

AUGMENTED REALITY & DIGITAL TWIN APPLICATIONS IN SPORTS AND BUSINESS

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Abstract. This paper proposes a novel approach to implementing digital twins (DTs) in Industry 4.0 facilities with reconfigurable systems. The challenge of maintaining DT accuracy in a dynamic workplace change is addressed by the introduction of augmented reality (AR) authoring tool. This employee-driven tool enables updates to be available directly on the factory floor, eliminating the need for specialized AR training. The design prioritizes a user-friendly interface with a short learning curve, and advanced DT has been developed to ensure adaptability to the ever-changing nature of reconfigurable workstations, with workspace including data and 3D models of enterprise contact centers. Employees use the AR network to connect DTs with their physical counterparts and update environments as resource demands evolve. The experimental verification confirms the effectiveness of the proposed method, especially when using gesture interactions and AR presentations. This research contributes to the development of Industry 4.0 by providing practical solutions for implementing DT in dynamic enterprises, ultimately increasing operational efficiency and flexibility

INTRODUCTION

Digital Twins and Augmented Reality: A Powerful Combination for Industry 4.0

A digital twin (DT) is a physical object or system that accurately reflects its real counterpart throughout its lifecycle. It is updated with real-time data and incorporates simulation, machine learning, and reasoning to support decision-making. Augmented Reality (AR) is another key technology in the ongoing technological revolution, enabling the physical world to be overlaid with digital information. Together, DT and AR offer a powerful tool for human-machine interaction and situational recognition. By integrating these concepts, users can seamlessly interact with both digital and physical objects, increasing their understanding of complex situations. There has been an increase in research in this area, focusing on potential synergies between ARs and DTs and exploring new potential combinations of strategies. This integration allows users to contextualize digital content and real-world objects, creating a deeper understanding of both the digital and physical aspects of a situation.

The Digital Twin (DT) is a pivotal technology riding the virtual transformation of industries by using digitalizing bodily property. In latest years, the call for for DT answers has surged, attracting attention throughout industries from aerospace to healthcare. The ability to create a digital illustration of physical property opens up new business possibilities and offers treasured insights. In assessment, Augmented Reality (AR) has been a idea for several many years but has recently garnered renewed interest due to affordable and capable generation. Modern hardware permits the implementation of AR packages that revolutionize human-gadget interaction and data visualization in various scenarios. This convergence of DT and AR technologies holds massive capacity for industries looking for innovative answers to beautify operations and consumer experiences.

Augmented Reality

Augmented reality (AR) is a technology that enhances real-world objects with additional digital content, giving users an augmented sense of reality. AR provides a more immersive and contextual experience by encapsulating digital content from the perspective of real-world users. This technology finds applications in a variety of environments, where information is projected onto the user's environment through compatible devices. For example, the environmental instructions may be displayed directly, or the assembly instructions may display the next item and placement.

AR is closely related to Virtual Reality (VR), which combines virtual and virtual worlds. However, they are distinguished on the reality-virtuality continuum proposed by Milgram et al., where VR fully immerses users in a virtual environment, while AR overlays virtual information in real-world AR through activity. Three key factors achieve this immersion: This development places AR at the opposite end of VR, emphasizing its ability to seamlessly blend digital content with the physical world.

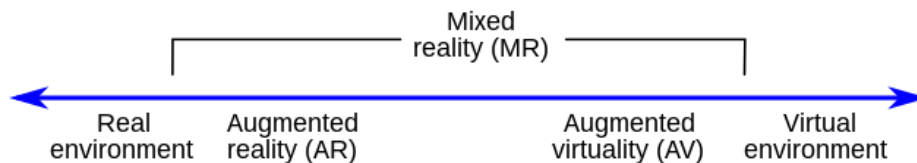


Figure 1. The Reality-Virtuality Continuum (Source:- Wikipedia)

AR technology has emerged as a key enabling technology for Industry 4.0, which has seen applications in a variety of applications in recent years. Another important technology shaping the future of the industry is the Digital Twin, discussed in the next section. AR technology has emerged as a key enabling technology for Industry 4.0, which has seen applications in a variety of applications in recent years. Another important technology shaping the future of the industry is the Digital Twin, discussed in the next section.

Digital Twin

The Digital Twin (DT) concept has been around for a long time, with the first vision dating back to 2002. However, it is only in the last five years that DT has received significant interest from various research and industry sources. Despite these advances, challenges remain, suggesting that the concept of DT is still in its early stages of development. DTs find roles in different industries, resulting in different definitions of the term. In general, a DT can be defined as a virtual representation of a real-world object or system throughout its life cycle. Key features of DTs include their focus on a single asset, their virtual nature and the unique insights they can provide. One of the main objectives of DTs is the effective management and management of real-world assets. For example, in the case of a wind turbine, sensors are used to collect data on key performance metrics such as power output, temperature, and environmental conditions and then transmit this information to operating systems which uses in a digital couple model. These digital systems can be used to run simulations to analyse performance issues and explore potential improvements. The objective is to find methods that can be used to increase the operational efficiency and effectiveness of hazardous air conditioners.

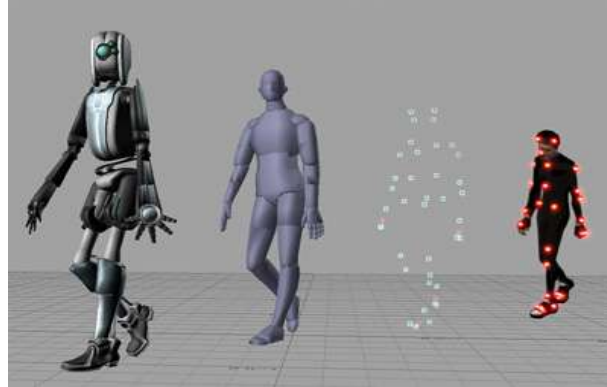


Figure 2. Digital human twin (Source:- By Hipocrite at English Wikipedia)

II. METHODOLOGY

To ensure clarity and transparency, we will provide a detailed explanation of the methodology used in our systematic literature review (SLR). We will utilize a sequential search approach across five extensive databases specializing in Information Systems literature. Our SLR is meticulously crafted to encompass a comprehensive corpus of research on the intersection of augmented reality (AR) and digital twins (DT). To achieve this, we employ a combination of keyword, backward, and forward searches, laying the groundwork for subsequent knowledge organization and analysis. The initial step of our SLR involves defining an appropriate string of keywords. We carefully examined existing literature on DT and AR to identify relevant keywords and synonyms. Notably, in the context of DT, we accounted for several synonymous terms, such as "digital shadow."

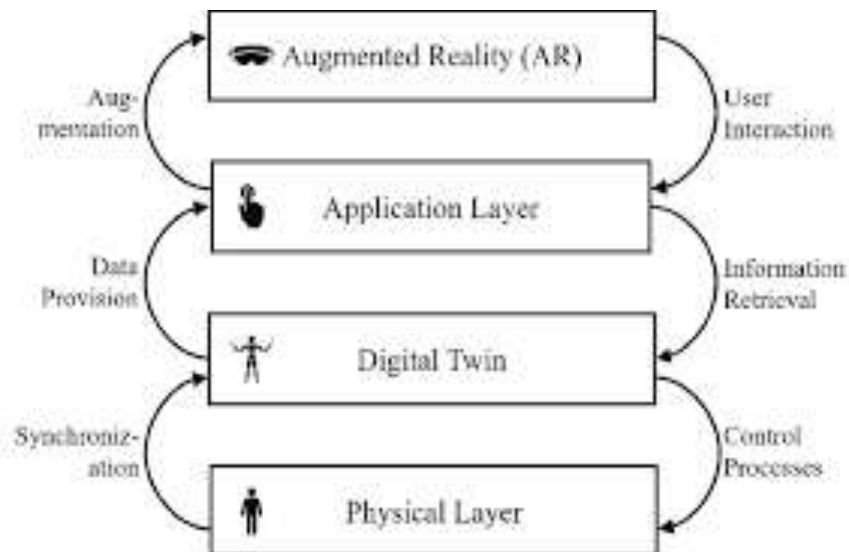


Figure 3. Augmented Reality Layers

A. Tools

For the Augmented reality and Digital twin we have certain tools to create them. In the previous part, we highlighted the importance of accurately positioning Digital Twins (DTs) on their corresponding Physical Twins (PTs) and dynamically updating their locations. To achieve this, we suggest investigating different tools used for creating 3D content in Virtual Reality (VR) and Augmented Reality (AR) applications. In industrial environments,

3D models of workstations, components, and equipment are extensively employed for designing new products, evaluating workstation layouts, and assessing ergonomics. These models are often developed using Computer-Aided Design (CAD) programs such as SolidWorks, Inventor, 3dsMax, or Maya. While these tools provide robust capabilities and enable the creation of highly accurate 3D models, they face certain limitations. Some of the tools used for creating Augmented reality and Digital twin:-

<https://www.solidworks.com/>

<https://www.autodesk.com/products/inventor/overview>

<https://www.autodesk.com/products/3ds-max/overview>

<https://www.autodesk.com/products/maya/overview>

Existing Tools Requirement for 3D Image Recognition in AR Usually requires an expert to search images on a computer, making it difficult for assembly line operators Furthermore, to use in AR want, these images usually consist of general direction, flight direction and address.

Cannot be changed or updated easily, except reporting system (ACARS) 3D image overlay in real-world scenario is generated by environment and object detection, and modules that can look at AR logo on many different types

This approach is effective when high-resolution 3D models of facilities are available, providing an accurate visualization of the environment, and when advanced building information modelling (BIM) systems are available exist but many facilities struggle to meet these needs, because they are old, only partially replicated, or reconfigurable can be, making it difficult to effectively implement such AR systems.

Here's a comparison table of various tools and technologies for creating and placing Digital Twins in AR environments:

TABLE 1 | Summary of the main features of 3D authoring tools suited for AR mat

	SolidWorks	3dsMax	Autodesk	Maya	API
Digital Twins placement	0	0	0	0	0
GUI-based	0	0	0	0	X
HMD compliant	X	X	X	X	X
AR authoring	X	X	X	X	X
Usable by operators	X	X	X	X	X
Short learning time	X	X	X	X	X
Reconfigurable factory compliant	X	X	X	X	X

Figure 4. Summary of the Features of 3D tools

Tool/Technology: -

- SolidWorks, 3dsMax, Autodesk Maya, APRIL, Vuforia , ACARS, ARAUM ,
- METAAR-App , INSITER Guides

Features: -

- Digital Twins Placement , GUI-based, HMD Compliant, AR Authoring, Usable by Operators

- Short Learning Time, Reconfigurable Factory Compliant

This table provides a comparison of various tools and technologies based on their capabilities for creating and placing Digital Twins in AR environments. Each tool or technology is evaluated based on its usability by operators, learning curve, compliance with reconfigurable factories, and other relevant factors.

A. Application of AR & DT in Sports Apparels

Augmented Reality and Digital Twin are the most fascinating technology aid which reduces more manufacturing errors and defects in manufacturing.

- In Sports apparel especially in dye manufacturing of sports floorball blade which is highly expensive, nearly it costs around 5L to 10L INR to create a dye molding.

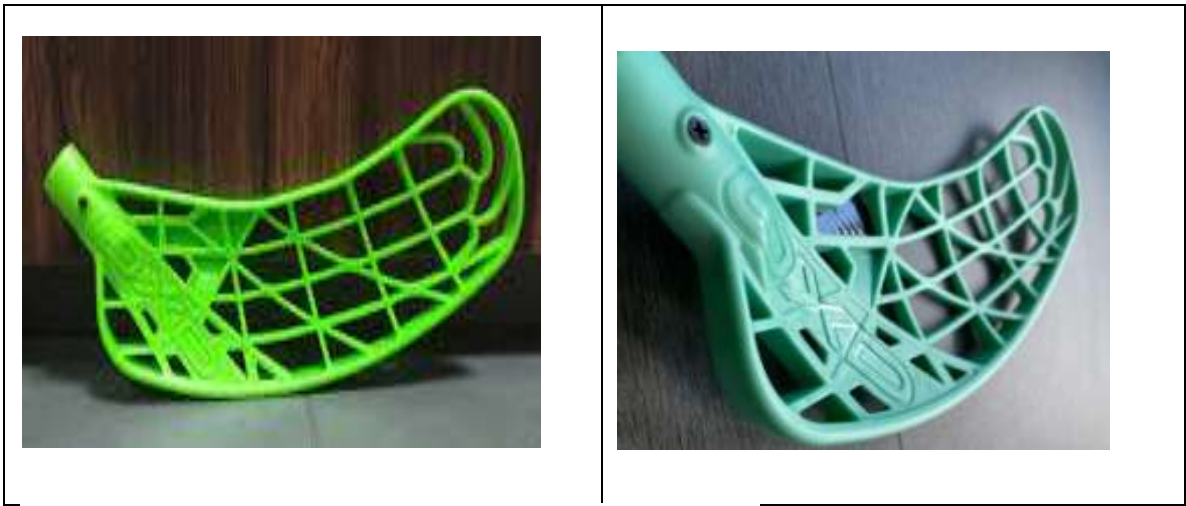


Figure 5. Dye molded Floorball Blade

Real-time Dye molded Floorball Blade

- The above picture is the real-time floorball blade which has manufactured via dye molding. In case of any of any defects and issue in design may cause huge property and time loss.
- So, we are implementing AR & DT so, we can visually appeal the design in virtual world and inspect the design and if there any issues we can rectify the issues in initial design phase and prevent the huge loss.

Real-time designed blade and implemented as AR & DT product: -

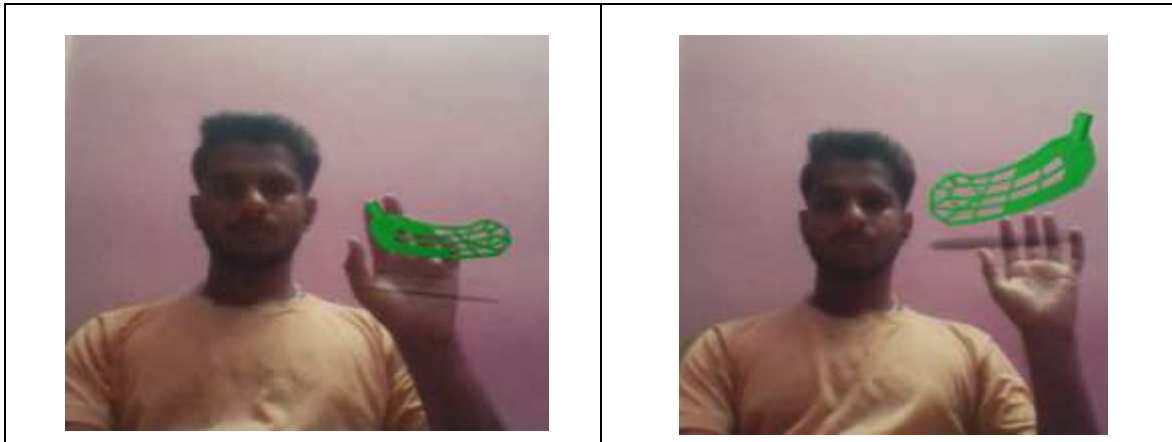


Figure 6. AR with DT of Floorball Blade

The Floorball ball was made in large scale on the count basis and on usage in worldwide. So, the AR and Digital Twin tech aids helps a lot. Here the applications of the Proof of concept; -



Figure 7. Dye molded Floorball Ball

The designed Digital Twin and Augmented Reality of Floorball Ball and tested.



Figure 8. AR with DT of Floorball ball

AR & DT IN BUSINESS

Augmented reality (AR) and digital twins are revolutionizing the industry, offering innovative solutions to age-old challenges. AR enhances the real-world environment by overlaying digital information, giving users an immersive experience. In the industry, AR is being used for product design, remote assistance, training simulations, marketing campaigns and other applications. Strengthens customer relationships, improves employee training and streamlines operations

Digital pairs, on the other hand, are virtual representations of real-world objects or systems. In operations, digital pairs are used for predictive maintenance, product development, and scheduling optimization. By creating a virtual replica, companies can analyze real-time data, identify inefficiencies, and make informed decisions. Digital Twins enable companies to reduce downtime, improve productivity, and increase customer satisfaction.

The combination of AR and digital twins opens up new possibilities in the marketing world. For example, AR can overlay physical objects with real-time data from the Digital Twin, giving employees actionable insights. This integration increases operational efficiency, reduces costs and drives innovation. Overall, AR and Digital Twins are reinventing the business landscape, delivering transformational solutions for a wide range of industries.

APPLICATIONS OF AR & DT IN BUSINESS

We use AR & DT in industry 4.0 on the whole but on the entrepreneurship for example Business cards.



Figure 9. AR with DT of Business Card

These technological innovations in traditional business cards pushes the non-technical organizations or company to adapt to the industry 4.0 and web 3.0. Which molds and stacks up the seeds of Augmented reality and Digital twins of real-time materials into Digital one which also clone the behavior and usage of the physical material into augmented ones.

The AR and DT business card is the technological innovation in the primitive visiting card culture which will be more eye catchy and grabs attention in the market also make use of web 3.0. Which results in acknowledge of the business owner's websites, email, business WhatsApp in simple it improved and made easy the mode of communication with the customer by just simply scanning the QR code.

You can get visual representation of the website into secs which helps the business owners to claim the order by the customer as soon as possible which any delay or procrastination from the customer side.

CONCLUSION

This paper Augmented Reality & Digital Twin And Their Applications In Sports And Business explain the adaptability and scalability of business using Augmented Reality (AR) and Digital Twin (DT) and also planning and error controls using the Web 3.0 briefly

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