Digital Simulation based Demonstration of Induction Machine

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***Abstract*— Virtual reality (VR) is an emerging technology with applications in various fields including medicine, gaming, and psychology. Its potential for education is promising but research on its effectiveness in this area is lacking. Design education is crucial for architecture students, but traditional methods can be challenging for visualizing complex structures. VR offers a solution by providing a 3D immersive experience, such as simulating a running engine, to enhance understanding and engagement in learning. In this paper, it is proved that the 3D visualization using virtual reality is better in understanding as well as improvement in the knowledge gaining and is presented by taking an Induction motor as an example.**

Keywords—virtual reality, simulation, 3D model of induction motor

I. INTRODUCTION (*HEADING 1*)

An electric motor is a device that converts electrical energy into mechanical energy. It achieves this by utilizing the interaction between a magnetic field and electric current in a wire winding, which generates torque and applies force on the motor's shaft. Electric motors can be powered by either direct current (DC) sources, such as batteries or motor vehicles, or alternating current (AC) sources, like power grids or electrical generators. Conversely, an electric generator is similar in structure to an electric motor but operates in reverse, converting mechanical energy into electrical energy. Electric motors can be classified based on factors such as power source type, internal construction, application, and type of motion output. They can be either brushed or brushless, have various phases, and be air- cooled or liquid-cooled. General-purpose motors with standardized dimensions and characteristics are commonly used in industrial settings to provide mechanical power. The largest electric motors are utilized for ship propulsion, pipeline compression, and pumped-storage applications, with power ratings reaching up to 100 megawatts. Electric motors are also present in industrial fans, blowers, pumps, machine tools, household appliances, power tools, and disk drives. While some students may find it challenging to visualize the motor during their studies, teachers' classroom delivery partially helps students understand. However, some students still struggle to grasp the concepts. The use of ICT tools can be a partial solution to this problem, but for a more effective learning experience, virtual reality (VR) technology is better suited. VR allows for 3D visualization, which can greatly enhance students' understanding.[1-6]

II. VIRTUAL REALITY

A. Introduction to Virtual Reality

The concept of virtual reality is derived from the definitions of 'virtual' and 'reality'. 'Virtual' refers to something that is near, while 'reality' pertains to the experiences of human beings. Therefore, 'virtual reality' essentially means 'near- reality' and is commonly associated with a specific type of reality emulation.[4]

Our understanding of the world is shaped by our senses and perception systems. In school, five basic senses were taught: taste, touch, smell, sight, and hearing. However, humans possess additional senses, such as a sense of balance. These various sensory inputs, along with the processing of sensory information by our brains, contribute to a continuous flow of information from the environment to our minds. All our knowledge about reality is acquired through our senses, indicating that our perception of reality is a combination of sensory information and the brain's interpretation of that information. Therefore, if artificial information is presented to our senses, our perception of reality would be altered accordingly. This altered version of reality, though not physically present, would be perceived as real from our perspective, leading to what we call virtual reality.[4-6]

Explaining "what is virtual reality" in technical terms is simple. Virtual reality refers to a computer-generated, three-dimensional environment that can be explored and interacted with by an individual. The person becomes immersed in this virtual world, where they can manipulate objects and engage in various activities. The concept of reality is rooted in the human desire to transcend the limitations of the physical world by embracing cyberspace.[4]

B. Three I's Of Virtual Reality

ThethreeI'sofVirtual Realityare:1.Imagination2. Immersion3. Interaction as shown in figure 1

1. IMAGINATION:

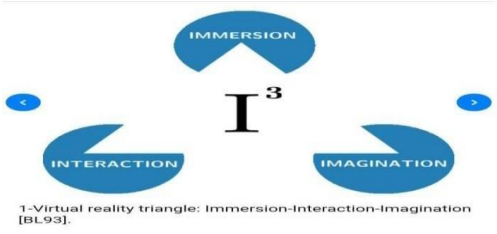
Imagination: Many individuals are unaware that Imagination plays a crucial role in Virtual Reality (VR). Mostpeople mistakenly believe that Immersion and Interaction are the sole components of VR. However, it is actuallyImagination that serves as the foundation for creating VR. The ability to solve problems, determine the mosteffective simulations, andmake design decisions all rely on Imagination. VR is the latest medium for storytellingand experiencing narratives, offering limitless possibilities for marketing. The human mind's capacity enables us toperceive things that do not exist and create the illusion of their reality. Virtual experiences can be crafted to unfoldstories, allow users to step into dreams or visions, engage in games, or experience products from within. ThroughVR, businesses caninfluenceemotions, shape decisions,andevokememories.

2. IMMERSION:

Mouse and keyboard can function with the computer, but without Immersion, they cannot be classified asVR. Immersion allows individuals to step into a real-world experience from the screen, sensing through touch,moving through commands, and interacting through physical contact. Immersion is the key element that makes VRseem authentic to users. Whether it involves product visualization or a branded experience project, we continuouslyadapt the format and explore innovative methods to transport individuals into different realms. Studies indicate thatoffering users a real-time sensation of being physically present in a virtual environment and the ability to engagewithit seamlesslyleadsto enhanced comfortand affinitytowardsthe brand deliveringsuchimmersiveexperiences.

3. INTERACTION:

Interaction is the foremost aspect that must be defined in virtual reality (VR), as it serves as a crucialcomponent. Individuals desire to witness the actions portrayed on the screen that align with their instructions. ThisservesasthefundamentalelementofVR,functioningasani nstantaneousoperatingsystem.Intermsoffunctionality, VR is highly receptive to user input, encompassing gestures, verbal commands, head movementtracking, andmore.[1,4]



1-Virtual reality triangle: Immersion-Interaction-Imagination [BL93].

Figure 1. The 3 Is of Virtual reality

III. VIRTUALREALITY ACROSSVARIOUSDOMAINS

A. *Virtual Reality In Military*

The military has embraced virtual reality technology across all three branches (army, navy, and air force) for training purposes. This type of training is especially beneficial for preparing soldiers for combat scenarios or hazardous environments, allowing them to practice appropriate responses without the actual risk of harm. Through virtual reality simulations, soldiers can engage in realistic scenarios, such as enemy encounters, without facing real- world dangers. This method has been shown to be safer and more cost-effective compared to conventional training techniques.they are unavoidable. Figure 2 depicts about


virtual reality in military

Figure 2

B. *Virtual Reality In Health Care*

Healthcare has widely embraced virtual reality technology, utilizing it for surgery simulation, phobia treatment,robotic surgery, and skills training. One key benefit of this technology is the ability for healthcare professionals toacquire new skills and enhance existing ones in a risk-free environment, ensuring patient safety. Robotic surgery is aprominent application of virtual reality, enabling surgeries to be conducted with the assistance of robotic devicescontrolledbyhumansurgeons,therebyreducingoperation timeandminimizingtheriskofcomplications.Additionally, virtual reality has found utility in training programs and remote tele surgery, allowing surgeons toperformprocedures from a different location thanthe patient.

C. *Virtual Reality In Electrical Engineering*

Virtual reality engineering utilizes 3D modeling tools and visualization techniques to enhance the design process. By enabling engineers to view their projects in 3D, this technology provides a deeper understanding of functionality and helps identify any flaws or risks prior to implementation. Additionally, it allows the design team to make necessary changes within a secure environment, ultimately saving time and money. The key aspect of virtual reality lies in its ability to accurately depict intricate details of engineering products to uphold the illusion. This involves high-quality graphics, fast video refresh rates, and realistic sound and movement. Figure 2 depicts about virtual reality in electrical engineering.

Figure 2. Virtual reality in electrical engineering

D. Virtual Reality In Entertainment

Virtual reality games have gained immense popularity among numerous teenagers who are captivated by the stunning graphics, captivating animations, and most importantly, the ability to communicate with fellow players. Undoubtedly, there is nothing more enticing than the opportunity to engage with cutting-edge technology without any interference from adults. These games are accessible on various platforms including Xbox 360, PS2 and 3, as well as Mac and PC, ensuring that there is a virtual reality game available for every console. When you contemplate this, it is truly remarkable. The figure 3 given below depicts virtual reality in entertainment.

Figure 3. *Virtual reality in entertainment*

E. Virtual Reality In Sports

Virtual Reality is employed as a training tool in various sports, including golf, athletics, skiing, cycling, and more. Its purpose extends beyond aiding in the assessment of athletic performance and technique analysis; it is also utilized in the realms of clothing and equipment design. Moreover, it plays a crucial role in enhancing the overall audience experience, aligning with the ongoing efforts to elevate it.The figure 3 given below depicts virtual reality in sports.

Figure 4. Virtual reality in sports

F. Virtual Reality In Education

Virtual reality has been integrated into education to facilitate interactive learning experiences for large groups of students in a three-dimensional environment. It has the capability to convey intricate information to students in a manner that is engaging and simple to comprehend. Additionally, students are able to engage with the objects within the environment to further explore and learn about them. In this project an application i.e “Development of virtual reality based 3D view of winding of a Motor” is considered by using Virtual Reality Technology, The next section deals with VR technology requirements. Figure 5 shows a picture of virtual reality in education.[1-6]

Figure 5. Virtual reality in education

IV. VR TECHNOLGOY REQUIREMENTS

A. Software

Unreal Engine: The 1998 first-person shooter game Unreal served as the debut release for Epic Games' Unreal Engine. Though it was primarily created for first-person shooters, it has since been adopted by various businesses, most notably the film and television industries, and employed in a range of genres, such as fighting games, platformers, and massively multiplayer online role-playing games. The Unreal Engine is very portable, supporting a variety of systems, and is written in C++.

Hardware: The majority of studies concentrated on how users are presented with visual information. In addition to quick view updates, the creation of an immersive experience is greatly influenced by image quality. An overview of the key components of the human visual system that need to be taken into account while creating visual displays was provided by visual perception characterization. A large field of vision, high brightness, high contrast, high resolution, and quick update rate are all desirable features in a display. Conversely, wearability—weightlessness, simplicity of usage, etc.—must not be overlooked. Unfortunately, current technology cannot provide an HMD that satisfies all of these requirements. There are presently two display technologies on the market. That is CRT and LCD. But due to many constraints such as image poor quality, resolution, contrast, brightness etc tiny displays are preferred in virtual reality as explained below.

Small Field Of View (FOV) is a result of the tiny displays used in HMDs. LEEP or Fresnel lenses are examples of special optics that can be employed to increase the viewing range. A predistortion of the image that will be viewed through the special optics is necessary for both of these methods. For example, VPL Research uses wide field optics in the design of their head-mounted displays.

Different output visual displays are used by different types of VR systems, ranging from desktop to full immersion. They can range from a basic computer monitor to an advanced head-mounted display. The most widely used VR screens will be briefly reviewed in the section that follows.[6]

a) The most basic VR systems, such as 3D glasses, show the user the scene on a display. However, by using LCD shutter glasses to add a stereo image, the "window onto

a world" paradigm can be improved. Sequential stereo is used by LCD shutter glasses to provide a three-dimensional image. When the appropriate images appear on the monitor, the glasses close and open their eyes sequentially at a high frequency. A projection screen is used as an alternative to a CRT display. In this instance, light can be polarized, and each eye can extract the correct image with the use of inexpensive polarization glasses. To provide the user with a motion parallax depth cue and enhance the realism of the pictures being presented, head movement tracking can be incorporated.

b) Surround displays Large projection screens can be used as an alternative to traditional desktop displays. They are highly appealing for VR applications because they provide a larger field of vision in addition to improved image quality. The need for complete immersion could be satisfied by CAVE-style displays, in which the user is encircled by one domed screen or several flat panels. A full 360° field of view would be ideal. These projection systems' drawbacks include their size, cost, fragility, and requirement for exact hardware configuration.

c) Fake Space Labs developed and marketed Binocular Omni Oriented Monitors (BOOM). BOOMs are intricate devices that support stereoscopic display technology in addition to mechanical tracking. A box with two forstereo view visual screens is attached to a mechanical arm. The displays are visible through two holes, and the user can get hold of the box. Since the mechanical structure typically provides counterbalance, the displays utilized in BOOMs don't have to be tiny or light. Better resolution and image quality may therefore be achieved with CRT technology.

d) Head-mounted (coupled) displays, or HMDs, are headgear that sit in front of the user's eyes and consist of two tiny CRT or LCD monitors. Based on the user's existing position and orientation as determined by a tracker, the visuals are displayed to them. Given that the HMD is fixed to the user's head, it needs to meet tight ergonomic standards, including being reasonably light, cozy, and simple to put on and take off. It ought to have the highest quality possible, just like any other visual presentation. These requirements compel engineers to make difficult decisions. As a result, there is a wide range in both the cost and quality of HMDs: a low-quality, low-priced device can cost approximately 800 dollars, while high-tech military HMDs can cost up to one million dollars.

HMDs fall into two main categories: see-through and opaque. Through the use of virtual reality images, opaque head-mounted displays (HMDs) completely replace the user's field of vision in applications such as scientific visualization, games, and architectural walkthroughs. See-through head-mounted displays (HMDs) overlay computer-generated images onto actual objects, adding extra information to the real world. The majority of HMDs that are now on the market can be powered by either PAL or NTSC monitor signals and offer stereo vision. Oculus Rift S is an example is shown in Figure 6.

Figure 6. Oculus Rift S

e) Haptic displays: Aural representations perception can be categorized into two primary categories. Forces that thetendons, muscles,andjointsperceiveareknownaskinesthetic(force)feedback.Feedbackreceivedthroughtheskin,suchastemperature, pressure,texture, orsenseoftouch,isreferredto astactilefeedback.

When carrying out any exact manipulation activities, these perception concerns are crucial. Every real-world objectthatmaybemanipulatedwillalwayscollidewiththehand; thiscollisioniswhatisunderstoodashapticfeedback.As a result, many dexterous manipulators and certain data gloves have electronics built into them that replicate thesefeelings.Withoutappropriatehapticindications,adistanti nteractionwithdelicategoodsmaynotbedoneeffectively.

In this work Samsung curved LCD as display and Oculus Rift S as Head Mounted Display are considered.Next section deals with the Implementation of project.

V. IMPLEMENTATION

A. Development Of Virtual Reality Based Internal 3d View Of Winding Of A Motor

Virtual reality (VR) is an emerging technology that is being used in a wide range of fields such as medicine, gaming, and psychology. The use of VR is promising in the field of education and requires investigation, but research on the use of VR in education is still limited. This enables the exploration of new territories, and design education is one of them. Design education, an important part of the curriculum of architecture students who aim to conceptualize problem solving, is still taught using traditional methodologies with touches of digital technologies.

It can be difficult for students to imagine and analyze the internal structure of the Electrical equipment. VR can strongly enhance problem-solving activities in interior architecture. The main aim of this work is to develop 3D view of winding of a motor model in virtual reality environment by using VR technologies we can get real time experience which enhances better understanding for students and involvement in learning. Figure 7 shows the preview of the machine.

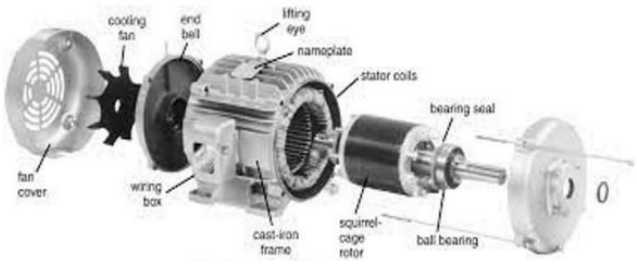


Figure 7. Preview of machine

The three phase induction motor is a preferable type of motor. It is mostly used in industrial drives because it is very reasonable and vigorous, economical and reliable. It is also called an asynchronous motor because it does not run at a synchronous speed. The induction motor requires very

little maintenance,and it has high overloading capacity. [2-4]

A three phase Induction motor mainly consists of two parts called the Stator and the Rotor. The stator is the stationary part of the induction motor, and the rotor is the rotating part. The construction of the stator is like the three-phase synchronous motor, and the construction of rotor is different for the different machines. Step by step briefing is explained below for development of VR based Internal 3d View Of Winding Of A Motor

1. Create room to place the motor and where we can explore the project in that room and create accordingly. Figure 8. is the picture related to the Outer View of the room

Figure 8. Outer View of the room

2. Place the motor on the table and place the charts on the walls to create the room teaching friendly. So, thatusercan getgood experienceto exploretheproject. We canapplythematerialswhateverwewantto becomeit morerealistic. Figure 9 shows the inner view of the room

Figure 9. Inner view of the room

3. User can Teleport from one place to other place using joysticks. By using thumb sticks in joysticks user canteleport from one place to other. We can move forward or backward or left or right. user can't manually move fromone place toother musthave to use only thumb sticks forteleportation. The picture rleated to this is shown in Figure 10.

Teleportation using joystick

Figure 10. Teleportation using joystick

4. Here screen is using to show the part name which user is holding so that one can get clear idea about whichpart is holding because of this one can easily understand about the part like this it will create good environment forstudentstolearn. Figure 11 shows the screen to show the parts of the machine.

Figure 11 Screen to show the parts of the machine

5. The picture shown below Figure 12 is the overall preview of the project in visual script developed in Unreal engine software. And internal view of the room, motor and the table which is used in the project

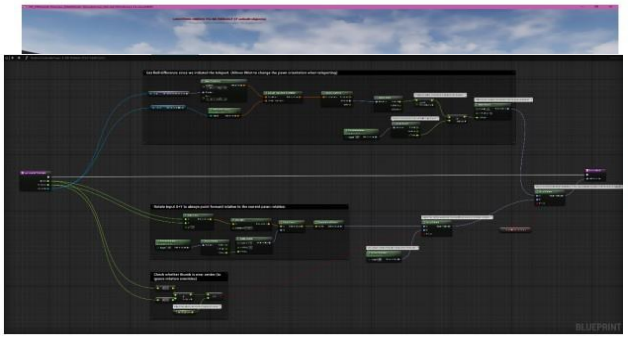


Figure 12 Visual scripting used in Unreal Engine

B. *Tools Used For VR Development*

Though there is Unity and Unreal Engine software for developing Virtual Reality Unreal Engine is preferred in this work because Unreal Engine (UE4) offers a powerful set of VR Development tools.

With UE4, VR apps can be built that will work on a variety of VR platforms, e.g.: Oculus, Sony, Samsung Gear VR, Android etc.

The UE4 platform has many features which offers access to its C++ source code and python scripts, it has a multiplayer framework, real time rendering of visuals and a flexible editor, add animation, sequence, audio, simulation, effects easily and the 3D model of motor will be developed using 3DS max.

C. *Advantages*

*1) ProvidesOutstandingVisualizationsThatAren't PossibleinTheTraditionalClassroom:*Because it allows us to explore several realities and change up our experiences, virtual reality is fantastic. You'reseeing excellent representationswhen wearing a virtual reality headset,which couldmake a goodimpression onyou. Traditional teaching approaches willnever be able to emphasize concepts using images in such an efficientway.

*2) Creates interest:*Students would always choose to sit and watch something rather than read it, regardless of their age. Virtual reality (VR) technology is fascinating because it

can produce incredible experiences that are impossible to "live" in the real world. Using this technology will undoubtedly increase students' motivation to learn.

3) Doesn't feel like work: It's true that doing a headset, witnessing things flash before our eyes, and learning new information through captivating visualizations and films doesn't seem like labor. Children will love to learn more and will be more

4) Improvinmg the quality of education in different fields:

Consider medication as an example. Innovative medical professionals are utilizing virtual reality (VR) technology in 2016 to investigate novel medical topics and improve their ability to instruct others. The field of content authoring and editing would be another example. Virtual reality offers fantastic editing features and is frequently helpful in identifying errors in content.

*5) Eliminates the language barrier:*When it comes to education, linguistic barriers frequently pose a significant challenge. It is a requirement to study abroad that you be able to communicate in the local tongue. Every conceivable language can be used with virtual reality software. Language will therefore no longer be an obstacle to students' educational goals.

D. Disadvantages

1)Lack of flexibility: Using a virtual reality headset differs from the traditional classroom setting if you are able to be adaptable, ask questions, and get answers. Should you be utilizing specialized software that is designed to function in an identical manner, you will be limited to performing your assigned tasks only. Since schooling isn't a set activity, most students may find this lack of flexibility to be a negative. It varies constantly.

2) Addiction to the virtual world: There's a significant chance that students may develop an addiction to their virtual environment. We've observed theeffects of intense events and video games on people. We may even use drugs as an excellent example: there's a goodprobabilitythatsomeonewilldevelop anaddiction if usingthemispreferable thanlivingaregular life.

3) *Quite expensive:*Modern technology is frequently pricy. We need to invest billions of dollars in these features if we want to take this virtual reality movement mainstream. Furthermore, only the wealthy will have access to the contemporary schooling that makes use of the virtual reality environment. Because the impoverished cannot afford it, there will be educational inequity.

VI. RESULTS

The implementation of "Virtual Reality based Demonstration of Induction machine" is done successfully. Design is done to meet all specifications. Software tool like Unreal is used to develop the Virtual Reality. The experience is done with the design implemented in the present work provide portability, flexibility and experienced with less difficulty. Figure 13 and 14 depicts the user getting experiencing the above mentioned work.

Figure 13 User experiencing the work done

Figure 14 User experiencing the work done

VI. CONCLUSION

The purpose of this paper was to explore the changes in the Teaching field and to achieve our decided objectives like time and cost saving by the help of VR. Sample project in VR as compared to the Sample project in existing gives more beneficiary results. Furthermore, research has shown that Virtual technology is a supplement of Teaching field giving users a real time view of what is occurring before them.

It is clear from the research reviewed that these great improvements in Virtual technology are having an effect on the industry in multiple ways. For example, when trying to get a picture of how a final project will look during different stages in the construction process. Along with this, it is also clear that Virtual technology can greatly improve the effectiveness of safety training, because it allows people to get a real time view of different situations on the work site. Even though Virtual technology appears to be an important tool in the Teaching field, it has some drawbacks butit is almost certain that technology will play a critical role in construction for years to come

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