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"BIG DATA VISUALIZATION WITH AUGMENTED REALITY: REVIEW"

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Abstract

Originating from real life and digital objects, big data plays an important role in modern day technologies like Artificial Intelligence, machine learning and automation. Augmented Reality on the other hand merges real world objects into digital world, enhancing the visualization experience. When big data is effectively modelled it can represent the data source which can be a real-world object. The digital representation is termed as "Digital Twin" where a twin of real world is created digitally using the data collected. This representation can be effectively visualized using Augmented Reality techniques improvising visualization of real-world entity for a remote user. This has many applications like a traffic control room where the traffic of a busy city traffic intersection is visualized and controlled remotely using the data collected from the traffic signals. In this paper, I explore some of the visualization techniques and discuss the scope and possibilities for Augmented Reality in big data visualizations.

Context

Big data is a paradigm that represents data generated from anything and everything around us. It can be information of how individuals use social media like Facebook, YouTube, Twitter, Google etc. It also includes information collected from sensors like temperature, wind speed, noise level. Internet of Things (IoT) sensors collect data from

electrical appliances, traffic sensors, collars attached to animals, heavy industry tools make Big Data boundless. Usage of big data is massive that ranges from determining trend of buyers and determining personal choices/opinions to controlling and coordinating medical procedures or industrial process.

With big data from almost all objects around us, world is becoming a canvas which influences people's perception and understanding of the environment around them. From the big data a digital world can be created which requires a user-friendly interface to interact with the digital world. Traditional user interface design is constrained by finite physical dimensions especially when mobile devices are preferred as a medium to interact with enormous stream of big data.

Primary consideration of big data visualization is the ability to associate data with the physical world and disclosing the causality between data and reality. Creation of virtual models of object represented by big data is significant for effective visualization. In addition, correlating data from different but associate sources dramatically increases the probability of discovering relevant and interesting patterns and observations. Furthermore, not only the user interface (UI) is a key factor in users' engagement for big data applications, but the user experience (UX), which involves user behaviour and emotions towards a specific artefact, needs to be considered in any current application design.

Augmented Reality and Digital Twins are two most modern concepts that can effectively visualize big data for providing user experience and interaction. AR, Digital Twin, and big data have been around shaping their own landscapes in various fields for a few years. The rich insight of big data, virtual modelling of Digital Twin and novel display modality of AR is promoting the convergence of these technologies. AR has great opportunities to bring innovation to big data in terms of visualization and interaction.

With these technologies, big data applications will be available for easy usage to end users who need not know the technology. The end users will include doctors, retail consumers, law enforcement officers, city administration, students, and labours in manufacturing unit.

Big Data Visualization

A. Big Data and Digital Twin

Digital Twin is a digital representation of a physical object, process, or service such as a jet engine or larger items such as buildings or even whole cities. This technology can be used to replicate processes to collect data to predict how they will perform. It was NASA who first embraced the digital twin concept and the idea was used to create digital simulations of space capsules and craft for testing. Gartner names it as one of the top 10 strategic technology trends.

Digital twin is created from a mathematical derived from data representing physical attribute and operational data that represent the state of the object. The result is a simulation of real world entity as a virtual computer model that can receive feedback from sensors in the real world version. This lets the digital version mimic and simulate what is happening with the original version in real time, creating opportunities to gather insights into performance and any potential problems.

Digital Twin visualization of a smart city for centralized operations with data collected from different sensors

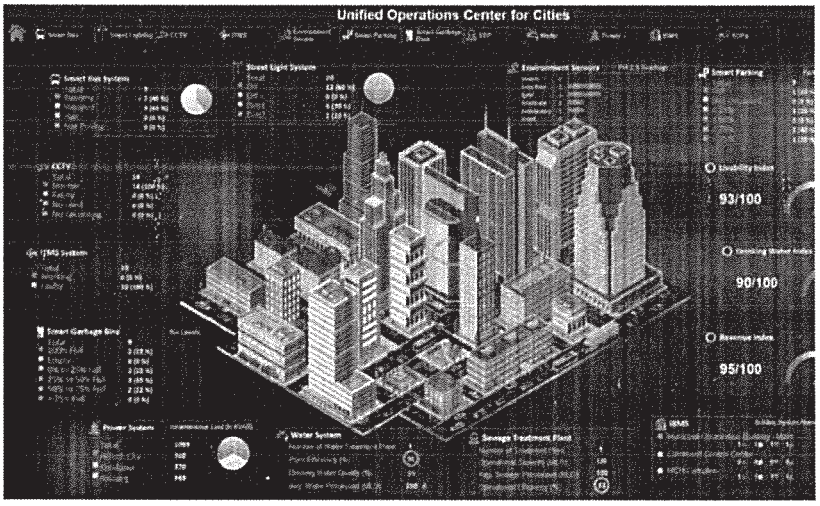
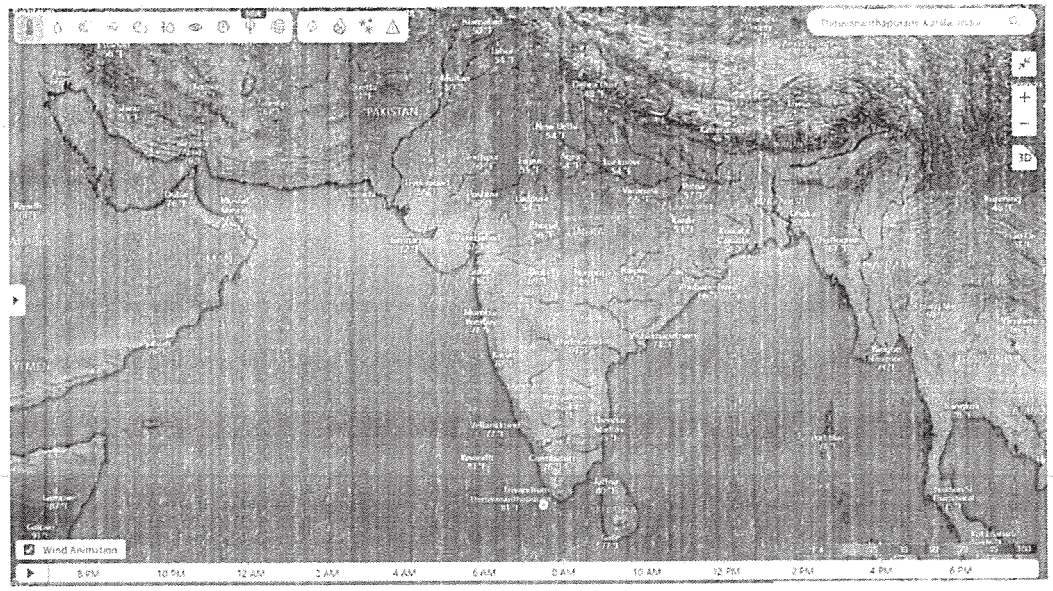


Figure 1:Unified Operation Centre. (Source: Smart Cities World Trend Report, Aveva)

Digital Twin visualization of a smart city for centralized operations with data collected from different



Msn weather digital twin in public domain

Weather (msn.com)

Digital Twin visualization of global map with temperature indicators and wind flow, provided by Microsoft

Digital twins are used in a wide variety of industries for a range of applications and purposes like:

- Manufacture - make manufacturing more productive and streamlined while reducing throughput times.
- Automotive - gather and analyse operational data from a vehicle in order to assess its status in real time and inform product improvements.
- Retail - model and augment the customer experience, whether at the level of a shopping centre or for individual stores.
- Healthcare - organ donation, surgery training and de-risking of procedures. Systems have also modelled the flow of people through hospitals and track & prevent pandemics
- Disaster Management - creation of smarter infrastructures, emergency response plans and climate change monitoring.
- Smart Cities - guide planning decisions and offer solutions to the many complex challenges faced by modern cities.

B. Big Data and Augmented Reality

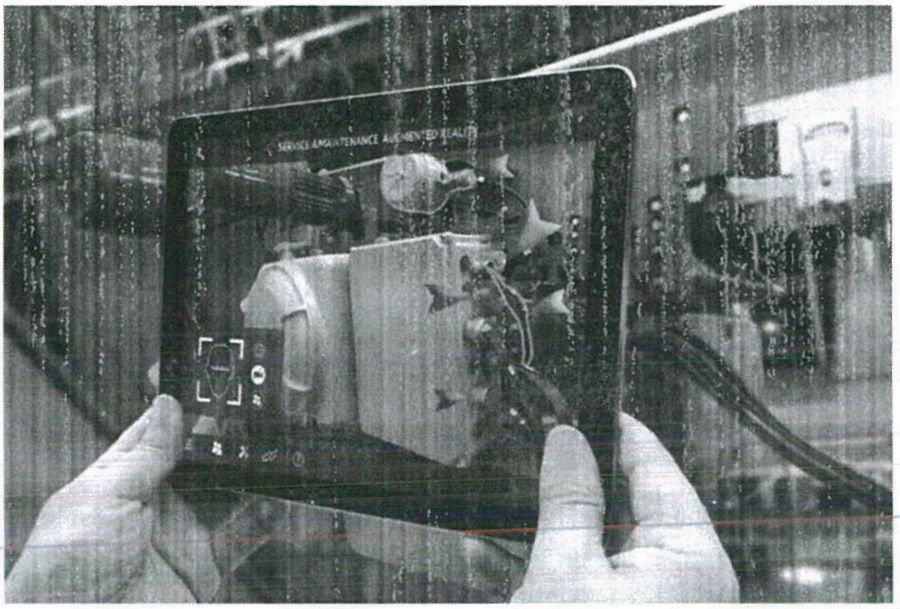
Augmented reality visualizes digital images or content on real world entities. Apart of the application-specific digital content that users see and interact with, AR needs uses information about surroundings and descriptions about how it relates to the application data. This includes information like geospatial coordinates and models of nearby buildings, features and semantic descriptions of objects, and linkage between physical and virtual content. Augmented reality gives user easy, real world interactions through wearables and handheld devices. Wearable and invisible accessories such as Google Glass reduce device intrusion, which provides a hand-free interaction experience.

With Big Data, AR applications gets a boost by enhancing digital elements into real world. The IoT information collected from the actual real object can be rendered on the AR visualization to give exact status of the object. This has bigger use cases in retail, manufacturing, and medical field. On the other hand, AR is very convenient visual canvas for big data applications that provides data visualization of complex Big Data structures in an easier manner and provide a better experience for users to interact with it.

AR virtual mirror in retail shop to try dress

https://www.youtube.com/watch?v=lNKJRltaUmI

AR powered glass to overlay digital dress on real person



AR for machine maintenance

https://blog.thomasnet.com/augmented-reality-manufacturing

Data regarding the machine being serviced is overlayed on the actual machine and viewed through handheld device

Augmented Reality are used in a wide variety of industries for a range of applications and purposes like:

- Retail – Digital and virtual stores with virtual try ons and digital shopping
- Automotive – Precise designing of components and virtual models. Coordination and precise assembling of motor part. Self-repair and virtual assist for repairing
- Manufacturing – Precision manufacturing and assembly. Easy inspection, service and maintenance of manufacturing units and plants
- Healthcare – Visual enhancement of Xray's and MRIs for diagnosis. Remote surgery assistance and consultancy
- Tourism – Location based AR for direction, overlaying details on monuments, places

C. Converge Digital Twin, Augmented Reality and Big Data

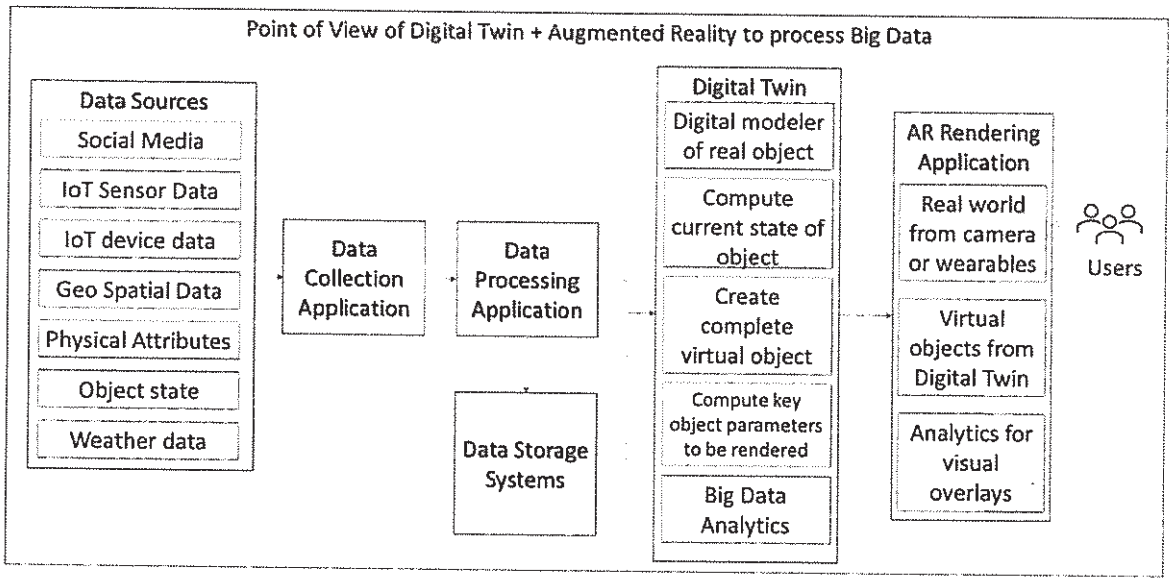
The big data will contain all the information of a physical object in real word which can include

1. A real time interface between the digital model and an actual physical object to send and receive feedback.

2. Lifecycle of a product, design specifications, production processes or engineering information.
3. Production information including equipment, materials, parts, methods and quality control.
4. Operation, such as real-time feedback, historical analysis and maintenance records
5. Business data or end-of-life procedures.

A digital twin design is made by gathering data and creating computational analytical models to show operating effects, predict states such as fatigue, and determine behaviours. These models can prescribe actions based on engineering simulations, physics, chemistry, statistics, machine learning, artificial intelligence, business logic or objectives.

The digital twins created can then be displayed via 3D representations and augmented reality modelling in order to aid human understanding of the findings.



Numerous tech companies are developing AR data visualization tools that can enable people to have a clear understanding of situations requiring the analysis of hundreds and, sometimes, even thousands of data points. Wearing AR devices, people can walk around in physical space to see the correlation between a wide array of variables presented in a lucid, interactive format. They can use gestures to interact with the AR visuals and gain a detailed look into the data that would otherwise be presented in a pile of reports.

Efficient visualization tools should consider cognitive and perceptual properties of the human brain. Visualization aims to improve the clarity and aesthetic appeal of the displayed information and allows a person to understand large amount of data and interact with it.

Comparison of some AR visualization Tools

Name	company	Function
Vuforia	Qualcomm	Includes basically, real objects, recognizing which, your application can array virtual objects in the needed locations and corresponding proportions.
Wikitude	Australian software development company	Includes various rendering features
ARKit	Apple	identifying dimensions of the surrounding and consider lighting conditions to integrate virtual objects with real life
ARCore	Google	motion tracking, environmental recognition, and lighting recognition.

Challenges

Big data possess challenge in terms of volume, non-standard format and on collection methods. Augmented Reality solutions available are more custom developed and does not resolve a common problem. Reusability of solutions is limited. While digital twins provide standard virtual models, this challenge of augmented reality can be mitigated. Big data applications itself is technically complex and the visualization with Augmented reality and digital twin makes it more complex and expensive.

Conclusion

In today's world driven by analytics, machine learning, automation and robotics, data driven applications is taking the driver seat. Augmented Reality, Digital Twins and their combination can visualize the big data application output in more user-friendly way beneficial to end user who has limited technical knowledge. Digital Twins standardizes the virtual models that can be consumed by AR applications which will standardize the solution a lot.

Emerging big data technologies and AR technology is bound to make this concept a lot simpler. While big data technologies are intended for improved services, cost reduction and seamless manufacturing, digital twin and Augmented reality will surely boost the benefits and make big data applications useful for end consumers.

References

- *https://ieeexplore.ieee.org/document/7979812*
- *https://journalofbigdata.springeropen.com/articles/10.1186/s40537-015-0031-2*
- *https://www.twi-global.com/*
- *https://en.wikipedia.org/wiki/Digital_twin*
- *https://www.ptc.com/en/blogs/corporate/combining-augmented-reality-ar-digital-twin*
- *https://www.networkworld.com/article/3280225/what-is-digital-twin-technology-and-why-it-matters.html*
- *https://www.geospatialworld.net/blogs/digital-cities-digital-twins-for-connected-city-infrastructure/*
- *https://www.researchgate.net/publication/317576691_When_Augmented_Reality_meets_Big_Data*
- *https://blog.thomasnet.com/augmented-reality-manufacturing*
- *https://www.ptc.com/en/technologies/augmented-reality/solutions-for-manufacturing*
- *https://escapetovr.com/applications-for-ar-in-manufacturing/*
- *https://www.ptc.com/-/media/Files/PDFs/IoT/digital_twin_industrial-enterprises-6-11-19.pdf*
- *https://softengi.com/blog/use-cases-and-applications-of-digital-twin/*
- *https://support-cn5.envisioniot.com/docs/dtv/en/latest/overview.html*
- *https://blog.contus.com/digital-twin-solution/*
- *https://chips.engineering.txstate.edu/research/ie4/digital-twin.html*
- *https://thehealthcaretechnologyreport.com/digital-twins-the-virtual-future-of-healthcare/*
- *https://www.researchgate.net/publication/338608141_A_Digital_Twin_Paradigm_Vehicle-to-Cloud_Based_Advanced_Driver_Assistance_Systems/figures?lo=1*