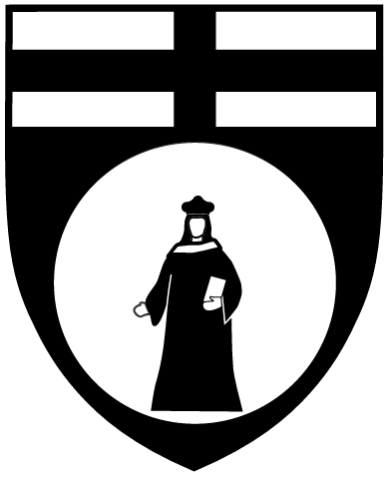

Dibris Dipartimento di Informatica, Bioingegneria,
Robotica e Ingegneria dei Sistemi

Virtual Reality for Robotics - a.y. 2023-2024

Assignment 1

About the Metaverse

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Contents

1 Give a definition of the Metaverse.

The origin of the term Metaverse was coined by author Neil Stevenson in his 1992 novel "Snow Crash" where the protagonists used the Metaverse to escape authoritarianism[12]. In 2021, Facebook changed its name to Meta to highlight to the world its role as a leading force in the development of the Metaverse[8]. But now, let us list some definitions of the Metaverse:

> The term Metaverse refers to a collection of completely immersive digital environments in which users may speak with each other via 3D avatars. This mode of interaction has the potential of becoming an extremely prevalent means by which persons/friends engage among each other[5].

> The Metaverse is a type of virtual environment that can imitate the natural world through the use of interactions with many senses and 3D objects[1].

> The Metaverse may be thought of as an expansion of the Internet which enables users to engage in conversation with one another and the world around them. This is accomplished via the use of many different kinds of technology, such as virtual reality as well as augmented reality[2].

I believe that these definitions of Metaverse are great because, for example, the first one explains the main feature of the Metaverse that anyone can do: meet each other in the Metaverse.
This feature will be an incredible innovation since today there are lots of problems about climate change (where among the causes we find the high production of CO_2 through the use of airplanes) so if an employee must go in presence in another country to meet someone, for example for business reasons, it is enough for him and the person in question to see each other in the Metaverse to be able to talk comfortably from home.
In this case, two people can interact in a virtual environment that imitates the real world through the use of interactions with many senses and 3D objects, but also various technologies (like Meta Quest 3 of Meta).

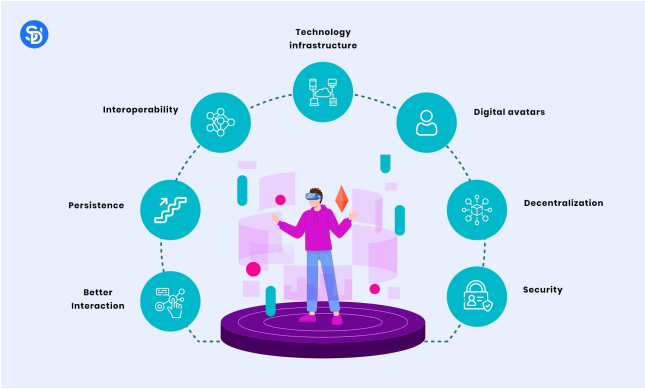

Figure 1: Metaverse features[3]

2 What are the pillars (hw, sw, market, economy, media, industry, education, etc.) that you consider absolutely necessary for the development of the Metaverse(s)?

We know that the Metaverse is an Internet-based 3D universe featuring virtual land and things, so we can imagine a future where we may work remotely (is already possible but in another way), tour virtually museums, and attend virtual concerts from home.
The technological advances that enable the metaverse are as follows[4]:

- Blockchain;
- Augmented Reality;
- Virtual Reality;
- Artificial Intelligence;
- Internet of Things (IoT).

Blockchain technology facilitates the decentralized validation of ownership, the creation of digital collectibles (NFTs), the transfer of value, transparency, and interconnectivity indeed cryptocurrencies enable individuals to transfer assets in a three-dimensional environment while engaging in work and social interactions[4].
Augmented Reality and Virtual Reality offer an engaging three-dimensional encounter. AR blends the real surroundings with digital graphics and entities, creating a fusion of the physical and virtual worlds; is widely accessible and compatible with most smartphones and digital cameras, making it a more readily available technology compared to VR; while VR introduces physical simulations into the realm of the Metaverse, enhancing the virtual experience with tangible interactions.
Artificial Intelligence has found applications in corporate strategy formulation, decision-making, facial recognition, and accelerated computational processes. More recently, experts in the field of AI have delved into the creation of immersive Metaverses, indeed the AI is close to being able to generate avatars of the Metaverse; furthermore, advanced AI algorithms can analyze two-dimensional and three-dimensional images, resulting in the generation of remarkably realistic avatars[4].
Internet of Things establishes a connection between our physical world and the online realm through the use of sensors and devices. Once connected to the Internet, these devices are assigned a unique identifier and have the capability to autonomously transmit or receive data. The special feature is that data streams from IoT devices could potentially alter the behavior of objects in the Metaverse based on factors such as weather conditions and other variables[9].

I believe that today if a common user want to access to the Metaverse, he need to have a visor, headsets and a joystick (to give an idea: Meta Quest 3) as Hardware components, while as Software components a fast images processing program for the quick streaming of high-definition images, good internet protocol for a quick communication of great amount of data and a good software for the creation of human-like game's agents.

3 In your opinion, which relationships exist between Robotics, Generative-AI and Metaverse?

In my opinion, the relationship between Generative AI and Metaverse is that as generative AI research advances, it is anticipated to emerge as a fundamental AI technology within the Metaverse, facilitating its seamless integration into various domains. The future pathways for applying generative AI in the Metaverse will primarily revolve around three central aspects[7]:

- Bolstering technical research to enhance generative AI's adaptability and elevate the quality of the produced content;
- Investigating the utility of generated materials in different sectors, particularly in Metaverse content creation;
- Fostering the synergistic amalgamation of generative AI with other technologies to amplify its overall application impact.

About Robotics and Metaverse i think to the possibility to virtualize something like an environment to simulate driving for example a drone o an airplane before to access to them in the real world, so that we can learn in safety how to use and avoid to destroy them (they could cost a lot of money);

Between Robotics and Generative-AI i believe that in the future we will see the so-called Sentient-AI probably placed inside a Robotic body that could represent the next era of AI (since nowadays AI is still in a primordial stage), about that there exist an interesting Japanese novel called " Sword Art Online " where the concept of AI applied to Robotics is treated, also ethically, and how the author represents ordinary people who find themselves dealing with something they have never seen and that they are afraid of (so something vaguely similar to what we are facing nowadays)[13].

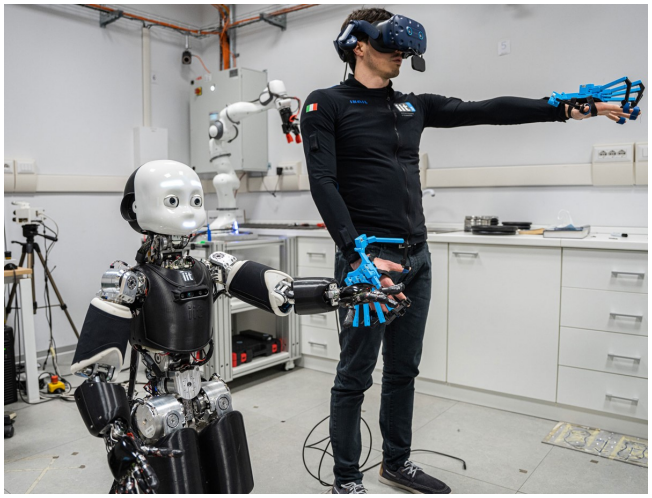

Figure 2: Humanoid robot to tap into the Metaverse[6]

4 What do you think are the pros and cons of the Generative-AI applied in the Metaverse(s) today? And in 5 years?

I believe that the Generative-AI applied in the Metaverse has several pros like[7]:

- create content within the Metaverse, so we are talking about generating 3D models, environments and textures that are increasingly detailed and similar to reality;
- develop of procedural content (in a game for example, the creation of potentially infinite environments);
- manage NPCs (Non-playable Characters) through generative AI that can interact with users by simulating more realistic behavior, changing and adapting to circumstances so as to improve the user's immersive experience (in this case I can quote a game called " The Elder Scrolls V: Skyrim " that has a Mod which improves the behavior of several NPCs[11]);
- Data Collection and Analysis because it would be possible to simplify the work of developers to find several problems (mainly bugs or different functionality and mapping errors) thus making more precise changes.

As cons there are:

- Inaccuracy of created content, because today the Generative-AI is quite elementary (i think that in next years we will see something of incredible about the development of it);
- Resource Intensiveness, because training and running large-scale generative models can be computationally intensive, requiring substantial computing resources and energy[10];

In 5 years i believe that the Metaverse will additionally manifest an exponential surge in information intricacy as a consequence of the escalating dimensionality of data, surpassing the computational boundaries of the human brain.
The Metaverse plays a pivotal role in bolstering the high-quality evolution of the intelligent economy, achieved through the integration of foundational technologies such as artificial intelligence, AR/VR, the Internet of Things and Blockchain.
These technologies are on the verge of becoming the prime catalysts for future advancements in computational power, creating a significant need for computing resources and heralding a revolution in the methods of computational deployment.
AI, serving as a pivotal element of future technological advancement, as demonstrated by applications such as ChatGPT, when amalgamed with the Metaverse, carries the potential to establish a fresh social and economic realm in which socioeconomic activities can thrive within a self-contained ecosystem.
However, the progress and implementation of the Metaverse demand deep contemplation: critical matters to confront include finding an equilibrium between technological advancement and safeguarding privacy, guaranteeing the Metaverse's inclusivity and variety, and mitigating potential security threats and ethical quandaries that might surface[7].

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