Visual cues in moving scenes

Perception

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1. Abstract

Visual cues represent a crucial role for humanity, allowing them to retrieve a representation of the environment that is suitable to perform vital control tasks such as moving within the environment, tracking and manipulating objects, and recognizing them.

In this report we will especially focus on visual cues dues to a moving observer. Visual cues in moving environments are a huge subject with many different and contradictive theories.

For a better understanding, we will describe the human visual system and those cues, which release the impression of the visual room.
To create an interaction and a better understanding for the reader of this report, most of the cue-descriptions will be represented with a small example of what effects the cues have.

We especially investigated the question on manipulation of cues used for motion perception. We have made a number of flash- and 3D movies in different scenes with both unreal and real situations. We will test such scenes on a number of persons in order to illuminate the power of motion cues by perceiving the visual world.

Keywords: Cue-manipulation, depth- and distance perception, focus of expansion (FOE), motion parallax, moving scenes.

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2. Introduction

Cue-manipulation in moving environments has always been a major issue for psychophysical investigation.

How do humans actually perceive and judge distance in the surrounding world? This is a question many scientists have been studied for decades, even though distance perception was one of the first topics to be studied by people interested in perception, it still remains very much as a mystery.

What happens in the visual cortex of the occipital lopes in the back of our brain? Some scientists believe that cues are an inborn function, others that cues are a part of our visual education, acquired in our years of growth.

Many factors influences how each person see the surrounding world, these factors are called cues. Cues represent a crucial role for humanity, allowing them to retrieve a representation of the environment that is suitable to perform vital control tasks such as moving within the environment, tracking and manipulating objects, and recognizing them.
If we think about modern traffic or even the simple-looking task of directing a fork with something to eat into our mouth, it is easy to recognize that three-dimensional perception of our three-dimensional world is essential for humans. Our ears can help in giving us cues for direction, but for guessing a distance, our visual sense is much better.
Our eyes only have two-dimensional retina images and no special third component for depth perception. This requires an explanation of our physiological cues that leads to useful "perception". But why has perception of distance always been such a big issue?
The main goal for many scientists is to create all kinds of computer systems, which can be a substitute for the humanity. We already see different kinds of systems, which are used in our everyday life. This could be systems such as:

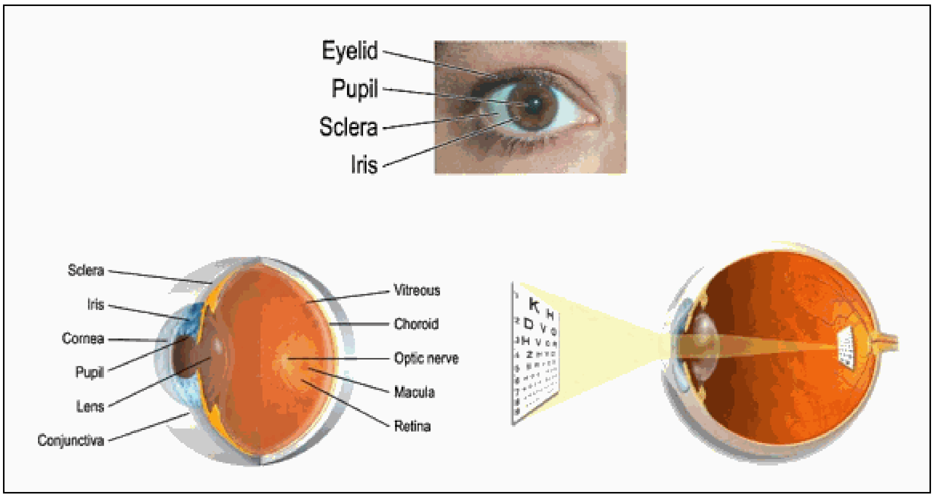
- **Flight training, actual flight maneuvers.**
- **Tele operation of robots.**
- **Visualization of complex data sets.**
- **Product visualization.**
- **Medical training.**
- **Etc.**

The knowledge of distance is very valuable because of the many interests in this subject. If we knew everything about it, we would be able automate a lot of things for an example in the industry, through artificial intelligence.

2.1 The human eye

Our eyes are marvelous sense organs that allow us to appreciate all the beauty of the world we live in, to read and gain knowledge, and to communicate our thoughts and desires to each other through visual expression and visual arts.

Vision is the most fundamental of our senses and it is perhaps the greatest tragedy of all when blindness robs us of this modality. Although all parts of the eye are important for perceiving a good image, the most vital layer for vision is the retina. The retina is essentially a piece of brain tissue that gets direct stimulation from the outside world's lights and images.
Light enters the eye through the cornea, passes across the aqueous humor (the liquid behind the cornea), and passes through the pupil and through the lens. The cornea stops high ultraviolet light. The lens stops violet and blue light, especially as we get older, and is damaged by UV light.
The human lens grows continuously with age, with new cells added on the outside of the lens, resulting in an onion-like layering of cells. The older, central dead cells degenerate and "yellow" the lens with age, a design flaw built into us. Eventually, cataracts (crystallization) of the inner lens may occur, blocking vision. Cataracts are also promoted by exposure to radiation. After passing the lens, the light then crosses the "vitreous humor" a jelly-like substance that fills the inner eye, and reaches the retina, the light sensitive tissue at the back of the eye. Sometimes clumps of cells detach from the retina and migrate into the vitreous, creating "floaters" when they are in the line of sight, and this gradually progresses with age[1].



The retina is actually an outgrowth of the brain and processes some of the information it receives before passing the signal over the optic nerve to the visual center of the brain (occipital cortex in the back of the head). The actual receptors are the rods and cones of the retina. There are three types of cones (red, yellow-green, and blue), and work best in bright light, and are also used in perception (resolution). They unfortunately fail us in dim light situations (this is why night vision is black and white). Cones are concentrated in the

[1] http://www.atmob.org/Articles/AstroAndEye.html

fovea, the center point of your vision when you stare at an object. As you increase light intensity, a threshold is reached where color vision recurs.

Some of the parameters of the human visual system are[2]:

- 120 million rod cells in each eye.
- 6 million cone cells in each eye.
- 2000 cone cells in each fovea in the region of maximum uniform density.
- 1 million nerve fibers in the optic nerve exiting each eye.
- 250 million receptor cells in the two eyes versus 250 000 elements in a TV picture.
- Distance from effective center of lens to fovea: 17mm.
- Interpupillary distance: 50 to 70mm.
- Visual angle subtended by fovea: 20 min of arc for region uniform max. Cone density, 1-2 deg for rod-free area.
- Angle with respect to visual axis of eye at which rod density is maximum: 15 to 20 degrees.
- Rod cells are about 500 times more sensitive to light than cone cells.
- Wavelength of visible part of electromagnetic spectrum: 0.4 to 0.7 micrometers.
- Wavelength of maximum rod sensitivity: 0.51 micrometers (green).
- Wavelength of maximum cone sensitivity: 0.56 micrometers (orange).
- Intensity range: 10 exp 16 (160 decibels).
- Minimum visual angle at which points can be separately resolved: 10 to 60 seconds for dots.
- Object distance from eye for stereoscopic depth perception: 10 in to 1500 ft.
- Involuntary eye movements: 10 to 15 seconds of arc for tremor, slow drift of up to 5 min of arc.
- Wavelength of maximum cone sensitivity: 0.56 micrometers (orange)

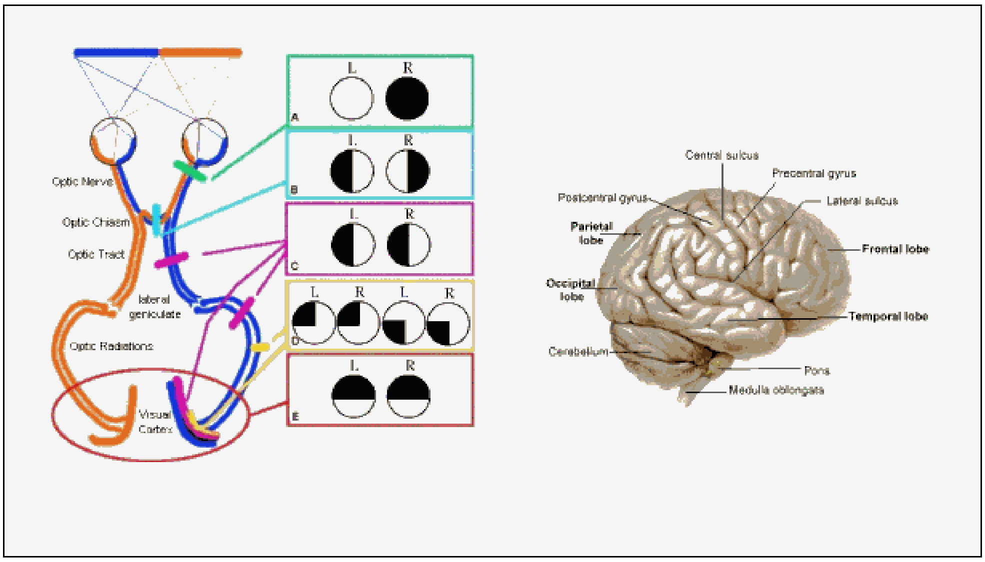
[2] http://www.siggraph.org/education/materials/HyperVis/vision/eye.htm

2.2 The visual sense

The nerve fibers from the eye, reaching the striate cortex, preserve the topology and much of the geometry of the imaged scene information the **visual projection area** is in approximate one to one correspondence with the retina.

Stimulation of the nerve cells in the visual projection area causes subjects to "see" elementary visual events and lesions in this area lead to blind spots in the visual field.
The region of the striate cortex immediately surrounding the visual projection is called the **visual association area.**

Stimulation of the visual association area give rise to complex recognizable visual hallucinations and lesions in this area leads to disturbance of the perception of complete visual complexes, the inability to recognize complex objects or their pictorial representations.



2.3 Depth- and motion perception

Depth perception is our ability to see the world in three dimensions and to perceive a distance. Depth perception is significant considered that the images projected on each retina are two-dimensional. These flat images give us the opportunity to create a three-dimensional world. We distinguish between two main sources of information: binocular and monocular cues, we will describe those later on page 8 (monocular cues) and page 14 (binocular cues).

Motion perception gives humans the ability to perceive motion. The ability to move, and to perceive motion is the basis of perception. Motion perception helps you to avoid moving objects; attracts your attention; provides information about the 3D shape; separates objects from ground.
We discount such movement on the retina as due to our own bodily motion and perceive the objects as stationary.

When we walk around or move our head in a particular way, we unconsciously expect that images of stationary objects will move on our retina.
In contrast, when we are moving and the image of an object does not move on our retina, we perceive that object as moving.
Movement is also at the heart of a set of observations of considerable significance in the historical development of Gestalt theory. These observations concern circumstances in which people perceive movement in the absence of actual physical motion of the stimulus. One familiar instance of this class of events is referred to as the phi phenomenon. In simplest form, the phi phenomenon can be demonstrated by successively turning two neighboring lights on and off. Given appropriate temporal and spatial relations between the two lights, an observer will perceive the first light as if it were moving from its location to that of the second light. People may perceive motion when none actually exists. The motion-picture screen, for example, presents a series of briefly flashed, still images; the movement people see is a creation of their own perceptual systems[3].

3. Cues

Distance perception is the ability to recognize the distance relationship in the visual scene. There is found three different types of these relationships:

- Egocentric distance, which is the distance between the viewer and the object.
- Relative distance is the distance between two objects. (Which store is closest to your house?)
- Three-dimensional: We perceive objects being three-dimensional with depth, thickness, height and length.[4]

[3] http://sapdesignguild.org/resources/optical_illusions/
[4] Sensation and perception chapter 6

The depth-cues are a help for us to understand the distance between the object and us.

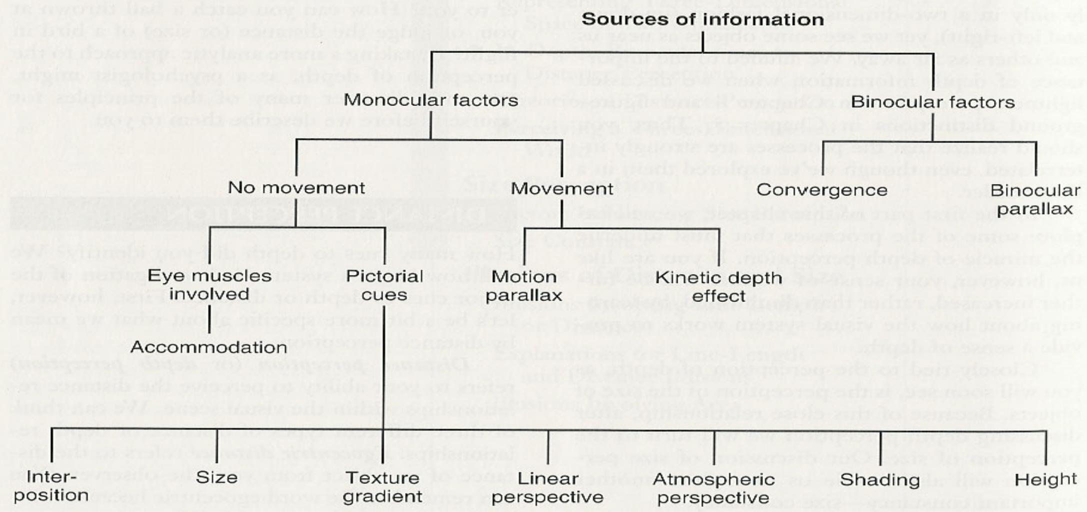


FIGURE 6.1 A classification scheme for information about depth and distance. As the text indicates, all the cues shown in the hierarchy are not equally effective; cues lower in the hierarchy are not inferior sources of information compared to cues higher in the diagram.

3.1 Monocular cues (no movement)

Monocular cues are available to us with just one eye, which means that we with just one eye can reach distance-information. These cues are less powerful than retinal disparity, but they still provide us with solid depth-perception information.

These eight cues do not require movement of object or observer.

- Accommodation
- Interposition/Overlapping
- Linear perspective
- Texture
- Haze/Atmospheric perspective
- Size
- Shading
- Height

3.1.1 Accommodation

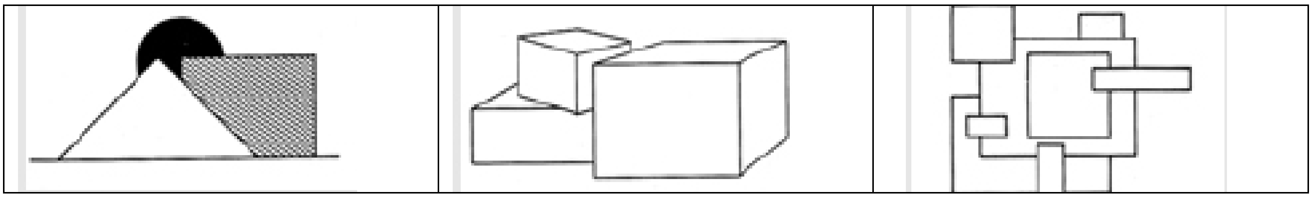
Accommodation is the change in the shape of the lens, when you focus on objects at different distances.
When you look at distant objects, the lens is thin; and when you look at objects nearby, the lens is very thick.

Accommodation occurs with both eyes, but it is still a monocular cue, because one eye alone would give the same information as both.
Try the following: Hold a pencil in front of you at one arm's length, cover one eye with your other hand. Now, gradually bring the pencil closer to your uncovered eye. You will find a point about a foot or less away from your eye where you can feel those eye muscles strain. Move your pencil back and forth with a six-inch distance. Can you feel the muscles working? That is accommodation and you have learned, perhaps unknowingly, to use it as a depth perception cue.

This cue differs from the other seven cues, because it is a muscle-cue and the others are image-cues.

3.1.2 Interposition/Overlapping

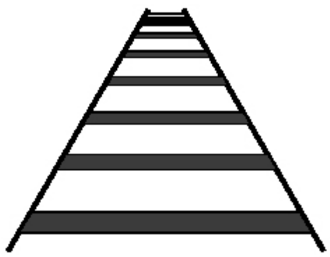
Interposition/Overlapping is a cue that contains that an object, which partly covers another one, appears closer. It is a depth cue copied from the overlapping position of objects. Objects that are in front of other objects may partially block our view of the rearmost object. Because we know what the object should look like, and because we see only part of it, we understand the blocked object as being farther away.



This is the most ordinary and most used cue of all eight.

3.1.3 Linear perspective

Linear perspective is the monocular cue provided by the junction or convergence of lines toward a single point of the horizon. If you look down a set of railroad tracks you have an example. We know that the tracks do not converge. They are parallel throughout, but when we look down the tracks, it appears that they converge to a single point.

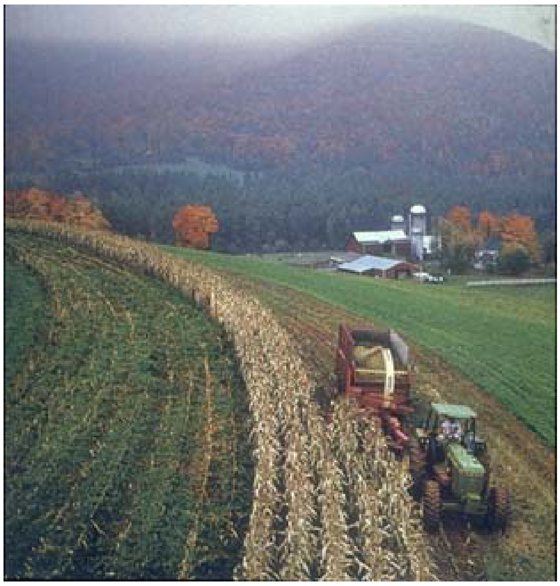


3.1.4 Texture

The closer you are to something, the more detail or texture you can see. For example, if you look at a wall from 20 feet away, it will look fairly smooth. But if you

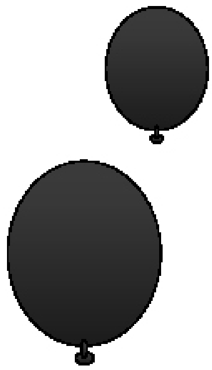
move closer to the wall, you will begin to see more and more detail or texture. When you are right up against the wall, you can see things that you could not see further away. (That correlation between distance and texture is interpreted as a distance cue.)

3.1.5 Haze/Atmospheric perspective



Haze/Atmospheric perspective is similar to texture, but broader. This perspective acts as a depth cue over long distances when we are outside. On a clear day (no haze), mountains far away seem so close that you can touch them. Did you first look at the mountain on a hazy day, it would not have seemed so close. The reason that the objects seem foggy and blurred is that the air between the object far away and the observer is not totally clear. Therefore, this cue involves lightning.

3.1.6 Size



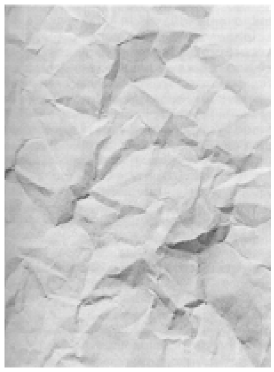
Our learning contributes seriously to this cue. Over the years, we have learned that objects on our planet change size slowly, if it does at all. In other words, it is not the case that people shrink to half their size, or double their size in an eye blink. If they did, we would not be able to tell whether they were shrinking or moving away, or whether they were growing or coming closer.

Instead, when the image of an object gets larger on the retina, we interpret that as a distance cue (closer). On the other hand, when the image on the retina gets smaller, we interpret that as the object becoming farther away. So, if we are in a high building looking down at some people, we do not say, "Look at those small people just outside the window." Rather, we say, "Look at those normal-sized people far away."

Our knowledge of the world helps out in the perception. In other words, when the real size of the object is known, our brain compares the sensed size of the object to this real size, and as a result acquires information about the distance of the object.
For example, if there are to balloons in a dark room with the same distance to the viewer, the biggest balloon will seem closer.
Therefore a very general and often inaccurate rule is that larger objects are closer. The more space of view an object takes up, the closer it is. This mostly relates if you have two of the same object.

As shown below in the first picture, one of the sitting women looks closer than the other because it is larger. This example works well because we have two illustrations of the same object, which your brain assumes are the same size. Consequently the picture to the right doesn't seem right. The "little" woman has been moved forward and down beside the "bigger" woman to ruin the realistic picture. Our brain interprets the picture as being none real and impossible.

3.1.7 Shading



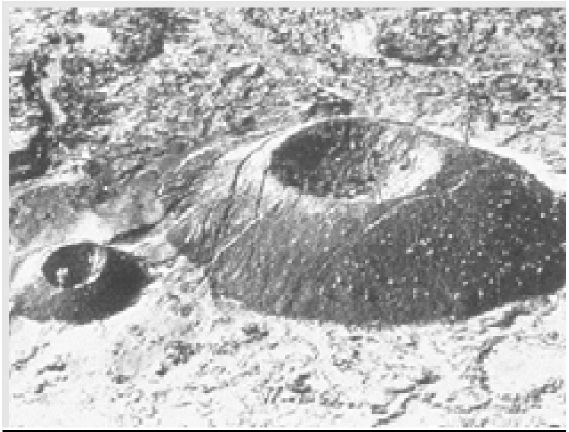
Shading is very effective for the perception of shape. Shading is a luminance distribution across a scene formed from the object, shape and lighting. It is impossible to reconstruct a unique three-dimensional shape from shading cue mathematically.

To perceive shape from shading correctly, it is said that human uses some theories, such as "the light from above assumption", "the convexity assumption", and so on.[5]

Shadows help to define the shape of an object, because they give information about the parts of the object that stick out or cave inward, plus about curved or flat parts. If you observe an object at your desk, you can see how the light cast the shadows; the surface is not constant and smooth.
Shadows and shading are able to give three-dimensional information about objects that is otherwise occluded. They also can give information about the location of a light source.

[5] Report: "Mechanisms of shading and texture analysis in the perception of 3-D surfaces" Prof Mark A. Georgeson and Dr Andrew J. Schofield

But shading and different lightning can also mislead, look at these photos:



The only thing that has happened with these pictures is that the one of them is turned upside down. But anyway, look how much difference there is.

3.1.8 Height

Objects near the horizon seem farther away from us, than objects further away from the horizon.

3.2 Monocular cues (Movement)

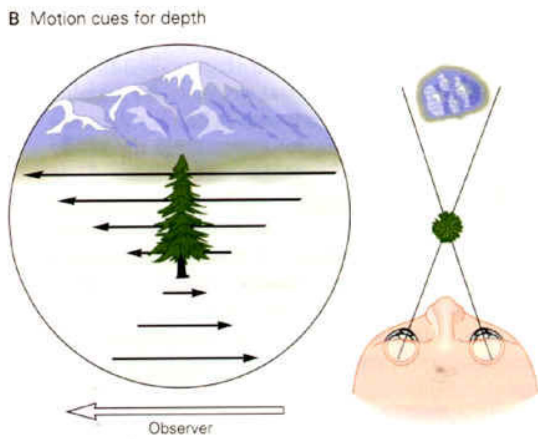
These two cues necessitate movement of either object or observer:

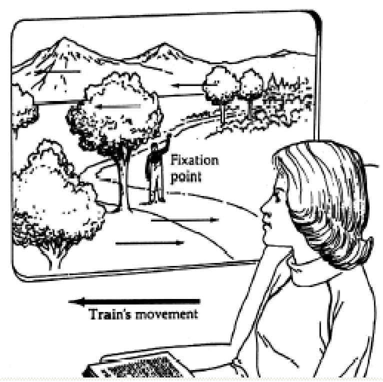
- **Motion parallax**
- **Kinetic depth effect**

3.2.1 Motion parallax

For more distant objects, the visual system relies on this cue. In stereovision the brain uses disparity to compare the view in each eye.

As the world moves, whether that movement is caused by the perceiver or by his surrounding environment, objects in the environment move in separate, predictable patterns.





When you move you head to the side, it looks like objects with different distances moves in dissimilar directions with different speed. The speed and the direction of the object depend on the distance between viewer and the item.

In a moving car or train for example, try to focus on a tree far away, and notice how much the distance means for the speed of the tree's movement. The closer the tree is, the faster it moves by in the opposite direction.
When your head translate, near objects move quickly across the retina. Far objects move more slowly.

Fixate on your fist, arms-length away and hold your finger in front of your fist. Then turn your head. The objects beyond your fist will travel in the same direction as your head movements, but your finger will appear to move opposite.

See an example of motion parallax here:
http://psych.hanover.edu/Krantz/MotionParallax/MotionParallax.html

3.2.2 Kinetic depth effect

Kinetic depth effect is a monocular movement factor, which needs motion of object rather than observer. An object that looks flat in motionless condition appears to have depth once it moves. Motion helps extract the three-dimensional structure of the world.
"Take a pipe cleaner or a paper clip and bend it into a clearly three-dimensional figure. Find a piece of paper and a lamp. Place the figure between the lamp and the paper and notice that the figure, as seen through the paper, looks flat and two-dimensional. Now rotate the figure and notice how it suddenly appears to have a third dimension."[6]
We have made another example of kinetic depth effect with a cylinder. (See the file cylinder.avi on the enclosed cd.)
The stationary picture of the cylinder only looks like a black rectangle with dots. The depth appears when the cylinder starts spinning around, and it is easy to detect the shape.

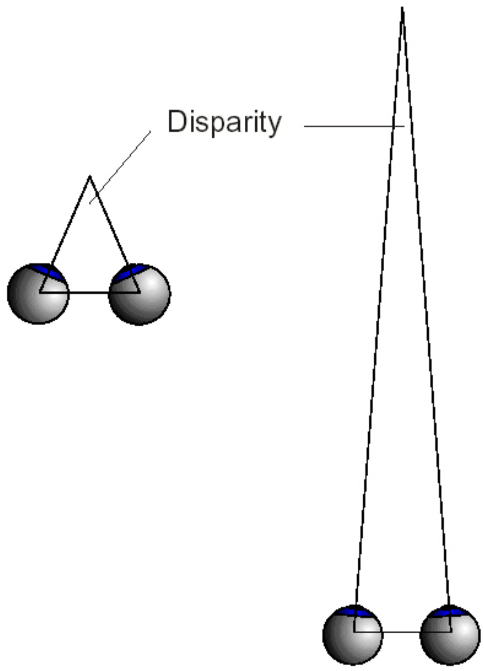
[6] Sensation & Perception chapter 6, page 177, Demonstration 6.2

3.3 Binocular cues

Binocular cues are cues that only can be seen by the co-operation of both eyes. (Also called stereopsis).

- **Convergence**
- **Binocular parallax**

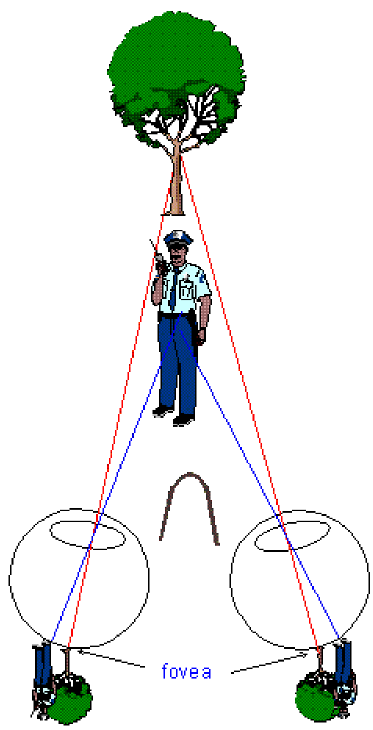
3.3.1 Convergence



Convergence is when to lines verges each other. There is a change of focus that occurs when the lens gets thicker for nearby objects. When you look at objects that are very far away, your eyes point very nearly straight ahead. As objects come closer (less than about 6 meters or so) your eyes will noticeably turn in.

Stereovision depends on the disparity in the views of the two eyes.
This disparity becomes little for an object located more than an arms length away. Look at a person's eyes as you hold your finger in front of him or her and move it towards the nose. You will see the eyes converge very clear.

3.3.2 Binocular parallax



Binocular Disparity

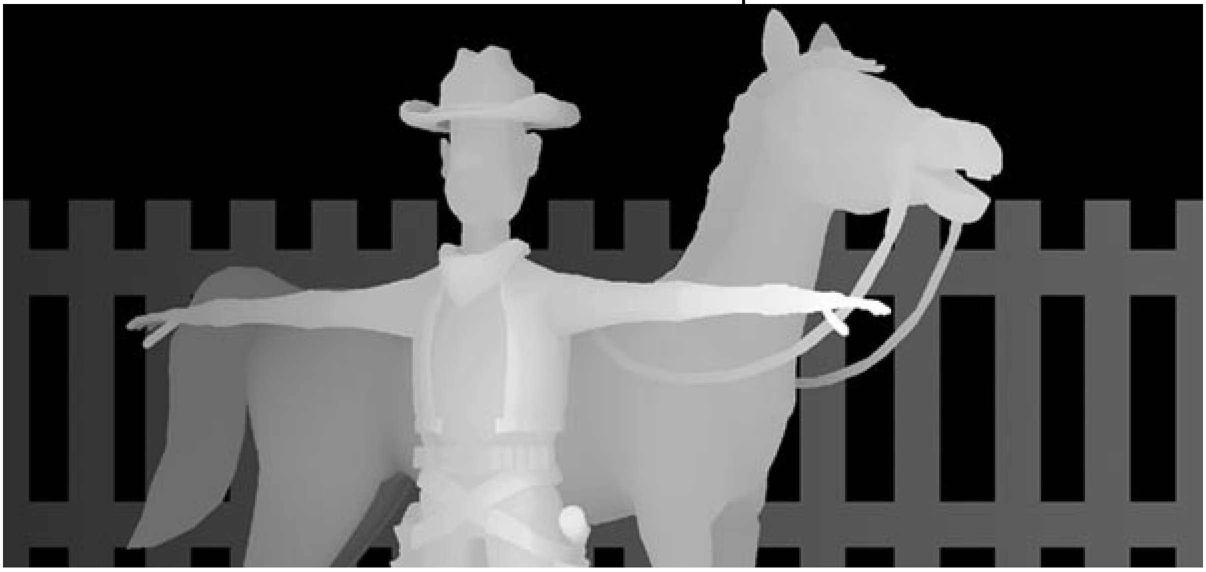
Binocular parallax is one of the most well known and more used cues in depth perception, but may not be confused or compared with convergence. Binocular parallax is not a physiological depth cue like convergence is.
Notice that the tree and the policeman are about the same size on the retina. We will definitely perceive the tree to be further away than the policeman. There are multiple reasons for this. One, of course, is that most trees, this well developed, are much larger than people. Consequently, knowing that the size of the tree is likely to be much larger than the policeman helps to make it appear further away.
In the disparity diagram the eyes are fixated on the tree. The red lines between

the tree and the retinas describe the angle of junction the eyes make when the tree is imaged on both foveae. It is said that the tree is imaged on corresponding points of the retina and thus there is no disparity. Those points would be identical if one retina was moved over to cover up the other retina. In other words, you have two slightly different images on each retina. (http://staff.aist.go.jp/y.yamauchi/data/2002MICCAItutorial-e.pdf)

Other examples of binocular- parallax or disparity can be the way to see depth in a stereogram like this:

Some people can have a hard time finding out what the picture is showing, and others, more trained, just need very short time to figure it out.
You can train yourself to get better to see the depth in stereograms.
The stereogram above for example shows a cowboy in front of his horse.

Here is an illustration of what is to see in the picture:

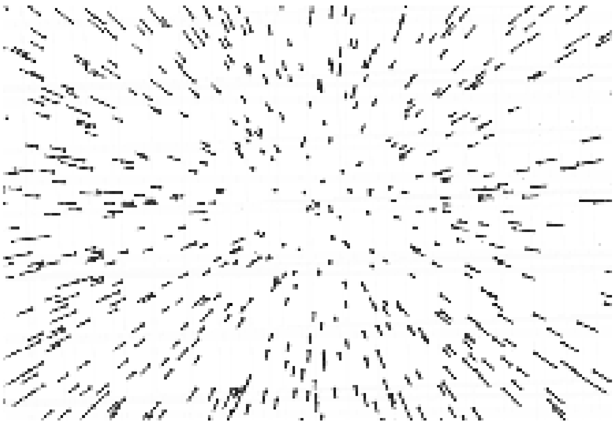


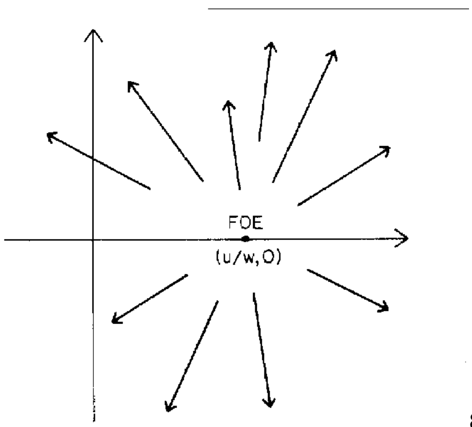
To try more stereograms for yourself, we have enclosed a couple of stereograms in Enclosure 1.

3.3.3 Focus of expansion (FOE)

People are very good at perceiving direction, even when there are no obvious cues from a Head up display, car hood, or even road edges or lane markings. A general source of heading information is available which might account for this ability the focus of expansion of the optic flow field.
When an observer moves in a rigid environment, the light reflected to the moving eye from elements of the environment experienced an official transformation over time called the optic flow. Optic flow may be represented by an instantaneous two-dimensional velocity field (see example below) where each vector corresponds to the optical motion (magnitude and direction) of each environmental element.[7]

It is very easy to notice where the focus of expansion is in the picture; where the dots are coming from and are heading.





[8]

In other words, all the flow lines or dots appear to spread out from a single point.

An example of FOE by translation: When an observer is moving on a straight path with no eye, head or body rotation, visual velocity vectors in the image plane on the retina radiate outward from a focus of expansion that stays constant in the image plane. This FOE indicates the observers heading direction.

If you move your head, a new FOE takes place. Therefore there are many FOE's, but there can only be one at the time.

The retinal displacements of objects moving with different relative velocities have different FOE's.

[7] http://www.hms.uq.edu.au/percept/self.htm
[8] http://ilab.usc.edu/classes/2002cs564/lecture_notes/20W-Optic-Flow.doc

For more information of FOE, a good source can be J.J. Gibson, who has made many very nice explanations.

4. Experiments

The main goal with the experiments is to illustrate the effect of cue manipulation in a moving scene.

We have chosen to make three different experiments:

- *Experiment 1:* Illustrates the effect of shadow in a moving environment.
- *Experiment 2:* Illustrates the effect of the motion parallax cue.
- *Experiment 3:* Illustrates a scene in a moving environment with different types of focus of expansion.

Experiment 1
We have created a range of experiments to show how useful the shadow is, and how effective it is to create depth in a two-dimensional image.
We also want to show how fundamental the recognition of this is to us. We do this by changing the shadows position in ways that makes no sense in the "real world".

We will show our scenes to a test panel and make it up to them what is realistic or not.

We have produced the experiment in Flash, which makes it possible to construct this illusion.

Experiment 2
Our main goal of this experiment is to demonstrate how the motion parallax can be used in different scenes. We want to show how easy it is to make depth in a scene, just by adding motion.

We will test a number of different scenes, which illustrates the motion parallax, followed by an evaluation of the test panel, who has answered questions about their perception of depth. Furthermore the test results will give of valuable information about the strength of the different visual cues used in a scene.

The scenes are produced in 3D studio max, by creating a 3D scene viewed through a moving camera.

Experiment 3
In this experiment we have created a number of scenes, focused on FOE. In a realistic world with a rigid environment, it is only possible to have one FOE. But in this experiment we have manipulated with an environment made in 3D studio max, this gives us the opportunity to construct more than just one FOE.

The primary goal with this experiment is to define the edge between the realistic and the unrealistic world. To define this, we have asked a number of questions, which will be answered by the test panel.

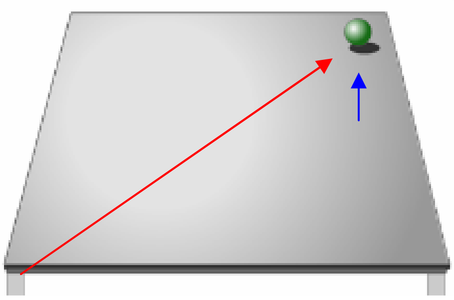
The scenes are produced in 3D studio max, by creating a 3D scene viewed through a moving camera.

The questioner we gave the test panel to fill out is placed in Enclosure 2.

4.1 Experiment 1 – Shadow

In this experiment we will work with the effect of using shadows. We have made a table with a ball moving across it.

Look at the scene bellow. Notice that the ball always moves in the direction of the red arrow. The only thing we are changing is the position of the shadow (blue arrow). By doing so we make it appear that the ball is jumping, rising or just moving across the table.



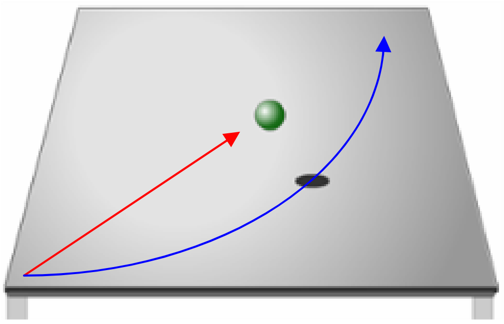
The question is which way this is possible. In relation to our knowledge, we know that humans in general need extra cues to perceive depth in a two-dimensional image. Most painters use the shadow all the time to achieve depth in their paintings. In our case we use the same principle, except we included motion to the scene.

In our experiment we observe three clear indications of a light source:

- The brighter area of the table
- The bright area on the ball
- The shadow from the ball

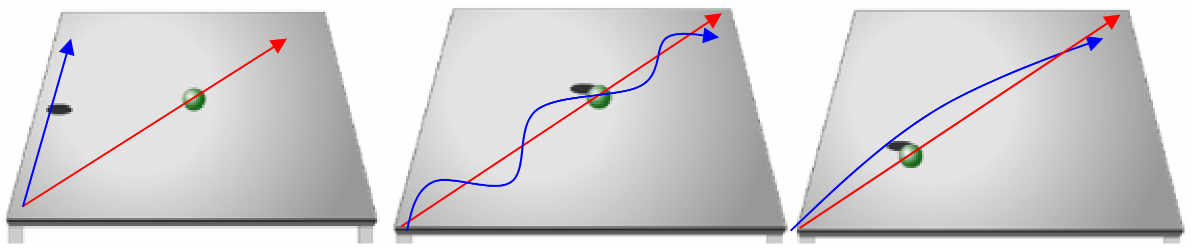
These shadows make the brain believe that it is a table and not just four lines forming a trapeze. The shadow of the ball is a natural result of light shining.

In slide 2, we move the shadow in another direction but leave the ball in the same direction as in the original image.



The result of this is that the ball appears to be jumping across the table.

We have made a couple of experiments where we move the shadow in ways, which is impossible.



We have asked the test panel about their perception of depth in the current experiment.
The question has to be very open and general, to avoid unnecessarily giving the correct or our answer to the problem.
We have simply asked the test panel if the situation is realistic or not.

4.2 Experiment 2 – motion parallax

In our second experiment, we want to find out how the test panel perceives depth in different scenes. Furthermore the test results illustrate the differences in strength of the used cues. The test panel is navigated through the following procedure:

Scene 1 (No movement): Take a close look at the image, and tell us which trees are closest to the viewpoint.

Scene 2 (Movement): Watch the movie and tell us which trees happens to be closest the viewpoint.

***Scene 3 (Movement)*:** Watch the movie and tell us which trees happens to be closest the viewpoint.
Compare this movie to scene 2 and judge if there is differences in the tree's distance of depth.

Scene 4 (Movement): Does the tree's distance of depth appear to be like you imagined, in relation to the previous movies?

4.3 Experiment 3 – Focus of expansion (FOE)

In the third experiment we wish to make differed scenes to show how to manipulate with more than one focus of expansion, and therefore to emphasize the correlation between truth and fake.
We want to point out a limit where exactly we can see the changes and where we cannot.

The test panel is navigated through the following procedure, and is given a few questions:

Scene 1-5: Watch the movie, and tell us – Is the scene realistic?
If not, what is wrong with it?

Out of the test results we will get an idea of how much changing we can make to manipulate with human minds.

To make the experiment more detailed, it would be an opportunity and also a good idea to view the scenes with different speed.
Furthermore we could change the movement of the trees. There are a few examples of this on the CD (examples/foe/).

4.3 Evaluation of the tests

We have evaluated the test results. 10 randomly chosen persons have participated in the tests.

4.3.1 Evaluation of experiment 1

In this section we will evaluate the test results of experiment 1.

Scene 1
100% of the test panel evaluated that scene 1 was realistic. Everybody agreed that the illustration is a ball rolling across the table.

Scene 2
100% of the test panel evaluated that scene 2 was realistic. Everybody agreed that the illustration is a ball jumping across the table.

Scene 3
This scene divided the test panel in two parts; one part of the test panel (70%) found the scene realistic the other part did not. But almost every person in the panel, were able to see a rising ball. The reason of the disagreement could be the length of the table or the cast of the shadow. This scene was supposed to a realistic presentation of a rising ball.

Scene 4
Almost every person in the test panel (90%) found the scene unrealistic. Only one of the test persons found the scene to make sense. The person saw the ball moving sideways out of the scene.

Scene 5
All of the test persons (100%) immediately agreed that this was unrealistic.

Scene 6
All of the test persons (100%) immediately agreed that this was unrealistic.

Summary
This experiment has shown us, that a randomly group of persons in general has the same idea of what is realistic or not. Furthermore the test results helps us to understand how little is needed to create depth in different environments.

4.3.2 Evaluation of experiment 2

In this section we will evaluate the test results of experiment 2.

Scene 1
90% of the test panel agreed that the largest trees were closest the viewpoint. It is important to know that this scene is a stationary image and not a movie like the others. The test result was expected. Actually the largest trees were the ones furthest away. This illustration shows the strength of the size cue.

Only one person in the test panel disagreed, and he could not explain why!

Scene 2
Everybody in the test panel was convinced that the largest trees were furthest away form the view point. This shows that the motion parallax cue is stronger than the size cue. The test result was expected.

Scene 3
In this scene it was pretty difficult to see any differences compare to scene 2. It ended up with a doubtful result, where 60% of the panel saw no variation in the two movies.

The movies were not supposed to show any difference at all.

Scene 4
80% of the test panel thought that the rear trees were closer to the trees in front, than they really were. This confirms that even though the size cue is not stronger than the motion parallax cue, it still has influence on our perception of depth.

Summary
This emphasizes that the motion parallax cue is very powerful compared to the size cue.

4.3.3 Evaluation of experiment 3

In this section we will evaluate the test results of experiment 3.

Scene 1
No one in the test panel could see anything unrealistic in this scene.
This was expected, because no manipulation was used for this scene.

Scene 2
20% notice a change in focus of expansion, because of the tree's movement slowly sideways which is not realistic in real life, as a result of the rigid scene. The others did not observe any change.

Scene 3
Everyone notice a wrong and unrealistic situation in this scene. It is impossible for trees to cross the road in that way, even though it in the beginning it appears that the road further away is turning.

Scene 4
Everybody agreed that this scene could not be, unless of course the road will turn further away. This is what we expected, because of our manipulation with more than one focus of expansion.

Scene 5
Each person in the panel agreed that this scene could not be, unless of course the road will turn further away. This is what we expected, because of our manipulation with more than one focus of expansion.

Summary
The experiment ended as expected, because a majority of the test panel reacted as expected.
In the scenes with more than one clear focus of expansion, the motion seemed unrealistic and also impossible.

5. Conclusion

Our main goal with this report was to get a better understanding of visual cues in moving scenes.

Introductory we have made a description of the general perception process in the visual system, followed by an introduction to the visual cues used in human perception. This has given us a basic knowledge of the subjects, which we have used through the entire report/project.

We have made 3 experiments to get closer to our goal. The test results of the experiments have given us a good and realistic point of view to visual perception in moving scenes.

Through the tests we have realized that the visual cues, focus of expansion and shadows have different strength in various scenes and situations.

The test results have confirmed that the theories from our information sources have been correct. Through the experiments we have learned how easy it is to use visual cues in practice for creating depth in a stationary or moving scene.

6. Sources

Litteratur:

Sensation & Perception – Margaret W. Matlin & Hugh J. Foley.

Web resources:

http://instruct.uwo.ca/psychology/215b-002/115-8-Depth3big.pdf

http://epsych.msstate.edu/descriptive/Vision/mparallax/DC6.html

http://www.med.uwo.ca/physiology/courses/sensesweb/L4Motion/L4VisualMotion.pdf

http://psylab.yonsei.ac.kr/~acv2002/026.pdf

http://www.nvnews.net/articles/3dimagery/humaneye1.shtml

http://www.kyb.tuebingen.mpg.de/publications/pdfs/pdf1461.pdf

http://www.eri.harvard.edu/faculty/peli/papers/Heading_TV.pdf

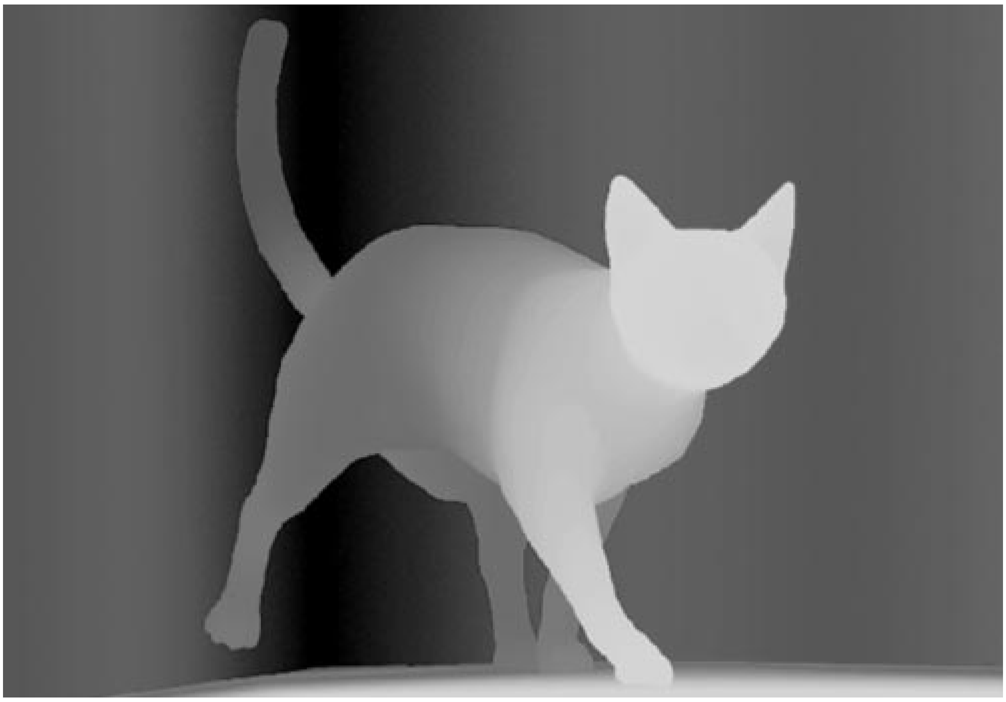
http://www.hms.uq.edu.au/percept/self.htm

http://www.uni.edu/~maclin/sp/files/ch9_Perception_Action.pdf

7. Enclosures

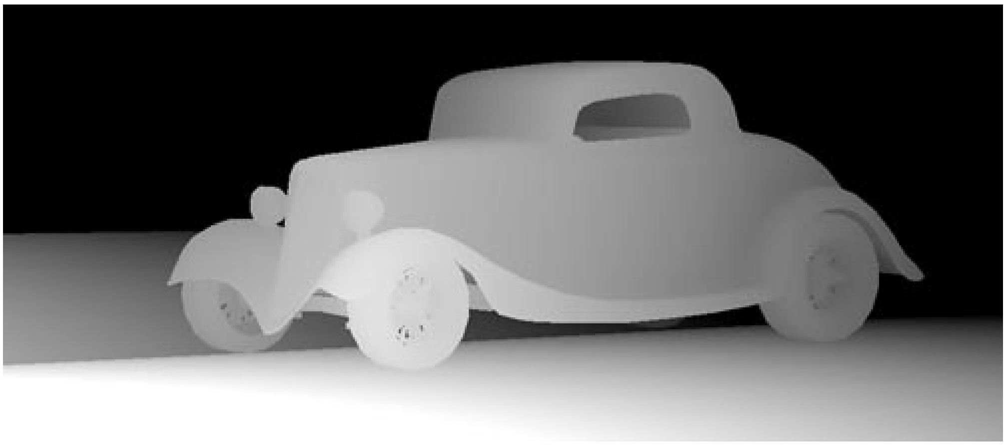
1:

Stereogram

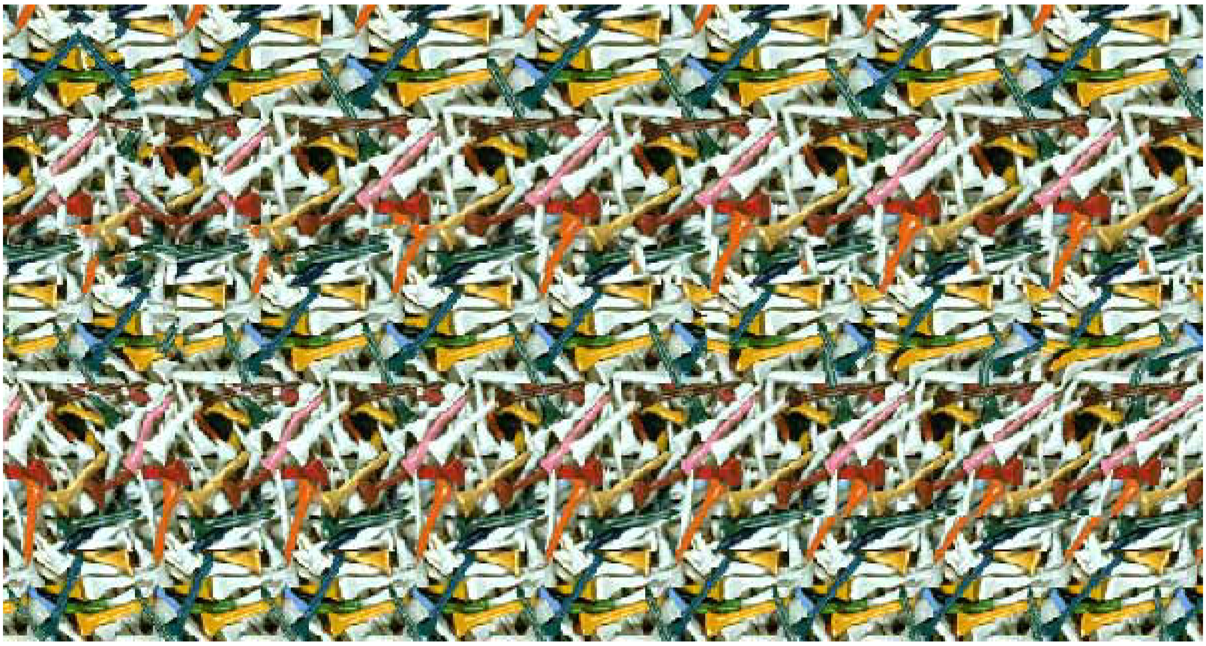


Solution

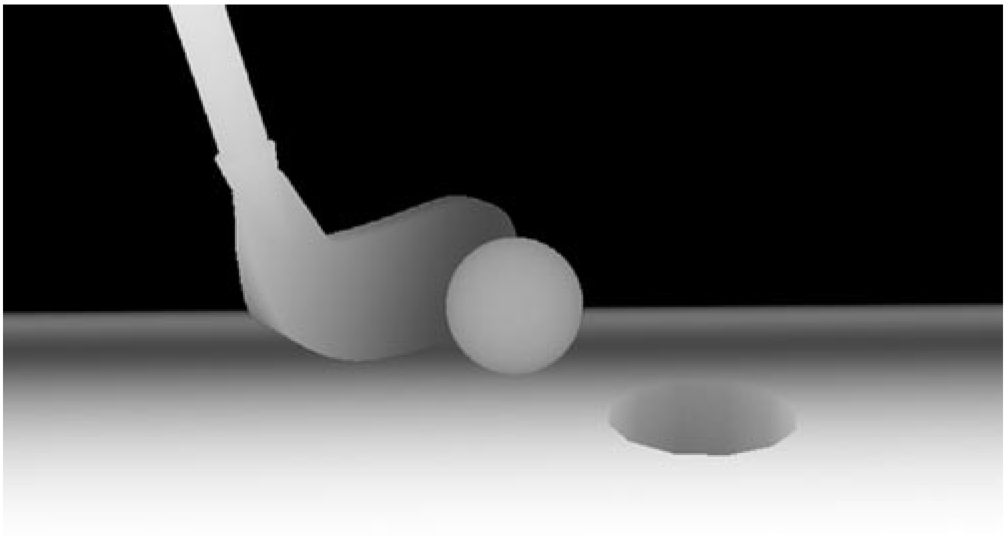
Stereogram



Solution



Stereogram



Solution

http://www.magiceye.com/3dfun/stwkdisp.shtml

2. Questioners

Experiment 1	Question	Yes	No	Why?
Scene 1	Is this situation realistic or not			
Scene 2	Is this situation realistic or not			
Scene 3	Is this situation realistic or not			
Scene 4	Is this situation realistic or not			
Scene 5	Is this situation realistic or not			
Scene 6	Is this situation realistic or not			

Experiment 2

Scene 1 — Take a close look at the image, and tell us which trees are closest to the viewpoint.

Answer ______________________________

Scene 2 — Watch the movie and tell us which trees happens to be closest the viewpoint.

Answer ______________________________

Scene 3 — Watch the movie and tell us which trees happens to be closest the viewpoint. Compare this movie to scene 2 and judge if there is differences in the tree's distance of depth.

Answer ______________________________

Scene 4 — Does the tree's distance of depth appear to be like you imagined, in relation to the previous movies?

Answer ______________________________