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Virtual reality as an industrial training tool: A review

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ABSTRACT

This review presents generally about Virtual Reality (VR) technologies in industrial training. Virtual reality training is increasingly used for maintenance and operation, assembly procedure, welding and operative construction training that allow the workers to work on existing and new tasks in safe, and perceive on how an item takes shape as it travels through the manufacturing system, which result more effective training. For companies to spend the large amount of economic resources in training people, thus VR systems for training may reduce in dealing with issues such as the high economic costs of training for travel and living expenses for those who need to move from work to training centers. An adaptive technology has been used for pilot training and vehicle driver training that may improves accuracy of the procedure. VR training could create a more effective and efficient learning even without the presence of a trainer.

1. Introduction

Virtual reality training and evaluation is progressively utilized for industrial training [1]. Virtual reality (VR) systems are characterized as human–computer environments in which users are drenched in, and ready to see, act and cooperate with a three-dimensional world [2].

This innovation gives advantages for training which are constrained in conventional guideline. For example, VR is perfect for unsafe training under no risk, allows representation from different points of view many of them inaccessible in real-world environments, allows visualization of virtual equipment, intelligence design allows dynamic learning, gives learners the feeling of control since they can repeat a lesson the same number of times as they need it and gain progress at their own pace. 3D interactive animation environment which has now been implemented and once again more appealing than manual's photography to learners and this assumes a positive part in learning. For companies to spend the large amount of economic resources in training people, VR systems for

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training to deal with issues such as the high economic costs of training for travel and living expenses for those who need to move from work to training centers. Other than this, it builds the present set number of trained personnel.

2. Virtual reality in industrial training

2.1. Maintenance and operation training

Running and operating flexible manufacturing systems (FMS) is an exceptionally complex undertaking, because of the substantial number of parameters included. Since the tasks are changing in time, operators have no real way to learn or get prepared to unravel their undertakings routinely. Virtual Reality systems can help fundamentally in the operation and in the maintenance. By applying VR, the administrator can get on-line and on-going directions can be guided to perform operation tasks never done, by downloading such interactive media data streams that could incorporate movement, reproduction, real life video groupings, or their blended set, from a so-called innovation multimedia database, or even from the real framework. For instance, the maintenance strategy is produced through an activity that demonstrates the gathering and dismantling developments of the piece, and the learner controls the whole procedure [3].

VR technology can be helpful when it is difficult to set up a proper input from the remote site to the observer or controller. In these circumstances the real framework ought to be demonstrated and frequently envisioned, so that the remote observer or controller gets data from the real operation, as well as from the model that coordinates real and simulated data [3].

Presently, there are great cases of Non-immersive applications identified with industrial maintenance and assembly, for example, Vrealism [4] and perception choice emotionally supportive network (VDSS) [5]. The principal illustration is an object-oriented system, which gives the assembly teams, with the aim of providing 3D visualisation and maintenance engineers simulate effective disassembly sequences in specialized engineering work pieces equipment maintenance [6].

In terms of aspects technology, FMS environments are unsafe machine structures, and operators are not permitted move it around freely in the cells. As instance, Automated Guided Vehicles (AGV) or mechanical cells should not to work, when people are available in their workplace. The VR innovation could permit the operators to run the FMS, and just virtually present in hazardous locations. Such applications recommend exceptionally refined, ongoing with multi-media database tools executed [3].

An architecture of virtual reality-based training system (VRTSs) and a modelling knowledge, Petri Net (PN) theory of design approach that VRTSs has been utilized as a one of a kind device for reconstruction of the training work plans and training environments. The application demonstrates the effectiveness of the approach in CNC training using VR [7].

Training for hydroelectric unit of vitality (HUE) by utilizing virtual reality non-immersive methods offers student utilizes the learning approach in view of practice and offers distinctive training levels, separated into three modes: programmed, guided, and exploratory, in which these modes are gotten to as per the procured level of information by the learner in connection to support systems. The second module, allows the student to envision the operation of HUE during a specific event as the electromechanical elements of the turbine-generator gathering in the virtual world by the perception of a few imperative conditions before the startup-shutdown methodology of HUE [6].

2.2. Assembly procedure training

One of the fundamental issues in manual assembly is that expert assemblers are difficult to prepare, especially for gathering forms that require critical thinking abilities. For assembling forms that have high many-sided quality, it regularly takes months or even years for a learner assembler to create expert knowledge. At times, even the specialists should always refer to the guideline manual for infrequently performed systems or procedures with high complexity.

In the manufacturing agile, assemblers confront the challenge of a process continuously changing of the assembly. It is not practical to train assemblers whenever the assembly processes are changed. The assemblers should be broadly educated for various assembly tasks, so that they have a deeper understand of the process as a whole, and this training needed to be done at work. Therefore, the successful implementation of the VR can have a significant impact in the manufacturing industries by manual human support operators that could be necessary custom environments [8].

With the target of training assembler in virtual environment distinctive levels of training relying upon the intelligence, direction and realism required, can be recognized. Referring to the maintenance of spatial capacity for assembly tasks infers that the maintenance of the capacities of the learner is higher when VR is utilized, in examination with conventional means, particularly when it includes a specific timeframe after the training [9].

In this option the grouping of assembly steps is pictured in a virtual environment. Worker interactivity is constrained to review every method step, bouncing in reverse and forward, examining and questioning data about assembly parts, and picking viewpoints [9]. He has the likelihood to investigate the entire virtual scene with the target of exploring functional conditions.

The learner needs to play out the assembly tasks independent from anyone else. He needs to remember the right arrangement of steps and plays out the assembly in the virtual environment. The mentoring system will show the potential misstep that have been made and is giving insights if desired. Indeed, even a rating of the assembly execution is possible [9].

Incorporates integrated virtual assembler training complex procedural assembly training with a dynamic environment and simulation of the virtual factory. A simulation of the installation in a commercial simulator simulates the production line of the factory. The test system is associated on-line with the virtual environment. Both frameworks are synchronized [10].

The trainee can assume control over any assembler in the virtual environment and perform its task assigned from assembly. Execution of the assembler (e.g. terms for undertaking finish) is input to the recreation where it is considered in like manner [9]. A pilot venture was directed with a maker of business vehicles. Its goal was gone for the long-term vision to build up a virtual reality training environment for creation assemblers.

The pilot project consolidated a current ability to perform simulations of mounting detailed with interactive perception in a virtual environment. The capacity of create virtually a line of assembly very early in the process of design and development allows the management and the worker for cooperation on evaluation of assembling, ergonomic, safety and part stream issues before the design is concluded keeping in mind the end goal to find potential issues before they turn out to be costly to fix. Along these lines it is conceivable to qualify specialists at the soonest by utilizing the virtual sequential construction system before the real one is accessible [9].

According to Borsci design and evaluation tool in the management of training services for cars, in accordance with the new approach emerged, such as serious games and gamification, are still unexplored [11]. It will able to play an important role to illustrate the effectiveness of the tools and much more, to uncover new potential tool VR / MR for operator training.

2.3. Welding training

In numerous industries, for example, shipbuilding, machinery production and manufacturing of little parts, welding is still generally a manual procedure done by human operators. Training of new welders is an important activity for both for industry and for the professional instruction group. Training is particularly important for welders who work in critical components for example, pressure vessels, nuclear piping, and naval ships, where welds are deliberately examined. It is evaluated that the joined welder training costs for all U.S. shipyards is in abundance of $5M every year. There is dynamic enthusiasm among maritime shipbuilders in decreasing welder training costs [12].

A mixed reality system has been created to simulate the gas metal arc welding GMAW welding process. A welder can hold a real welding light while seeing and listening to a virtual weld dab made with precisely predicted quality. The system gives a sensibly practical ordeal of the real welding process. The system can be enhanced through further refinement of the visual, audio/sound, and haptic show constancy [13].

2.4. Operatives construction training

The conventional development industry has continually been tested to enhance its inherent risky practices. Offsite generation (OSP), under the umbrella of present day techniques for development (MMC), has been recognized as a way to enhance development industry execution and additionally meet new market requests through the arrangement of enhanced, versatile, and manageable structures [14].

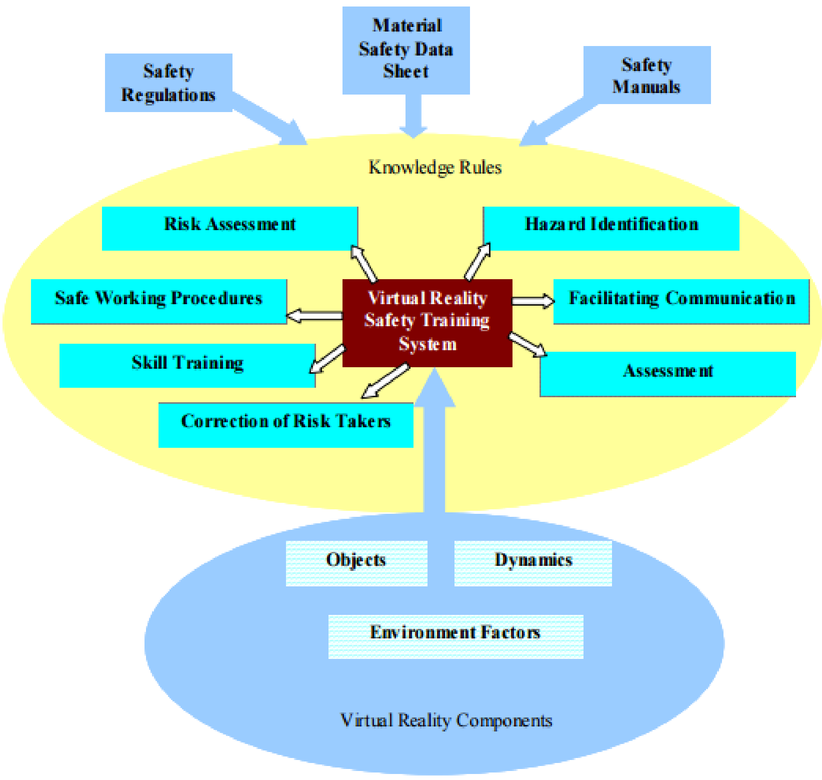

Fig. 1. Details of VR safety training system [15]

The VR simulation can be used in safety training to help users understand and learn the safety rules, standards and regulations. VR can also be used to assess the extent of construction workers acquire skills after taking safety class [15].

On job training (OJT) has been condemned for being costly, constrained, and some of the time without the real training setting. So as to address the issues experienced with OJT, a few virtual reality (VR) arrangements have been proposed. One such VR arrangement model, keeping in mind the end goal to give a risk free environment to learning without the 'do-or-die' outcomes frequently confronted on real development ventures [14].

Mining industry accident statistics also contributed the most dangerous and the highest workplace accident [16]. With the use of Virtual Reality (VR) enables acquisition and practice correct behaviour by the miner in a controlled environment, safe [17]. According to Grabowski, technology training of Head Mounted Displays (HMDs) will encourage owners with training and cooperation of polish mines for basic training, especially young miners.

The model design and advancement of a VR intelligent training environment for OSP created with a particular order of allowing learners to encounter OSP practices and procedures utilizing real living environments. These environments depended on a real-life project situated in the UK, the representation of which was further supported and approved by area specialists to amplify validness [13]. The iterative way to deal with testing and approval process was attempted keeping in mind the end goal to guarantee that the completed item:

a) was fit for reason (content/level/OSP outcomes);
b) meet the need of wide range of stakeholders; and
c) learners engagement (level of detail/interactivity)[14].

Consequently, these are able to ensure that learners could recover precise and proper data keeping in mind the end goal to settle on exact and educated choices. In this regard as well, there was a need to adjust the level of complexity nature and interactivity offered to learners in the VR environment, against the desired learning results that should have been accomplished.

According to Xu, the visualization of smoke, fire simulator, and model Integrated Hazards Dose (IHD) path, with rational VR training, and smoke hazard assessment, suggested by Xu can reduce the potential danger of the cause of the fire smoke [18].

3. Self-adaptive technologies in VR training

A present issue is that VR students all experience a similar training schedule, which is not customised to individual learning designs. However, every student learns contrastingly and will require their preparation to concentrate on particular parts of the tasks. Routinely, keeping in mind the end goal to adjust or re-design appropriated training frameworks, human supervision is required which is exorbitant and tedious. Computerization can stay away from this human supervision to decrease or maintain a strategic distance from these expenses [1].

Self-versatile VR could possibly make training more efficient and effective. VR training could be enhanced by joining autonomous, information driven perspectives to customise and computerize training for people [19].

Adjustment has been connected to each of the five center advances inside VR training: adaptive technology, haptic devices, head mounted displays, assessment, and autonomous agents. With haptic devices, adaptive components of a client's physical abilities can be measured as far as the point, force or pivot of the haptic instruments [1]. This is valuable for adjusting to the learner's skill and expert haptic direction.

Adaptation can empower a change far from course book that just need to figure out how to the utilization of smart media and onscreen learning. This new change gives chance to customised adaptive figuring out how to individualize e-content [1]. As adaptation innovation are considered, for example, benchmark checks which ought to be performed to survey the ability of this new stage to out-perform traditional method. The current new era of learners will show the advantages of the present brilliant training insurgency.

4. Advantages of VR training

VR offers the best training by permitting every representative have a full access to the whole office and copies a whole assembling procedure to a virtual situation to give coaches their own manufacturing factory to learn in. The virtual environment of the office will likewise permit the workers to work on existing and new tasks in safe, and perceive how an item takes shape as it travels through the manufacturing system, which result more effective training [20]. In other words, VR can provide a worker with an environment to investigate the results of their choices without risk themselves or equipment and empower to allow the workers to work on existing and new tasks in safe.

5. Conclusion

In summary, involvement being developed of non-immersive VR frameworks for training demonstrates that VR is helpful in incorporation of learning settings; this makes it a proficient learning instrument [21]. We understand that 3D scenes and movements are speaking to individuals regardless of whether they are proficient or not. The issue of virtual reality into truly intelligent and immersive environments is the following sensible stride in the improvement of visual 3D simulations and is a legitimate result got from the prerequisites of the advanced production line or industry.

By one means or another property of possessed the capacity to make virtual settings empowers VR as a learning apparatus. It has been watched that presentation of VR in training, impacts not only the training itself but also of training costs and modifies the way in training is handled mainly in companies. For example, one of the markers used to quantify training is the quantity of hours per individual every year. At the point when VR frameworks are accessible to potential learners, sometimes they spend numerous a larger number of hours than those characterized by the company, mainly when they can introduce the framework in a tablet that they can bring home. These additional hours don't suggest educators' hours, which decreases costs. In conclusion that there may be instructional spaces where learners can self-learn utilizing a framework whose instructional substance is exhaustive and truly well done. In such cases, presence of trainers would not be determinant for trainees.

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