CHAPTER 2

LITERATURE SURVEY AND PRIOR ART
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2.1 Introduction

Computer Based 3D Visualization is a powerful way of presenting information that otherwise would be difficult to analyze and understand. Engineers in manufacturing industries use sophisticated Computer Based Visualization to model complex events and visualize phenomena that cannot be observed directly. Literature review reveals that, this has been an emerging area of research and development in the current decade. The related literature review is presented in this chapter. This review is supplemented by referring about 150 research papers. Some selected references for broad overview are taken here.

2.2 Prior Art Vis-à-vis Our Research Work

In this literature review, we have taken references of the similar work and explained the same with respect to our research work.

2.2.1 Historical Perspective

Bowman, Chen, Wingrave, Lucas and Ray,31 in this paper, authors have made some observations about the history of 3D User Interfaces and the current state-of-the-art. They have illustrated and discussed some of the new directions using case studies of research projects undertaken in their group. Three-dimensional user interfaces support user tasks in many non-traditional interactive systems such as virtual environments. Although 3D UI researchers have been successful in identifying basic user tasks and interaction metaphors, evaluating the usability of 3D interaction techniques, and improving the usability of many applications, 3D UI research now stands at a crossroads. Very few fundamentally new techniques and metaphors for 3D interaction have been discovered in recent years, yet the usability of 3D UIs in many real-world applications is still not at a desirable level. Developers have proposed that research topics related to specificity, flavors,
implementation enabling the rapid and robust development of 3D UIs, and emerging technologies applying or redesigning existing 3D UIs for new technological contexts will have a major positive impact on the field and on the usability of real-world applications of 3D UIs. These new approaches indicate the potential for improving 3D interaction design and development. Our research is one of the new directions in 3D user interfaces. It is a passive stereo system uses red blue eye wares to perceive 3D effect. It is a cost effective computer based visualization technique specially designed for manufacturing industries.

An interesting paper by Jimeno and Puerta explains the idea that technology can transfer a person to a different environment without any physical movement and create the illusion of interaction with the artificial environment is not new. Scientists and engineers have been dedicating their efforts to its progressive development over the last fifty years. However, most of the technological advances have been made in the last ten years, undoubtedly thanks to improvements in computer efficiency and the miniaturization of sensorization devices. Nowadays, Virtual Reality is successfully applied in different fields, such as telemedicine, robotics or cinematography. Following on from this success, it is confirmed that virtual reality can be applied to industrial design and manufacturing processes. The lack of recent reviews on this technology applied to CAD/CAM, together with its rapid evolution over the last decade, have been the primary motivations for carrying out this study.

In a yet another interesting paper by Wegman and Symanzik an overview of current virtual technology is taken. It describes how this technology can be used for data visualization and exploration. Authors’ perception of the Virtual reality is the domain that refers to immersive, interactive, multi-sensory, viewer centered, three-dimensional computer generated environments and the combination of technologies required to build these environments.

2.2.2 Reviewing the Current Technology

Another related paper in this area is by Koschan. The objective of the report is to show and to categorize the novel developments in stereo research since 1989.
This overview is supplemented in an appendix by a survey on 86 current papers on stereo research. The paper reveals that, only few problems in computer vision have been investigated more vigorously than stereo. Consequently, many different stereo vision methods have been published and their number is increasing. Although the principle of computational stereo has been known for more than 20 years, new directions in stereo research are still being under development. Stereo is a well-known technique to obtain depth information from digital images. The key problem in stereo is how to find the corresponding points in the left and in the right image, referred to as the correspondence problem. Worldwide, many research activities are known dealing with stereo vision. In their solution, these methods use different approaches to solve the correspondence problem and to select constraints imposed on the visibility of objects in the scene. Furthermore, the methods are applied to rather different tasks, and a large number of distinguishable features are used in the solutions. This aggravates a direct comparison of the methods. Taking inspiration from the above mentioned research paper; our research focuses on computer based stereo visualization for manufacturing industries. Thus the visualization in general is a tool for interpreting image data fed into a computer and for generating images from complex multidimensional datasets. Further the Stereo visualization is a feature of Virtual Reality which adds reality to computer generated scene, where any three dimensional scene can be viewed using stereo glass to get 3D effect. It provides depth cues, which gives better visual effects to the user than 2D projection. It is an effective way to enhance insight in 3D scientific visualization.

Yet another paper by Steed reviews the current technology, in the context of Virtual Reality. Many aspect of the design of VR system considered are – the interface devices, system management software and actual virtual world structure. Here the author has described few specific applications that have been developed. Out of the reported applications in the above paper, our research deals with development of computer based visualization tool for manufacturing processes.

Ressler et. al. have reported virtual environment as a synthetic environment; a collection of technologies that offers the opportunity to integrate the human into computing system. This technique consists of a high-speed graphics display computer, a head mounted display, a 3D position tracker and spatial audio.
When combined into single system the computer application can track a user’s head position generates a display that changes depending on where the user is looking. The 3D input device allows the user to interact with synthetic objects and the spatial audio heightens a user’s sense of place. In this paper various case studies are explained as examples related to application of virtual environments in several aspects of manufacturing as follows:

- **Boeing** – The research and technology organization of Boeing was pursued two projects using VR technology.

- **Caterpillar** – Researchers at Caterpillar Inc. have used VR to improve the design process for heavy equipment. The team is able to perform visibility assessment of the new design. The engineers can operate the equipment and evaluate visual obstructions in a natural manner without having to build a physical prototype.

- **Ford** – In Ford Alpha organization evaluation of automotive assembly done using VR. Here the vehicle parts are represented in a CAD system. The CAD files are transferred to VR equipment. The user than manipulates the virtual part and attempts to assemble it into the virtual vehicle.

- **Maintaining Equipment in Space** – The Software Technology branch of NASA’s space center was explored the use of virtual environment as a training aid. Virtual environment, which immerse the user into a synthetic space, can play an important role in training for maintenance missions.

Thus the application of Virtual environments gives manufacturing engineers a new tool to solve complex problems. It offers the engineer to not only visualize their problem spaces but to interact with their environment. Many manufacturing problems are visualized by images of parts or manufacturing processes. Stereo vision is a primary feature of virtual environment. In our research we have worked for developing a stereo visualization suite for manufacturing industries. The main focus of our research was to develop an effective low cost passive stereo executable on a fairly general-purpose computer used in manufacturing industries. This has achieved in our research by constructing the computer based three-dimensional passive stereo vision solution. Passive stereo is a low cost technique, which requires only red blue eye ware. It is envisioned that the distinction between CAD (Computer-Aided Design) and virtual reality systems converged as new design systems by encompassing features from each of the technologies.
2.2.3 File Formats and Their Manipulation

Pioneering work in this area has been reported by Rock and Wozny\textsuperscript{105}. They have explained a flexible file format for Solid Freeform Fabrication data that significantly improves on the de-facto industry standard STL format. The new format reported by them removes the redundancy present in STL files and contains topological information. Its specification flexibility allows users to balance storage and processing costs. Since facet boundary models currently provide the greatest common denominator for data exchange between many CAD systems, they are supported by this format. In our research work also, the visualization tool developed parses STL and VRML ASCII files generated by modeling software. This tool fetches the data from these files which are required only for visualization.

2.2.4 Integration of Passive and Active Stereo

Chen and Zheng\textsuperscript{19} have reported integration of passive and active stereo vision for shape detection. This approach has been designed to detect the shape of curved/smooth surfaces of metal plates. The boundary and shape are first roughly identified by passive stereo vision. This identification helps ease the correspondence problem in active stereo vision, whereas active stereo vision detects the shape of the object. In particular, this dynamic passive and active integration approach is shown to be effective in detecting and solving the false-boundary problem embedded in strategy is developed to assist such a sensing approach. Passive stereo vision is proposed to work in a complimentary manner with active stereo vision for detection of smooth surfaces of deformed plates. Passive stereo vision is used to obtain the boundary of the smooth surfaces, whereas active stereo vision with the projection of structured light is applied to detect the details of the surfaces. An inherent problem in passive stereo vision, called false boundary problem, is identified. The problem is solved by calibrating the structured light in active stereo vision and dynamically placing the cameras in passive stereo vision. The matching criteria in active stereo vision and the sensing process of the proposed approach are presented. An experiment was conducted to test the effectiveness of the proposed approach.
Connacher, Jayaram and Lyons\textsuperscript{55} have reported a novel approach for “Design by Manufacture”. The work described in this paper is part of a larger effort called “Design by Manufacture” (Angster, 1996). In this environment, the designer has access to manufacturing processes and tools in the form of virtual environments. These virtual environments will allow the designer to “virtually manufacture” the product while designing it. Here developer describes the feasibility work in using virtual reality for design for assimilability, the design of a virtual assembly environment and preliminary results from the use of this environment. The overall goals of the research explained in this paper are to develop models, tools, and environments supporting assembly of mechanical components, to aid in design for assembly, design for maintainability, and assembly planning and to assist in the development of assembly relevant standards.

The objectives achieved in this development were,

- High-performance computing and communication
- The focus on the conceptual design phase
- The use of advanced technologies such as VR

VR systems can be viewed as an enhancement to current CAD systems for visualize and manipulate the underlying product model. This has become increasingly important for assembly modeling and analysis, trajectory/swept volumes functionality, assembly process planning and assembly-based design. The primary objective of the research described in this paper to address an assembly scenario representative using VR tools and exchanging this information with other engineering applications such as a CAD application. The prototype developed in this research achieves the virtual environment which allows an engineer to consider assembly issues of mechanical systems earlier in the design cycle. In performing virtual assembly tasks the designer creates product and process information. The technical aspects included in this virtual assembly development were,

- Creation of the virtual environment
- Transfer of information from a parametric CAD system (Pro/ENGINEER) to the virtual assembly environment
- Creation of component trajectory information
- Transfer of virtual assembly data to the CAD system

The benefits of this VR technology are reduced product development and fabrication time, therefore reducing time-to-market, faster technology insertion of
advanced design methods and tools, improved product design (quality, reliability, etc.), and reduced costs. Proposed research is an application development for virtual prototyping. It increases the efficiency of manufacturing process. Before manufacturing the actual component it is possible to represent model on the screen.

Lane and Thacker further provide a short review of some of the key publications in the area of stereo vision research. Their paper is the summary of the important research issues and approaches that researchers have taken and how these techniques are related.

Lucente describes the approaches used to addresses emerging technologies and techniques that provide firm footing for the development of practical interactive three-dimensional holographic displays. A real-time electronic holographic (holovideo) display can create a truly 3-D computer graphics image with all of the depth cues and resolution sufficient to provide extreme realism. It displays promise to enhance numerous applications in the creation and manipulation of information, including telepresence, education, medical imaging, interactive design, and scientific visualization. The technology of electronic interactive three-dimensional holographic displays is in its first decade. Though fancied in popular science fiction, only recently have researchers created the first real holovideo systems by confronting the two basic requirements of electronic holography:

(1) Computational speed
(2) high-bandwidth modulation of visible light.
Our research designs a three-dimensional visualization display for manufacturing industries to view the CAD model in 3D.

2.2.5 Challenges in the Field

The main challenges and need of the visualization has been reiterated by Tseng, Jiao and Chuan. In an era of reducing time to market window, customized product development is facing the challenges of maintaining mass producibility and exploring customer perception on target products. The above paper reports an approach by combining virtual prototyping (VP) with design by manufacturing simulation techniques. By constructing virtual prototypes, accurate assessments of
mass producibility and customer acceptance will enable better informed design of customized products. The primary goal of VP for customized product development is to provide a multidisciplinary design definition and rapid prototyping environment for concept development and a tailored, scenario-based simulation environment for concept evaluation within a single facility. This design environment facilitates the capture and utilization of information generated during the design phase, and the simultaneous generation, at design time, of manufacturing, materials, costing, and scheduling data, together with visual evaluation of customer perception on target products, hence supporting the implementation of concurrent engineering. Consistent with the above mentioned paper our research is all poised to play an important role in manufacturing industries. The visualization suite developed in our research is very useful for virtual prototyping.

Yet another paper by Gobbetti and Scateni\textsuperscript{35} provides a short survey of the field of virtual reality, highlighting application domains, technological requirements, and currently available solutions. The above report presents details of the background and motivation of virtual environment research and identifies typical application domain, the characteristics a virtual reality system must have in order to exploit the perceptual and spatial skills of users, current input/output devices for virtual reality, current software approaches to support the creation of virtual reality systems etc. Stereo vision is a prime feature of Virtual Reality. In the context of above paper the stereo vision system developed by us for manufacturing industries provides realism to computer generated scene.

Saadoun and Sandoval\textsuperscript{70} presents news problems linked to the increasing use of virtual spaces in the building of new types of manufacturing what is currently called Virtual Manufacturing (VM). The VM has many consequences in the activity of industrial companies whatever be size, economic sector or geographical area. Particular attention is paid on virtual spaces, manufacturing and collaboration, skills matrix and manufacturability, the CAD and Virtual Prototyping case and, finally, the virtual partnerships or enterprise as a new type of organization. The 3D Visualization tool developed in the course of our research plays a major role in manufacturing process of mechanical components. Initially the models are designed in CAD. These designs are viewed in virtual world as virtual prototypes. These
virtual prototypes are visualized in immersive 3D for analysis and evaluation. If there is any change required, changes are done in the design world and modified CAD data visualized in virtual world further. After the satisfaction of the virtual prototype manufacturing of the physical prototype takes place in the real world.

Zhigeng, Jiaoying and Qin\textsuperscript{124} have given an overview of the research and development on VR in China. This paper provides the summary of selected papers in this field. In China researchers have obtained a lot of achievements in various VR fields. The applications explained in this paper includes various VR fields such as multi-resolution modeling, real-time rendering, image-based rendering, touring, medical treatment, teaching, training, visualization, distributed VR, virtual gesture recognition, behavior modeling, and computing model of VR etc.. In the context of the above paper, our research is an application development for manufacturing industries. It is a development of 3D stereo visualization software suite applicable for manufacturing process.

Kamat and Martinez\textsuperscript{112} describes on-going research took place at Virginia Tech that focuses on the development of a general-purpose, 3D text file driven visualization system. This system enables visualization of both the construction processes and the evolving products in 3D. The input to the program is an ASCII text file consisting of sequential animation commands. This file can be generated automatically by a variety of simulation software capable of writing formatted text during simulation runs. Due to the flexibility of the command set and the independence of the tool from any particular simulation modeling software, the system has numerous potential applications in fields other than construction, such as in the manufacturing and service industries. In the course of our research work, we have designed a 3D visualization tool to simulate manufacturing process. The simplest form of virtual reality is stereoscopic visualization in which 3D image can be displayed interactively at a personal computer, usually by operating with keys or the mouse the image can be moved in some direction or zoomed in or out.

Boyles and Fang\textsuperscript{73} have constructed an immersive system, called 3DIVE, for interactive volume data visualization and exploration inside the CAVE virtual environment. Combining interactive volume rendering and virtual reality provides a
natural immersive environment for volumetric data visualization. More advanced data exploration operations, such as object level data manipulation, simulation and analysis, are supported in 3DIVE by several new techniques: volume primitives and texture regions are used for the rendering, manipulation, and collision detection of volumetric objects; the region based rendering pipeline is integrated with 3D image filters to provide an image-based mechanism for interactive transfer function design; a collaborative visualization module allows remote sites to collaborate over common datasets with passive or active view sharing. The system has been released as public domain software for CAVE/ImmersaDesk users, and is currently being actively used by a 3D microscopy visualization project. 3DIVE employs a region-based approach for volume rendering and data exploration. By combining the concepts of region-based manipulation, data filtering and collaboration in an immersive environment, researchers, scientists and doctors are able to explore their data in a more intuitive way which leads to higher productivity. Our research achieves Immersive verification of the prototype before the manufacturing of mechanical components. Immersion is the great reason to attract manufacturing engineers. The benefit is that better understanding of the model before its actual manufacturing which reduces number of iterations in design. This is an impressive technology used to evaluate complex products for manufacturing process through conceptual design stages. It provides facility to test the product in a simulated functional framework without the need to manufacture the part physically.

2.2.6 From Visualization to Virtual Assembly

Wang, Jayaram, Lyons and Hart\textsuperscript{120} have reported “Virtual assembly” as a promising application of virtual reality in design and manufacturing that has drawn much attention from industry and research institutes. Physically based modeling has been an important research topic in computer graphics and virtual reality. In this paper, physically based modeling issues in virtual assembly are investigated. The specific requirements and characteristics of physically based modeling in virtual assembly versus those in traditional computer graphics are analyzed and studied. The mass properties of the assembly models are extracted from the Computer Aided Design (CAD) system while the design models are transferred from the CAD system to the virtual assembly environment. The assembly models are categorized
using human strength survey data. The interaction between the parts, the environment objects, and the human are analyzed. In the fully immersed virtual environment, it is discovered that the gravity acceleration needs to be scaled down to achieve maximum realistic feeling. Finally, the benefits and limitations of physically based modeling in virtual environments are discussed. In the mechanical industries the virtual prototyping has become an important process during manufacturing of components. Immersive visualization changes the dynamic of manufacturing by virtual prototyping instead of physical prototyping. Various modeling software are in use for the design of models. High performance visualization tool for viewing of 3D CAD on general-purpose computer was a basic requirement of our research. An efficient, easy to use, cost effective visualization system for manufacturing industries has been developed in our research. This provides computer-generated realism to decision makers and development team for their collaborative work.

2.2.7 Effectiveness of Visualization

Knight\textsuperscript{22} has explored the concept of visualization effectiveness. Ways of evaluating visualizations provide the focus for this paper. Providing evaluations of visualizations is one way to demonstrate that they support a purpose and are adequate for the role claimed for them. The problem in doing so is that there is no central source of evaluation issues that one can use a subset of for this purpose. There is also very little in the way of agreement over what constitutes a good visualization hence the evaluation criteria differ. There are the human-computer interaction ideals, the slightly differing ones from usability engineering, those from the visualization community, and also the need to be able to support the variable abilities of the users. Graphics, as the medium behind visualization, may support greater bandwidth, but is also prone to more likes and dislikes than other forms of interface. The visualization tool developed in our research supplements physical verification of the components in manufacturing industries through virtual prototyping. Reduction in product development cycle time and cost are important area of focus. Stereo Visualization technology is a major contributor to achieve this goal.
In another related paper Kunz, and Spagno\textsuperscript{3} reported the effectiveness of virtual reality in exploring new possibilities for collaborative work over distributed environments. To enable collaborative work, it is necessary that both, virtual objects as well as the other users can be seen simultaneously in real-time. A novel technique is necessary to overcome the contradiction of darkness and light for image projection and video acquisition, respectively. A stroboscopic light and a camera system are added to the existing VR-system and a few modifications are made to existing shutter glasses. In such a solution, the method of projection in the VR-system remains unmodified. In this paper authors have described how to resolve this contradiction with the constraint to make as few changes as possible to existing VR-systems. Furthermore the timing of the different devices is discussed. Our visualization tool too provides immersive 3D effect of CAD model. In our method left and right eye images are made up of two independent colors. By wearing glasses with matching filters, the left eye image is delivered to the left eye and the right eye image to the right eye.

\textbf{2.2.8 Visualization Tools Developed so far}

A good number of visualization tools under different brand names have been reported in the literature. Del R, Bartz, Jager, Gurvit and Freudenstein\textsuperscript{1} have presented stereoscopic VIVENDI, a virtual endoscopy system which integrated stereoscopic rendering to increase the depth perception for virtual endoscopy applications. Two different stereoscopic rendering techniques were applied; synchronized shutter glasses-based rendering on graphics systems with quad-buffer support, which enables a multi-color representation of the scene, and simple red/blue monochrome stereoscopic rendering which is also viewable through video animations via the Internet. Besides the very limited color representation, red/blue stereoscopic rendering also provided only a limited (perceived) contrast in comparison to the possible black/white representation of the synchronized approach. Our research designs an efficient stereoscopic rendering tool can be utilized for manufacturing process of mechanical components.

Steinwand, Davis and Nathan have reported the Geowall system that is a continuation of work initiated in fiscal year 2000 with the identification of
individuals at U.S. Geological Survey (USGS) Mapping Centers interested in building an information science research infrastructure within the Geography Discipline. Geowall systems are low cost visualization systems built with off-the-shelf components, run on open-source operating system and using open source application software. This project makes use of components to view stereo imagery and 3D models in a low cost environment. System here creates two images a right eye view and left eye view and displays them on the same space on the screen. This is done by using projectors- one for each eye, so that viewer sees only one image with each eye. The light from each projector is polarized differently, and the projection screen has special properties that preserve polarization. The viewer wears polarized glasses, which allow the light from only one image to enter the eye. The cost of Geowall vary depending on the requirements such as location and size of the venue, size of the screen, front projection versus rear projection, mounted projectors or table top projectors, types frame for glasses. These system components are,

- A graphics card with dual monitor output. These cards will drive two separate monitors and OpenGL capable
- Two InFocus LP530 DLP projectors are ceiling mounted in the lab. Ceiling mount bracket provides permanent alignment of the projectors in the lab. The portable system makes use of a modified 35mm slide projector stacker
- The light polarization filters are mounted on to the projector such that light passing through each of the separate filters is restricted to one specific polarity.
- A polarizing preserving screen is necessary to maintain the polarization of the light filtered by the linear polarization filters
- Polarized lens glasses are necessary to complement the splitting of the computer signal form each of the projectors by the polarization filters. The filters at the lens of each projector allow light traveling in a single plane, bounce of the screen and strike the lens of the glasses.

Another system named as Immeersa view is an open source viewing application for displaying 3D surface model. Viewer is a stereo image pair viewer. It enables pan, zoom and animation. Geowall is considered as a valuable resource for research in earth sciences and gives educators and the general public access to data in new and existing ways. These not yet mature and require additional software development in the areas of user interfaces, data conversion and ingest utilities and robust
packaging for public service. Current implementation is a development of low cost visualization suit for manufacturing industries. The anaglyph method has been used here to represent stereo pairs. One eye image is displayed in red and the other in green, blue or cyan so that the appropriate eye sees the correct image. The Red-Blue method displays the scene in the same frame with red for the left eye, blue for the right eye. It requires red-blue glasses. This is an effective method for presenting stereo images and the cost of viewing glasses is very low.

2.2.9 Visualization leading to Virtual Prototyping

Zorriassatine, Wykes, Parkin and Gindy\textsuperscript{42} have reported that the Virtual Prototyping is becoming very advanced in product development process. In their paper authors have presented a general survey of the available Virtual Prototyping techniques and highlight some of the most important developments and research issues while providing sources for further reference. The purpose of the paper is to provide potential users with a broad picture of the field of VP and to identify issues and information relevant to the deployment and implementation of VP technology. Repeated, efficient, and extensive use of prototypes is a vital activity that can make the difference between successful and unsuccessful entry of new products into the competitive world market. In this respect, physical prototyping can prove to be very lengthy and expensive, especially if modifications resulting from design reviews involve tool redesign. The availability and affordability of advanced computer technology has lined the way for increasing utilization of prototypes that are digital and created in computer-based environments, i.e. they are virtual as opposed to being physical. The technology for using virtual prototypes was pioneered and adopted initially by large automotive and aerospace industries. Small-to-medium enterprises in the manufacturing industry also need to take virtual prototyping (VP) technology more seriously in order to exploit the benefits. In the context of above approach, our research is related to virtual prototyping that deals with the visualization of the 3D data imported from CAD packages like AutoCAD, I-DEAS, through open standard STL, VRML format. It has got direct interface to Virtual Reality through stereo glasses. 3D rendering is the key component of this system. This technology provides the capability to immerse the user in the design of virtual
product. To enhance the visualization various additional features are incorporated in this suite.

Vega, Sußner, Reuding and Greiner\textsuperscript{38} reveal that stereo visualization is an area which can greatly benefit from cluster computing due to the parallelizable nature of the rendering task. In order to implement this idea, authors have developed a novel software architecture which allows the construction of parallel OpenInventor-based stereo applications. As a result of this work, the OpenInventor Stereo Library for Clusters has been presented. The library provides tools to port transparently OpenInventor applications to stereo cluster-based OpenInventor applications. The distribution of the rendering tasks is encapsulated, and the developer does not have to take care of non-graphics-related tasks. Evaluation was carried out on a prototype cluster consisting of a master and two slave rendering Linux PCs. The resulting pair of stereo images was visualized with polarization-filter projector and glasses. A standard X desktop is available and multiple OpenInventor based windowed applications can be used simultaneously. The visualization solution developed in the course of our research work is a Visual C++ application using OpenGL. The value of the present work was demonstrated with an example 3D-visualization application for the manufacturing industry.

Zelle and Figura\textsuperscript{122} have developed the stereoscopic visualizations that can be produced using low-cost, off-the-shelf hardware components and simple programs. They were interested in bringing aspects of virtual reality, primarily true 3D visualizations into the classroom. The main barriers to VR have been the cost of the equipments and need of the technical expertise. The two keys to making this 3D vision are producing the correct view for left and right eyes and delivering each view to appropriate eye. Active stereo techniques produce excellent stereo effect, but this is not possible in the classroom settings, as required projector and glasses are expensive. Passive stereo works by displaying left and right images simultaneously superimposed on each other. Viewers wear special filtering glasses that only allow the appropriate image to each eye. The most common methods are anaglyph and polarized. Anaglyph uses color to filter the two images. Typically left eye image is produced in red and right eye image is produced in blue. Viewers wear a glass having red filter over left eye and blue filter over right eye. This is easy to
produce, but drawback is that the scene looses its original color in stereo. A better stereo effect is achieved by polarized method. Here left and right images are projected through filters that polarize the two views perpendicular to each other. The superimposed images are viewed through inexpensive glasses with appropriate polarizing lenses. This produces full color image and excellent stereo effect. The downside is that it requires the images to be projected. This development’s setup contains two LCD projectors. Left half display takes place through one projector and right half display through other. External polarizer was placed in front of the projector and scene was viewed through polarized 3D glasses. The screen of polarized passive stereo was preserving the polarization light. The special consideration for graphics card was that a dual head card to provide output to the two projectors. Polarized 3D viewing glasses with 45/135 degree polarizing was selected. The polarization of the left and right images from the projectors to match the glasses was accomplished with external projectors. This graphics application was developed using C/C++, Python and OpenGL. The primary goal of the development of our 3D Visualization suite is to empower the designers with a fully functional stereovision and facilitating them to explore their datasets in a graphical manner that too at low cost. This visualization suite offers affordable 3D interface for manufacturing industries. It involves viewing and manipulation of 3D models, of manufactured components and large assemblies of products. Two achieve 3D effect two images of a same model are drawn on a scene. Left and right eye images are combined into a single image consisting of blues for the left eye portion of the scene, reds for the right eye portion of the scene, and shades of magenta for portions of the scene occupied by both images. The viewer wears a pair of glasses with red over left eye and blue over the right eye.

Ostones, Abbott and Lavender describe the most accepted 3D stereoscopic display techniques presently available and summarize how hydrographic data is currently presented. They discuss the suitability, opportunities and benefits of implementing stereoscopic techniques. The latest stereoscopic display technique includes virtual retinal displays that project the stereo pair directly on to the eye’s retinas. The latest auto stereoscopic technique includes electro holography and complete virtual environment with immersion. While viewing stereoscopic displays the observers normally wears glasses that have color filtered lenses or polarized
lenses. Anaglyph is the most familiar stereoscopic technique. It consists of stereo pairs with color red and blue. The observer views the image through a pair of complementary filters corresponds the colors used in the stereo image. The advantage of this method is that it is inexpensive to implement, can accommodate multiple observers. In polarization multiplexed technique left and right images are separated. Polarization glasses are used in combination with orthogonally polarized images presented on two displays. In time-multiplexed technique, by displaying left and right eye images alternately at high speed on a single display it is possible to obtain a stereoscopic effect. The observer must wear electro optical shutters, one for each eye, which is synchronized with the alternating images on the display. In this paper anaglyph, polarization multiplexed, time multiplexed, time sequentially controlled polarization, location multiplexed, chromo stereoscopy such stereoscopic display techniques are explained. The research and development of auto stereoscopic techniques are continuing. These techniques are expensive and require a vast amount of computer power to produce 3D image. Electro holography, Volumetric displays, Direction multiplexed techniques are the common auto stereoscopic techniques. Direction multiplexed displays are the most common auto stereoscopic displays and are most compatible with computer graphics. The observer directly views the same display area with both eyes. The left eye image is presented only to the left eye and the right eye image is presented only to the right eye. The difference in viewing angle is caused by the separation of the eyes, and vertical bars or lenses are built into the display, permitting or blocking certain parts of the underlying display from view. Stereo vision implemented in our research works based on the principle of time-parallel method. It present both eye views to the viewer simultaneously and use optical techniques to direct each view to the appropriate eye. It requires the user to wear glasses with red and green lenses or filters. Both images were presented on a screen simultaneously; hence, it is a time-parallel method.

In another related paper, Balc and Campbell\textsuperscript{84} have reported their tool which deals some of the important aspects regarding how to get a good 3D solid model, how to transfer it to RP machines and how to produce quickly a physical prototype. This tool has been designed to provide technical specialists with an overview of the connections between CAD, 3D modeling, Rapid Prototyping, Rapid Tooling and
Innovative manufacturing. With the CAD model in the appropriate format, a rendering option could be selected within the CAD system. Adjusting such parameters as color, lighting, texture, material, transparency, luminescence, etc, the model will be transformed into a pictorial image. Depending on the capability of the CAD system, the model can generally be rotated and positioned on the screen, enabling all aspects of the design to be viewed and assessed visually. Different CAD models store a virtual 3D model in different ways. This requires a standard interface between the CAD systems and the RP machines. The generally accepted interface to all the RP machines is the STL file format, which approximates the virtual model with a collection of planar triangles. This is a precise representation only for planar boundaries and all the curved ones will only be approximated in the STL representation. Rapid Prototyping (RP) is a modern technology which takes 3D CAD data and reproduces a physical model in a very short time, normally hours, without the need for any specific moulds or tooling. Instead, all the RP techniques build parts by continuously adding layers of material. This helps to build very complex parts. The Rapid Prototyping methods available today are: Stereolithography, Laminated Object Manufacturing, Fused Deposition Modeling, Selective Laser Sintering, Laser Engineering Net Shaping and others. Our research work pertains to the development of cost effective visualization suite for rapid simulation of the performance of mechanical systems in a virtual prototyping environment. After designing the model, the details about the model are stored as CAD databases. The CAD data considered here are STL and VRML. This visualization tool access model’s data and present it in a useful fashion. It provides immersive, stereoscopic access to database and renders the model in 3D so that user can able to see a stereoscopic model as if it is physically there. It supports digital prototyping for manufacturing industry by providing various studies related to manufacturing and depending on that one can take the decision. With 3D tools it is possible to create, visualize and optimize manufacturing.

In yet another related paper Alpaslan and Sawchuk have described new techniques for interactive input and manipulation of three-dimensional data using a motion tracking system combined with an autostereoscopic display. Users interact with the system by means of video cameras that track a light source or a user’s hand motions in space. This 3D tracking data processed with OpenGL to create or
manipulate objects in virtual space. Then two to nine images were synthesized as seen by virtual cameras observing the objects and interlace them to drive the autostereoscopic display. The light source is tracked within a separate interaction space, so that users interact with images appearing both inside and outside the display. With some displays that use nine images inside a viewing zone, user head tracking is not necessary because there is a built-in left right look-around capability. With such multi-view autostereoscopic displays, more than one user can see the interaction at the same time and more than one person can interact with the display. Anaglyph method developed in our research is a low cost passive stereo technique that simply requires a red blue eye ware. The main focus of the development is an effective low cost passive stereo-based visualization technique that would run on a fairly general-purpose computer used in manufacturing industries for virtual prototyping.

2.2.10 Peer-to-peer Collaborative Visualization Systems

Pan and Marchese\textsuperscript{119} in their paper explain a peer-to-peer collaborative visualization system has been built by the developers that can support both traditional displays and 3D virtual reality hardware. The software is built around Sun’s Java3D graphics and JXTA peer-to-peer networking APIs, allowing two users to load VRML geometry files and manipulate their contents. Although this software takes advantage of VR hardware, it may be used between any two Java supporting peers. Finally, because no dedicated server is required, collaborative visualizations across the web become easier to initiate and more spontaneous. The visualization solution developed in the course of this research work is a Visual C++ application using OpenGL. This new approach could lead to an improvement in quality and performance of most current techniques in visualization. It enables the user to enter a world of Virtual Realism. Our research deals STL, VRML files, parsing such files and rendering the model and passive stereo vision of respected model.

Möller\textsuperscript{28} outlines the core technologies which underline the principle of virtual reality and the way it is being applied today in industry. In a more general sense virtual reality provides a true 3D interface to a range of computer applications. The essence of virtual reality is immersion, which is the ability to
immerse the computer user in a computer generated experience, as an active participant, as opposed to a passive viewer. Hence this paper provides an introduction into the methodology of virtual reality, including its historical background, as well as some basic taxonomy, that are helpful defining the elements of a virtual reality, that are used to create immersive and interactive experience. Moreover this paper report about industrial case study examples of Virtual Reality as an advanced computational method in modeling and simulation of complex dynamic systems.

Seth, Shana, Mack and Jiang present a low-cost user-friendly VR-based interface for interacting with CAD models. The above mentioned authors have developed the interface which provides a stereo view of the CAD model for enhanced visualization. A data glove device is used as a 3D interface for CAD model manipulation in a virtual design space. To make the visualization more realistic, real-time active stereo vision is provided using LCD shutter glasses. This system was facilitated with two-way data transfer between Pro/Engineer and a VR environment, and had collision detection, multiple part manipulation, and dynamic simulation capabilities for assembly evaluation. The prototype explained in this paper is a low-cost VR CAD model-viewing interface that can import CAD models created in commercial CAD systems like Pro/Engineer and display the models in stereo views on a standard computer monitor. To make object manipulation more intuitive and efficient, the interface uses a data glove device to allow more natural hand interaction with displayed CAD models. Stereo viewing capability provides depth cues, which carry information concerning spatial relationships between the parts in a complex assembly, and, thus, provides better visual feedback to users than traditional 2D projection techniques. VR interface here consists of visualization component and 3D interaction component. For enhancing visualization, real-time stereo viewing is provided. A computer monitor and a pair of LCD shutter glasses are used to create a virtual world. In order to make the interface more intuitive, CAD model interaction is provided using hand gestures. A data glove device is used for gesture recognition and model manipulation in the virtual environment. The main reason for using a 3D interface is to enable a designer to manipulate CAD models with the same number of degrees of freedom as the environment in which the actual part exists. This VR CAD model viewer imports CAD models using the
Open Inventor ASCII file format, which is supported in Pro/Engineer. The entire system was implemented in C++, and a Microsoft foundation class graphical user interface was provided. The VR CAD model viewer uses the glove interface to perform fundamental navigation tasks, such as zoom-in, zoom-out, and viewpoint translate, rotate, and reset. The user can manipulate the CAD model by changing their hand orientation. In the context of the above papers, our research has an implementation of an effective stereo visualization suite for manufacturing industries. It demonstrates how a low end, inexpensive viewing technique can be used as a quick trick to produce many of the same affects as high-end stereo viewing. This visualization suite is able to browse the STL, VRML files, fetches the data sets that are required for visualization and renders the model on the screen. This tool supports additional properties required for visualization. This interface provides three-dimensional effect of the CAD model for enhanced visualization.

2.2.11 Applications of Visualization

Arzu Çöltekin\textsuperscript{10} has documented development of 3D visualization system named as Foveation. Foveation is a biologically motivated image compression method that is often used for transmitting videos and images over networks. It is possible to view foveation as an area of interest management method as well as a compression technique. While the most common foveation applications are in 2D there are a number of binocular approaches as well. For this research, the current state of the art in the literature on level of detail, human visual system, stereoscopic perception, stereoscopic displays, 2D and 3D foveation, and digital photogrammetry were reviewed. After the review, a stereo-foveation model was constructed and an implementation was realized to demonstrate a proof of concept. The conceptual approach is treated as generic, while the implementation was conducted under certain limitations. Immersive environment is yet another interesting area in the arena of visualization. Maes and Hunter have explained the role of immersive environment in data analysis and interpretation. A reasonable expectation is that a large-scale visualization capability reduces project costs and field error. VR and immersive environments combine advanced technology with social interaction to analyze complex problems and to take quick and accurate decisions. Very powerful, their applications range from large-scale 3D collaborative viewing rooms over
relocatable and portable environments, to fully immersive spaces completely surrounding the interpreters with their data. Applications by the world’s leading oil and gas companies include real-time visualization, analysis, and decision-making of seismic data, complex reservoir models, well logs, and geologic cross sections. The system explained in this paper allows multi-disciplinary teams of up to 20 viewers to effectively visualize and evaluate geophysical data for oil and gas E&P in 3D. This system consists of high-resolution three-chip LCD projectors enabling the building of a stereoscopic large screen display using only two projectors. Teleconferencing windows can be added and several locations can be visually linked for efficient collaboration. Active stereoscopic viewing gives excellent depth perception, but this comes at a cost in light efficiency. Reaching the brightness for viewing in normal light conditions requires the use of high brightness DLP projectors, delivering data at double the refresh rate to produce the stereo images. By offering asset teams the stereoscopic viewing of large amounts of data, stand alone displays can deliver the functionality of a high-end visualization room without the high investment. Light conditions require the use of high brightness DLP projectors, delivering data at double the refresh rate to produce the stereo images. By offering asset teams the stereoscopic viewing of large amounts of data, stand alone displays can deliver the functionality of a high-end visualization room without the high investment. Typical brandings for this technology include CAVE, I-Space, and Holospace. In these environments, analysts are completely surrounded by virtual imagery inside a cube that has at least three sides and as many as six sides. Our research work is a development of immersive visualization platform for manufacturing industries. Initially the prototypes are designed in a computer, using this immersive visualization the designs are verified and finally manufacturing the product physically takes place. Immersion is the great reason to attract manufacturing engineers. Here the brain is interacting with visual information. User can perform walkthrough, viewing the object from various angles that are not possible in 2D.

2.2.12 Interactive Virtual Human (IVH) systems

Nadia Magnenat-Thalmann, Arjan Egges, In the course of this research work, developers have implemented Interactive Virtual Human (IVH) systems.
Because of the complexity of interaction, a high level of control is required over the face and body motions of the virtual humans. In order to achieve this, current approaches try to generate face and body motions from a high-level description. Although this indeed allows for a precise control over the movement of the virtual human, it is difficult to generate a natural-looking motion from such a high-level description. Another problem that arises when animating IVHs is that motions are not generated all the time. Therefore a flexible animation scheme is required that ensures a natural posture even when no animation is playing. They have presented MIRAnim, our animation engine, which uses a combination of motion synthesis from motion capture and a statistical analysis of prerecorded motion clips. As opposed to existing approaches that create new motions with limited flexibility, our model adapts existing motions, by automatically adding dependent joint motions. This renders the animation more natural, but since our model does not impose any conditions on the input motion, it can be linked easily with existing gesture synthesis techniques for IVHs. Because we use a linear representation for joint orientations, blending and interpolation is done very efficiently, resulting in an animation engine especially suitable for real-time applications. Virtual Prototyping is a more powerful tool in manufacturing process. Before manufacturing the actual component it is possible to represent model on the screen. The reduction of the time to market of a product is a major contribution of VP in manufacturing. Here virtual prototypes are used instead of physical prototypes for innovating, testing and evaluating the design.

Bruce Ricketts\textsuperscript{15} has focused on stereo enabled systems with its configurations. The model created with 3D drawing program provides depth as one of its parameter. The key to seeing in stereo is the fact that two eyes separated by nose with the difference in viewing angle is about 5 degree. 3D stereo can be enabled in a few ways including stereoscopic, anaglyph, active and passive. Passive stereo is an inexpensive technique for visualizing 3D data in stereo. Modern passive 3D stereo systems can be delivered with multiple channels using image blending technology and even image wrapping. The two visualization system explained in this paper are,

- VIZ3D is a single channel system consists of two matched projectors, a stereo converter, polarizing filter screen and polarized glasses. One projector
displays the left eye information and other displays the right eye information, both at standard refresh rate. The data stream comes from stereo enabled video card is sequential with left and right eye information. The converter unit separates the signals into the right and left eye components and sends them to the two projectors.

- BIZWALL is a front projected wall that is made up of 2 or more channels of passive 3D stereo systems. Creating a multi channel wall is more than just lining up multiple VIZ3D systems side-by-side. It uses image blending. Blending of passive stereo requires that the passive stereo setup and alignment is exact and that the alignment between the channels is also exact.

There is number of factors that can affect the image of stereo image WALL. The fundamental design of a quality passive stereo system includes matched projectors, and in the case of multiple channels a quality blending algorithm together with quality installation and training. Our research provides a passive stereo visualization platform for virtual prototyping. The model rendered in this tool has depth as its parameter along with height and width. This enables the rotation of model to view the model from any angle. Even though stereo offers three dimensions of viewing angle, the image is generally viewed on a 2D plane. The 3rd dimension is visualized by wearing stereo enabled glasses. An anaglyph is a method of viewing stereoscopic images used in this research.

Holleis, Kranz, Winter and Schmidt86 have provided a framework that enables the rapid development of applications using non-standard input devices. Flash is chosen as programming language since it can be used for quickly assembling graphical applications. The state information generated by input devices is transferred to a PC where a program collects them, interprets them and makes them available on a web server. Application developers can integrate a Flash component that accesses the data stored in XML format and directly use it in their application. Two examples, one from a pervasive gaming background and one from an installation in an office setting have explained in this paper. Our research is a virtual prototyping application uses anaglyph as a passive stereo technique. This is a cost effective method can be adopted in manufacturing of mechanical components.
Toro, Posada, Wundrak and Stork\textsuperscript{17} authors have developed architecture for the inclusion and exploitation of semantic aspects in a CAD environment. This schema focuses on the enhancement and improvement of a commercial CAD system on its Virtual Reality (VR) capabilities. Current CAD programs offer a myriad of options to the designer, but their limited integration of the non-geometric information, and in general the semantics of the design process, can still be improved for the current needs of the industry. Authors argue that the use of semantics could improve the workflow and capabilities of the software and would benefit a new user in order to produce better results in shorter times. The main focus of this is the enhancement of the visualization and VR capabilities in generic CAD applications. This semantic CAD framework uses ontology modeling as well as engineering standards in order to conceptualize and exploit the information contained in a CAD model. To show some benefits of this proposed schema, two cases in different engineering domains (plant design and Steel detailing design) were presented. In this work, authors have presented an architecture that allows the enhancement of generic purpose CAD VR capabilities through semantics. This architecture implementation allows the semi-automatic recognition, and semantic simplification of the elements contained in the model. Developers have introduced semantics into the visualization of VR large models by applying semantic criteria to traditional optimization techniques. Our current implementation is a virtual reality application uses CAD. This software is able to browse the VRML and STL files. The 3D scenes are rendered by reading .wrl and .stl files, with an inclusion of properties: applying various lights, material colors, options for solid, wire frame, points and lines viewing, texture mapping, transformation, different camera views etc. A stereoscopic display is a prime part of this implementation that accounts for virtual reality. The passive stereo is a low cost 3D visualization technique.

Cheuk and William\textsuperscript{18} address the problem of manufacturing process discrimination. According to the authors this work can be the basis for practical new techniques for manufacturing cost estimation, engineering analysis and design archival. This paper examines the manufacturing classification of mesh-based Computer-Aided Design models with curvature descriptors. Mesh models have become a useful CAD representation to the development of rapid prototyping and 3D scanning acquisition technologies. A long-term goal of this work is to develop
methodologies to interact with CAD data in engineering information management systems and enable long-term preservation of engineering artifacts. This paper bridges the gap between low-level shape representation and engineering semantics by presenting a methodology for discriminating the manufacturing processes for an individual part from the mesh representation of the artifact. Solid model representations of CAD objects are traditionally exact representations of 3D solids, which are suitable for creating physical models. In commercial CAD systems like Pro/Engineer and I-DEAS, models are dominantly represented by a data structure that gives information about the object's faces, edges, vertices, and how they are joined together. Solid models give a complete and compact representation for design, simulation, and manufacturing purposes. Shape model representations of 3D objects are approximated models characterized by a mesh of polygons for presentation or rendering purposes in computer graphics. Rather than exact parametric equations, polygons are used to approximately curved surfaces. Only the geometry of triangles is stored without any topological information. In contrast to proprietary solid model formats, open mesh file formats such as VRML and STL, are widely available. Although shape models are not suitable for modeling physical properties or simulations in CAD/CAM systems, polygonal meshes can serve as the lowest common denominator in comparing CAD models, by faceting solid models generated by different modeling systems. The Virtual Reality/Visualization solutions are critical tools that manufacturing industry to reengineer their product development practices in order to bring new, better-quality products to market faster, at a lower cost, with more options for consumers. It supports the entire product development process, from conceptual modeling to engineering and design review, visualization of complex analysis data, factory floor simulation, training, and review for customers. In the course of our research, we have developed computer based visualization solution for manufacturing process. In our research VRML and STL file formats are considered. The models designed in CAD software can be saved as such standard file formats. Readability is the major benefit of these files. Model descriptions are encoded here in a human readable form. These files consist of a list of triangles in 3D space. Each triangle definition contains coordinates in 3D space for each point of the triangle as well as other details about the CAD model.
2.2.13 Model Based Approaches

Wuest and Stricker\textsuperscript{50} have presented a model-based approach for real-time camera pose estimation in industrial scenarios. The line model which is used for tracking is generated by rendering a polygonal model and extracting contours out of the rendered scene. By un-projecting a point on the contour with the depth value stored in the z-buffer, the 3D coordinates of the contour can be calculated. For establishing 2D/3D correspondences the 3D control points on the contour are projected into the image and a perpendicular search for gradient maxima for every point on the contour is performed. Multiple hypotheses of 2D image points corresponding to a 3D control point make the pose estimation robust against ambiguous edges in the image. The advantage of this model-based approach is that no drift can be accumulated during the tracking, since through the model a very significant connection between the virtual and the real world exists. No preprocessing step like the generation of a line model or the calibration of the scene is necessary. The virtual information can be created in the same coordinate system as the polygonal model, which is used for tracking.

Woods, Yuen, and Karvinen\textsuperscript{5} have reported that although there are a range of stereoscopic display technologies available that produce much better 3-D image quality than the anaglyph 3-D method, the anaglyph remains widely used because of its simplicity, low cost, and compatibility with all full-color displays. This paper highlights one particular way of improving the image quality of anaglyph 3-D images specifically relating to spectral crosstalk. This study has revealed that crosstalk in anaglyphic 3-D images can be minimized by the appropriate choice of anaglyphic 3-D glasses. The study has revealed that there can be considerable variation in the amount of crosstalk present when an anaglyphic 3-D display is viewed with different anaglyphic 3-D glasses. The study has also revealed that there is considerable variation in the amount of anaglyphic crosstalk exhibited by different displays. For example, on average CRT monitors exhibit approximately 45\% more crosstalk than LCD monitors and plasma displays. An anaglyphic crosstalk calculation algorithm has been developed that appears to work well and generates outputs that agree well with subjective assessments of anaglyphic 3-D crosstalk. This paper summarizes the results of two projects that characterized the...
presence of anaglyphic crosstalk due to spectral issues on 13 LCD monitors, 14 plasma displays, and a CRT monitor when used with 25 different pairs of anaglyph 3-D glasses. A mathematical model was used to predict the amount of crosstalk in anaglyphic 3-D images when different combinations of displays and glasses are used, and therefore highlight displays, glasses, and combinations thereof which exhibit lower levels of crosstalk when displaying anaglyphic 3-D images. Passive stereo vision is a major outcome of our research. Two achieve 3D effect two images of a same model are drawn on a scene. Left and right eye images are combined into a single image consisting of blues for the left eye portion of the scene, reds for the right eye portion of the scene, and shades of magenta for portions of the scene occupied by both images. The viewer wears a pair of glasses with red over left eye and blue over the right eye. The combined image can be viewed with suitable glasses in 3D. The most common color combinations are red+blue and red+green. The color filtering limits that there are only few possible colors in use in the picture so the images made using this method are not very nice to look.

### 2.2.14 Virtual Workshops

Iqbal, Samsuzzoha and Hashmi have attempted to construct a virtual workshop. It has been shown that the designer can build up a virtual workshop just like constructing a miniature model of the real workshop. Thus 3-D solid modeling and animation based simulation technique provides a fast, effective method of visualizing and experiencing new designs which can be easily modified. Virtual environments have great potential to allow some thing to be done in industry in future. Knowledge and skill of VR designer includes conceptual skill, analytical skill, modeling skill, knowledge of hardware, knowledge of solution and their uses. The visualization tool developed in our research verifies the feasibility of using Stereo Visualization technology for improving the productivity of manufacturing industries. It plays an important role in virtual prototyping.

Wormell, Foxlin and Katzman have described vastly miniaturized commercially available interactive 3D tracking devices and systems for use in virtual environments are discussed in their paper. This paper reviews the technological improvements to this commercially available technology and
discusses new enhancements including device miniaturization, power reduction. The goal of these improvements was to reduce size and weight of head worn tracking devices for use with passive immersive display systems. The major changes include a 2-fold reduction in the size and weight of the wearable sensor devices and improvement of wireless tracking capability. This paper will briefly describe the underlying technology advances that have allowed for these new miniaturized and 3D interactive device designs. Passive stereo vision is used in our research to design an improved algorithm for visualization of mechanical components.

2.2.15 Conversion of 3D CAD Models

Hwa, Taha, Khai, Ghazilla and Ahmad\textsuperscript{118} have reported that the manufacturing industry, conversion of 3D CAD models has become an important process. Various software have been developed for design, viewing and etc. However, most CAD data format are nonuniversal, which may not be able to be read by other software. This paper discussed the development of a three-dimensional CAD model conversion software. The software is able to convert CAD data between three universal file formats i.e. Stereolithography (STL), Virtual Reality Modeling Language (VRML) and Extensible Markup Language (XML). STL is widely used for rapid prototyping and computer-aided manufacturing (CAM), while VRML is designed to be used on the Internet. Lastly, XML is a general-purpose markup language, which is very famous and popular nowadays. A Lexical Analyzer Generator (Lex) is used for character input streams without using an input analyzing program while OpenGL is used to handle all the graphics related matters. The program used anaglyph imaging technique to create stereo 3D with red-blue glasses, and this is the most economical method for stereo visualization system. Its target users are CAD system users who often deal with various types of CAD files which are not supported by one CAD system. Our research is facilitated with an A Low Cost 3D CAD Model Visualization Interface for Manufacturing Industries. This provides computer-generated realism to decision makers and development team for their collaborative work. This tool exploits STL and VRML files.
2.2.16 Web based Approaches

Mohamed Hamada\textsuperscript{78} has illustrated a web-based virtual environment for automata theory, as an example, is introduced in addition to an evaluation of its use in context. This offers learners unique experiences that are consistent with successful instructional strategies such as hands-on learning, simulations, abstract topics visualization, etc. The virtual reality learning environment contains a multimedia information context that offers unique interactivity and can be adapted for individual learning styles. Here authors have introduced a set of visual tools to support interactive e-learning for automata theory concepts. Our research is an example of virtual environment for manufacturing process. It is the use of computer graphics systems in combination with various display and interface devices to provide the effect of immersion in the interactive 3D computer-generated environment. It is a creation of virtual 3D world in which one can feel and sense the world as if it is real. This pretend world seems to be real with the use of special graphics and additional interfaces.

Andrew Woods\textsuperscript{6} this paper discusses the technical characteristics of 3D displays facilitated in home. A good range of high quality 3D displays is gradually penetrating home consumer market. The successful roll-out of 3D cinemas and 3D movies are greatly responsible for increasing consumer interest in this display category. This article describes the types of 3D displays that are currently available with their technologies. Our research achieves 3D display of mechanical components during manufacturing process. The key fact of stereo viewing is to generate two views of the scene, one from each eye position. This can be achieved by maintaining separate drawing buffers for the left and right eyes.

Steinicke, Bruder, Hinrichs, Jerald, Frenzy and Lappey\textsuperscript{41} have presented redirection techniques that support exploration of large-scale virtual environments (VEs) by means of real walking. These authors have introduced the concept of dynamic passive haptics by which any number of virtual objects can be mapped to real physical proxy props having similar haptic properties (i.e., size, shape, and surface structure), such that the user can sense these virtual objects by touching their real world counterparts. Dynamic passive haptics provides the user with the illusion
of interacting with a desired virtual object by redirecting her to the corresponding proxy prop. This paper describes the concepts of generic redirected walking and dynamic passive haptics and present experiments in which we have evaluated these concepts. Furthermore, it discusses implications that have been derived from a user study, and presents approaches that derive physical paths which may vary from the virtual counterparts. The 3D vision tool developed in our research supplies immersive effect of CAD model which makes the user to enter the world of virtual reality.

2.2.17 Importance of Simulation

Linda L. Bell\textsuperscript{63} has introduced the importance of 2D to 3D, upfront simulation and trends that will affect the software market in 2010. Ease of adoption of a 3D product continuous to be a major concern for many customers. Simplifying the 3D environment also helps in adoption from 2D. Virtual Prototyping is a trend that has been the focus of discussion for number of years. It enables the designer to simulate how a product will work in software, without physical models. Improved collaborations makes easier for engineers to share their designs and get help. Our research work is an effective stereo visualization system for virtual prototyping. It is a computer-based engineering method that consists visualizing 3D view of the model under real-world operating situation, and refining the design through iterative process former to building the first physical prototype. In this development cycle it allows engineers to visualize their full-system design ideas on the computer, with realistic 3D models. It enables manufactures identify design related problems in beginning. Physical prototype will be built at the end.

Bresnahan, Gasser, Abaravichyus, Brisson and Michael Walterman\textsuperscript{46} address the “Deep Vision Display Wall” of Boston University. It is a large scale, high-resolution, tiled, rear-projected, passive stereo display system based on commodity components. Passive stereo is a affordable technique with the use of very inexpensive glasses and inexpensive projectors. By careful selection of projectors, polarizing filters, and screen material, problems such as cross-talk, chromatic aberration, and low luminance are minimized. The display surface at Boston University is installed as one wall of the viewing room. An attempt has
made in our research was to design the development of an efficient, easy to use, cost effective visualization system for manufacturing industries. This visualization tool is an ASCII text file driven system to visually simulate the modeled operation in 3D virtual space.

Antonino Gomes de S´a, Gabriel Zachmann have investigated the steps needed to apply virtual reality for virtual prototyping to verify assembly and maintenance processes, CAD-VR data integration, identification of new requirements for design quality. Authors have presented several new interaction paradigms so that engineers and designers can experiment naturally with the prototype. Computer-aided tools for manufacturing industries can simulate a lot of the functions and operating conditions of a new product. However, they still do not meet all requirements completely. Certain functions of a new product cannot be simulated at all by current CAD tools, while others don’t provide the results in an acceptable time. In order to fill these gaps, manufacturing industries have established projects to investigate the use of VR technologies for verification of designs and processes. Our research work is a virtual reality application for manufacturing industries. This Virtual Reality visualization solution enables teams to identify and resolve design and manufacturing problems earlier. This facilitates early troubleshooting of the problems within existing designs and to significantly reduce the risk associated with manufacturing them.

E.A.Edirisinghe, J.Jiang have provided the result of an in depth survey of stereo imaging technologies, introduction to subject area of stereo imaging with a brief historical overview, detailed description of stereoscopic image capturing technologies, detailed analysis of various stereoscopic display techniques, introduces the reader to various data reduction techniques, identifies human factor considerations related to stereo imaging, provides an insight in to applications of stereoscopic imaging and possible future developments. Stereovision could be simulated by acquiring two views of a 3D scene and by presenting them separately to the left and right eyes. Single camera and dual camera capture technologies have been used. The ultimate aim of a stereoscopic imaging system is human perception, in three dimensions. Many variations are present between the methods in which the left and right views can be directed to the corresponding eye. Stereoscopic display
units are classified into \textit{Off Head Displays, Head Mounted Displays} and \textit{Auto stereoscopic displays}. Off Head Display devices are used to direct left and right optical signals to the appropriate eye by the use of multiplexing techniques such as color multiplexing, polarization glasses and time-multiplexed displays. In Head Mounted Displays the two views are created at separate places and relayed to the appropriate eye through separate channels. The HMDs generally offer larger fields but suffer from weight concerns, resolution problems, computing power requirements and user discomfort. Auto stereoscopic are free viewing 3D displays designed with idea of solving drawbacks of HMDs. Human factors play an important role in the development of any technologies. The viewing distance, screen size, horizontal and vertical parallax, binocular asymmetries etc, will result in determination of overall viewing comfort of a stereo scene. The success of a stereo image system design depends on the visual comfort it provides to the viewer of high quality stereo images. Development of stereo visualization system is an objective of our research. It adds reality to computer generated scene, where any three dimensional scene can be viewed using stereo glass to get 3D effect. The main idea of stereo viewing is to generate two views of the scene, one from each eye position. Having separate drawing buffers for the left and right eyes does stereo display. Both the images are drawn on the screen. Left eye sees one image and the right eye sees another image. Combination of this in brain gives the 3D effect.

Wei, Robert, Howell, Conatser\textsuperscript{115} have reported a Virtual Haptic Back (VHB) project is to develop a realistic haptic/graphical model of the human back that can be used for palpation in medical training. The goal of this research is to design, implement, and evaluate methods to improve viewing realism for the VHB project by applying 3D stereo effects and bringing the virtual model to the user’s fingertips like in the real world. Two graphical viewing methods were designed and applied to the VHB project for evaluation along with the standard 23-inch flat-screen LCD monitor: a Head Mounted Display (HMD) with head tracking and a Mirror Viewing System (MVS) which combines graphic and haptic images so that the 3D stereo VHB model appears at the user’s fingertips. Evaluations with osteopathic medical students showed that both of these methods (especially the MVS) improve the VHB realism compared to the flat-screen monitor. The research reported in this paper grew out of a need for increased visual realism in the Virtual
Haptic Back Project at Ohio University. In this context our research is a Three Dimensional Stereo Viewing System for manufacturing industry project. Stereo is a direct method of obtaining 3D structure of visual world, which makes it attractive for applications. Here the three-dimensional scene can be viewed using stereo glass to perceive 3D effect.

2.2.18 Cost Effectiveness

Huangi, Kongi, Guoi, Baldwinii and Heng have reported that the Virtual prototyping technology has been regarded as a cost-effective way of envisaging real circumstances that enhance effective communication of designs and ideas, without manufacturing physical samples. In the construction field, although a large number of digital technologies have been developed to visualize the innovative architectural design, few VP systems have been developed to facilitate integrated planning and visualization of construction plans of the building projects. In this paper authors have described a virtual prototyping system, called the Construction Virtual Prototyping system, which is developed for modeling, simulation, analysis and VP of construction processes from digital design. The CVP system allows project teams to check constructability, safety and to visualize 3D models of a facility before the commencement of construction works. The real-life case study presented in the study shows that the CVP system is effective in assessing the executability of a construction planning including site layout, temporary work design, as well as resource planning. This Construction Virtual Prototyping (CVP) approach used for modeling and visualizing the construction processes based on the Dassault Systemes solutions. The framework enables the users to rehearse and simulate construction process virtually prior to the commencement of a real construction project. The example illustrated in this study showed that the CVP enables the users to visualize the constructability of the proposed construction approach. The CVP system also assists the project team to design a precise construction schedule so as to remove any potential unproductive activities. The rapid prototyping of the CVP system can be enhanced by improving the existing process and resource optimization, constructability and safety evaluation. The simulated virtual manufacturing environment generated by our research enables to develop and optimize production, assembly, machining, and other manual and mechanized manufacturing processes
eliminate the need for physical product prototypes. Thus virtual prototyping software reduces costs and development time by conducting design reviews with virtual prototypes rather than physical. Many manufacturing industries have already begun to routinely use virtual prototyping as a tool in styling and design reviews in the concept phase, assembly/disassembly simulations and maintenance verifications. It is an application of virtual reality for prototyping physical mock-ups using product and process the data.

Francesco, Giuseppe and Adelaide\textsuperscript{16} aims basically to offer an overall view about the potentialities, not yet adequately expressed, which simulation technologies based on VR can provide to the improvement of production systems. The resources employed in VR application to design, either installation, management or upgrading costs, are remarkable. In manufacturing processes the most important applications realized are in assembly area in order to reduce design cycle time, redesign efforts, to predicted the quality of an assembly, product cycle and cost, to provide an environment for studying the inspection methodologies and collision detection. According to authors, in order to realize a virtual simulation, in a manufacturing environment, the following actions have to be performed,

1. Data collection - layout, 3D models, pictures, sequence of operations, assigned cycle time, productivity, availability, etc.
2. Work cells Simulation using dedicated software tools.
4. Integration of each machine/station into plant discrete event simulation tool.
5. Output analysis: it must be verified that each assigned parameter, such as technical efficiency, availability or throughput, fit with customer’s requirements
6. Presentation of the whole work to customer.

We have developed a computer based visualization tool for manufacturing industries. This techniques place an important role in the manufacturing industries. It allows acquisition of important information that can help the designer in correcting and controlling the product right from the early conceptualization to the final assembly design stage. It helps for design review is one of the very important applications of Virtual Reality in manufacturing process.
Tsioukas, Sechidis and Patias suggested low cost visualization and measuring “tool” for architectural and archaeological photogrammetric applications, tries to bring photogrammetry closer to the two disciplines that can certainly take advantage from the photogrammetric processes and the value added photogrammetric products. This effort is also supported by the downfall of the hardware components prices and especially of the special graphic subsystems. It has been accomplished to develop a system that can fully support the capabilities of a graphic card with stereoscopic vision capabilities and the photogrammetric process have been introduced to a simple software application that can easily be operated by a novice user such as an archaeologist or an architect. The developers will try to embed more tools and automation in the application that can help the job of an architect or archaeologist. For that reason, the successful cooperation of the photogrammetric community with the other two communities is essential. In our research we have developed a low cost 3D stereo visualization suite for industrial applications for manufacturing of mechanical components.

2.2.19 Projection Methods

Eric Dubois et. al. have designed a projection method to form an anaglyph stereo image from the left and right color images of a stereo pair. An anaglyph image allows the perception of depth when observed through colored glasses such as the familiar red/blue glasses. Although the method is very old, the techniques used to generate anaglyph images are very empirical. This paper describes a projection method to generate anaglyph stereoscopic images using the spectral absorption curves of the glasses, the spectral density functions of the display primaries and the colorimetric properties of the human observer. The projection method described in this paper has been used to generate numerous anaglyph images adapted to different types of colored glasses. The images produced are superior to those produced with classical methods. In our research we have generated Anaglyph Stereo Images using Time Parallel Method. An anaglyph is a method of viewing stereoscopic images using red-blue colored spectacles. The left view in blue (or green) is superimposed on the same image with the right eye view in red. When viewed through eye ware of corresponding colors but reversed, the 3D effect is perceived. Time-parallel methods present both eye views to the viewer.
simultaneously and use optical techniques to direct each view to the appropriate eye. This method requires the user to wear glasses with red and green lenses or filters. Both images were presented on a screen simultaneously; hence, it is a time-parallel method.

McAllister\textsuperscript{25} reports that recently there have been rapid advancements in 3D techniques and technologies. In this paper author has introduced technological advancement in the field of stereo and 3D display. In computer graphics, the improvements in speed, resolution, and economy make interactive stereo an important capability. Old techniques have been improved, and new ones have been developed. True 3D is rapidly becoming an important part of computer graphics, visualization, virtual-reality systems, and computer gaming. This paper provides detail explanation about Stereo pairs, Overview of various Display technologies, 3D Displays, Field sequential devices, Large format displays, Auto stereoscopic displays. In our research we have used anaglyph display. It follows time-parallel method. It presents both eye views to the viewer simultaneously and use optical techniques to direct each view to the appropriate eye.

Cooperstock and Wang\textsuperscript{59} have conducted a comparative study of different stereoscopic display modalities (head-mounted display, polarized projection, and multiview lenticular display) to evaluate their efficacy in supporting manipulation and understanding of 3D content, specifically, in the context of neurosurgical visualization. Their study was intended to quantify the differences in resulting task performance between these choices of display technology. The experimental configuration involved a segmented brain vasculature and a simulated tumor. Subjects were asked to manipulate the vasculature and a pen-like virtual probe in order to define a vessel-free path from cortical surface to the targeted tumor. Because of the anatomical complexity, defining such a path can be a challenging task. To evaluate the system, they quantified performance differences under three different stereoscopic viewing conditions. The results indicate that, on average, participants achieved best performance using polarized projection, and worst with the multiview lenticular display. These quantitative measurements were further reinforced by the subjects’ responses to our post-test questionnaire regarding personal preferences. Our present research pertains to development of visualization
platform for mechanical industries. In the course of this work we have developed a
cost effective software platform for easy visualization of the mechanical
components without much intricacies of the sophisticated computing platform.

Wozelka et. al. have presented the implementation of immersive virtual
environment using a custom projective stereo display built form LCD projectors
switched by externally mounted liquid crystal displays. The paper starts explaining
the various stereo separation techniques such as Time-sequential, parallax, spatially
multiplexed, polarized, color multiplexed etc. Authors have provided the details of
their research setup. The main focus of their development was placed on the
properties of the projection system. The visualization suite of our research has got
direct interface to Virtual Reality through stereo glasses. 3D rendering is the key
component of our system. This technology provides the capability to immerse the
user in the design of virtual product. To enhance the visualization various additional
features are incorporated in this suite.

Robertson, Czerwinski, and Dantzich explore techniques for evaluating and
improving immersion in Desktop Virtual Reality (VR). In the current experiments,
a visual search paradigm was used to examine navigation in Desktop VR both with
and without navigational aids. Authors have introduced a new navigation aid called
Peripheral Lenses, intended to provide simulated peripheral vision. Informal studies
suggested that Peripheral Lenses decrease search time, indicating an enhanced sense
of immersion in Desktop VR. However, formal studies contradict that,
demonstrating the importance of formal usability studies in the development of user
interface software. Authors have also gained evidence that visual attention findings
transfer to Desktop VR. In this paper, we explored methods for measuring or
observing immersion in Desktop VR, and enhancing it with a new navigation aid
called Peripheral Lenses. Our research achieves a type of immersion in Desktop
Virtual Reality. Immersion is a psychological feeling of the user to be present in the
actual situation, which is the most important part of VR. The presence felt by the
user allows them to behave naturally inside a synthetic environment.

Cyre, Hess, Gunawan and Sojitra have reported ModelMaker a tool being
developed by authors to help modelers rapidly develop behavioral models from
natural language descriptions to support the construction of virtual prototypes. This tool analyzes documents for behavioral patterns and constructs a component and signal index for search and retrieval of relevant text. The tool’s interface features an edit window for HDL model development and a source window in which retrieved text and behaviors are displayed. Relevant source text can be retrieved by searches on entity and signal identifiers or on noun phrases automatically extracted from the source document. In addition the document can be automatically analyzed for behaviors which identify processes and events, as well as the devices and values which participate in them and, in some cases, how they interact. A natural agent/transaction modeling style is suggested for exploiting the extracted information. The visualization solution developed in the course of our research work can be utilized as a virtual prototyping tool in manufacturing industries.

Mizell, Jones and Slater\textsuperscript{27} aims at determining whether or not immersive virtual reality (IVR) technology gives a user a measurable advantage over more conventional display methods when visualizing complex 3D geometry. Subjects were shown an abstract rod sculpture in a variety of display and display-control modes, and were tasked with assembling a physical replica of the sculpture they were visualizing. They were scored on the speed and accuracy with which they assembled their replica sculptures. Head-tracked immersive VR was shown to have a statistically significant advantage over joystick-controlled display modes, especially in the case where the displayed sculpture was shown in super-scale, surrounding the subject. Anaglyph is selected as a stereo vision technique for the development of our visualization solution. Since it is inexpensive, it is affordable for everyone.

2.2.20 Some Problems related to Visualization

Coomans, Oxman\textsuperscript{77} have reported the identified problems underlying the inability to use CAD systems in the early, conceptual phase of the design process. Conventional CAD systems have not yet proven their ability to provide support for activities which characterize the early conceptual phase of design. By analyzing these problems it has shown that a VR environment can support the early design process better than the conventional desktop based computer interfaces. It achieves
this result by offering a higher interactivity and by its potential of presenting highly complex information in an easily understandable form. Authors have explored Virtual Reality as a potential design prototyping environment in which prototypes of designs can be constructed, communicated and visually evaluated at a high level of verisimilitude. This system has been used for extensive internal evaluation. Developers have constructed an empirical research to observe designers at work on design prototyping in the Virtual Reality environment. 3D models designed using CAD software leads to very heavy file size. This is due to the fact that the modeler not only holds the geometric information, but also topological information of the object. Therefore it requires a powerful computer system to view the components. Since the file contains data sets, which are not required for visualization, manipulating such files solely for visualizing stereo mode results in slow operation on a general-purpose computer. The visualization suite developed in our research fetches the data required only for visualization and renders the model.

Bullinger, Breining and Bauer [49] have reported digital mock-ups which are the platform for Virtual Prototyping. In this paper authors have provided the answers to the questions concerning VP were focused on the integration of computer-based tools and methods for Digital Mock-ups. This paper explains reliability concerning the assessment of product characteristics, kind of representation/visualization is necessary to achieve a high reliability concerning the assessment of product characteristics, possibilities for interaction with the digital mock-ups directly.

Pratt gives an overview of some of the modeling and virtual prototyping techniques used in product realization with emphasis on the mechanical engineering field. It is pointed out that virtual prototype, in the commonly accepted sense of computer models permitting realistic graphical simulations. This paper illustrated the point that multiple different types of product model are generated and used for different purposes in the course of the product realization process. The ability to visualize the CAD prototype in a virtual environment, penetrating the prototype, examining it from different angles and eventually manipulating it, offers significant benefits to the designer, to the manufacturing engineer and to the mold maker or tool maker. This technology will reduce the time to market of products by
drastically reducing if not eliminating the iterative process of design and manufacturing.

Hossain, Akbar and Starkey have reported the developed mechanism that does not require any special devices to calibrate the stereo images. They have used a hand-held inexpensive digital camera to take the stereo images of a face. The stereo images were taken holding the camera in hand and moving it to two slightly different viewpoints. They constructed a depth map from these two stereo images and utilized this depth map to reconstruct the three dimensional face model. The 3D face model reconstruction process described in this paper uses some existing theories and combines them to develop a new system to generate the depth map. The system requires minimal user interaction for the reconstruction. As a result, this system could be used by anyone with a cheap digital camera to build 3D face models. The limitation of the technique is that it is not suitable for large objects (e.g., buildings, cars, aircraft, etc.) because the depth map has constructed from the RGB color intensity of the stereo images. The primary goal of the development of the 3D Visualization suite reported in the present communication was to empower the designers with a fully functional stereovision and facilitating them to explore their datasets in a graphical manner that too at low cost. With a combination of inexpensive hardware and easy to use software, this development enables manufacturing industries to perform virtual prototyping.

2.2.21 Accurate Depth Estimation

Bhat and Nayar\textsuperscript{29} have reported the problem of accurate depth estimation using stereo in the presence of specular reflection is addressed in their paper. Authors have developed a physically based approach for reliable stereo in presence of specular reflection. A scene independent binocular stereo solution was obtained by minimizing the intensity differences at corresponding points while maximizing the depth resolutions. In our research we have developed a low cost visualization suit for manufacturing industries. This software architecture provides detailed visual information for manufacturing team before products to go in to final production stage.
Smedback, Carro and Hermenegildo have reported an interface that provides a portable, standardized, and easy to use solution for the application programmer, and a familiar behavior for the user, typically well versed in the use of WWW browsers. Among the proposed standard description languages, VRML is an aimed at representing three dimensional scenes including hyperlink capabilities. VRML is already used as an import/export format in many 3-D packages and tools, and has been shown effective in displaying complex objects and scenarios. Authors have described a Prolog library which allows parsing and checking VRML code, transforming it, and writing it out as VRML again. The library converts such code to an internal representation based on first order terms which can then be arbitrarily manipulated. Authors have presented as an example application the use of this library to implement a novel 3-D visualization for examining and understanding certain aspects of the behavior of CLP(FD) programs. In this context the visualization suit designed in our research parses and renders the 3D models of VRML and STL files which are generated from modeling software. 3D models designed in modeling software leads to very heavy file size. This is due to the fact that the modeler not only holds the geometric information, but also topological information of the object. Since the file contains data sets, which are not required for visualization, manipulating such files solely for visualizing stereo mode results in slow operation on a general-purpose computer. This visualization solution parses these files and fetches only the required data sets for visualization in order to obtain the desired displays.

2.2.22 Supporting Devices

Roberts, and Slattery surveys the capabilities and characteristics of traditional displays such as CRT and LCD panel, and a board assortment of newer display technologies including color plasma, field emission and other reflective systems. Relevance of display characteristics to various stereo presentation formats is discussed with description of laboratory experimentation. Recommendations are made regarding the stereo formats to be used with various display technologies. The simplest form of virtual reality is stereoscopic visualization in which 3D image can be displayed interactively at a personal computer. In our research we have designed stereo vision system for virtual prototyping.
2.2.23 Product Geometry Design through Visualization

Fiorentino, Monno and Uva present the issues in the development of VR interfaces for product geometry design. The ongoing research addresses two main topics: user anisotropy during 3D space interaction and the reduced perception along depth direction especially when visual occlusion occurs. Authors have proposed a user aligned snap tool and the use of vibro-feedback to improve basic CAD tasks in VR as pointing, picking and selecting. In this work developers have identified two critical issues in virtual reality based CAD applications. The first issue regards human interaction precision in 3D space. The second issue is the lack of spatial sensitivity of virtual objects surface especially along the depth direction. The proposed solutions have been validated by statistical analysis with practical tests. The presented results offer a significant contribution for developers of modeling applications in Virtual Reality. On a computer, virtual reality is primarily experienced through vision. Our research designs such a visualization tool utilized for virtual prototyping. The ASCII format of the models designed in CAD software can be parsed and model can be rendered in our visualization tool.

Michael Rorke, Shaun Bangay, Peter Wentworth addresses the problems associated with interaction in immersive virtual reality and makes recommendations as to how best to deal with these problems, thereby producing a usable virtual reality interactive environment. Immersive virtual reality means that the users are immersed or contained inside the environment in which they are working. For example, they are able to turn their heads and look around, as well as use their bodies to control the system. The work in progress involves a study of various virtual reality input devices, some designed and implemented as part of the project. Additionally, the paper describes a simple framework for separation of the interaction and application parts of a virtual reality system in order to facilitate an object oriented approach to the implementation of the recommendations, and to the building of future virtual reality applications which incorporate these ideas. In our research we have designed a passive stereo vision system which is a low cost tool to view 3D models only through Red/Blue glasses. The drawback of this mode compared to active stereo is that the object is visible only in the composure of red
and blue colors i.e., rendering a model in magenta color. So the original colors are not visible to the viewer.

2.3 Conclusion

This study verifies the feasibility of virtual prototyping simulation to improve the production applicable to the manufacturing industries. In our research we have made an attempt to design the development of an efficient, easy to use, cost effective visualization system for manufacturing industries. This visualization tool is an ASCII text file driven system to visually simulate the modeled operation in 3D virtual space. It is able to browse the STL, VRML files, fetches the data sets that are required for visualization and renders the model on the screen. This visualization solution provides three-dimensional effect of the CAD model for enhanced visualization. These virtual environments can be explored by using Visualization hardware. This technique expands the results of two-dimensional and three-dimensional CAD modeling into 3D spaces that a designer can explore and interact with virtual models. This new approach could lead to an improvement in quality and performance of most current techniques in visualization.

It enables the user to enter a world of Virtual Realism. In the field of manufacturing industries, the distinctive advantage of Stereo Visualization application compared to traditional way of planning is that this technology allows the user to feel his presence in the manufacturing environment without actually being present. It provides an alternative way for traditional iterative process of repeated development of hardware prototypes for experimentation and performance evaluation.

As a prologue of this literature survey, we have found that there is still a great scope for a low cost visualization tool for the manufacturing industries. With the gaps revealed from the extensive literature review, we have formulated the problem statement for the research and taken up the reported development.