Best practices in immersive technologies implementation for industry 4.0*

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ABSTRACT

We are in the era of growing and developing technologies, where immersive technology is one among them. Immersive technology is designed using a computer program, also known as interactive technology, which is being used worldwide. It replicates real world in digital form. Immersive technology has a wide range of tools which include Virtual Reality (VR), Augment Reality (AR) and Mixed Reality (MR). These technologies allow the person to feel that they are actually present within the environment. This can be achieved through motion capturing such as body postures and gestures that are used for interacting within the environment. Several attempts are made to use these technologies in businesses such as Manufacturing process and Advertisement Industries to promote new products. Currently, many industries started experimenting with VR, but still hesitate to fully commit. On the other hand, many are interested in the state of being free from tension and anxiety, but do not want to put into financial schemes on the technology's hardware. The paper pays attention to the challenges involved in using this Interactive technology in commercial activity successfully.

Keywords:
Augment Reality,
Motion Capturing,
VR Environment,
Challenges of
Implementation

1. Introduction

Immersive technology is nothing but a person fully immersed in an artificial environment and feels lost by being present in the real environment. Understanding immersive technology is itself a great barrier. Usage of the precise hardware by developers can add time to develop. With the new arrival of hardware coming out every month is hard for developers to understand the requirements. At a user level, many problems arise due to lack of understanding the limitations or investments on the technology. It is not suitable for every type of training until we see major advances in touch feedback technology. Alongside all of these issues are around cost and adoption of the hardware. Setting up the hardware will be another issue, For example, few hardware devices require installation to all the new places we move. The devices are mostly heavy in weight and restrict to stay within the particular room space. These immersive technologies are widely used in the form of smart connected engineering, smart connected operation and smart connected product.

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1.1. Smart connected engineering (SCE)

Smart Connected Engineering (SCE) is embedded with sensors, software and connectivity that allow the data exchange between system, operators and the manufacturing environment. The product designing procedure can be briefed to the user through immersive technologies by providing systematic instructions that can be visualized using Wearable's. It can be viewed as many times required by the individual. Anything is made understandable through visualization.

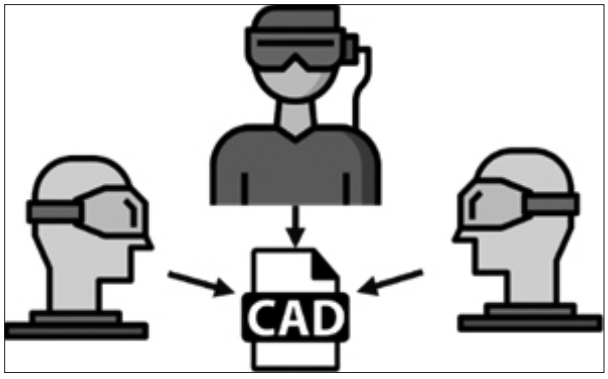

Fig. 1. User's discuss complex cad model through VR.

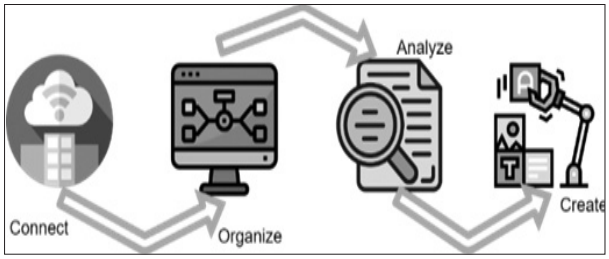

Fig. 2. Implementation of digital journey.

1.1.1. Engineering design solution

The client and designer arrange for a review meeting through phone calls which doesn't meet their needs to explain the design properly. But with the help of immersive technology people from anywhere can collaborate within the same environment in order to discuss about the models. The client also has an opportunity to look the model from different aspects and can walk around within the environment. And can also provide further feedbacks within the environment that gives immediate feedbacks to the designers. Figure 1 resembles the users visualising the complex CAD model through immersive technology.

1.2. Smart connected operation (SCO)

With the advantages of the Industrial Internet of Things (IIOT), we can now solve operational challenges of integrating assets, operations and business systems to create Smart Connected Operation. It mainly explains how the future industries will look like. The data's are captured through sensors and has machine to machine communication, integrated with applications. When more sensors connected to more machine the real time data captured will also be cumbersome, this will give way to new analytical techniques for predictive analysis. Through the analysis the customer demand for the future and requirements can also be easily determined. So the product can be designed in such a way that it will increase the product efficiency and increase the customer satisfaction

The above Figure 2 infers the implementation techniques of digital journey that helps in creating a better product to satisfy customer needs.

1.3 Smart connected product (SCP)

The products in industries are connected to sensors to collect the real time performance data in change provides a new range of solutions. It increases profitability and helps in better decision making. The companies need to start using entire new technology infrastructure to go with SCP. It provides the capabilities to monitor, control, optimize and automate the product.

2. Immersive Technology

Immersive technology is an integration of digital content into the real environment. The user feels that the immersed environment is the actual environment. Immersive technologies have been used by numerous industries, such as marketing, engineering, education, medicine, manufacturing and real estate.

2.1. Virtual reality

VR is an imaginary world in other words an artificial world in which a person can experience and interact through vision, audio, tactile and other forms of feedback hardware's that takes the individual into an imaginary world rather makes them feel that they are being present in the real-world. It helps the user to visualize the 3D model and enhance the current perception of reality.

2.1.1. Design immersive environment

It is easy to design scenes that immerse users in 3D, real- time surroundings that are inhabited with 3D objects and animated characters. Users can also import 3D objects and select from already loaded scene assets. The behavior of objects in the scene can be scripted in a logic to control them.

2.1.2. Run on devices

The scene VR/AR developed and built can be made to run on the web browsers using Web VR.

Fig. 3. User interacting within collaborative VR environment.

Fig. 4. User operates the robot MARC through VR headset.

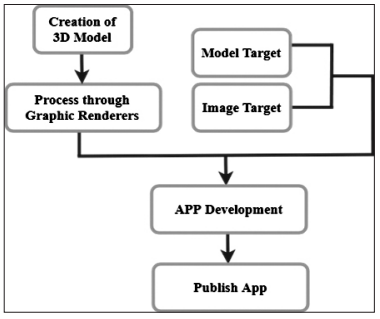

Fig. 5. Methodology of augment reality application.

And can also run on devices such as HTC Vive, Oculus Rift, Holo Lens and many more platforms like Android and iOS.

2.1.3. Collaborative VR

Several users in other physical locations can connect together and have an interactive meeting through VR. The same product can be viewed and analysed from different locations at the same time. The group of people can share their information along each other and can provide feedbacks and design changes that can be implemented. It will enhance more of teamwork and also improves productivity. All the members can suggest their thoughts in real time. Rather than spending money on travelling, one can invest in just new innovative techniques. The Figure 3 shows the Collaborative VR Environment created by Maxbyte Technologies.

2.1.4. VR Hardware to control robot

Virtual reality can be used to operate the Humanoid robot. Even though robots can do things on their own, sometimes under the particular circumstance they need humans to take control. For example when we send a robot to defuse a bomb and we can operate the robot miles away using the virtual reality device. Here the robot MARC is getting ready for industrial Oscars that includes of giving alert when there is some failure with the machines. Every time an official cannot go visit the factory. Instead the user can wear the VR Headsets and can operate the robot and also helps to gather meetings with the engineers present in the factory. Marc also helps in taking pictures and sending to the officials. The Figure 4 shows the user operating Robot through VR developed by Maxbyte Technologies.

2.2. Augmented reality

Augmented reality (AR) is extended from virtual reality (VR). It also makes the user to engage by interacting with their own mobile phones. AR integrates virtual information into an individual real environment so that they can perceive that information as existing in their surroundings. It is a collaboration of the real scene viewed by the individual and an imaginary scene generated by the computer graphics that is augmented with additional information. The Figure 5 represents methodology and architecture of augmented reality applications.

2.2.1. Methodology and architecture

2.2.2. Generation of 3D models

Products are modelled using 3d modelling program. Real world machines are developed as computer generated 3D CAD models. It is always important to give more realistic texture to the models. Always keep in mind that the model must be made up of low polygon meshes and light weight in order to process through so many graphic renders.

2.2.3. AR, made easy

After analysing the problems, solutions were addressed to overcome the challenge by developing AR mobile apps by initializing Vuforia plugin and AR camera. Configuration is done by adding the app license key. The target can be 2D imaged (QR codes) or even 3D object (Model Target). The Figure 6 represents the experience of augmenting reality using a smartphone developed by Maxbyte Technologies.

Fig. 6. Augment reality experience using smartphone.

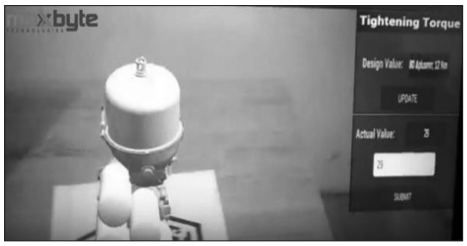

Fig. 7. Design value of the tightening torque with actual value updated by the service engineer.

Fig. 8. User experiences AR through real wear HMT.

2.2.4. Product lifecycle management PLM

PLM is product lifecycle management and are also called as information management which integrates the data, process managed throughout the entire lifecycle of the product i.e. from the concept initialisation to destroying the product.

i. Integration of AR with PLM

AR that is used in industries mainly includes Maintanence, Product Visualisation and Service. The service engineer needs to record all the details that are to be done with the product. Here the service engineer notes the tightening torque of the nut which he uses to tighten the nut. Some standard value will already be provided in order to avoid the failure. The service engineer needs to check the manuals for the standard value and note down the value that to be used to tighten the nut and gives the noted value to the plan engineer which will be updated to the plm sytem software manually. But here by integrating both AR and PLM, the Service engineer has an opportunity to directly update the tightening torque that he used to tighten the nut. The Figure 7 shows the PLM system integrated with Augment reality developed by Maxbyte Technologies.

Design Value is already given to the user through AR Application and helps the user to update the actual value of PLM system. The database directly goes to the PLM software by submitting the actual value.

2.2.5. AR wearables

AR Wearables are mostly glasses. It is mostly wireless and works on battery. Vuzix is totally made like the glasses we wear for regular use. In other words, it can be called as a hands free device. They mainly pave way for industries. Real Wear HMT is one such which resist temperature and non-breakable.

i. Real wear HMT

It mainly works with voice command. It has Removable Head Pad, Speaker, Camera, Removable Head Strap, Mic etc. It has completely hands-free voice controlled user interface allowing the user to operate the tools and equipment needed for their work even while climbing and at heavy industries. It can also be called as a voice controlled Android tablet designed to be worn headgear on an industry. The Figure 8 shows the user using an AR wearable to view the experience at DFX conducted by Maxbyte Technologies at PSG College of Engineering and Technology.

2.3. Mixed reality

It is a mix of real and virtual. The digital content seems to be really present in the physical environment. It creates a sense of being present, which hides the real world and replace with digital information. The user is not brought out from the rest of the world.

3. Best Practices In Immersive Technology Implementation

To adopt immersive technologies, they need better user experience design. 3D interface design needs much effort and expensive, and there are few people with the necessary design skills to overcome these issues. The main effort of user experience design has been to get users to just wear their HMD and go to work. However, this is not completely a design challenge. Challenges such as eye strain and sound discomfort need to be overcome. Nobody wants to buy a device or an experience that gives you a stress. Major challenges include hardware and software issues, heavy weight, ergonomics,

limited acceptance, eye strain and concentration, performance issues, data transfer, integration and security issues, content authoring, adaptive instructions, marker tracking reliability and cost.

3.1. VR Mass adoption

3.1.1. Challenges

VR is brought out through devices such as HTC Vive, Oculus Rift which is not very easy to use and not available at an affordable cost. HMD with a larger field of view tends to be heavier. It is not easy to set up the device everywhere. It needs some installation procedures to be done. It requires a High configuration PC. Not all industries want so much to be invested in something unrealistic. Most of the headsets are wired and limits within the room space. The user must have prior knowledge on using the hardware. Even with the advent of wireless devices, there are some limitations to stay within the particular space which is tracked through the sensors. Due to a lack in resolutions it makes the user disorient from the environment and creates nausea. The main drawback is most of the headsets are wired. It constrains the user within the particular freedom of movement. Wires will entangle which makes the user lose their consciousness.

3.1.2. Solution

Untethered and light weight VR Headsets can be used. MobileVR will offer an experience at an affordable cost.

3.2. Smartphone AR adoption

3.2.1. Challenges

Despite of limitations, smartphone AR will establish a strong place in the market. The hardware is already in wide range of use and has an effective developer base. A handheld smartphone AR can produce good user experiences, but still restrict certain movements. No User would wish to hold their phone extended periods of time.

3.2.2. Solution

A hands-free AR Head Mounted Display will make the experience much more comfortable which will also meet the business expectations.

3.3. Voice recognition

3.3.1. Challenges

Voice is the natural way of communication. Voice helps people to transmit information easily. But when it comes to immersive technology, there are still some limitations that exist with voice control. When using voice based AR in the industries there may be more noise from the machineries present in the industry. The user cannot call out the same voice command several times, which may create stress and lack of interest to the user. Sometimes voice command may vary with pronunciation. The voice control interface must always be contextual. It constrains the user to stay within the noise free environment.

3.3.2. Solution

Real time Contextual recognition of sensory data will be a better option to be used.

3.4. Need for Power Backup

3.4.1. Challenges

Most of the AR device battery life is less. It stays mostly for 4 hours and maximum of 10 hours. It is difficult for anyone to charge the battery very often. Most of the batteries are internal. If the battery is very large, it directly reflects with the weight and cannot be easily worn which makes the wearable less comfortable.

3.4.2. Solution

To overcome this we can allow the battery to stay out, which can be worn around waist.

3.5. Knowledge is power

Most of the users may have knowledge on VR through gaming devices. A few may not have experienced any sought of VR Experiences. So it is important to bridge the gap between the barriers to make everyone understand before they start using it to use it safely and effectively. Immersive technologies such as VR and AR are readily deployed. New user's mostly younger ones are ready to adopt both these technologies. Immersive learning is not just more successful in producing a desired one, but, it is also easy to

modify and maximize productivity.

4. Implementation Benefits

Immersive technology brings in better involvement and exposure of the products directly to the users. Anything explained through visualisation reaches better heights. It creates a more level of interest. It allows anybody to use anywhere and everywhere.

Virtual reality (VR) improves quality, safety and also helps in succeeding complexities of use cases thereby increasing productivity. VR paves a better way by providing access to the 3D models for the assembly workers. It reduces the time required for inspection. It mostly helps with ergonomic issues through motion capturing which helps in overcoming injuries.

Augment reality (AR) is very complex to put into effect; it is more resulting than VR. AR helps in productivity benefits by providing procedural instructions and visual animations, while also allow experts to connect through remote to visualize and provide corrections and feedback to the technician or user. It allows the user to view the digital product from any angle. Even if the product is much complicated, this approach can reduce the service time.

5. Conclusions

Immersive technology long back had no impact in any of the industries rather than gaming. But with the advent of computer graphics and new hardware's. It is one of the technology that plays vital role in today's industrial growth. It not only creates a wow factor, but has many more uses which reduce the use of paper works by creating digital manuals. Complicated machineries can be viewed on a hand held device which doesn't require much effort for the user. But still immersive technology has many more challenges and risk to overcome and bring the future near. This technology is incredibly useful. In a few years, the problems of today will seem like a bad dream. It has all the ability to shape a better future. The Solutions has to appeal through better understanding, ergonomic factors. It is a kind of actual social bridge that gives the user better experience.

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