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Virtual reality (VR) technologies in education of industrial design

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Abstract

Design is an art and art is a design. Today, all industrial products are the result of a design process. Industrial design is a multi-disciplinary field of study, which has a goal to create and produce new objects and it focuses on designing of products by using knowledge related with applied science as well as applied arts and various engineering disciplines. Academic programs related to industrial design focus on achieving the proper balance between practicality and aesthetic pleasure. Courses may include graphic and industrial design basics, manufacturing, modelling and visualization, environmental and human interaction in design. Computer aided design software are strongly emphasized. Students constantly observe, model and test their creations. They investigate the optimal ways to design virtually any type of products, including computer interfaces, appliances, furniture, transportation and recreational items. The developments of new interactive technologies have inevitably affected to education of design and art in recent years. VR is an interdisciplinary emerging high technology. VR interfaces, interaction techniques, and devices have been improved greatly in order to provide more natural and obvious modes of interaction and motivational elements and it is an integrated technology combining; 3D graphics, human-computer interaction, sensor, simulation, display, artificial intelligence and network parallel processing. This study presents notable VR systems have been developed for education and the methods of design, such as modelling and visualization.

Keywords: industrial design, interactive technologies, modelling and visualization, environmental and human interaction, virtual reality

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1. Introduction

All industrial products are produced by the design process. In this process, the role of an industrial designer is to create and execute design solutions for the problems of form, usability, ergonomics, marketing, brand development and sales.

The profession of industrial design is specifically linked to the growth of industrialisation and mechanisation that began with the industrial revolution in United Kingdom in the mid 18th century. Last decade, the profession of industrial design has begun to be recognized as a primary element for all the competitive countries and firms.

Industrial design is a specific field of art and technology, which has a goal to create and produce object. This can be done in combination with technology and art fields and industrial designers must not only deal with product functionality and appearance, but also they have to ensure user satisfaction related with product.

Industrial design is a creative act and arises from the origin of the historical crafts. The combination of industry and crafts formed the industrial design disciplines. Along with Bauhaus, scientific knowledge began to gain importance on this combination (Findeli, 2001), and *t*he transition of skills towards knowledge has played a major role in the development of industrial design education. An industrial designer in this period, Morris (1938) emphasized that design could be a kind of semiotic and also the design education should be in the dimension of verbal, semantic and instructive; design need to include artistic, scientific and technological inputs in order (Morris, 1938).

In today's products; scientific, technological and artistic contents are gradually increasing. Moreover, design and industries based on it; include more complex elements in terms of form, function, material and manufacturing. Now, industrial design sector requires human resources who are innovative and able to use high technology by increasing global competition. The aim of the study is to determine the most basic and the most probable effects of virtual reality technology which is today's most advanced technology on industrial design education for near future.

2. Virtual Reality

Development of new interactive technologies has inevitably impacted traditional sciences and arts. Mixing of disciplines and evolution of techniques has brought forth need for better modes of communication. VR; a computer generated, interactive, 3-D dimensional environment in which a person is immersed (Figure 1).

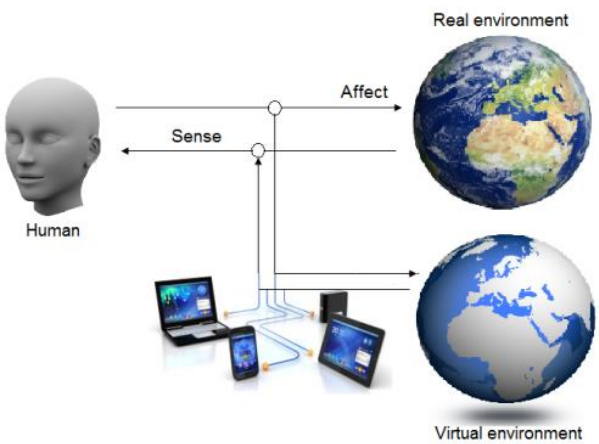

Figure 1. Interactions of VR

VR is the use of modelling and simulation to enable a person to interact with a 3D environment visual representation of a real or imaginary system as an immersive, multi-sensory, and interactive manner.

Reality-virtuality continuum graphic which classifies the system as a display technology can be used while passing from virtual to real and vice versa (Figure 2).

Figure 2. Milgram's reality-virtuality continuum graphic (Milgram and Kishino, 1994).

Real environment (RE) and virtual environment (VE) are at two sides, mixed reality (MR) is in the middle, AR is near to the real environment side. Data created by the computer can augment real environment and enhance user's comprehension about environment. Augmented Virtuality (AV) is a term created by Milgram and Kishino (Milgram and Kishino, 1994).

Augmented reality (AR) is an important branch of VR. AR is that organically, in real-time and dynamically overlaying virtual images created by computers and other information on real environment which the observer sees. And when the observer moves into real environment, virtual information becomes changed according to the movement, just like those virtual information truly exists in real world.

Virtual Environment is a 3D graphical computer-created environment which has/has not correspondence in real world. It can also be called as "Virtual Environment" (Sherman&Craig, 2003).

VR technologies include virtual environments, visualization, interactive 3D, digital prototypes, simulation, visual simulation and 4-dimensional computer-aided design (Whyte, 2002). The user wears goggles, headsets, gloves, wands to interact with the simulation and visualization (Figure 3).

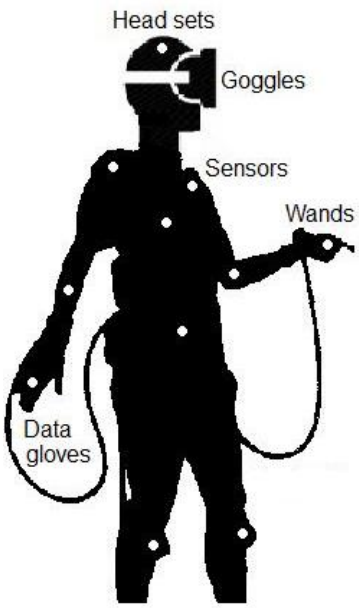

Figure 3. Body suits for VR

The motion sensors (tracking camera) pick up the user's movements and adjust his or her view and action accordingly during the interaction (projectors), usually in real-time by computer systems (Figure 4).

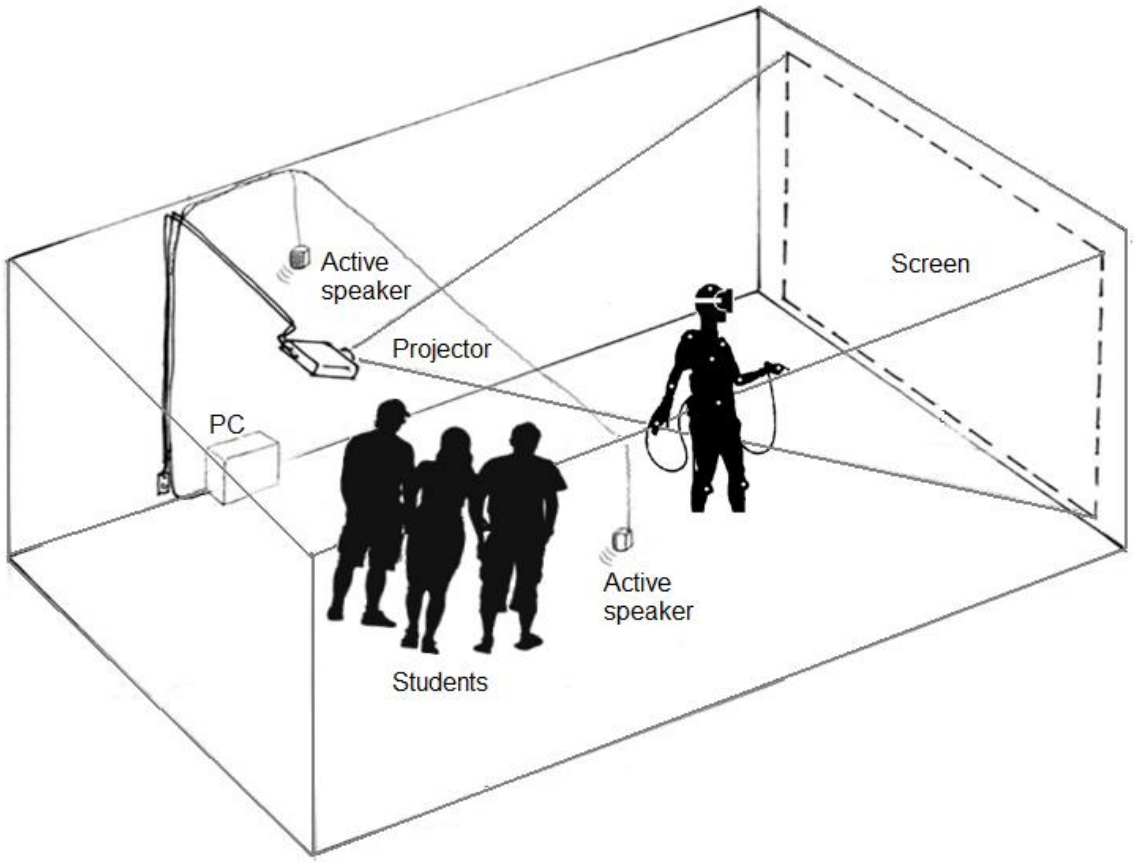

Figure 4. Basic equipments of VR

The VR engine of the component of VR is the graphic modelling and processing system. It is for object modelling, texturing, mapping, lighting, rendering and finally displaying 3D scenes in real time. VR software is used to design, build, and maintain virtual worlds. There are two types of software systems; open source and commercial toolkits. According to Burdea and Coiffet (Burdea and Coiffet, 2003), VR modelling includes geometric modelling such as kinematics, physical, and behavioural.

The visualization and presentation of design are some processes. This process; resource gathering, measurement and assessment works, data analysis, 3D modelling, visualization and multimedia presentations (computer, web, mobile etc.). VR technologies have been rapidly rising in the field of design and architecture (for example, immersive reality technologies like CAVE systems).

3. Virtual Reality in Education

Today, the main branches of design are industrial, interior, graphic, textile, exhibition and display, fashion, jewellery, furniture, TV-film and set, interior decoration, digital media, design management, design education and other disciplines.

Industrial Design both as a profession and a university program such as undergraduate, master and postgraduate is in developing and spreading day by day.

Basic courses of industrial design departments; Design theory&practice, communication skills, manufacturing materials and processes, design history, design software applications, computer aided design & manufacture, presentation techniques, ergonomics, project management and business management.

Industrial design students want to be well-prepared for their professional life and expect more courses with practical application of theoretical knowledge acquired during their studies. Undergraduate students in industrial design deal with a number of design projects in their study. Design tools learnt are basic CAD systems such as, Sketch up, Rhinoceros and Autodesk Alias, mock up's and physical prototyping, These systems provide very useful tools to assist students for product drawing and structure design. However, they are not good for an interactive evaluation and detail research of the design. VR provides a tool in 3D interactive environments to allow a design to be explored exhaustively. It is necessary for design researchers to have the VR knowledge for using VR in design applications.

So far, applications of VR have been the subject of several investigation and report. Important studies are carried out in recent times as follows; First study (Ye et.al. 2006) has been developed an innovative conceptual design system as called the LUCID system for conceptual design. Another study (Zhigeng et.al., 2006) researched on educational uses of virtual learning environment concerned with issues of learning, training and entertainment. They are described education and simulation. The current application of VR systems in the design process is limited mostly to design review. A research group (Weidlich et.al., 2007) researched the reason for this limitation is the different data formats used for CAD and VR visualization. They show that integration of CAD core functionalities in VR systems for solving the problem. Another research group (Nee et.al., 2012) researched on the development of AR applications in design and manufacturing. In another study carried out recently (Häfner et.al., 2013) researched the teaching methodology for a practical course in VR for graduate and undergraduate engineering students. One of the recent studies on VR in the arts by Grenfell (Grenfell, 2013). She wrote the results of multiple modes of teaching and learning, ranging from real world experiences. The most recent studies in this field (Wei et.al., 2015) are researched based on the model of motivational design, social psychology, and a computational model of creativity. They are show that the proposed teaching scheme significantly improves learning motivation, student creativity, and the teaching of creative design.

As a result of this vivid interaction, a stream of new ideas and new forms of creativity can be generated. Industrial design courses combine ideas both digital technologies and those of creative design.

4. Conclusions

Design education and technology are interconnected. Benefits of the three-dimensional real-world conditions' implementation in a virtual learning environment design;

- Allows students to gain experience closer to real life,
- Accelerates and diversifies learning to work with virtual prototypes instead of high cost mock-ups and physical prototypes,
- Allows students to evaluate design theory and methods more effectively,
- Contributes students' learning the design history interactively,
- Can increase productivity by accelerating the activity of industrial design studio courses,
- Develops students' creativity and imagination. May lead to an increase in motivation,
- Can increase students' productivity by reducing of time they spend to reach their goal,
- Provide students' experiences about real life more permanent,
- Facilitates teaching user-centered design (ergonomics),

- Facilitates learning materials that will be used in the new design projects. Such as; ABS, PS,...etc,
- Students will have opportunity to practice this new technology. So they can utilize this technology in their professional work life,
- Students can solve many manufacturing problems by this technology before doing physical prototypes,
- Students will have more time to create new ideas instead of consuming time for prototyping.

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