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ADDING LIFE TO VIRTUAL REALITY USING VRML

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Abstract

Producing 3D interactive models is becoming a greater challenge every day. Choosing the right tool to handle the modeling process is essential if the final product is to be a VRML world, which can satisfy the user's desire for both interactivity and realism. This research paper explains how the tools and techniques available within VRML can be harnessed to produce complex interactive models, which can be viewed with a VRML browser.
Keywords:VRML, Virtual Reality, Interactivity, 3Ds Max, Modeling, 3D Model

1 Introduction

As the processing power of the average computer grows, in seeming fulfillment of Moore's law, so do the expectations and requirements of the average user. The demands placed on Virtual Reality programmers can be described in one word, "More": More realism, more interaction. What was excellent yesterday being unacceptable today. For practitioners who model Virtual Reality worlds, the continual demands from users mean more hours spent optimizing the code that describes these virtual environments. The modeling process is becoming more of a nightmare than an inspiring and creative challenge. So modeling process can be shortened and, at the same time, achieve the necessary level of interaction? One solution is to combine the use sophisticated tools, designed to support the creation of high quality models, with the techniques necessary for achieving interactivity. Some such tools are CREO, AutoCAD, 3DS Max Studio and Blender. In this research work, it has been tried to investigate the full scope of the 3DS Max Studio along with other software and to demonstrate how best the packages can be exploited to achieve interactivity in 3D models targeted for use as VRML worlds.

Adding Interactivity and Life to Virtual World

Interactivity in Virtual Reality worlds traditionally means employment of three of humans five senses:

- Sight
- Hearing
- Touch

Combining targeted impressions on these senses produces perceptions of space and interaction with objects located in that space. For example, incremental enlargement of an object produces a perception of movement towards that object. What a user expects to do in a virtual world is to move freely about, manipulate objects as one does in the real world and experience a spatial sense of sound. A spatial sense of sound means that the sound has a source fixed at a single point (a node) in the virtual environment. Moving towards that source increases the volume of sound and moving away decreases the volume. Also, the perception of the source of the sound is experienced relative to the user's position in the world. By shifting position in the virtual environment, the user's perception of the

direction of the sound source changes. User interaction in VRML world is gained by using standard predefined VRML sensors. Sensors can be considered as special kind of nodes designed to react when properties of the Virtual Environment change or when a user operates a sensor in a predefined way. Following VRML nodes were used to achieve interaction and dynamic environment in VRML.
Anchor - creates a link in a VRML file. The link is embedded in an object;
Background - the Background helper allows the creation of a Sky and/or Ground backdrop for the virtual world. This produces very simple and plain "Earth and sky" perception.

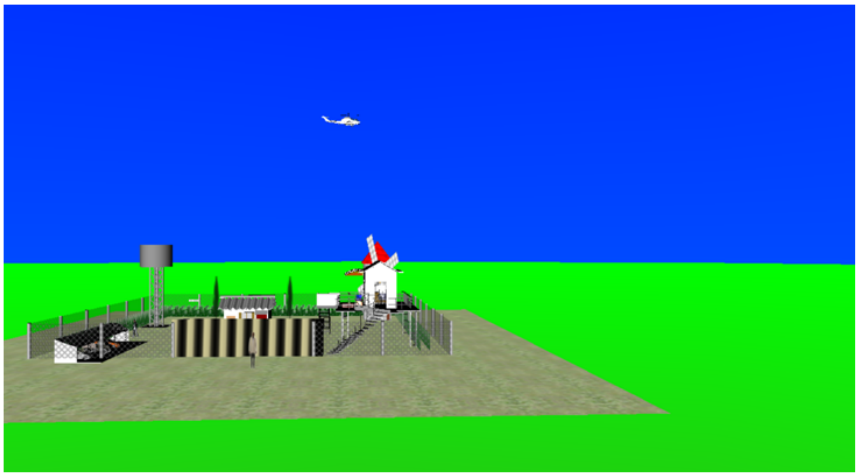


Fig1: Background (The image at, or color of, the infinite horizon. In VRML, the objects or object can never be approached by a visitor)

Touch Sensor (touch sensor) represents an area of sensitive space that, when touched by user, triggers event. There is a difference between Anchor and Touch Sensor. Touch sensors are sometime combined with scripts to play predetermined animation. Touch sensor has been used at number of places in this virtual world. Some distinct examples are explained as below

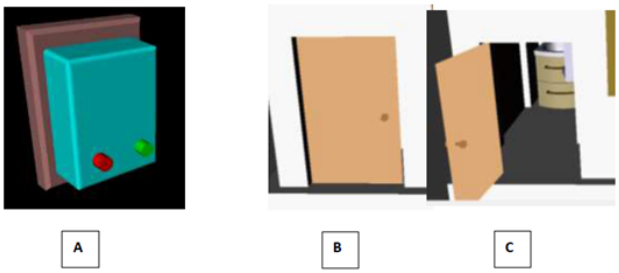


Fig.2 A: Control Panel having start (green) and stop (red) button to start/stop conveyor and other machines. B: Door script coupled with touch sensor (closed door default position) C: Door script operated with touch sensor (door will open outside by 90^0).

As shown in figure A, control panel toggle switches have touch sensor attached to it. As user, operates (touches red/green) switch, machine/conveyor cycle will start/stop accordingly. The door script inserted in this scene as shown in Fig. B and C. This door script is coupled with touch sensor i.e. as user touches door, it will trigger either door opening or closing action. Another instance where touch sensor has been used is computer table drawer in virtual office as shown in figure below. Every drawer of computer table has touch sensor coupled with script. (script is responsible for pre-determined action). User can operate (open) all the four drawer (not shown in figure).

C

Fig. 3 A: computer table drawer (default position closed). B: computer table drawer operated (opened) with touch sensor. only upper left and lower right operated C: computer table drawer operated (opened) with touch sensor. Only lower left and upper right operated

Fig. 4 Table lamp switch in off condition (by default)

Fig.5 Table lamp switch in on condition operated by red switch placed at the base. Blue switch will put bulb in off condition (bulb on/off condition can be judged by rendering effect on computer monitor, keyboard and table

Computer keyboard is also equipped with touch sensor. User can operate keys by touch sensor. All keys will get equally pressed as user operate touch sensor associated with keyboard. User can see downward movement of keys while operating this touch sensor.

Fig. 6 Keyboard keys (unpressed)

Fig.7 Keyboard keys (pressed) using touch sensor

Sphere Sensor: This sensor maps the mouse movement into a surface of a conceptual sphere, rotating the shape about the center of its local coordinate system.

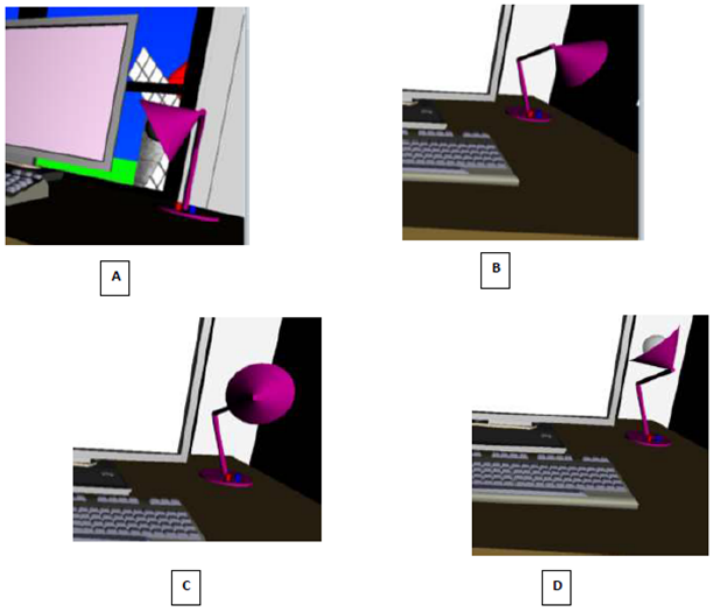


Fig. 8 Table lamp with sphere sensor coupled with touch sensor in the neck A. Table lamp neck pointing towards computer monitor B. Table lamp neck pointing away from computer monitor C. table lamp neck pointing on back wall D. table lamp neck pointing towards ceiling

We have used this sensor in table lamp neck. User can rotate table lamp neck in spherical region within local coordinate system as

shown in figure. Sphere sensor here is coupled with touch sensor.
Cylinder Sensor The Cylinder Sensor changes between these two styles of interaction automatically, based on the current viewing angle. The cylinder Sensor always rotates about the Y-axis. Imagine that it is sensing a Cylinder in its default position. Looking at the cylinder head on, you can grab its side. When you do this, an imaginary cylinder forms that is infinitely tall. The radius of the cylinder is the distance from the rotation axis (the Y-axis) to the point clicked. By default, this gives you the cylinder behavior. Moving the mouse from side to side sends out rotation changed events, relative to the initial point clicked.

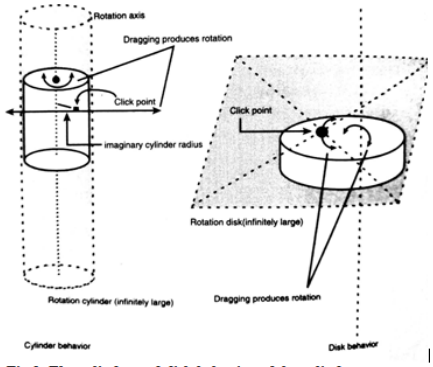


Fig.9: The cylinder and disk behavior of the cylinder sensor

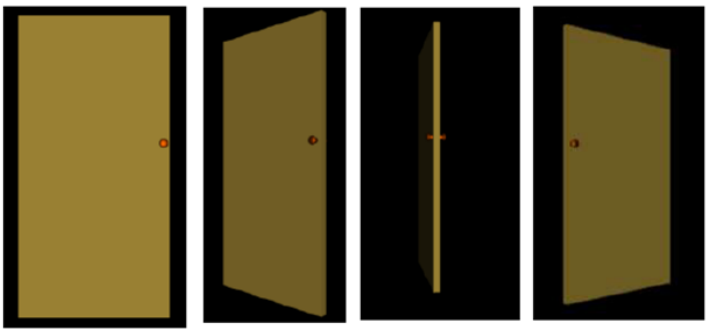


Fig.10: Cylinder sensor used in door. Starting from left, Default position (door closed completely), Door pulled outside by 45^0, Door pulled outside by 90^0, Door Pulled out side by 135^0 *(Door in this virtual world can be rotated into 360^0 as **MAxAngle** and **MinAngle** fields are empty)*

Plane Sensor:lets the user move objects in the XY plane. The plane sensor also has the capability to restrict movement using the minposition and maxposition fields. We have used plane sensor in Window along with flag as shown in figure below.

Fig.11: Plane sensor used in window. Starting from left, Default position (Window closed completely), Window open halfway, Window open completely

Indian tricolor is also equipped with plane sensor. It will be at bottom of post in the default position which can be dragged to top to its maximum position as shown in figure

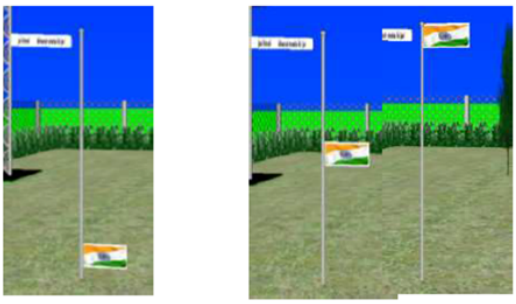


Fig:12. Plane sensor used in Indian Tricolor (Flag). Starting from left, Default position (Flag at bottom of post), Flag dragged to halfway by user interactively, Flag dragged to top of post (Max position)

Sound and Audio clip these two helpers allow the insertion of spatial or ambient sounds in a scene. Sound helper is always used in combination with Audio clip, while Audio clip can be combined with Touch Sensor.

Fig.13: Chopper/Helicopter rotor blade produce ambient sound which can be heard in vicinity as user approach near the object in virtual world.

We have used this at several places in this virtual world such as spatial sound produced by different machines and conveyors (different sound assigned to different machine so as to clearly distinguish between them). Information broadcast by sprite etc. The

most prominent example of ambient sound is the sound produced by helicopters/choppers blade rotation.

Proxy Sensor This class of sensor detect movement of the user in the scene. (proximity sensor) represents an area of sensitive space that, when activated by approach of user, triggers an event. Proximity sensor is useful in sensing users Location. This node (proximity sensor) sends out events when the user enters or exits a defined region of the scene. While inside that region, it reports the users location during movement.

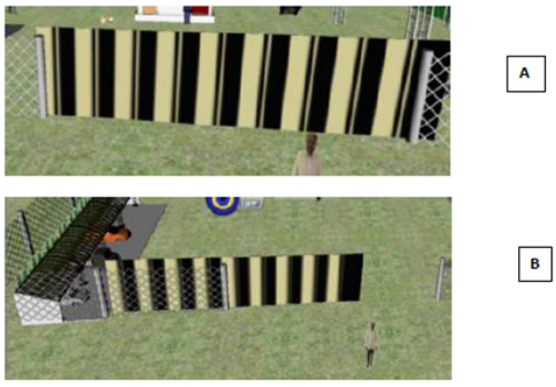


Fig14: A. Entry gate with proximity sensor is closed (default position) B. Entry gate with proximity sensor slowly moving leftward after detecting user presence

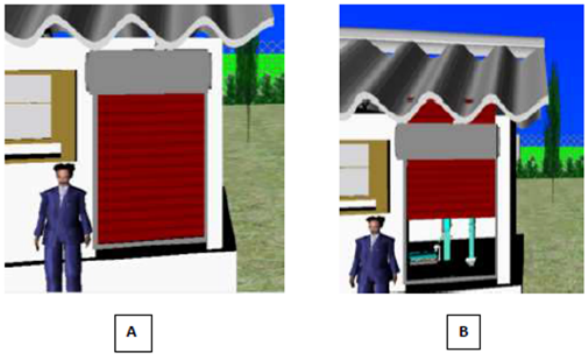


Fig 15: A. Rolling shutter with proximity sensor is closed (default position) B. Rolling shutter with proximity sensor slowly moving upward after detecting user presence

We have used proximity sensor at two locations in this virtual world. The first instance is entry gate, which moves in rightward as user

tries to enter the fencing area, the second instance is rolling shutter which moves in upward direction as user reaches within the proximity of shutter as shown in fig.

Time Sensor (time sensor) is used for adding time-based animation controls - such as the start and end frames for a particular object's animation.

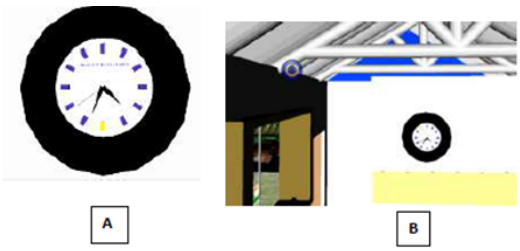


Fig16: A. Wall clock (close-up View) B. wall clock location in virtual world

In this virtual world, time sensor has been used for wall clock along with many other objects. The specialty of wall clock is that it displays system time (users computer/laptops time) graphically in analog and digital mode.

Keyboard sensor/ String Sensor: This sensor sense/detect alphanumeric input from the keyboard and display for the user. By virtue of this sensor, user can write alphanumeric characters directly in virtual world. We have used this sensor in the form of notice board below wall clock in this virtual world as shown in figure. This notice board when clicked activates keyboard sensor and allows user to input alphanumeric characters as shown below.

Fig 17 : A. Keyboard sensor coupled with virtual notice board A. Displaying string "HAPPY NEW YEAR" B. Displaying string "WELCOME TO VR WORLD" C. Displaying string "KEYBOARD SENSOR" D. Displaying string "My Contact 9226743354"

Navinfo (navigational information) provides navigational information of virtual space. This helper directly influences the way a user moves around the virtual world. Every scene should have this helper included;
Fog - enables specification of the color and range of fog in a VRML world; **LOD -** (Level of Detail) Lod helper allows for different levels of detail and complexity in an object depending on a user's distance from the object. When the user is closer to the object, the browser renders the object with a higher
quality - producing more details. This helper can be used for optimization of performance;
Billboard - permits creation of geometry that is camera-aligned in the VRML97 browser. Billboard is a special grouping node. All children nodes will turn to face you, as a sunflower to turns to face the sun as it moves. The children nodes will rotate in a user defined axis.
In Line - lets the user reference another VRML97 file. This second file would be included in the user's world when loaded into the VRML97 browser;
Avatars -When you move around a 3D world with the walk interface, there is actually an embodiment of yourself in the 3D world, known as an avatar.

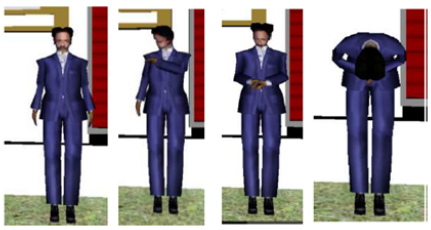


Fig 18 : Avatar (A visual representation of the body of visitor to a virtual world) Starting from left. Position 1: Standing ideal (waiting), Position 2: Cleaning dust on shoulder, Position 3: Looking into wrist watch for Time, Position 4: welcoming guest in Indian style (Namskar/Namaste) (when clicked with left mouse button)

This avatar gives you a height and dimensions, so you can walk up hills and not pass through walls. Your avatar is actually a cylinder with the eyes (your current view of the world) near the top. The size of this avatar, by default, has a 0.25-meter radius and is 1 .6 meters tall. It can also step over objects as tall as 0.75 meters. Any taller than this, and the avatar will run into the object instead. You

can create a staircase for your avatar to climb, as long as each step is less than 0.75 meters. These values are set in the avatar size field. You can change the size of avatars visiting your world using this field. You can make everyone in the world giants or ants.
Sprite: - VRML allows the placement of 3D objects in a 3D world. However, VRML also has a way to effectively use 2D objects in the world, as well.

Fig19: Sprite (Two-Dimensional representation of objects using images instead of three –dimensional geometries) introduced in Virtual World at Several places in different getup/costume

The game community calls these objects sprites. Used effectively, they can increase the richness of your worlds while achieving maximum rendering performance. A sprite is a 2D bitmap that looks three-dimensional. It is named after a mythological fairy that could move very quickly. When rendered in a 3D world, it looks like a normal object but can be rendered much more quickly, because it consists of a single image rather than many separate polygons. A sprite has the disadvantage that you can only see it from one angle, but for some applications (such as monsters chasing you in a game), it works well.
Scripting: The script node allows you to create your own fields and events, and then define the way they work by writing a script, or sequence of user defined instructions.

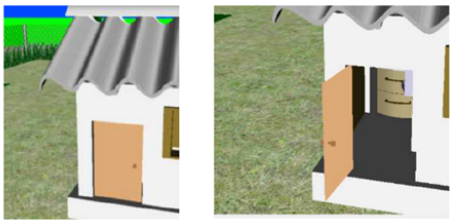
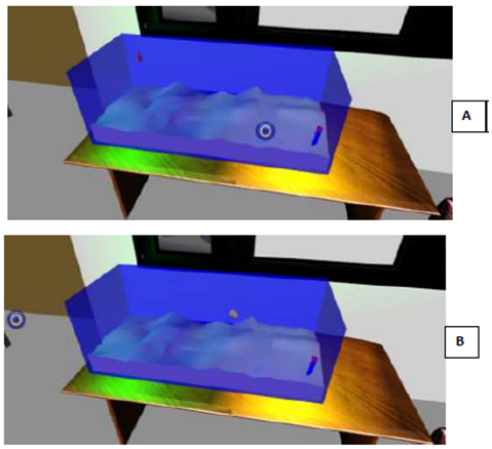


Fig20: Script coupled with touch sensor to operate door A. Door closed (default position) B. Door script operated with touch sensor to open door outside by 90^0

VRML supports several programming languages for writing scripts, including the most popular Java Language. Java language is a very powerful language but can be difficult to learn. The other simple language is VRMLScript , which is supported in browser. We have used script at two instances in this virtual world. The first instance is Door operated by touch sensor (without cylinder sensor). Here the script will open door by 900 if operated by touch sensor as shown in figure.



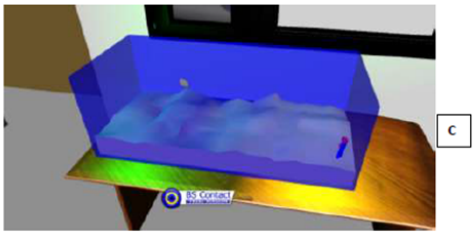


Fig 21: Script controlling fish movement in fish tank. Fish acquiring different positions A, B, and C as per predetermined instructions in script.

The second instance where script is prominently used in this virtual world is Aquarium. An aquarium is placed outside office have script for the movement of fish. The fish takes different positions in a confined region of Aquarium/ Fish Tank. The position and speed of fish is controlled by a set of predetermined instructions called as script. Different positions taken by fish in aquarium/fish tank are shown in figure above.

1. Discussion

Based on work Methodology for development of Interactive solid modelling in Virtual Environment conclusions can be drawn, which will be presented in the following text Creating models using visual environment of 3ds max does shorten the time of coding but only in cases where good model design was created beforehand. A general rule of thumb is that before to any coding begins; there should be an analysis time. The same applies here. Model should be first drawn on paper and only then modeled in modeling environment. Otherwise, too much time is spent in the search for good design. The interactivity achieved in this created worlds was found to be satisfactory. Animation and spatial sound were extremely easy to create and functioned in the required way. Working with sensors that are linked together, (see above in examples of Touch Sensor and animation and Touch Sensor and Sound node) showed that the automation of creating ROUTES in VRML functions in the required ways. This is very useful when working with scenes containing many different sensor nodes. The export utility that is integrated in 3ds max showed satisfactory results. All primitives were exported with high-quality results. Some results were achieved by exporting extended primitives with slightly bigger file sizes. Compound objects (Boolean type and Loft type) were also exported without problems and the size of exported files was shown

to be directly dependent on the objects that constructed the scene, and much less from the operation used. NURBS objects were also exported faultlessly, and exhibited high-quality result. Objects that cannot be exported are: Particle Systems and Space Warps. These objects would have been excellent for producing different weather conditions. All exported objects maintained most of their modifiers. Although modifiers increase quality of the final VRML world, they should be used sparingly, since they considerably increase the size of final VRML file (in some cases it has been observed this increase to be over 100 times!). For some applications even better export results might be needed. In this case, several third-party export utilities have been developed for specific need. These utilities come in the ready to use form of plug-ins. The approach adopted produces high quality 3d interactive models. The VRML files obtained through this approach, however, tend to be large. If this approach is to be used for Virtual Environments viewed via such medias as the internet, then optimization methods are required These would include controlling the number of polygons in the scenes, using simple transforms for animation, optimizing material maps and so on. This method, however is excellent for promotional materials that can be distributed via media such as CD-ROM, DVD and Website. Although it proved sufficient for the needs of this work, 3ds max only provides a few predefined sensors. This problem could probably be circumvented by use of the Max Script - a scripting language integrated in 3ds max and tools available Vivaty Studio. Probably the greatest advantage of this approach is that VRML worlds can be created without any great expertise in VRML. The only prerequisite is knowing how to model in the 3ds max environment. 3ds max takes care of the rest - but even so, optimization of the code is sometimes necessary and unavoidable.

2 CONCLUSION

The era of programming by writing code in a code editor is long gone. Demands on programmers are pushing them towards rapid code development. Shorter life cycle development and easier maintenance of developed systems can be achieved through different approaches ranging from computer-aided development to rapid pro-

totyping and model development. Demands from captivated users are driving virtual reality modelers to explore the modeling environments that can support high quality modeling and that possess integrated tool for achieving interactions in Virtual Reality worlds. Choosing a working environment is not an easy task. The chosen software tool may shorten the production period but, at worst, may considerably prolong it. If the modeling environment is too complex, the programmer will require training and practice time before becoming productive - time that people simply do not have. 3ds max is a premium modeling tool. Most people engaged in modeling have encountered the package at one point or another. This software is able to produce high quality and complex models and - what is more -produce them rapidly. It has a built-in VRML exporter that handles all elements of the constructed scene. As has been observed in this research work, it has built-in objects and helpers, which, if used alone or combined with one another, create the necessary perceptions of interactions. We can conclude that 3ds max presents an excellent environment for creating 3d interactive models, which can be explored in VRML. Visualization in many scientific fields (e.g. engineering, biochemistry, physics, and astronomy) has been greatly aided by computer graphics. Once translated into visual images, even very complex data can be easily interpreted. In addition to illustrating data, computer graphics can also be used to design experiments and analyze probabilities in advance to narrow the range of variables to be tested. Computer aided design is used extensively in the automotive, aeronautic, electronic, and textile industries. Computer graphics can be used to aid the imagination in all types of design, from choreography to architecture. Because simulation is generally so much cheaper than staging a performance of an entire dance troupe, for example, and so easily edited, CG allows more experimentation in the design phase. Instead of being forced to commit to a certain path fairly early on, a designer can take all manner of permutations of an idea to their logical completion before making a decision (or presenting options to decision makers). The software handles the computations, freeing the designer to focus on comparing the results of different routes rather than on figuring out the results. The caveat to this is that a 3D simulation of an experiment is only as good as the premises on which it is based. It is easy to be convinced by a visual

simulation, because vision involves its own mental processes separate from humans analytical minds. When using 3D to simulate a test that would be expensive in the real world, bear in mind that the assumptions of the simulations need to be carefully analyzed before you commit to a course of action. Visualization has always been recognized as the most effective means of communicating new ideas and design among designers, engineers and others. And a new concept of virtual realism has come into scene which enhances the practical visualization of object. What makes the concept of VR so exhilarating is the fact that it allows the user to feel that they are within the system, rather than outside it as in case of traditional computers. This system of VRML is a pioneering effort in the field of modeling and visual simulation of industrial processes which is the upcoming concept till date. However, with the technical advancement in the field of virtual reality and the demand for better and efficient processes or industrial applications, the need for VRML with much wider knowledge base must be required. This can create a virtual world in front of real world. The resulted VR environment was the outcome of applications derived from the individual software packages. Previous application each time constituted the base for next application to be developed. Though, initial modeling of operational activities in industries are complex and time consuming, once modeled graphically, it is easy to animate and represent in the VR environment. The processes modeled in the VR environment can be helpful in multi-tier applications like, process planning, routing & scheduling, machine capacity planning, motion and time study, work place design, ergonomic study, product display, employee training, etc. The above research work was carried out keeping in view the need and difficulty of marketing department of the company. As CREO was chosen as modeling software there are much more possible uses of 3d assemblies created in CREO. CREO can be used to create tool path generation for manufacturing of part. The rapid prototype of parts as well as assemblies can be created by exporting the assemblies in CREO to *.stl format (*.stl format is used in rapid prototype process). The parts created in CREO can be optimized as well as analysis can be carried out on them. Automated inspection devices can be coupled with CREO to have automatic inspection but this can be applicable where mass production is required. Besides marketing, the

moving 3d models of machines are useful in educating the farmers or workers regarding the operation of machines. The moving 3d virtual models will be also useful to the company to display their products in trade fairs or exhibitions of agro machines and also on website.

3 Future Scope

With the developments happening as fast as they are, the only thing which can be said with certainty is that, VRML/X3D is changing rapidly and by all indications, and will continue to do so well in future. Several companies are scrambling to make multi-user technology available. Today this work is in its infancy. The look of an avatar is limited. Persistence is a step along the road to virtual world. Persistence would allow the user to enter into a world carrying status, which has just been created, place it in the center of plaza, and them leave. Anyone else wandering in that plaza, will admire the beauty of placement and if another user tips the status, it will fall to the ground, broken into pieces. The benefits of VR to the user are obvious. Customers will be able to try their product before they actually buy and of course, during the trial, entertainment will also be added to the concept. VR will buy and of course, during the trial, entertainment will also be added to the concept. VR will allow perspective home buyers to simulate their future houses and move around inside as if they are living in the yet-built houses. VRML enable the designers to experiment freely without rebuilding the physical model every time. It offers an enormous potential to economize and the chances to improve design quality. VR is a reliable predictor of decision making process. These types of models are more reliable estimator of production cost and schedule because the models are based on actual processes. Another capability of VRML is adding sound to the world which can make simple world much reachable and more interesting. VRML produce geometrical shapes instead of the mathematical simple models required to create a fast and realistic virtual environment. The application of VR will also advance the training institutes for training the air force or commercial pilots without getting loss of man and machine. In advance, it will prove be more accurate than market survey. Vir-

tual environments can be used for automobile design engineering. It can be used for simulation digital prototyping and surface modeling. Engineers locate and analyze potential problems much faster, reducing long term costs. Medicine and scientific research can also benefit from virtual reality. Virtual surgery is one such area. Computer models and specialized interactive devices mimic surgical to allow medical personnel to practice surgical procedure. Interactive 3D modeling and viewing allow one to visualize and manipulate complex molecules in real time.

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