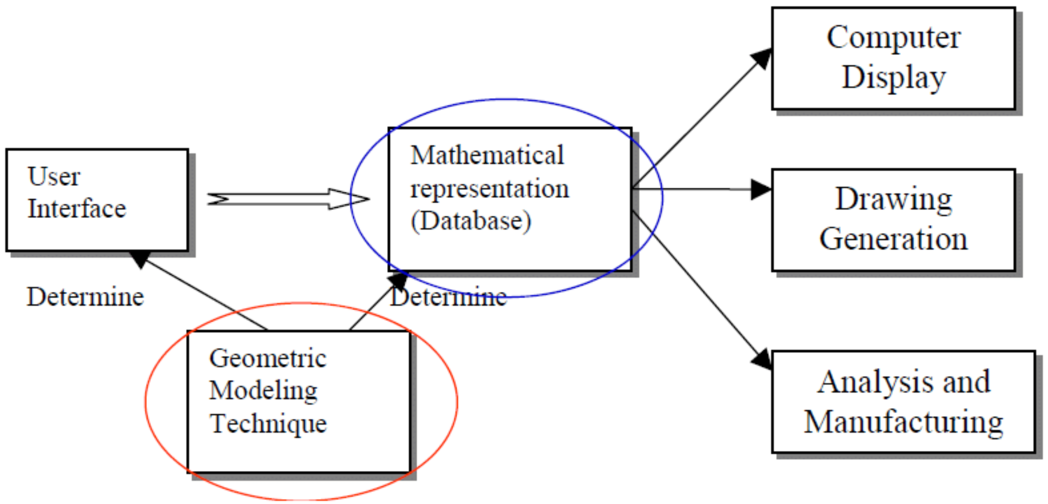
Module –II

GEOMETRIC MODELLING

Geometric Modeling: Introduction

- **Geometric modeling** is a branch of applied mathematics and computational geometry that studies methods and algorithms for the mathematical description of shapes.
- The shapes studied in geometric modeling are mostly two- or three-dimensional, although many of its tools and principles can be applied to sets of any finite dimension. Today most geometric modeling is done with computers and for computer-based applications. Two-dimensional models are important in computer typography and technical drawing. Three-dimensional models are central to computer-aided design and manufacturing (CAD/CAM), and widely used in many applied technical fields such as civil and mechanical engineering, architecture, geology and medical image processing.

- Geometric models are usually distinguished from procedural and object-oriented models, which define the shape implicitly by an opaque algorithm that generates its appearance. They are also contrasted with digital images and volumetric models which represent the shape as a subset of a fine regular partition of space; and with fractal models that give an infinitely recursive definition of the shape. However, these distinctions are often blurred: for instance, a digital image can be interpreted as a collection of colored squares; and geometric shapes such as circles are defined by implicit mathematical equations. Also, a fractal model yields a parametric or implicit model when its recursive definition is truncated to a finite depth.



From 2D to 3D

- 2D to 3D video conversion (also called 2D to stereo 3D conversion and stereo conversion) is the process of transforming 2D ("flat") film to 3D form, which in almost all cases is stereo, so it is the process of creating imagery for each eye from one 2D image.
- D-to-3D conversion adds the binocular disparity depth cue to digital images perceived by the brain, thus, if done properly, greatly improving the immersive effect while viewing stereo video in comparison to 2D video. However, in order to be successful, the conversion should be done with sufficient accuracy and correctness: the quality of the original 2D images should not deteriorate, and the introduced disparity cue should not contradict other cues used by the brain for depth perception. If done properly and thoroughly, the conversion produces stereo video of similar quality to "native" stereo video which is shot in stereo and accurately adjusted and aligned in post-production.
- Two approaches to stereo conversion can be loosely defined: quality semiautomatic conversion for cinema and high quality 3DTV, and low-quality automatic conversion for cheap 3DTV, VOD and similar applications.

Importance and applicability

With the increase of films released in 3D, 2D to 3D conversion has become more common. The majority of non-CGI stereo 3D blockbusters are converted fully or at least partially from 2D footage. Even *Avatar* contains several scenes shot in 2D and converted to stereo in post-production. The reasons for shooting in 2D instead of stereo are financial, technical and sometimes artistic:

•Stereo post-production workflow is much more complex and not as well-established as 2D workflow, requiring more work and rendering.

•Professional stereoscopic rigs are much more expensive and bulky than customary monocular cameras. Some shots, particularly action scenes, can be only shot with relatively small 2D cameras.

•Stereo cameras can introduce various mismatches in stereo image (such as vertical parallax, tilt, color shift, reflections and glares in different positions) that should be fixed in post-production anyway because they ruin the 3D effect. This correction sometimes may have complexity comparable to stereo conversion.

General problems

Without respect to particular algorithms, all conversion workflows should solve the following tasks:

Allocation of "depth budget" – defining the range of permitted disparity or depth, what depth value corresponds to the screen position (so-called "convergence point" position), the permitted distance ranges for out-of-the-screen effects and behind-the-screen background objects. If an object in stereo pair is in exactly the same spot for both eyes, then it will appear on the screen surface and it will be in zero parallax. Objects in front of the screen are said to be in negative parallax, and background imagery behind the screen is in positive parallax. There are the corresponding negative or positive offsets in object positions for left and right eye images.

1. **Control of comfortable disparity** depending on scene type and motion – too much parallax or conflicting depth cues may cause eye-strain and nausea effects

1.**Filling of uncovered areas** – left or right view images show a scene from a different angle, and parts of objects or entire objects covered by the foreground in the original 2D image should become visible in a stereo pair. Sometimes the background surfaces are known or can be estimated, so they should be used for filling uncovered areas. Otherwise the unknown areas must be filled in by an artist or inpainted, since the exact reconstruction is not possible.

High quality conversion methods should also deal with many typical problems including:

•Translucent objects

•Reflections

•Fuzzy semi-transparent object borders – such as hair, fur, foreground out-of-focus objects, thin objects

•Film grain (real or artificial) and similar noise effects

•Scenes with fast erratic motion

•Small particles – rain, snow, explosions and so on.

3D Boundary representation

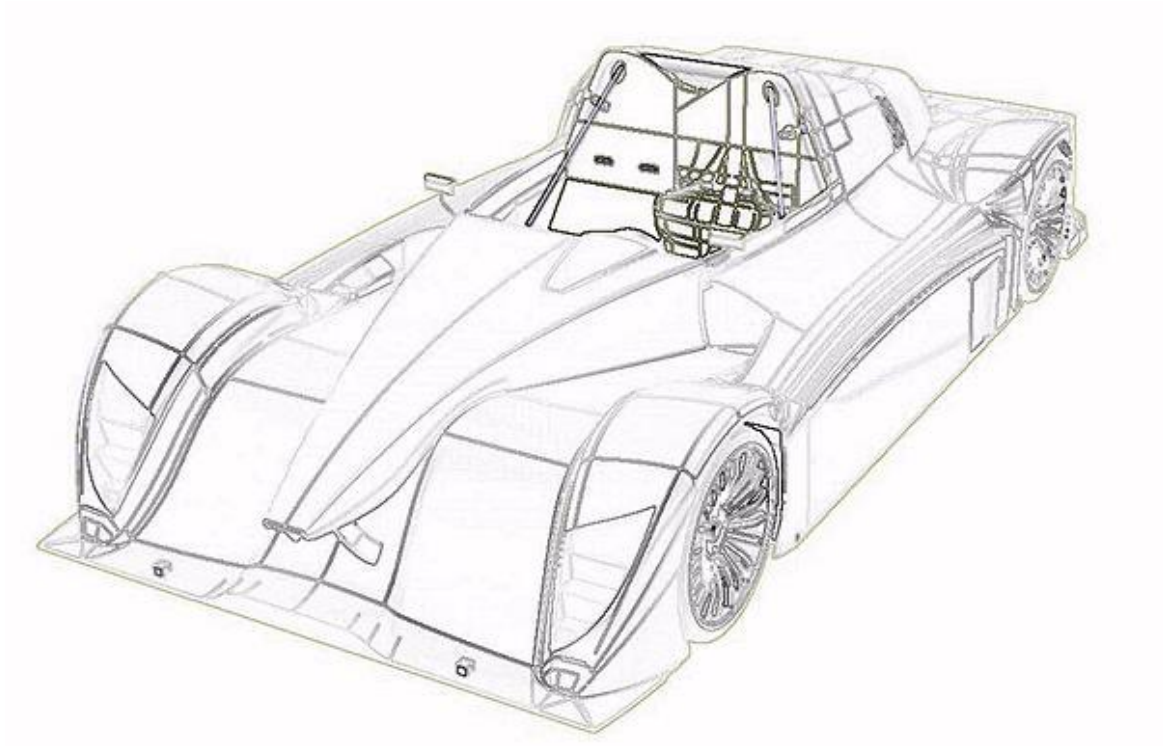
In solid modeling and computer-aided design, **boundary representation**—often abbreviated as **B-rep** or **BREP**—is a method for representing shapes using the limits. A solid is represented as a collection of connected surface elements, the boundary between solid and non-solid.

Boundary representation of models are composed of two parts: topology and geometry (surfaces, curves and points). The main topological items are: *faces*, *edges* and *vertices*. A face is a bounded portion of a surface; an edge is a bounded piece of a curve and a vertex lies at a point. Other elements are the *shell* (a set of connected faces), the *loop* (a circuit of edges bounding a face) and *loop-edge links* (also known as *winged edge links* or *half-edges*) which are used to create the edge circuits. The edges are like the edges of a table, bounding a surface portion. Compared to the constructive solid geometry (CSG) representation, which uses only primitive objects and Boolean operations to combine them, boundary representation is more flexible and has a much richer operation set. In addition to the Boolean operations, B-rep has extrusion (or sweeping), chamfer, blending, drafting, shelling, tweaking and other operations which make use of these.

Stereo cameras can betray practical effects used during filming. For example, some scenes in the *Lord of the Rings* film trilogy were filmed using forced perspective to allow two actors to appear to be different physical sizes. The same scene filmed in stereo would reveal that the actors were not the same distance from the camera.

By their very nature, stereo cameras have restrictions on how far the camera can be from the filmed subject and still provide acceptable stereo separation. For example, the simplest way to film a scene set on the side of a building might be to use a camera rig from across the street on a neighboring building, using a zoom lens. However, while the zoom lens would provide acceptable image quality, the stereo separation would be virtually nil over such a distance.

Even in the case of stereo shooting, conversion can frequently be necessary. Besides the mentioned hard-to-shoot scenes, there are situations when mismatches in stereo views are too big to adjust, and it is simpler to perform 2D to stereo conversion, treating one of the views as the original 2D source.

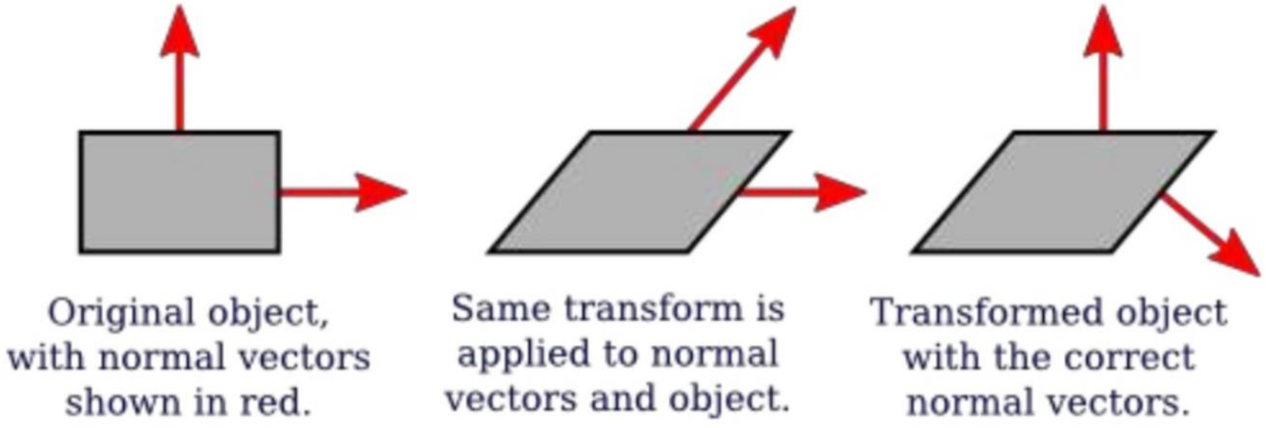


Coachwork example generated using the B-Rep model. Notice that the surface areas are stitched together.

Geometric Transformations

Geometric transformations

- It can changes the orientation, size, and shape of the objects in the database as well as on the graphics image, as shown in figure below. This alter the coordinate descriptions of objects.



TRANSLATION

A **translation** is a transformation that slides a figure across a plane or through space.

With translation all points of a figure move the same distance and the same direction.

- **Use of Geometric Transformations :-**

The geometric transformations are used for the following purposes:

i. In a construction of a model;

ii. In editing the model using the commands like : translate, rotate, zoom, mirror, array, etc;

iii. For obtaining orthographic, isometric and prospective views of the model;

iv. To view the model from different positions; and

v. In animations.

Basic geometric transformations :

The basic geometric transformations used in modelling are:

1) **Translation**
2) **Rotation**
3) **Scaling**
4) **Reflection**
5) **Shear**
6) **Concatenated (Composite) Transformation**

Reflections :- These are like mirror images as seen across a line or a point.

Translations :- This moves the figure to a new location with no change to the looks of the figure.

Rotations :- This turns the figure clockwise or counter-clockwise but doesn't change the figure.

ROTATION

A **rotation** is a transformation that *turns* a figure about (around) a point or a line.

Basically, rotation means to spin a shape.

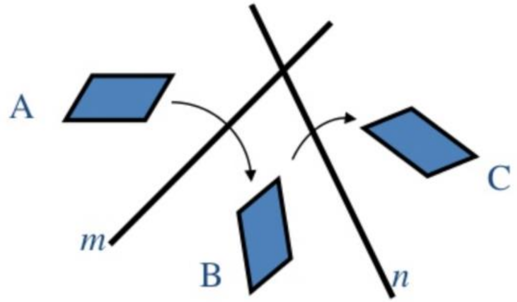
The point a figure turns around is called the **center of rotation**.

The center of rotation can be on or outside the shape.

Rotations

- An image can be rotated about a fixed point.
- The blades of a fan rotate about a fixed point.
- An image can be rotated over two intersecting lines by using composite reflections.

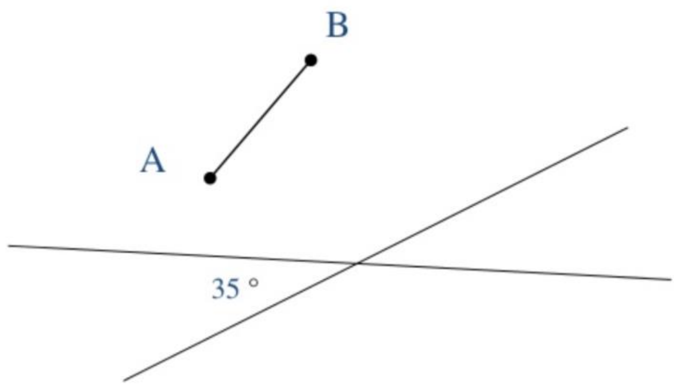
Image A reflects over line *m* to B, image B reflects over line *n* to C. Image C is a rotation of image A.



Angles of rotation

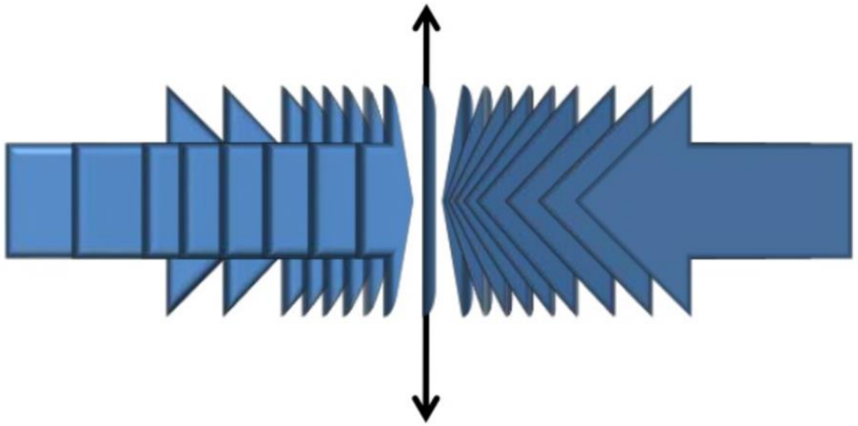
In a given rotation, where A is the figure and B is the resulting figure after rotation, and X is the center of the rotation, the measure of the angle of rotation $\angle AXB$ is twice the measure of the angle formed by the intersecting lines of reflection.

Example: Given segment AB to be rotated over lines *l* and *m*, which intersect to form a 35° angle. Find the rotation image segment KR.



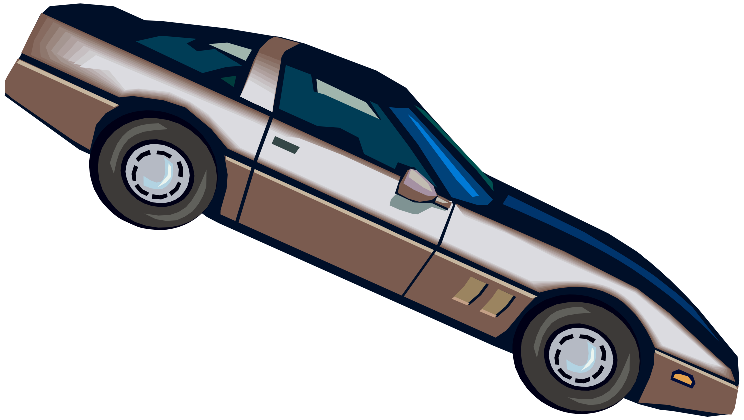
REFLECTION

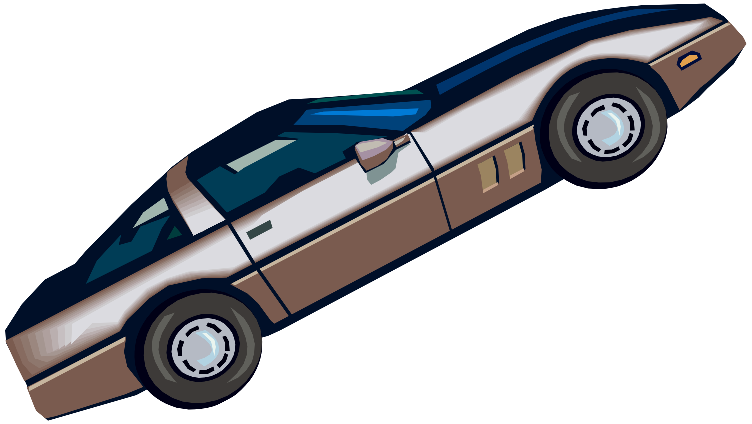
A **reflection** is a transformation that flips a figure across a line.



A REFLECTION IS FLIPPED OVER A LINE.

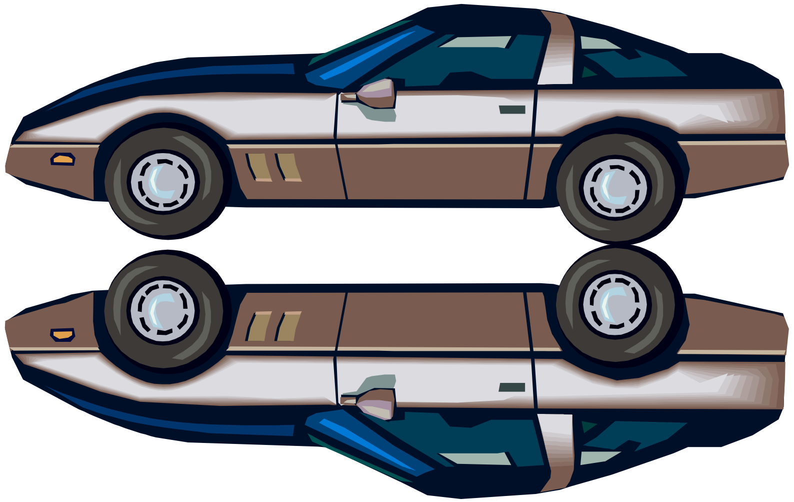
Reflection, Rotation, or Translation





Reflection, Rotation, or Translation

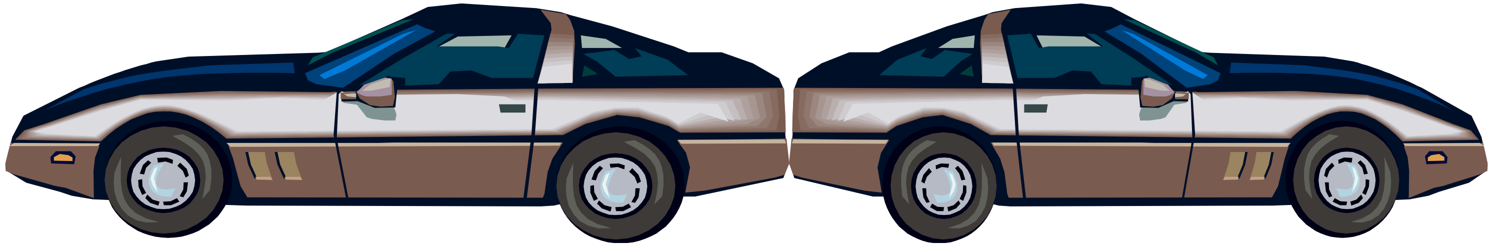
Reflection, Rotation, or Translation



Reflection, Rotation, or Translation

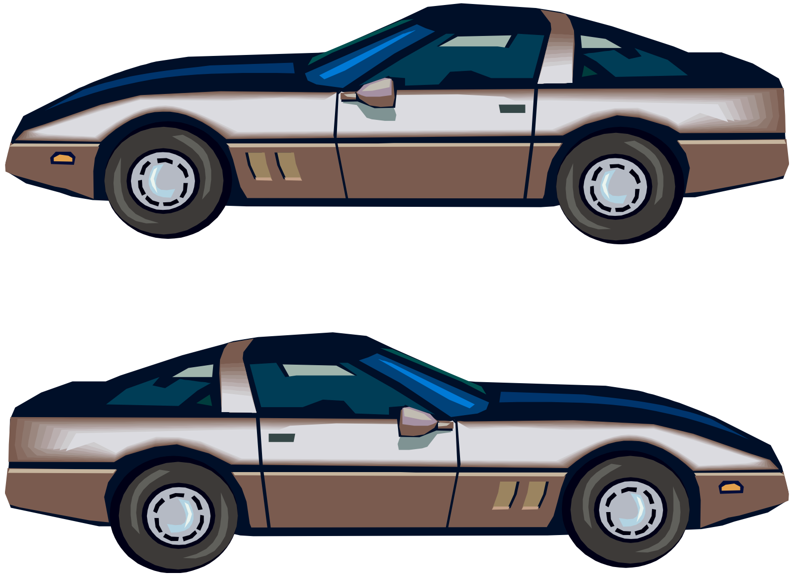
Reflection, Rotation, or Translation

Reflection, Rotation, or Translation



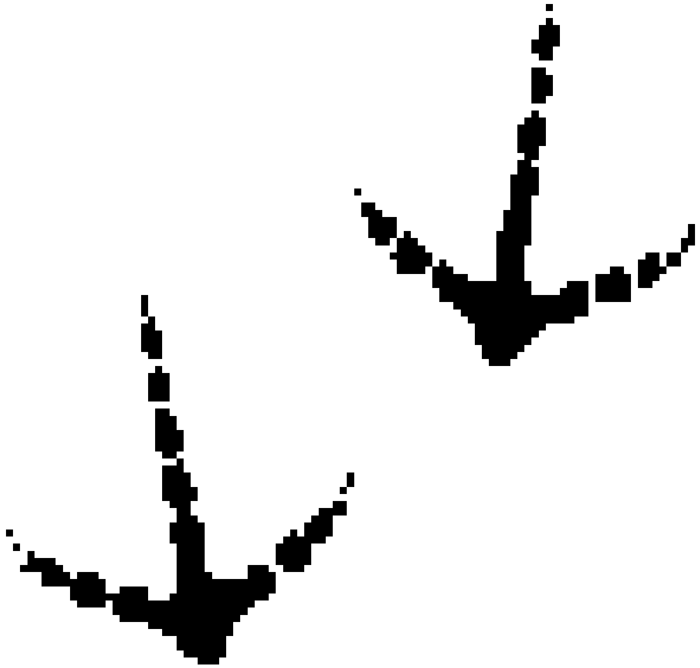
Reflection, Rotation, or Translation

Reflection, Rotation, or Translation

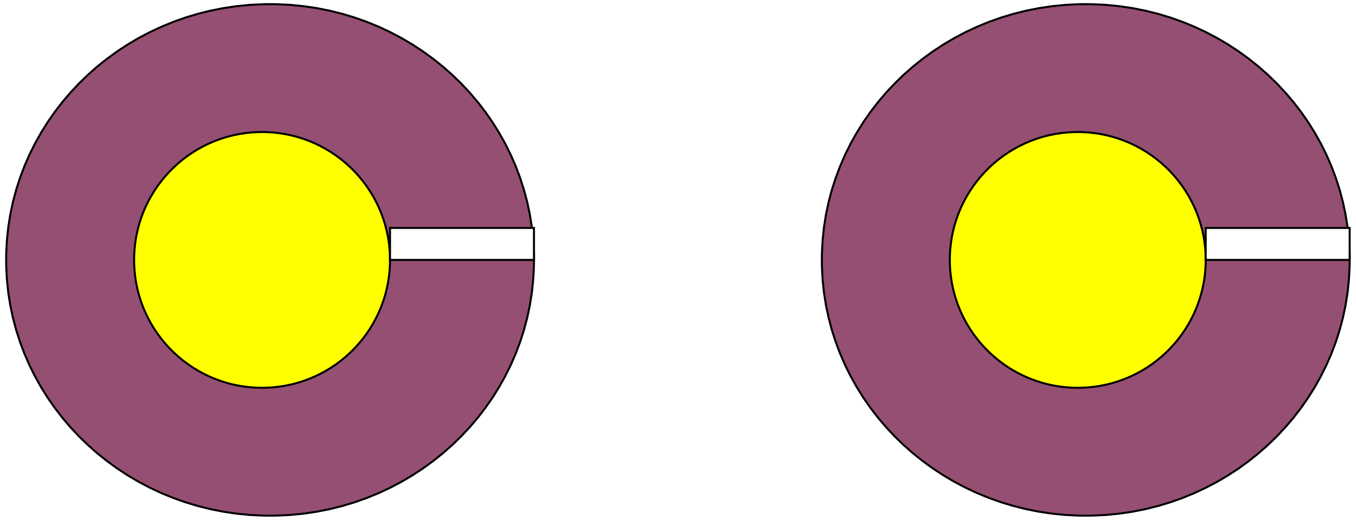


Why is this not perfect reflection?

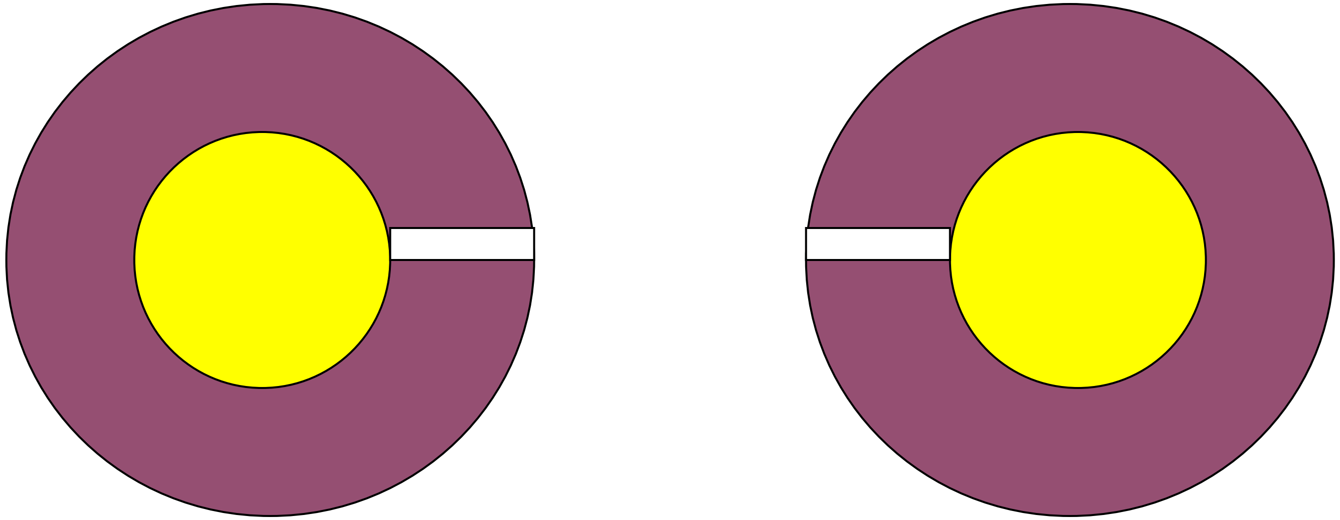
Reflection, Rotation, or Translation



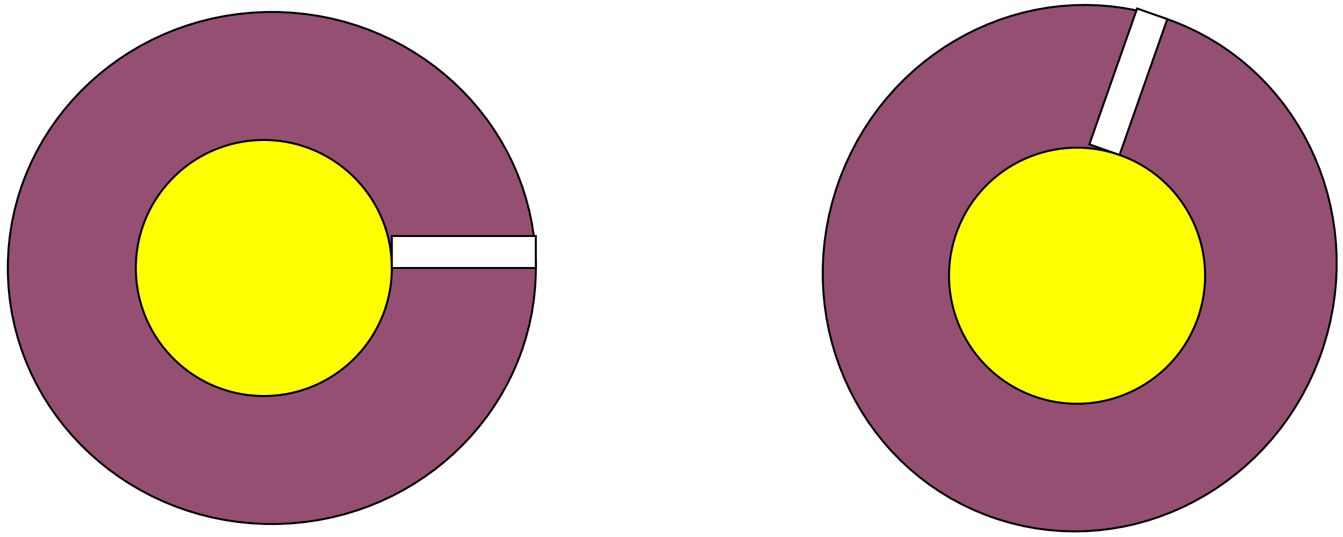
Reflection, Rotation, or Translation



Reflection, Rotation, or Translation

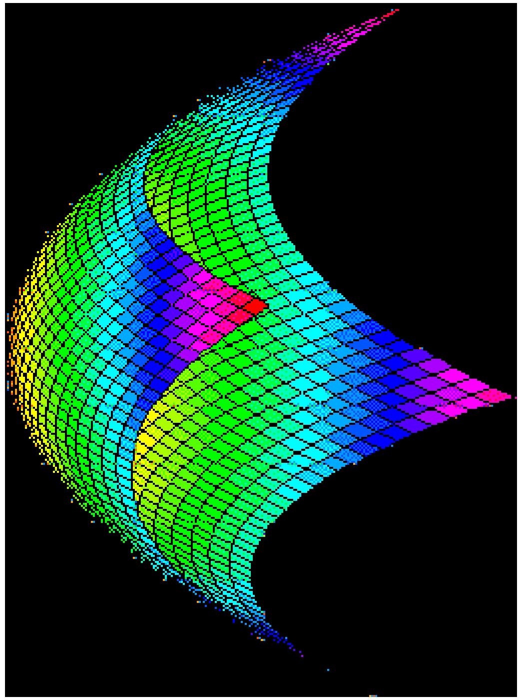


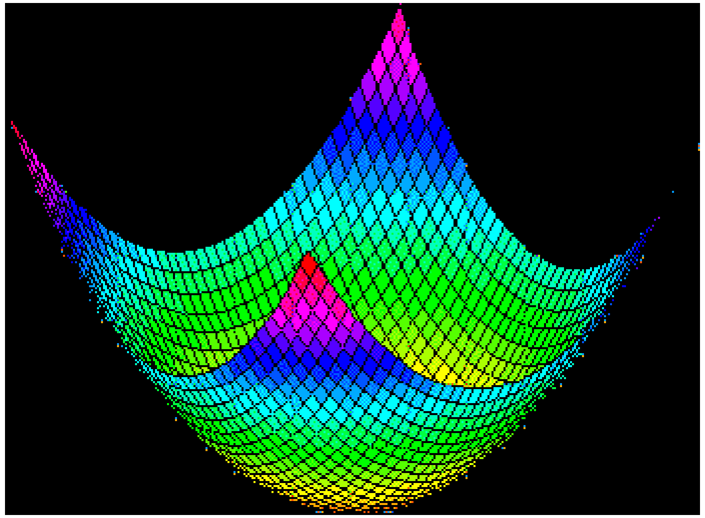
Reflection, Rotation, or Translation



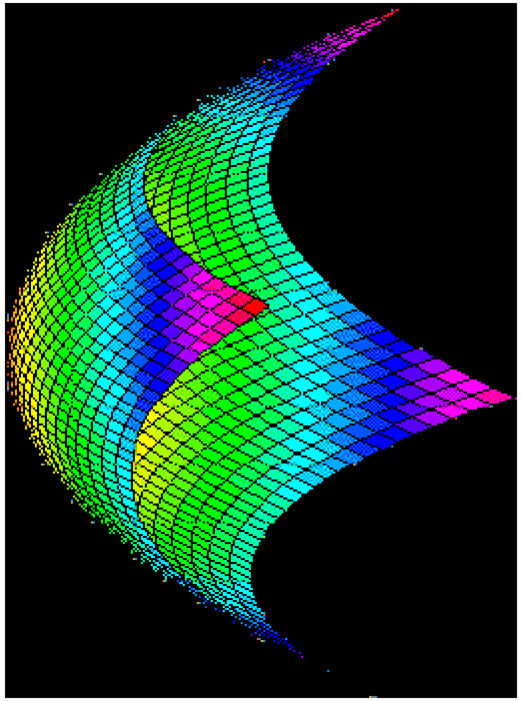
Reflection, Rotation, or Translation

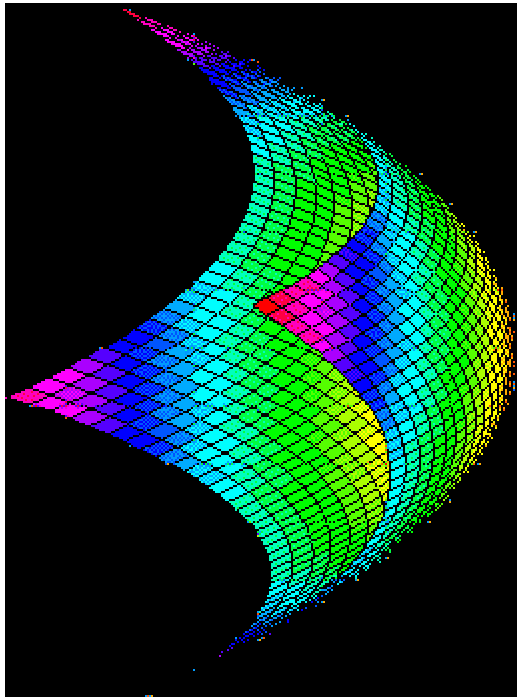
Reflection, Rotation, or Translation



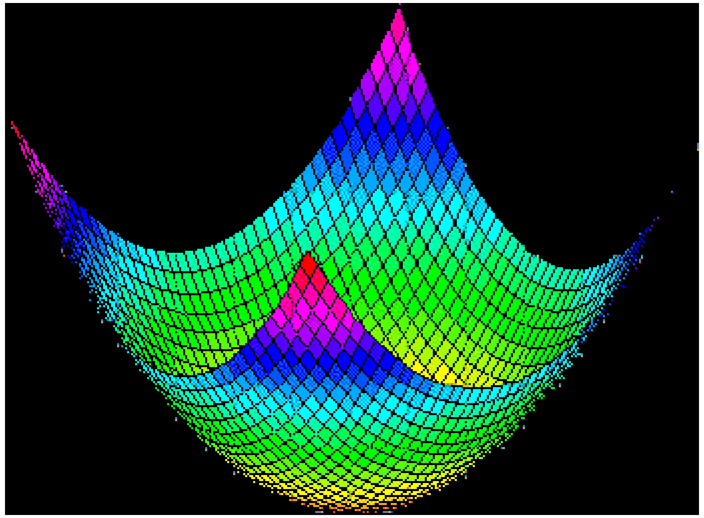


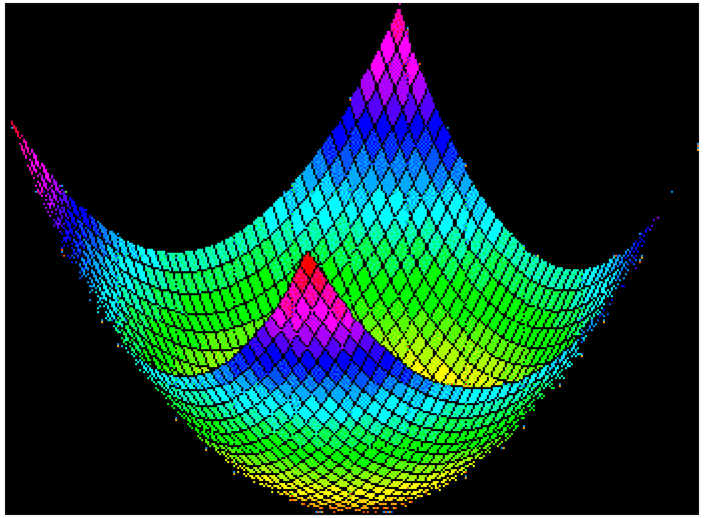
Reflection, Rotation, or Translation





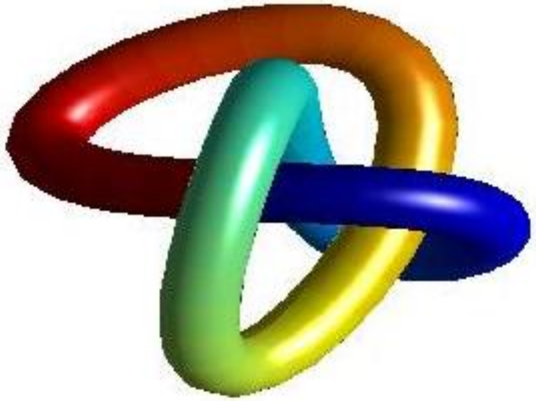
Reflection, Rotation, or Translation

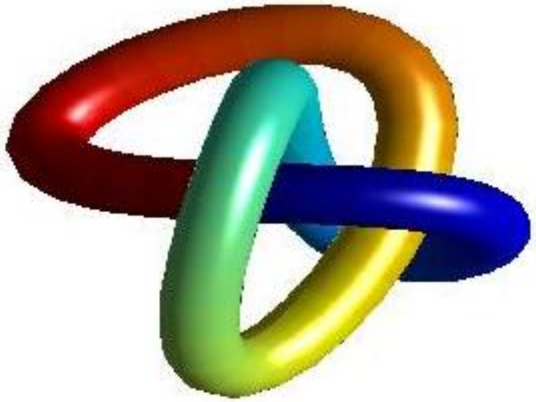




Reflection, Rotation, or Translation

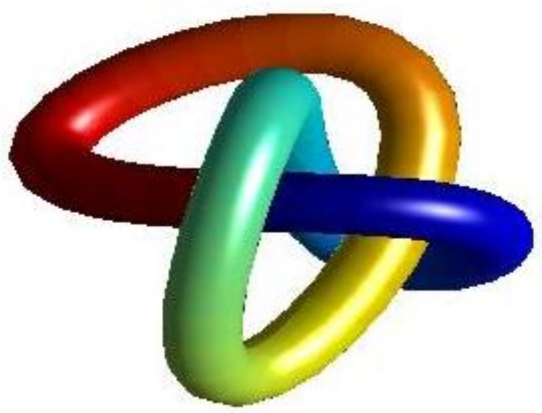
Reflection, Rotation, or Translation

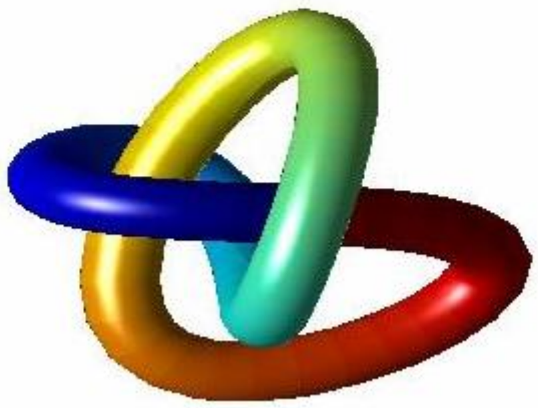




Reflection, Rotation, or Translation

Reflection, Rotation, or Translation





A Generic VR system-A **virtual environment**

A **virtual environment** is a networked application that allows a user to interact with both the computing environment and the work of other users. Email, chat, web-based document sharing applications are all examples of virtual environments. Simply put, it is a networked common operating space. Once the fidelity of the virtual environment is such that it "creates a psychological state in which the individual perceives himself or herself as existing within the virtual environment" (Blascovich, 2002, pg 129) then the virtual environment (VE) had progressed into the realm of immersive virtual environments (IVEs).

How Virtual Reality Environment Works?

Virtual reality environments, much like video games, provide sensory stimulation in a closed sensory environment isolating the user from real-world sensations, it emulates the setting by duplicating not only the objects and faces we see in everyday lives, but also audio feedback, motion, and movements as well as orientation mechanics. Moreo it provides the illusion of a placement to another location by offering an enhanced display accompanied by o modalities.

The architecture of a VR environment consists of a high-tech computer, a human-computer interfac combination with one or more users which interact with and perceive the artificially created world.

A virtual reality environment focuses on each of the human senses. Sensory feedback to the user is provided nume output devices which work in conjunction with input sensors. Graphic workstations are responsible for providing vi feedback while MIDI output provides the audio.

Some of the commonly used devices for immersive VR experiences include but are not limited to:

Magnetic trackers

Data Gloves

MIDI keyboards

Shutter Glasses

Head-Mounted Displays

CAVE

Types of Virtual Reality Environments

The cornerstone of Augmented as well as VR systems, virtual reality environments give the consumer a context preview of the experience they are about to have.

There are a number of different VR Environments. Tailor made with vastly different features; the various types give the users extremely diverse immersive experiences. As such, they are broadly categorized into four types. Each category is graded based on the level of immersion and perceptiveness it provides to the users. These four main categories are:

- Non-immersive
- Semi-immersive
- Completely Immersive
- Or Collaborative