hinges on effective stakeholder engagement and collaboration. In the context of the SUN (Stimulating Update of the Next Generation of Researchers) project, which aims to pioneer advancements in Extended Reality (XR) technology, stakeholders play a pivotal role in shaping the trajectory of innovation. By leveraging the International Association for Public Participation (IAP2) spectrum as a framework for stakeholder engagement, the SUN project navigates the complexities of involving diverse stakeholders while fostering co-creation on complex problems.

Before delving into the activities outlined in the IAP2 spectrum, the SUN project initiates stakeholder mapping to identify key players and establish initial engagement strategies. This early stage lays the groundwork for subsequent interactions and collaboration.

The stakeholder mapping survey conducted across the project's early stages reveals a diverse array of stakeholders spanning academia, industry, healthcare, patient advocacy groups, and public administrations. Each stakeholder group brings unique perspectives, expertise, and interests to the table, enriching the collaborative ecosystem of the SUN project.

One notable stakeholder group is the professional external to the pilot organizations, including domain experts and industry representatives. These stakeholders contribute

invaluable insights into technological feasibility, market potential, and real-world applications of XR solutions. Through interviews, demos, and workshops, their expertise fuels innovation and ensures alignment with industry needs.

Patient associations emerge as another critical stakeholder group, advocating for the rights and interests of end-users in healthcare settings. Their involvement in workshops, surveys, and demos provides essential feedback on usability, accessibility, and ethical considerations of XR technologies in rehabilitation and healthcare.

Public administrations' representatives and healthcare system managers are pivotal stakeholders too, offering perspectives on policy implications, regulatory frameworks, and cost-effectiveness considerations. Engaging them through interviews and dissemination efforts ensures alignment with broader healthcare objectives and facilitates future scalability and adoption of XR solutions.

Additionally, stakeholders such as unions, opinion leaders, and researchers play vital roles in advocating for inclusive innovation, ethical practices, and knowledge dissemination. Their participation in surveys, workshops, and multimedia materials amplifies the project's impact and fosters a culture of transparency and accountability.

The SUN project recognizes the dynamic nature of stakeholder engagement, emphasizing the need for continuous dialogue, adaptation, and co-creation. By embracing the principles of the IAP2 spectrum, the project navigates the intricate landscape of stakeholder engagement, harnessing collective intelligence to drive innovation forward.

In conclusion, the SUN project exemplifies the transformative power of stakeholder collaboration in driving XR innovation. Through strategic engagement strategies and a commitment to inclusivity, the project cultivates a vibrant ecosystem where diverse stakeholders unite towards a common goal: advancing the frontiers of XR technology for the betterment of society.

Legal and Ethical XR in the SUN Project: Protecting Fundamental Rights of Human Beings during Innovation

The Right to Privacy and Respect for Private Life

The right to privacy was first established as a core human right in the 1948 Universal Declaration of Human Rights (UDHR) and later recognized in Europe through the European Convention on Human Rights (ECHR). The European Court of Human Rights (ECtHR) and the Court of Justice of the European Union (CJEU) have interpreted 'private life' broadly.

Privacy is influenced by various social, ethical, and cultural perspectives and circumstances. Daniel Solove, an expert on privacy, categorizes privacy into six key areas:

- The Right to Be Let Alone: Freedom to live one's life without unjustified intrusion.

- Limited Access to the Self: Ability to shield oneself from unwanted public observation.

- Secrecy: Protection against public disclosure of private information.

- Control Over Personal Information: Right to determine how personal information is shared.

- Personhood: Protection of individual personality and selfhood attributes.

- Intimacy: Development of personal relationships and varying degrees of self-revelation.

In the SUN project, balancing the fundamental rights of individuals is crucial. On one side is the right to privacy for individuals using XR devices in our pilots. This involves collecting

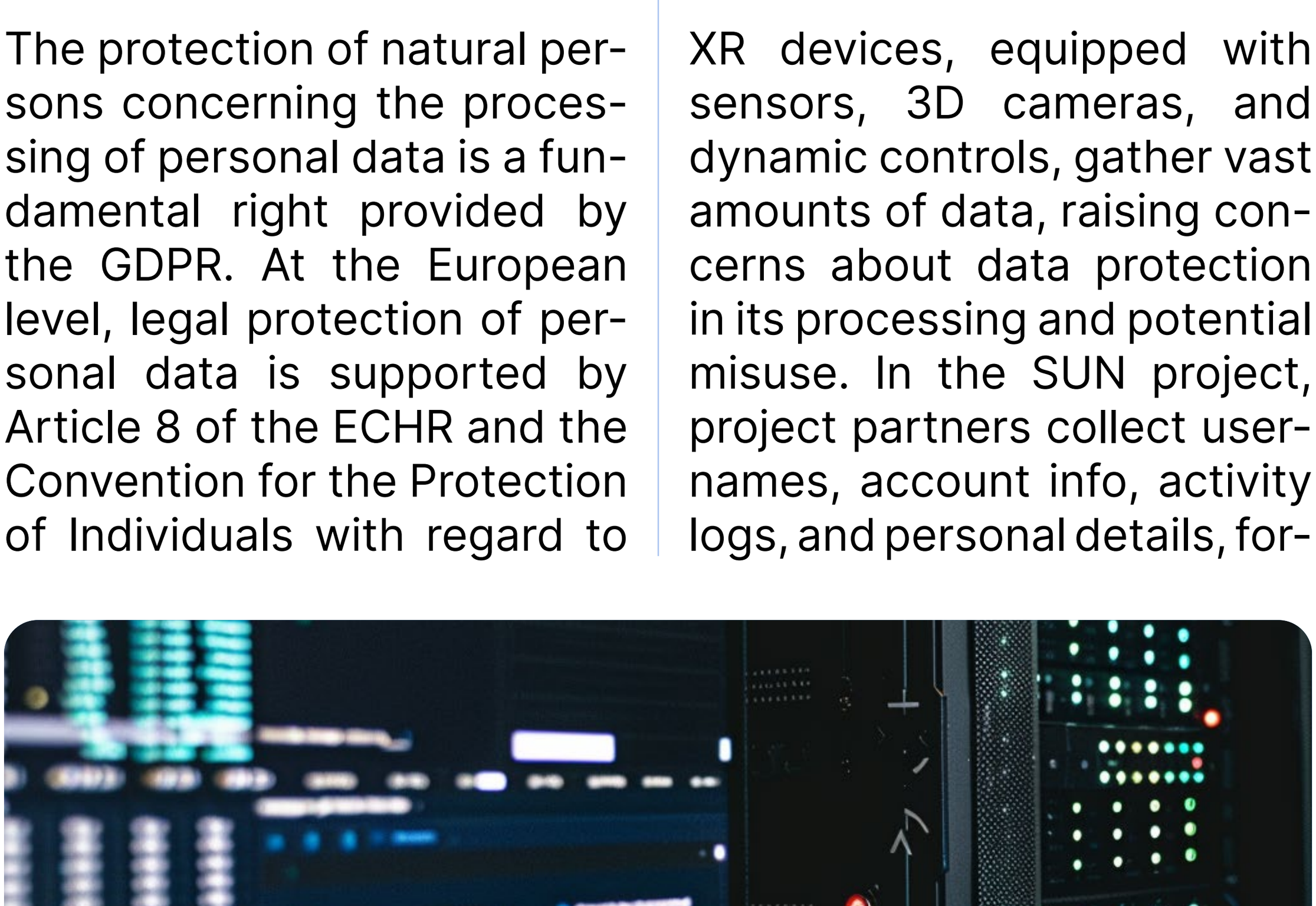
data to create digital twins, facilitate human-machine interaction, and conduct real-time monitoring. On the other side is the need for data collection to protect health and safety. Thus, the SUN project must navigate legal, legitimate, and democratic limitations on the right to privacy to ensure both user protection and the advancement of XR technologies.

The Right to the Protection of Personal Data under the General Data Protection Regulation (GDPR)

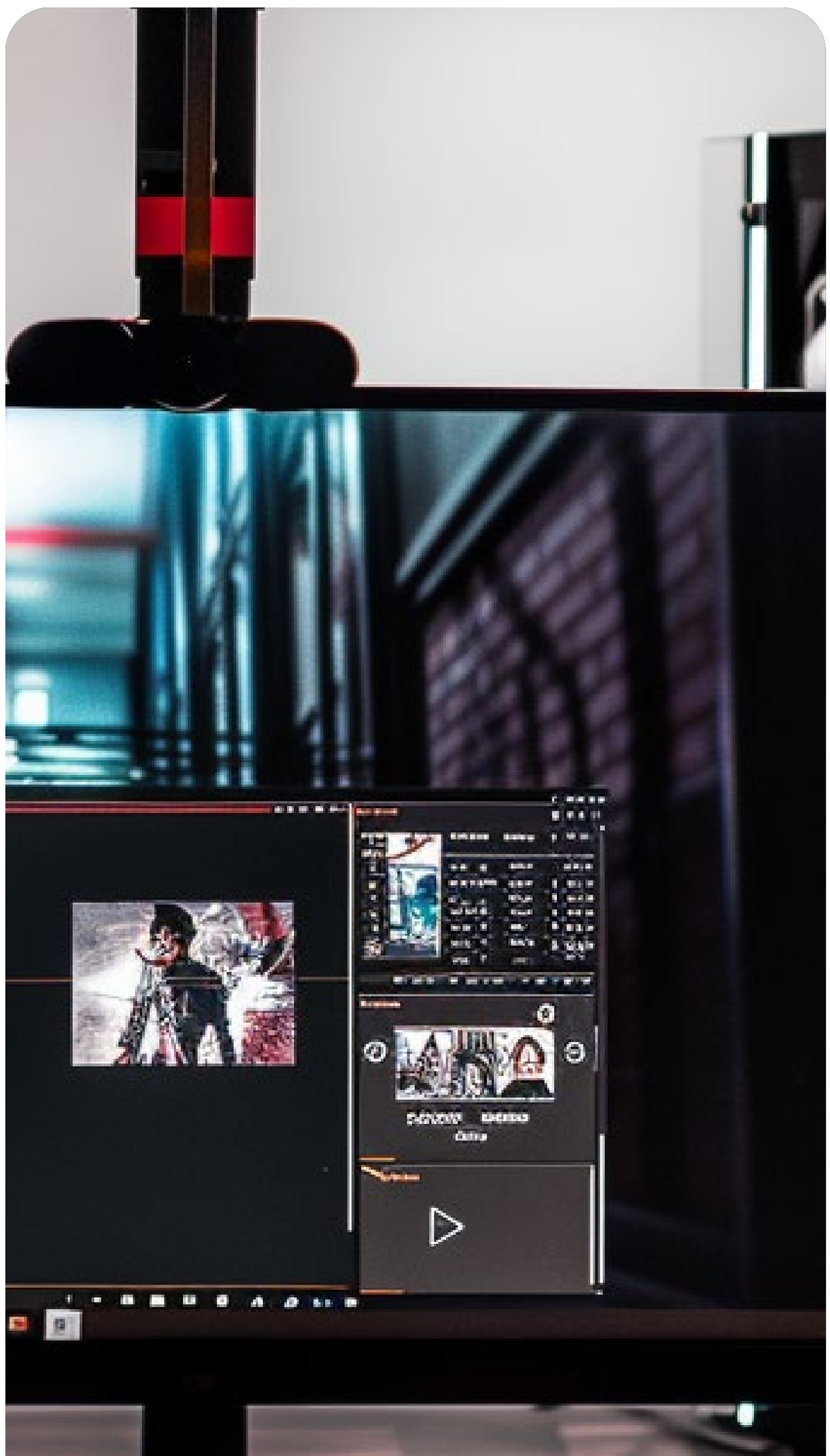
The protection of natural persons concerning the processing of personal data is a fundamental right provided by the GDPR. At the European level, legal protection of personal data is supported by Article 8 of the ECHR and the Convention for the Protection of Individuals with regard to Automatic Processing of Personal Data No 108.

The rights to personal data protection and privacy are crucial for democracy, stemming from similar values and safeguarding fundamental freedoms. While privacy focuses on personal control and autonomy, data protection ensures fair processing of identifiable information. Although privacy is a universal human right and data protection is more about individual rights, global data protection laws are increasingly important.

XR devices, equipped with sensors, 3D cameras, and dynamic controls, gather vast amounts of data, raising concerns about data protection in its processing and potential misuse. In the SUN project, project partners collect usernames, account info, activity logs, and personal details, for-



ming user profiles from video recordings. This data poses risks of unintended use, with the mere act of turning on an XR device potentially seen as consent for further processing. Technical capabilities and widespread usage bring unique privacy risks, including virtual reality, big data analytics, and biometric integration. Additional concerns include haptic responses, real-time data gathering, and bystander risks. Monitoring users and intruding on their private lives is worrisome, especially with data on emotional states used for health assessments. Privacy is further compromised when public sectors and organizations use this data beyond its original intent.



Societal and Ethical Issues

Several factors related to the SUN project can give rise to ethical and societal concerns. One significant issue is the power imbalance between data controllers and users of XR technologies. It's crucial to ensure that the fundamental rights of all individuals, especially vulnerable groups, are respected and protected throughout the research process. Safeguards should be in place to prevent potential exploitation or harm that may arise from the collection and use of personal data.

Another vital consideration is the development and application of new technologies. Promoting transparency, accountability, and responsible innovation is essential to build trust and acceptance within society. Engaging with stakeholders, including users, experts, and communities, can help ensure that the technologies developed in the SUN project align with societal values and needs.

The SUN project has established an internal platform wiki for sharing essential documents related to ethical compliance. Compliance with ethical and societal rules will be an ongoing, dynamic process conducted throughout the SUN project.

To ensure the legal and ethical development of SUN-related technologies, the project consortium is committed to striking a balance between innovative activities and protecting the fundamental rights of the individuals involved. In addition to benchmark research on legal and ethical issues, SUN's legal partner conducted a Social, Ethical, Legal, and Privacy (SELP) Impact Assessment to apply and validate the legal and ethical framework built within the project. The project identified the following potential issues related to pilots and provided specific mitigation measures.

The processing of sensitive data

Sensitive data are personal data that are particularly sensitive by nature, as the context of their processing could create significant risks to fundamental rights and freedoms. Broadly speaking, sensitive data usually refers to personal data containing sensitive information, such as biometric information, health conditions, and ethnic origin. It can also encompass confidential information about an individual, such as political opinions and sexual orientation.

To ensure the safe processing of personal data, especially sensitive data in the SUN project, the project consortium applied "data protection by design" and "data protection by default" throughout the project lifecycle, including:

- The project strictly adhered to data protection principles and observed them in most instances of processing.

- Appropriate technical and organizational measures were implemented by the project, such as pseudonymization and anonymization, to effectively implement data protection principles like data minimization.

- Implementation of a security policy for different types of sensitive data based on the degree of risk each data type posed in the event of a breach.

- Encryption as a protective measure to prevent unauthorized third parties from easily accessing or modifying personal data.

● SUN partners conducted Data Protection Impact Assessments (DPIAs) when their data processing activities could potentially pose high risks to fundamental rights and freedoms. New potential issues are dynamically monitored for data protection compliance.

The processing of vulnerable groups' personal data

Certain population groups are more vulnerable to risks due to characteristics such as age, gender, health conditions, disability, socio-economic status, or cultural background. The SUN project involves vulnerable groups in each pilot, including patients, employees, and people with disabilities. Recognizing the importance of protecting marginalized and vulnerable groups during the processing of their personal data, the SUN project is committed to benefiting individuals involved in each pilot while ensuring sufficient protection of their fundamental rights.

Privacy Impact

As mentioned earlier, the right to privacy extends beyond the processing of personal data. In analyzing potential privacy issues of the SUN project, the consortium considered various elements, including users of XR technologies and application scenarios. Given that the XR technologies will be applied in hospitals, factories, and clinics, SUN partners conducted Privacy Impact Assessments (PIAs) to explore potential privacy issues for patients, employees, disabled individuals, and their family members. They also devised ample mitigation measures to ensure a privacy-friendly environment during technological innovation and pilot implementation.

Wearable devices and real-time monitoring

In the SUN pilots, wearable devices will be utilized to monitor users' health conditions (e.g., in the XR for rehabilitation pilot), daily routines (e.g., in the XR for work pilot), well-being, and work performance. These devices aim to assist users in leading healthier and safer lifestyles by providing insights into how their bodies respond, move, and rest, enabling them to adopt systematic and personalized guidance. During the use of XR devices, users generate substantial amounts of data, gradually becoming repositories of information. These data may contain sensitive details that reflect users' private lives, as well as the lives of others. The collection and usage of such data necessitate careful

consideration of privacy safeguards and ethical practices to ensure the protection of individuals' privacy and the responsible handling of data. While the collection and processing of data by wearable XR devices may be legal, concerns do exist regarding the potential monitoring of users and interference with their private lives. As users move in both private and public spaces, privacy issues become more severe when SUN partners share real-time data with each other through the internal platform online. Aware of these issues, SUN partners implemented a series of privacy-enhancing technologies and practices to minimize the privacy risks associated with real-time monitoring and ensure the protection of both end users and other individuals,

Societal and Ethical Impact

The development and application of XR-related technologies also lead to several societal and ethical issues concerning the data processed and the vulnerabilities of participants. The SUN consortium addressed these issues and followed the "ethics by design" during research activities, including:

- Medical Ethics. SUN partners respect the human agency of involved individuals. Participants can make their own decisions and can carry out their own actions under clear guidance. Project partners realized that human beings are the goal/purpose instead of merely being treated as the tool for technological innovation.

- SUN partners ensure the SUN system contributes to and does not harm individual, social, and environmental well-being.

- The purpose, input, and operations of the SUN system are designed in a way that is knowable and understandable to all stakeholders.

- SUN partners take responsibility for assisting participants to understand and use XR-related technologies for better motivation and acceptance of new technologies.

Sun architecture for XR integrated platform

Over the past decade, extended reality (XR) technologies, including Augmented Reality (AR), Virtual Reality (VR), and Mixed Reality (MR), have evolved from niche specialist tools to pivotal industry mainstays. They now play integral roles in many crucial sectors such as healthcare and industry among others. The momentum now leans towards interactive, multi-participant XR environments.

SUN is going to provide an XR platform, offering a series of innovative XR tools, integrated all together in a modular a customizable solution, considering security and privacy by design, as well as business models that reflect the European values of openness, fair remuneration, security and privacy awareness with two main area of application:

- Supporting the recovery of human ability: SUN will improve the effectiveness of rehabilitation after accidents, strokes, or diseases.

- Improving workers conditions and effectiveness: SUN will apply innovative approach for Industry 4.0 improving both safety and social interaction among workers.

In order to implement the SUN XR Platform an important milestone was the design of the SUN Reference Architecture and the definition a preliminary set of Technical Specifications.

The purpose of **the SUN Reference Architecture** is to provide guidance for design and technical developments, incorporating the vision of the solution, as well the requirements and the technical specifications. It can be intended as the shared baseline for implementing all the possible systems that will be part of the SUN XR Platform.

SUN Architecture design paid particular attention to four key aspects:

- **Interoperability and Standardization**
- **Scalability for Large Multi-User Environments**
- **Real-Time Data Integration and Collaboration**
- **Security and Privacy**

The design of the SUN Reference Architecture, **led by Engineering Group**, conducted to a high-level architecture able to provide guidance for technical developments, incorporating the vision of the

solution, as well the requirements and the technical specifications.

The SUN Reference Architecture, shown in Figure 1, together with the technical specifications, will be the base for the implementation of the modular SUN XR Platform, able to be released and configured for satisfying specific pilots and use case needs.

In fact, the SUN Reference Architecture can be easily mapped with different configurations, taking into account a series of common technical specifications as well as specific pilot and use case requirements.

The **involvement of the pilot partners in a collaborative way** during the design phase, allowed to consider their feedback in an early stage and prepare the environment to be ready for the validation in an incremental way and with different configurations.

Starting from this important outcome, SUN consortium will now focus on the implementation of the SUN XR Platform, to be **validated within three different scenarios and six different use cases.**

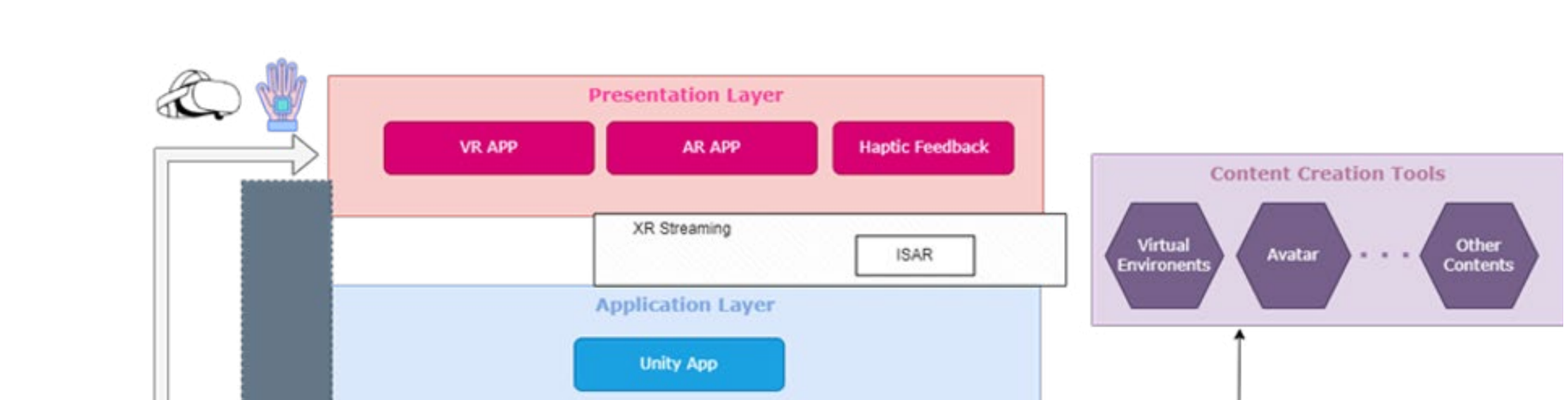


Figure 1: SUN Reference Architecture

User Requirements Development in the SUN Project

A co-creative methodology was used in order to engage the diverse stakeholders and define in more detail the three usage scenarios of SUN, physical rehabilitation, industry 5.0, cerebral rehabilitation, and elicit for each of these a list of user requirements. These are now used to guide the research and development of new technological components and the actual implementation of the SUN pilots.

It was paramount for the project to put users and stakeholders at the centre of the process. During an initial "inspiration phase" a wide potential user consultation was carried out using surveys, interviews, physical meetings and observations. In this way, the key user groups and stakeholders for the project were identified alongside the main problems, challenges and expectations that XR technologies could bring to them.

To facilitate the scenario definition process each pilot created a storyboard in a storytelling approach to give a clear perspective of a human-centric application of SUN in the specific framework. The first step was then represented by the definition of pilot objectives followed by a brief description of the situation before the use of SUN XR outcomes. The next step was to define the vision for each scenario using a step-by-step storyboard approach, and then to associate the experiences requested with related technologies to be adopted. Next, each scenario considered the overview of the context, situation and results as experienced now and as envisioned after SUN. The actors and stakeholders for each scenario were identified alongside the involved SUN technologies.

User personas were then identified for each scenario through interactive workshops consisting of the different stakeholder types represented in the project consortium. The user personas created present in a human-centric way the profile, needs, goals, pain points, technology proficiency and behaviour of the most important stakeholders from each scenario.

Based on all the previously gathered information from users and key stakeholders of each pilot, an initial list of user requirements was extracted. The requirements found were of different types (e.g. legal, experiential, functional, technological) and had to be further analysed and revised in consortium-wide workshops, making sure they were understood the same and without ambiguity by

all partners.

Finally, through interactive workshops involving all stakeholders from the project, the requirements were prioritised using the MoSCoW methodology[1], a common agile technique for helping to understand and manage priorities. The methodology aims to group requirements in one of the following 4 classes: “Must have” which are essential ,“Should have” which are important but not vital, “Could have” which are optional nice to have, and “Won’t have” which for various reasons should not be part of the list at this time. Following this approach, a voting decided the priority group in which the requirement should be placed. If there was not a clear winner, a discussion was conducted in order to better understand the implications of the requirement and the different points of view. Based on this discussion a prioritisation decision was taken either directly or after a re-voting. When selecting a priority group the view of the importance of the user requirement was with respect to the pilot as realised in the SUN project and not as a requirement for a final product to be released after the project.

Overall 69 user requirements were identified at this phase. The list will be maintained and possibly updated as the pilot planning will advance during the next months. The project will release these findings publicly in the form of a deliverable in July.

George

Office Manager

37 years old

In a relationship. 1 baby

About

George suffers from knee OA (osteoarthritis). After having 10 F2F sessions at hospital has been asked by his physiotherapist to continue to perform rehabilitation exercises in his home* for 3 months and be evaluated afterwards.

Needs

- He would like to be aware whether he performs the exercises correctly
- Keep motivation for a long-term rehabilitation process
- Receive feedback from the physiotherapist weekly
- Receive loads of feedback directly from the avatar

Pain Points

- He is not sure he remembers correctly the rehabilitation exercises
- Surveillance system (inform about data protection)
- He has difficulty to find time to perform the exercises once the first improvements are felt
- Limited space at home to perform the exercises
- Not so much privacy to perfom the exercises (when realizing the exercises at home)

Goals

- Posture awareness / exercise precision
- Increase capacity / pain reduction
- Increase time session duration
- Exercises connected to sports he likes to do or to his daily rutine

Technology proficiency and behaviour

- He feels insecure with the unsupervised approach
- Patient is able to asses the results of each exercise / self-asses (i.e. how far it is from the idea of movement)
- One therapist must be able to follow the progress of several patients

1: https://en.wikipedia.org/wiki/MoSCoW_method or Clegg, D., & Barker, R. (1994). Case Method Fast-Track: A RAD Approach. Addison-Wesley Longman Publishing Co., Inc.

The project started on the 1st of december 2022
and will end on the 30th of november 2025

Funded by
the European Union

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MAY 2024