International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 06 Issue: 05 | May - 2022 Impact Factor: 7.185 ISSN: 2582-3930

Industrial Training of Various Equipment and Machinery using AR

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Abstract - In today's world, with the latest and developing technology available for in industry it becomes necessary for any organization to train their employees on how to operate the latest technology aided machinery, tools and equipments. The equipment has complex structure, complicated relations and expensive price. It is difficult to carry out the repeated training with actual equipments in the factors like environmental conditions and costs. When the training has to be provided at a remote location the traveling expenses play a major role in increasing the unnecessary cost and risk of damage to the equipment. As a solution to the above mentioned problems, we can use AR applications for training. Augmented reality (AR) is an enhanced version of the real physical world that is achieved through the use of digital visual elements, sound, or other sensory stimuli delivered via technology. AR applications simulate exactly similar process for training as required. Organizations depend on complete team and not just an individual member. AR allows multiple members to learn, interact with each other and collaborate in the same space. AR exposes users to many different repeatable and randomized workplace scenarios, providing a career's worth of job experience in days or even hours.

***Key Words*:** virtual maintenance training, Augmented reality, human-computer interaction

1. INTRODUCTION

Augmented reality (AR) is a technology that allows people to superimpose digital content (photographs, sounds, scripts) over a real-world environment. AR is a leaping technology that enhances and augments what you see with help of external devices and computer vision. Reality makes so by attaching digital 3D or 2D content (models or data) to real-life objects captured by a camera in real-time.

Nowadays industries are facing a foremost challenge of expensive prices of equipment on which repeated physical training takes place. The human error occurs while performing the task on actual equipment and causes unnecessary equipment repairing cost so it is risky to provide physical training on those equipments. Also there are a variety of issues that bring up the cost of physical training such as venue, instructors and accommodation. Members of the team located at different locations and the instructor appointed for the training may be located at different location so it is not possible every time to collaborate all for the physical training as all people are in different conditions and in different environment. As well as there are chances of fear, anxiety, endangerment in trainees about the costly and complex equipment so there will be less understanding about the equipment due to these factors. This problem can we overcome by using augmented reality. Thus we propose a system that will provide virtual training risk free training by using vuforia engine and leap motion controller.

Vuforia:

Vuforia is known for its Vuforia Engine which is used for Augmented Reality Orientation and Tracking by almost all applications. The main use of tracking is to know the location of the tracker and then by the location of the tracker, we overlay the digital content into it.

Leap Motion:

It a non-intrusive USB based sensory device that enables the direct interaction between user and virtual objects. Users can communicate with the system and input commands by using their bare hands. It can be also counted as a motion capture device that can track hand movements and gestures above the device in a 3D space without contact.

2. METHODOLOGY

2.1 Leap Motion and .Net Framework

The system is developed using .Net Framework and written in C-sharp language. The system is designed for the users to visualize the different equipment and machinery from all different angles possible. It also provides information relative to different processes and functions of the system in both text and speech format. It helps users to learn about system using .mp4 files in video format.

Processing:

The system is developed suing C-sharp and UI is designed using XAML. The system has different modules:

1. Add Module
2. Show Module
3. Leap Motion module
4. Text to Speech module
5 .Login and Registration module

The inputs to the system are added in the first module. The inputs are taken in the form of:

1. CAD Data of the 3D model

2. Text input - Text information related to the equipment or process
3. Mp4 files- to provide visual information

We can add as many models required o the system. The show model is used to actually use the system for a trainee. The trainee can run the 3D rendering in a virtual environment and view the model using hand gestures from all angles. These hand gestures are captured using Leap Motion Sensor. These gestures are processed and the accordingly the model is rotated. The angle of rotation and speed can be changed in the program according to the user convenience. Tracking of hands and gesture processing is done using the library of Leap Motion. The text to speech module uses the provided text information as input and converts the text to speech. The Registration and login module is used to add the user to the system database. The user credentials are stored on the Firebase database.

2.2 Vuforia Framework

2.2.1 For Mobile Devices

The system application is developed in vuforia studio. It runs on mobile devices with Android, Mac and Windows Operating Systems. The application is developed to educate the trainees about replacing a valve in a pressure pipeline system with different visual modules that overlap on the real-world and give the real feel of the process.

Processing:

The 3D CAD model and sequence are developed in Creo illustrate and are imported in the project. Different elements like thing mark, gauges, 3D images, buttons, panels, etc are added to improve functionality and the UI of the application. The styling is done using CSS and the functionalities are maintained using the JavaScript where functions for different operations are defined and linked to relative objects. Then linking is created between different parts of the model to achieve required targets. The buttons are added and designed to match the UI and are linked to the JS functions.

Operation:

To experience the AR proposed system, the user needs to scan a thing mark (target image) in the vuforia view application to begin. The list of available project is seen from which the user needs to select the desired project. After successful loading of project the user can have the visual experience of the 3D model rendered in the real environment on the screen, there are 4 steps of the process for which the project is developed. To call each process a unique button is provided. The 4 steps are namely:

1. Locate
2. Analyze
3. Replace
4. Verify

The user can use these buttons on his/her screen and call these functions. On each function call a new panel opens on the screen with relative information and a button to perform the step. On button click the different steps are performed on screen for the user to learn from.

2.3 For Hololens

The system application is developed in vuforia studio. It runs on a 3D-Eye-wear device called Hololens developed by Microsoft. The application is developed to educate the trainees about replacing a valve in a pressure pipeline system with different visual modules that overlap on the real-world and give the real feel of the process.

Processing:

The 3D CAD model and sequence are developed in Creo illustrate and are imported in the project. Different elements like thing mark, gauges, 3D images, etc are added to improve functionality and the UI of the application. The styling is done using CSS and the functionalities are maintained using the JavaScript where functions for different operations are defined and linked to relative objects. Then linking is created between different parts of the model to achieve required targets. The gestures are added and are defined to perform different functions and steps in the system. The relative voice commands and voice assist commands are added and defined.

Operation:

To experience the AR proposed system, the user needs to scan a thing mark (target image) in the vuforia view application to begin. The list of available project is seen from which the user needs to select the desired project. After successful loading of project, 3D experience starts where the user can visualize the 3D rendered model of the equipment (here the pipeline system) in the real world. To perform the training and its different steps the user can use different predefined gestures or predefined voice commands. The user also gets voice assist, unique for each function. The system performs different steps and functions based on the voice command or gesture input from the user.

3. RESULTS

This paper concentrates on providing virtual training that would help anyone to take efficient & Risk-free Training. In proposed Virtual maintenance training system a method that can track objects in real time, eventually this leads to overlaying of virtual content over real environment. A generalized system is developed that will be used for maintenance, training and for fault analysis in industries. As discussed in the previous section, there are a variety of issues that bring up the cost of physical training. In this study, for First Application, we have taken the Leap Motion Controller which is an optical hand tracking module that recognizes the gestures/movement of user's hands. This module helps the system to recognize the gestures and rotate the model

accordingly and help the visualization process. In the below figure 3.a we see 3D model with working of 3D model with descriptive manner.

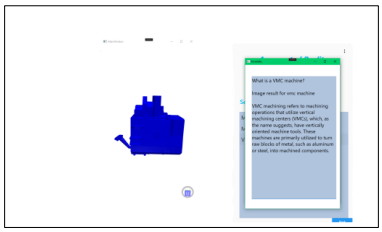

Fig -3.a 3D Rotation

As Discussed in section 1, The Proposed AR-based Training is provided using vuforia Engine with Microsoft Hololens & with mobile Device. Augmented reality (AR) experiences designed for Industrial Employee to provide step-by-step instructions for procedures within the context of the specific, physical machine that requires service. Delivering instructions via an augmented reality Hololens experience makes it easy for Employee to view procedural steps while they're working without having to disengage from the machine to find and check a digital or paper manual. This can save significant time and maximize technicians' efficiency. The Hololens allows for hand gestures and verbal cues to be used. First, User has to select their AR experience for visualizing the experience. The Figure 3.b shows the AR Experience on real world.

Fig -3.b AR Experience with Microsoft Hololens

The application is developed for mobile device to educate the trainees about replacing a valve in a pressure pipeline system with different visual modules that overlap on the real-world and give the real feel of the process. User has to perform all the functions appropriately, on respective calls via UI buttons. The Figure 3.c shows the home screen of the AR Experience application. The buttons with numbers represent the steps order in which the training needs to proceed.

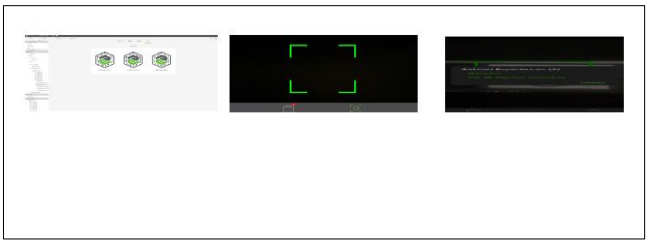

Fig -3.c Home Screen of AR Experience

Fig -3.d Showing AR Experience

4. CONCLUSION

The Virtual maintenance training system is developed using the augmented reality technology. Introduction of such systems which are a combination of the geometric constraints and physical simulation, the system will provide a low-cost, safe and effective training for maintainers of the organizations, so that they can completely immerse themselves into the virtual environment to complete the maintenance operation training. In the idea of an intelligent factory, man will continue to play an important role in the production process, which is why so much depends on his preparation and training. The AR Training system, using AR tech, seems to be one of the prominent solutions for organizing employee training, as it is fully integrated with a real production system.

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