VIRTUAL REALITY FOR METAL ARC WELDING: A REVIEW AND DESIGN CONCEPT

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ABSTRACT

Virtual Reality (VR) creates computer generated environment that facilitates multidisciplinary collaborative engineering. Computer graphics becomes very much user friendly for an average user. It allows people to see the surrounding world in new dimension and to experience objects that are not feasible in real life environment. Virtual reality helps into the world where one can interact with computer based simulation instead of just watching a picture on the monitor screen.

Virtual reality environment is based on visual experiences and computer screen or stereoscopic displays. Virtual environment creates users to interact with the devices such as a keyboard, a mouse, or a wired glove, goggles etc. Virtual Reality technology may provide an effective and innovative solution, and various complex high-tech VR systems for training. The paper aims at providing a review on virtual reality, virtual reality systems, virtual reality applications, challenges in virtual reality, virtual welding and Virtual Reality Modelling Language (VRML). The paper also emphasizes on conceptual design of virtual welding platform.

Key words: Virtual Reality, Virtual Welding, VRML, Virtual Welding Platform

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1. INTRODUCTION TO VIRTUAL REALITY (VR)

Virtual Reality (VR) is an environment based on computer simulation. It simulates human physical motion presence in the real and simulation world. It creates an interactive experience where human being feels totally involved in virtual environment by means of computer-human interface equipment. Virtual reality helps the users to interact with virtual 3D objects in a natural way, and making them to feel as real and getting to realize, analyze and simulate [1].

There are mainly three types of Virtual Reality namely Non-immersive, Sensory-immersive and Neural-direct. Non-immersive level is basically experienced on a desktop computer, where the virtual environment is created without any hardware equipments. In Neural-direct method, human brain is directly linked to a database and the observer's current position and orientation. [2]. In Sensory-

immersive method, modeling of the real environment plays a vital role in various virtual reality applications, such as navigation of robots and aircraft simulation. A common existing example is the Cave Automatic Virtual Environment (CAVE) cube where the user is surrounded by projected images which creates virtual environment [3].

2. VIRTUAL REALITY SYSTEMS AND ITS APPLICATIONS

Virtual reality technology produces simulating environment and simulates expanded behavior such as exploration and interaction with the virtual environment. The user interface part acts as a middleware connecting the virtual world, simulation and graphics engines with the user's input and output devices [4]. In 1956, Morton Heilig invented the Sensorama, a device came to known as the Head-Mounted Display (HMD) [5]. In Cave Automatic Virtual Environment, projectors cover the walls of a room with stereoscopic displays and the user need to use glasses which are synchronized with the projectors and speakers that surrounds the room [6]. Wired gloves, wands and computer vision are the common types of data inputs to virtual reality systems [7]. The Nintendo Wii was the first person to bring motion-sensor controllers in virtual reality which is popularly known as wands. This motion sensor calculates the position of the controller based on the distance of a fixed point and infrared rays [8]. Another way to enable movement interaction is using cameras to recognize models and identify motion. The main capability of computer vision is by using a RGB (Red Green Blue) camera that allows face recognition [9].

Virtual reality is commonly used in military for training purpose [10]. In entertainment field, virtual reality is used in simulation of modern computer games with haptic feedback [11]. In education field, VR is used in Science Space application which is focused on Newton World, Maxwell World and Pauling World that mainly uses HMD [12]. In the field of engineering, virtual workbenches are created with engineers in far locations all over the globe working in teams to design and manufacture the products. By using virtual reality in architecture, design can be modified at any point of time before the finalization of actual construction which saves time and money [13]. In medical field, complications in surgical operations are reduced by implementing virtual reality systems. HMD helps surgeon to operate human body as it is transparent for observing critical zones which makes the operations easier, faster and safer [14].The big challenge in the field of virtual reality is to develop better tracking systems and to find the best ways to allow users to interact within a virtual environment and thereby decrease the time to build virtual spaces [15].

3. INTRODUCTION TO VIRTUAL REALITY FOR WELDING

Even though automated welding techniques are being developed, manual welding is necessity for both technical and economic reasons [16]. For majority of welder's tactile learning methods are effective and safer compared to manual welding where skilled welders are required. Therefore, for welders to gain hands-on welding experience, welding simulation is best way to go ahead [17, 18].Since 1970's several welding simulating methods and devices have been designed for training welders by simulating welding operations [19] to address spark, electric-arc [20,21], using a television-type display [22, 23] introduction of microprocessor [24]. For training three basic skills namely maintaining a proper electrode angle, maintaining better arc, and tracking the bead, a microcomputer controlled welder training simulator was developed [25]. Charge Coupled Device (CCD)-based optical system is used to detect the height of welding torch [26]. At present, metal arc welding simulator with haptic display provides skilled welders where welder feels force taken an electrode into base metals [27]. Virtual reality (VR) technology is employed as a method for solving problems such as achieving skilled trainers, compatibility, material reduction, time saving [28-31]. For improving reality either force display, mixed reality, stereoscopic display are used. The force display and stereoscopic displays are not necessarily important in training according to skilled welder's advice. To improve welding skills without complication force display devices, stereoscopic

display devices, and mixed reality are used where a less expensive and simple training system may be implemented [32-35]. Weld properties such as weld depth, microstructure and residual stress and distortion are predicted easily using a computer simulation without any experimental trials by using virtual reality welding technology [36].

4. VIRTUALIZED WELDING SYSTEM PLATFORM & VIRTUAL REALITY MODELLING LANGUAGE (VRML)

Virtualized welding system platform consists of two workstations namely real welding workstation and virtual welding workstation. In real welding, completing the welding task is a primary task but in virtual welding workstation, primary focus is on visualizing the work piece in virtual environment [37]. EndeaVR software is used in virtual welding system to control the simulation which shows the weld puddle, the bead deposition, and the cooling effects as the bead solidifies.

VRML is a descriptive language belonging to the field of the Window on World System. Open GL is the foundation for VRML. VRML 1.1 aims in mapping user requirements for development of a new VRML format [38]. In 1996, VRML 2.0 was approved as ISO standard and became international standard as VRML 97 that has new capabilities which can be used for 3D complex representations creating of various scenes and products [39].
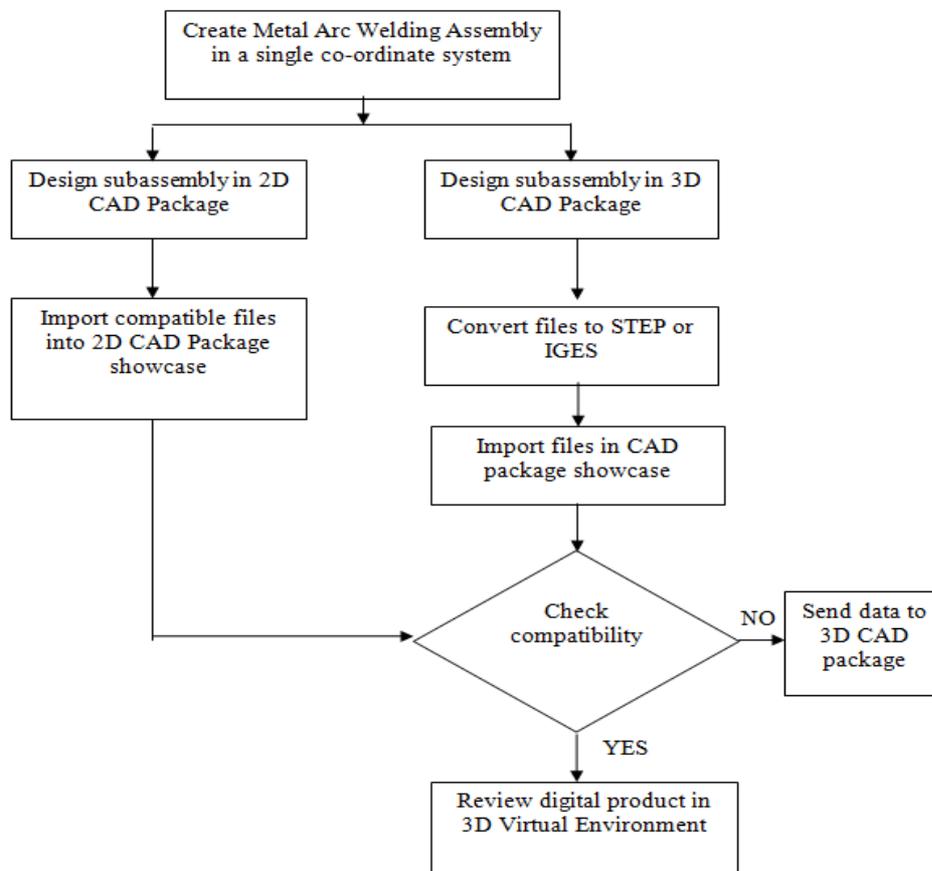
5. FLOWCHART OF DESIGN METHODOLOGY

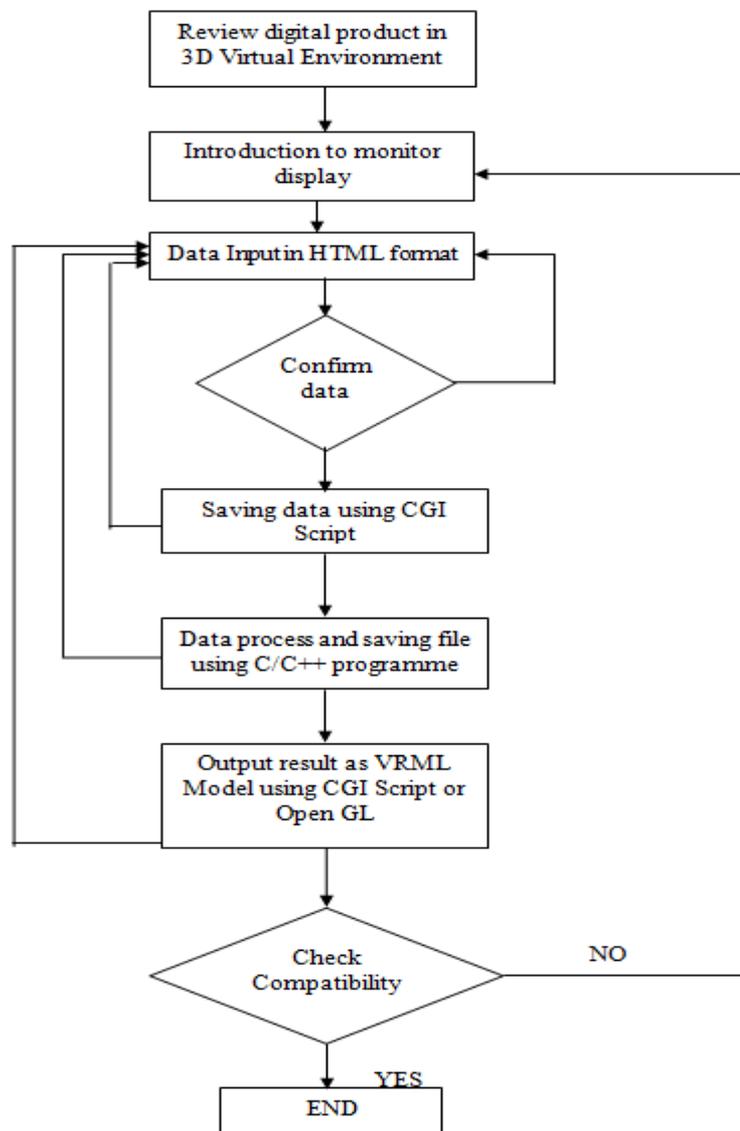Design methodology of virtual reality welding is divided into two stages:

Stage 1: Modelling of Metal Arc Welding Assembly in a commercial CAD tool

Stage 2: Conversion of 3D Virtual Model to VRML model for obtaining real experience in virtual environment.

Stage 1

Stage 2

6. CONCEPTUAL DESIGN OF VIRTUAL WELDING PLATFORM

The conceptual design has been developed using 3ds Max 2009 software. The design of virtual welding platform which is shown in fig.6.1. has two parts. The first part has tables and desk where the concept of virtual reality is explained to the trainers and the second part has worktable, virtual welding machine, VR glasses, head mounted display, gloves and sensors which creates a gap between virtual environment and real environment.
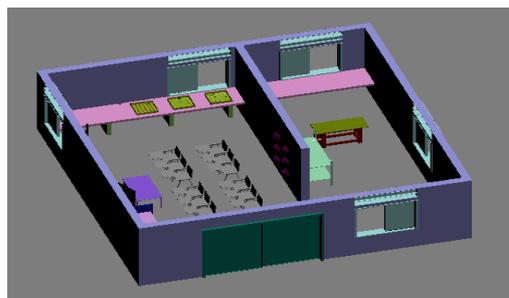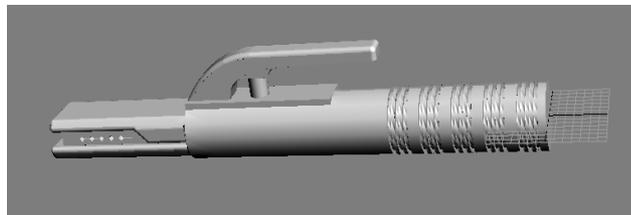

Figure 6.1 Virtual Welding Platform

The design of human body which is shown in fig.6.2 is build using 3ds Max 2009 which helps the human to move in virtual environment. In same fashion the design model of electrode holder as shown in fig.6.3. is designed.
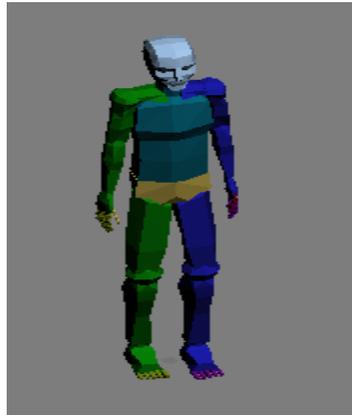
Figure 6.2 Human Model used in virtual environment

Figure 6.3 Electrode holder used in virtual environment

7. CONCLUSION

The modern concept of virtual engineering is the result of computer graphic technology, virtual reality technology, modeling and simulation technology, which changes basically the conventional manufacturing mode of design, trial & error manufacturing, design modifying, scale production and plays a significant role in product & process development.

This paper presents reviewing of the concepts, systems, applications and challenges in virtual reality. It is important to realize from this review that VR is not simply for visualization purposes, instead offers improved methods of interaction and visualization through suitable design, simulation and analysis, where it can be applied in real engineering problems. Finally the conceptual design of virtual welding platform is designed using commercial CAD software and a design methodology is made to complete the entire virtual environment to progress.

8. ACKNOWLEDGEMENT

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