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Impact of Digital Twin Model in Emerging Domains

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***Abstract*— Digital Twin the emerging and forefront in engineering revolution especially Industry 5.0. It simulates the industry environment and IoT connectivity. IoT enables smart connectivity in various engineering applications and medical applications. It strongly coupled with data science and analytics to handle large amount of data connected with sensors and devices. It also handles virtual environment with low cost but the challenges are complex. This paper analysis the technical issues faced when implementing digital twin model practices in engineering and medical applications.**

I. INTRODUCTION

This paper contributes to explore the misconceptions, challenges and how digital twin impacts the emerging technologies and recent digital age. It establishes popularity in IT infrastructure, data, privacy, security, trust and expectations with connectivity. It supports middleware architecture and that concretes data storage for large volumes of data.

The IoT architecture is personalized for their software compatibility and Application Programming Interface (APIs). This is implemented through simulation environment. It analyses based on simulation data and prediction algorithms. It demands the data in format of reduced dimensions.

II. LITERATURE REVIEW

It discusses about the digital twin enabling technologies[1] and challenges. It also explores the open research. The automatic data flow in digital twin is better than digital model and shadow. But the concept introduced in early 2000s and came into popularity from 2003 onwards. NASA implemented this in Air Force vehicles.

It discussed about the digital twin's role in manufacturing industry and integrated with blockchain integration. The case-study aircraft industry is analysed [2]. The framework discusses about the how to build digital twin in industry.

It explains about the IoT devices connected with sensor as smart cities [3] and how smart cities are built using digital twins and its difficulties are also discussed.

It suggests that how to optimize the digital twin in manufacturing industry by establishing virtual factory

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replication [4].
It exploits about how NASA introduced digital twin in their air force vehicles and their practical implementation [5].
It explains about how to integrate the intelligent with manufacturing strategies and their perspectives and enablers in various domains [6].
It depicts about the role of data fusion in prediction analysis using digital twin for maintenance [7].
This framework using digital twin for several case-study are discussed [8].
This model explains about the digital twin approach in life engineering services and their impacts [9].
It states that digital twin technology plays predominant role in model-based systems engineering [10].
Digital twin architecture in manufacturing perspective and their classifications [11].
In the electronics development design industry, digital twin technology is adapted as virtual validation [12].

III. PROPOSED SYSTEM

The architecture of data flow in digital twin will be dynamically changing from physical to digital. But it must be input as 3D model for the better accuracy and performance. It encompasses integration of simulating digital twin in the real-time environment. It can be applied to smart cities in order to handle large data produced by sensors and other devices. It provides services in ease for infrastructures and services of devices connected in IoT. The data collected from devices are used to analyse and predict some scenarios and for monitoring.
In manufacturing industries real-time assessment is challenging and to measure the performance of the machine too. It enhances the reliability and continuous accuracy for prediction analysis. It has the ability to assess future performance of the devices.
In healthcare industry, it is integrated with Artificial Intelligence (AI) algorithm to predict future analysis. It also helps in repairing medical instruments and can be applied for hospital maintenance. It also takes care of surgery with medical experts' guidance. It can be adapted for patient care too.
In engineering applications especially industry with cloud platform to connect IT infrastructure and machines. It can be tied with any other platforms easily.
Few challenges are in constructing hardware and compatible software for the simulated environment with more storage capacity.
Quality of the data impacts much on the accuracy and performance in implementing algorithms.
Security breaches are to be considered to ensure the privacy. Other characteristics of security such as integrity and trust, authentication.
Sensitive data should be dealt very seriously in order to protect from vulnerabilities. Active and passive attacks are dealt very carefully.
Connectivity demands high quality internet connection for online monitoring.

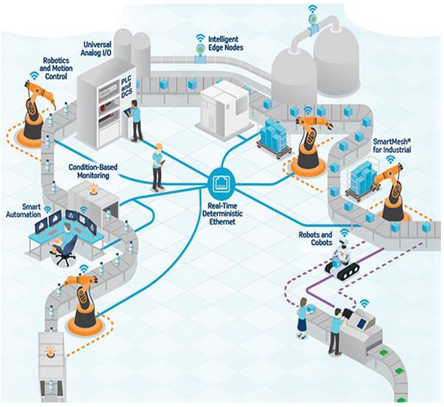

Figure 1. How digital twin technology works

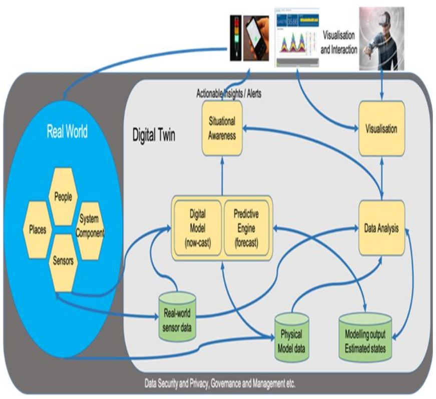

Figure 2. Digital twin network

Other factors such as software errors, missing IoT data and deployment errors.
International standards are observed in updating data on environment and operations.
Cyber-physical systems, aerospace and prognostics application domains are also focussed.
Extreme conditions in laboratory tests are managed by digital twin.
It can be tailored for the analytical approaches such as statistical distributions, physical testing and properties of heuristic design.

Real-time support is needed for digital twin framework to handle the similarities between real-time operations and testing.
It can make recommendations using self-mitigating approaches and is more desirable in industry operations.
It also applies to marine vehicles to contact physically with other ships and it is enabled through digital thread.
It handles information scattered around devices on and off the sea-shore. This is complex to build such a bijective relationship and other interoperability issues.
Optimization for sub-problems and computation resources are focussed.
This kind of dynamic environment demands planned literature survey and concrete framework and supporting practical equipment.
It analyses time series data collected from IoT devices and hybrid cloud data tool is used.
It enhances traceability and proper feed and updates.

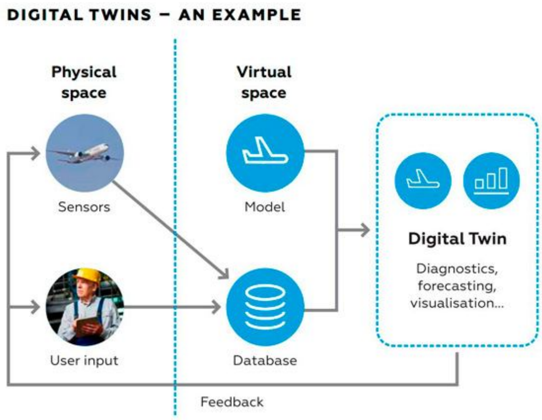

Figure 2. Digital Twin Technology

Challenges faced during building the framework of digital twin and its simulations are high-fidelity, interoperability, cybersecurity concerns, cost, resources and research.
Conceptualisation makes little difficult but facilitates distinction digital twin and other technologies.

IV. Results And Discussions

It works very efficiently in simulated environment and little challenging in establishing expected environment to work with. In order to produce accuracy, alignment is required. It needs to satisfy all metrics to prove its improvement. Noise-less data and quality data is expected to be an input for consistent and uninterrupted data. IoT signals plays vital role. All varieties of data for planning and analysis is used for efficient usage.
It builds trust between user and organization. Validating the model is challenging task.
Modelling standard structure is significant for ensuring the right development. Domain use is also verified for exact functionalities in digital twin. Compatibility also makes successful modelling.
It is generally enabled with IoT domain for its demand and it is beneficial to the universe and improving daily routines and manages gap between industry.
It focuses and huge impact on the applications transport, communication, building, agricultures, large scale processes and not limited to specified. The large amount spent recently on IoT projects are going to be speak sound in engineering domain in future decades.
It plays predominant role in development of industry 4.0 and its revolution without doubt.
It facilitates all domains in application, middleware, network and object domains.
It follows decentralized approach, so it is compatible with blockchain technology.

V. Conclusion

The advancement in industry 4.0 revolution enhances the existence of virtual environment. It can be applied for optimization and forecasting too. It provides framework to simulate the environment. It discussed explicitly about the bridge gap between digital twin and its challenges in implementation. It explained about the various emerging domains are shaking hands with digital twin technology. This paper reviews entire perspectives of digital twin by conducting effective literature survey. It clearly reveals about how it impacts the whole world.

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