Optical Illusion

and its use for

Design

A research that focuses on optical illusion
and its integration to the design process
for problem solving

Master thesis 2008
Ergin Safak Dikmen

Optical Illusion and its use for Design

A research that focuses on optical illusion and its integration to the design process for problem solving

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I. INTRODUCTION

II. RESEARCH / Analysis of Types and Reasons of Optical Illusions

III. DESIGN PROCESS / Using Optical Illusion as a Design Tool

IV. CONCLUSION / Result of the Research

Abstract

The aim of this thesis is trying to find the way of integrating optical illusions and design for solving problems. Optical illusion is a visually perceived image which is deceptive or misleading, however in the thesis this negative characteristics of illusions will be used as positive impacts for using it in design. By taking into consideration the characteristics and reasons, optical illusion will be adapted to design. In this way areas and fields that we can use optical illusion in daily life will be researched. The phenomenon of optical illusion will be analyzed in two main parts. In the first part of the thesis some study cases which represent the main types of optical illusions will be analyzed. How the image become deceptive or misleading, the reasons of the phenomenon and the result of these illusions will be researched. The second part will be centered on a specific optical illusion, some experimental changes and adaptation will be tried to be made in the illusion. At the end of the thesis, according to the results, areas that we can use this illusion in daily life will be researched.

I. Introduction

Aim and Scope of the Thesis

In this part the main problem, the scope of the study and also the research methods will be defined.

Information sign, Bercelona spain

The main topic of this master thesis is optical illusions and its integrations to the design process for solving problems. Visual characteristics, of any design has a crucial important in its function, either it is a design of a product, a graphic design for a billboard, or an interface design for a signage system in the airport nearly all the designs field has firstly a visual impact on people. If confusion occur in a design due to an optical illusion, the design that is made becomes useless. In this way illusion, more precisely optical illusions is a phenomenon that should be generally avoided. For this reason optical illusion is phenomenon which is avoided in design and mostly used in art. In this way the focus of the research is to find if optical illusion can be adapted and used in design for solving problems. During the research the phenomenon of optical will be researched into detail, the area which were used in the history, the formation reasons of the phenomenon will be analyzed, finally according to the results the possibility of adapting and using optical illusion in design will be researched.

Airport signage system

Times Square, New York

Times Square, New York

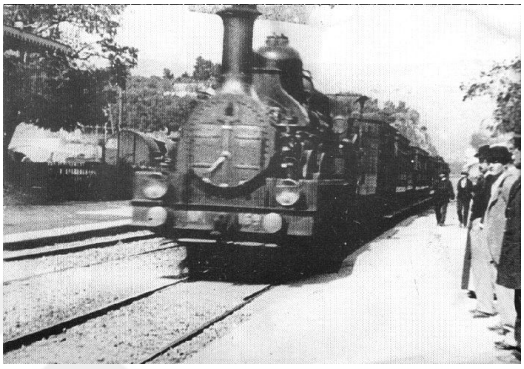
Shinjuku, Tokyo

Mary Anne Staniszewski wrote a book with the title "Believing is seeing" where she discusses the new way of seeing artistic heritage. For her, the event of seeing is related with believing and she thinks that we "see" events or objects that we want to see. According to Staniszewski everything is related to our "way to look", and the way that we want to perceive and see objects. But what happen if we define the topic seeing by its common usage; seeing as visual perception. Can we still say that the expression "believing is seeing" is through? What we see is it always the reality? Before answering these questions, it would be better to define the term seeing as a visual perception.

Hermann von Helmoholtz, described visual perception as "the unconscious inferences from sensory data and knowledge derived from the past" (Richard 1997: 1) The act of seeing is one of our five conventional senses which allows us to perceive outside stimuli, and give us information about our surroundings. In this way we can say that vision is one of our ways to get information from the outside world. Human being trust their senses, in this case their vision to interpret their world. However these terms become weaker on the 20th century, if we take into consideration all the information sources that surround us. In our century, the modern life style deal with tremendous amount of information. As a result, we need to struggle to filter all kind of data to understand if the information that we perceive is necessary or not? What we see is real or fake? Or most importantly, is the information collected is through or not (both in the abstract and concrete meaning)?

Lumiere brothers

La Sortie des Usine Lumiere, 1895



L'arrivée d'un train en gare de La Ciotat, 1895

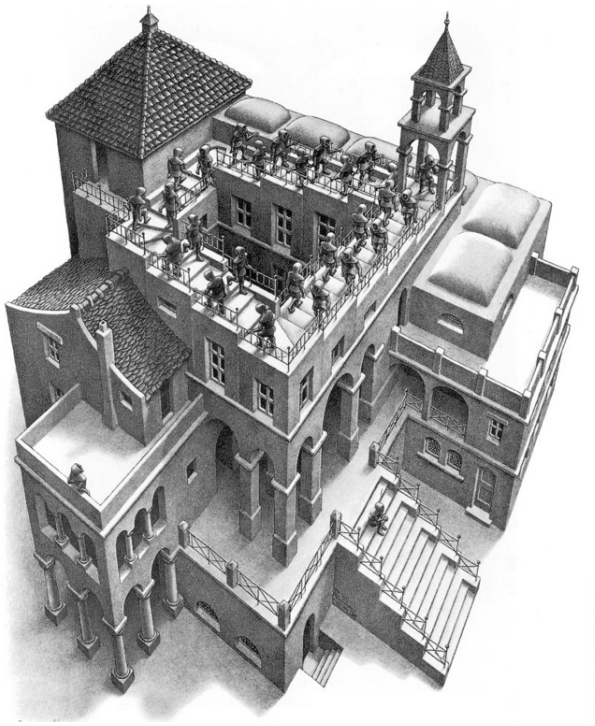
Until the invention of the early photo camera (the daguerreotype) by Louis Jacques Daguerre and Joseph Nicéphore Niépce in the middle of the 18th century, it was much easier for people to trust their senses or more especially their vision because the interpretation of an image was never that real before. As Arthur Asa Berger expresses that "Movies have a curious history. In their earliest days, they were regarded as miraculous but rather primitive amusements. Later, they were seen as entertainments, but not as a serious or significant art form. Now, the motion picture is considered an extremely important art form" (Berger second edition: 95). The century of wrong perception begun on 18th century, especially after the first public screenings of projected motion pictures by Lumiere brothers (Auguste and Louis Lumiere) in Paris. *L'arrivée d'un train en gare de La Ciotat,* 1895 *(The Arrival of a Train at La Ciotat Station)* is one of the first movies of Lumiere brothers, and also one first movies shown in public screening. This movie is characterized as an urban legend which marked the history of cinema. According to this legend when the film was first shown in a French Café on December 28, 1895 in Paris, the audience screamed and ran to the back of the room when they see for the first time a moving image of a real-sized train coming directly at them. As it is proved in this example, a simple illusion can have a powerful effect on people who are not used to. Technically this short movie was only a simple visual illusion; which was the screening of pictures one after another in a very fast way (sixteen images per second). However the impact of this illusion was very important because people who were not used to it, who had never seen a so realistic illusion before, they couldn't distinguish this illusion from the reality. As a result, they react as if the train that is coming was real. Because of this reason, for distinguishing an illusion from the reality, it is crucial to mention that the only and the most important tool is the experience that we had with the illusion. If the person can not use his/her experiences about an event, s/he cannot distinguish it from the reality.

Daguerreotype
1850

Mirage, illusion due to environment

By definition "Illusions occur when signals leads to internal inconsistencies within an image, or when conclusions are reached that are clearly contradictory to our preconceived notion of reality (Hendee 1997, 158). In other words, illusion can be defined as the transformation of reality. Although, there are different types of illusion, all of them share the same characteristics and in all cases the information perceived is deceptive or misleading. As we have five senses and illusion is the distortion of a sensory perception, it can be concluded that human being has five different types of sensorial illusions. These illusions can be categorized as; Optical illusion, auditory illusion, tactile illusion, and illusion occurred with taste and smell. As human senses deal with five different types of illusion, the most researched one by scientists is the optical illusion because of the domination of vision on the other senses. There are different reasons for illusions. Some illusions are based on past experiences, associations, desires, demands and imaginings. These illusions are manly errors of judgment (Luckiesh 1965: 1). On the other hand, some other illusions occur because of physiological reasons, that they are caused due to the specific characteristics of some organs in the human body. Another reason of illusion is caused due to physical environment outside of the body. Finally the last reason of illusions can be caused by psychological reasons.

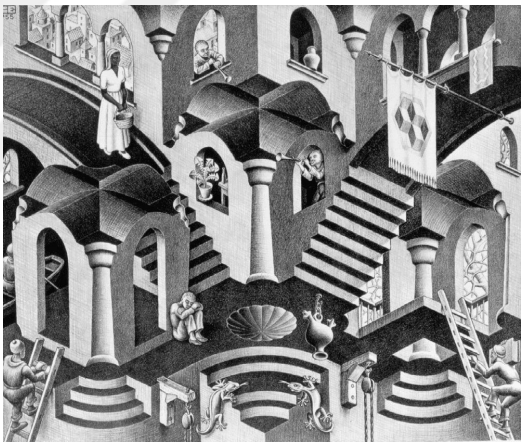
In summary there are different reasons and ways that an illusion occurs. But in all cases, illusions and especially optical illusions are a source of attraction. They were used in art, especially in paintings by many artists during centuries. Furthermore beginning with the 18th century, many scientific researches on optical illusion were conducted, especially in psychology for understanding the human visual system and visual perception.



Ascending and Descending, M.C. Escher

Optical illusions are events which chasing us from the pure reality because people perceive images which is deceptive or confusing. An illusion is in any cases a wrong interpretation of what we see, and for this reason people are avoiding it. Due to this characteristic, optical illusions are generally used in areas where the result of this misleading does not have any grave impacts. It is usually used in architecture as decorations, or in painting. In all these cases the wrong interpretation becomes only a source of entertainment, fun or curiosity.

In 12th century visual illusion was used in theaters with a big peace of glass disposed between the spectator and the stage. By projecting some strange reflections on the glass some visual illusions were made during the scene. In art, especially in painting, optical illusion was always a source of attraction for many artists. Painters such as M.C.Escher, Richard Allen or Victor Vasarely were only some of the artists among others which used optical illusions in their art pieces. Beginning from the 1960`s the genre of art called Op Art which used optical illusion on paintings appeared. "Optical Art is a method of painting concerning the interaction between illusion and picture plane, between understanding and seeing" (Lancaster 1973: 28). Op art works are abstract, where most of them are made in black and white. When the viewers observe the paintings, an impression of movement or rotation appears on the pattern (Opart.eu: Op Art 2008). Finally, today in architecture optical illusion is used as a tool of decoration, illusions are drawn on the pavement of the streets or on the wall of the buildings.



Convex and Concave, M.C. Escher 1955

Optical illusion drawing on pavement by Julian Beever

In summary Optical Illusion is used in different branches of art and architecture. The main reason is that, human being had always been attracted from things which were "mind-bending" or "tricky". In this way optical illusion is attractive by its nature because people were seeing "strange" things but they do not know the reason. However optical illusions have been usually avoided for using in a design. In some cases it is used in advertisements but generally optical illusion stayed as a source of distraction and amusement. For this reason optical illusion was mainly used by artists in their art pieces and were not used by designers as a "tool" for solving problems. Research on optical illusion is mainly conducted in psychology for decades, but sufficient research is not made for using optical illusion as tool for solving problems in design field.

The aim of this thesis is integrating optical illusions with design, for solving problems. Optical illusion causes wrong interpretations, however in this thesis this negative characteristics of illusions will be transformed into positive impacts to be used in a design process. Many problems related with optics and visual communication occurs in daily life. By taking into consideration their characteristics and reasons, optical illusions will be adapted to the design process for solving problems encounter in daily live. In this way areas and fields that optical illusion can be used will researched.

The scope of this researched will be based on these questions: What are the characteristics of optical illusions? What are the conditions of formation and reasons of optical illusions? How an optical illusion can be changed and adapted to a design process? In which area optical illusions can be used as a medium for solving problems?

During the research process some of the optical illusions will be researched in deep and according to the results obtained, ways of using them into design will be researched. As an end result some suggestions will be made for solving some daily life problems by using optical illusion.

For having a detailed research on Optical Illusion and the areas that it can be used, it is important to understand the nature of optical illusion and its working process. For this reason in the first stage, the use of optical illusions in the history is researched, than the main type of illusions and their working process is discussed. After this, human visual system, the main categories of optical illusion, and their causes are examined.

In the second stage an illusion called Hybrid Images is explained. This illusion is used on the research about perception of complex visual stimuli, in the University of Glasgow department of Psychology. In this part the technical characteristics and the working process of Hybrid Images is researched in detail. After understanding the characteristic and the creation process of this illusion, some experiments is conducted for finding the potentials of the illusion and ways of using it. At the end according to the results, areas that the illusion can be used are researched.

In the conclusion part, the result obtained in this thesis is explained and some suggestions for further research are developed.

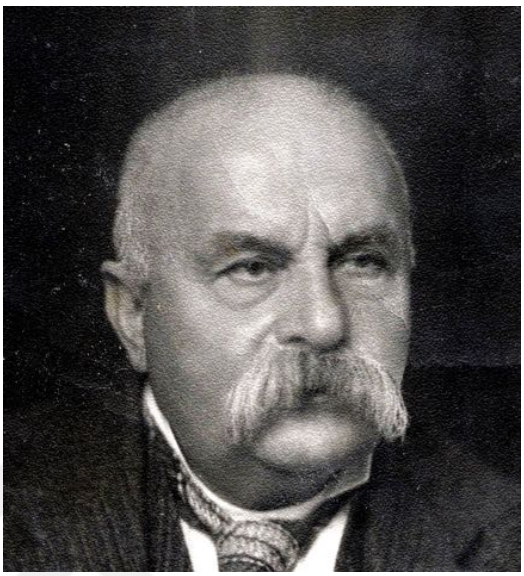
With this research optical illusion is integrated and adapted to a design for solving problems. Thus the illusion is not used only in sciences and in arts but also for disciplines like design. As a result, negative characteristics of visual illusion such as a deceptive or ambiguous perceived image are transformed into a positive one which can be used for solving a design problem.

II. Research

Analysis of Types and Reasons of Optical Illusions

The aim and the scope of the thesis were defined on the previous part. In this part the concept of optical illusion will be analyzed in a deeper way.

For a clear understanding of the topic, firstly the term illusion should be defined in a proper way. The word illusion originates from the Latin word "illudere" which means to mock. By definition an illusion is something that deceives by producing a false or misleading impression of reality, in other words it is the state or condition of being misapprehension (Online Dictionary). According to a scientific point of view illusion occur when signals produced from sensorial organs leads to internal inconsistencies within the norms, or when conclusions that are reached are clearly contradictory with the preconceived notion of reality (The Perception of Visual Information: 158). There are different types, characteristics and reasons of illusions but all of them lead to the same result, in all cases the information perceived is deceptive or misleading.



Johannes Muller (1801 - 1858) one of the first psychologists which started researches on human perception

Basilica di Santa Maria del Fiore

Tromp-l'oeil in *Basilica di Santa Maria del Fiore* by Filippo Brunelleschi, Florence Italy

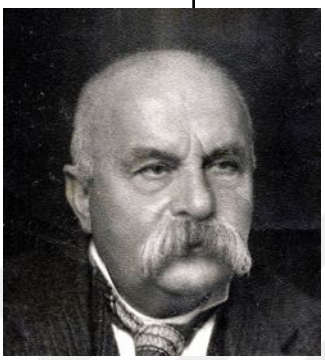
As optical illusion is related with vision and perception, human beings were always being aware of it, but his approach and explanation of this phenomenon change over the history. In the classic antiquity, philosophers tried to find out an explanation to visual illusion that they were experienced such as mirage. The Greek philosopher Plato (3th century BC) had explained the inconsistency between perception and reality in "the allegory of the cave". In the middle age, eye tricks and optical illusions were considered as magic created by the devil or something miracle created by God. In the 16th and 17th century tromp-l'oeil was used in ceilings where "fake" domes or windows were drawn by using "rules of perspective". One of the best example of tromp -l'oeil is the dome that Andrea Pozzo draws in the Jesuit church, Vienna.

Tromp-l'oeil in Jesuit church Vienna, by Andrea Pozzo

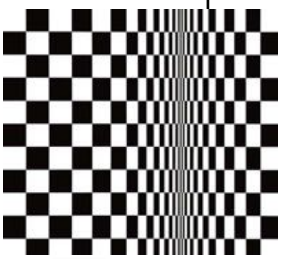
3h cent. B.C. | **17th cent.** | **19th cent.**

1626 *1820 - 1858* *1953* *1961* *1966*

In classic antiquity, philosophers tried to find out an explanation to visual illusion such as mirage.



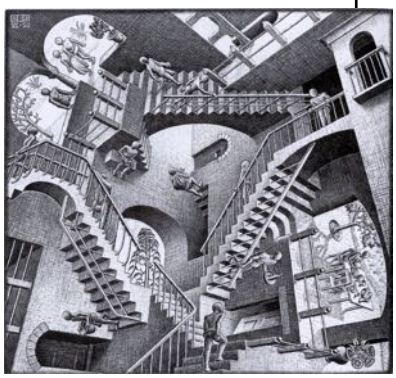
Psychologists Johannes Muller started researches on human perception



OP Art example
Movement in Squares,
Bridget Riley 1961

Ceiling of Sant'Ignazio Church (Roma) by Andrea Pozzo

A day dress by an Italian couturier inspired by the Op Art movement, modelled in Milan.



Relativity 1953, M.C. Escher

Beginning with 19th century psychologists such as Johannes Muller started to research on human perception and in this way optical illusion begin to be discussed in a new discipline like psychology. Beginning with the 1960's optical illusions enters into art galleries, a new visual art genre OP art appear. Op art works are abstract works in which some vibration rotation or feeling of movement occurs while observing the art pieces. Finally after the 1980's Optical illusion become a part of the pop culture, optical illusion begin to be seen in different areas, in fashion, in building decorations, many optical illusion web pages and fun clubs begin to be created. In art, optical illusions will be in galleries but also in streets for example artists such as Julian Beever is famous for his drawing of optical illusion in pavements.

20th cent.

1995 - ...

Optical illusion drawing on pavement by Julian Beever

2000

Relativity reinterpreted by Andrew Lipson

2004

Advertisement for Bionade

2005

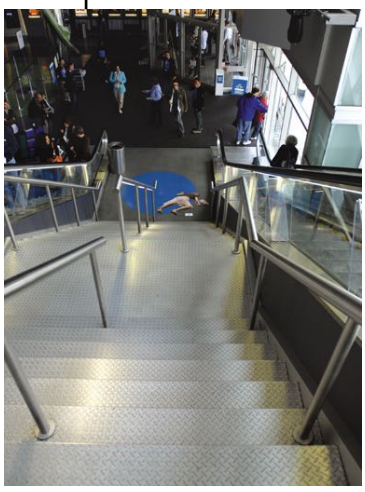
Use of optical illusion in architecture
Digital Harbour Port 1010, in Melbourne, Australia

Advertisement for Shell company
Agency: JWT Amsterdam

Unconventional life-size decals of a collapsed man and woman placed at the bottom of selected high-traffic Cineplex

2006

Spring runway in Milan Fashion Week



Advertisement for Red Cross Canada
Agency: Toronto's Downtown Partners

With a conventional approach, the human body has five different senses which perceive information from its surroundings. An illusion is a false interpretation of the information collected by the senses, in this way as humans has five senses; there are five different types of possible sensorial illusions.

2.3.1 Auditory illusion

It is an illusion of hearing, in this case the ambiguity occur in auditory recognition. For example in the stereo illusions "disagreement tends to arise between right-handers and lefthanders, indicating that they reflect variations in brain organization" (Deutsch: Online). Another auditory illusion is the tritone paradox which is described by Deutsch as: "When one tone of a pair is played, followed by the second, some people hear an ascending pattern. But other people, on listening to the identical pair of tones, hear a descending pattern instead". According to her this illusion is caused due to the languages or dialects that the people use in their mother tongue (Deutsch: Online).

2.3.2 Tactile illusion

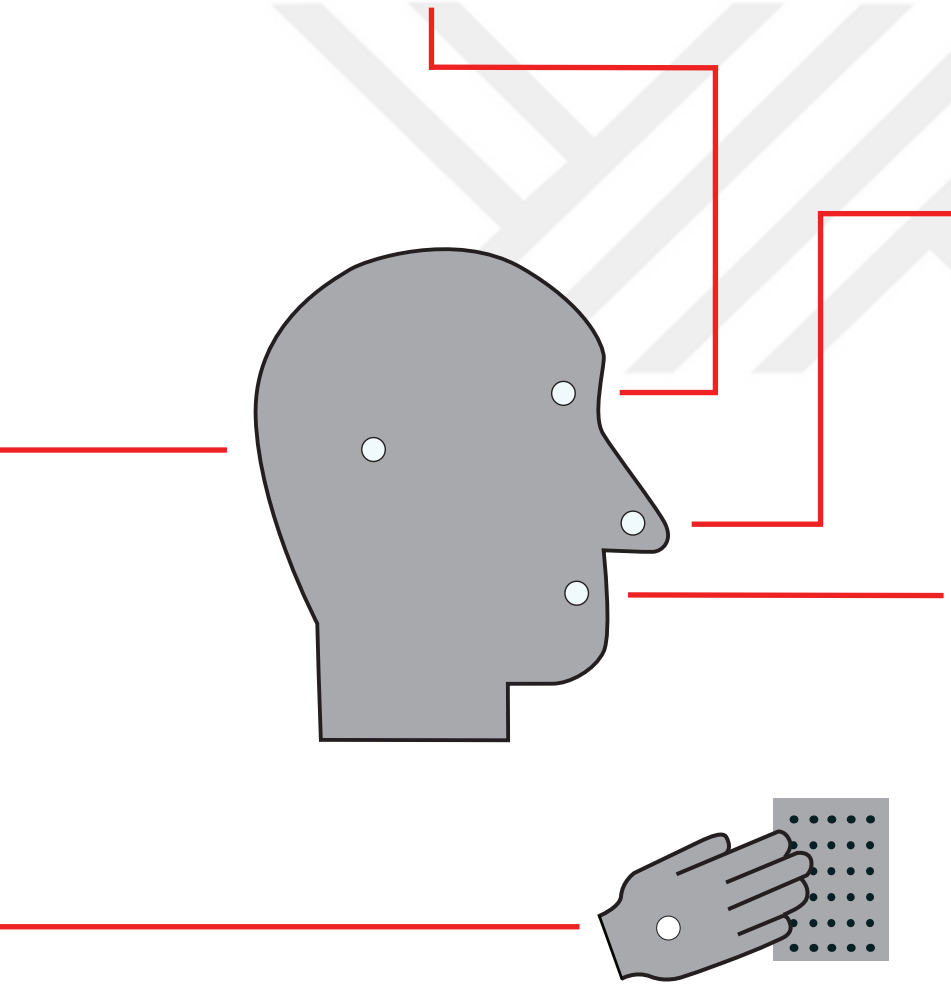
This illusion is related with the sense of touch. There are two different categories in the perception of touch, active touch where the information is collected by the movement of the fingers and hand or passive touch which occur when an external object out the body press the skin. In tactile illusion some virtual objects can be crated by using the active or passive touch (Robles-de-la-Torre 2006)

2.3.3 Optical illusion

It is characterized by visual images which are perceived different than the reality and generally can be described as ambiguous or misleading. The reason of this illusion is related to different factors; there are physiological illusions that occur biologically (mostly related to the functional characteristic of our eyes and neural system) and cognitive illusions which occurs due to our perception system (mostly related to the process of acquiring, interpreting, selecting, and organizing visual sensory information).

2.3.4 Smell illusion

This illusion is related with sense of smell, according to researchers the sense of smell can be manipulated and influenced by verbal labels. For instance according to positive or negative verbal label used for some odor, subjects can interpret and rates the odor differently. However according to Clare Batty "Olfactory illusion is just not something that resonates with us." It is more accurate to speak of an illusion in case of visual, auditory and tactile experience.



2.3.5 Taste illusion

This illusion is related with taste senses. Different parts on the surface of the tongue have cell receptors which have the ability to detect different taste like sour, sweet, salty and bitter. In taste illusion confusion occurs in these cell receptors. The illusion can occur while eating some ingredient, such as the "miracle fruit" where sour taste can become sweet. This illusion occurs due the protein called miraculin founded in this fruit. Miraculin creates connections between taste cells on the tongue for this reason a chaotic electrical signal is send to the brain from the taste receptors, thus the person confuse the sour taste with sweet, in a result a temporary taste illusion occur.

There are diverse reasons of illusion however whatever the sensory illusion that we have, illusion is a common phenomenon shared by the majority of people. This is also expressed by William R. Hendee that; "illusion universality is apparent when several observers arrive at a similar conclusions (Hendee 1997: 158) Among the illusion sited below the most well known and most understood is the optical illusions. As different distortions of sensory perception are defined, the next chapter will be focused on optical illusions.

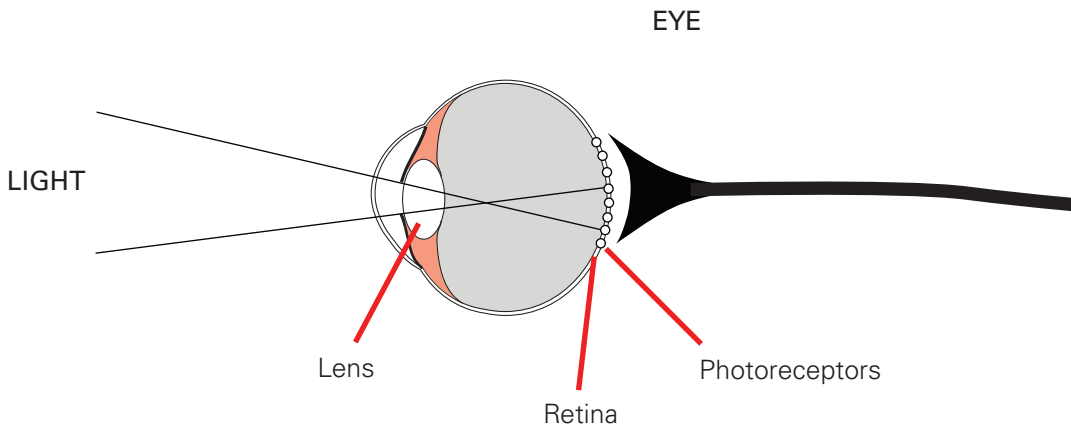
2.4.1 How we see?

For a better definition of the problems and understanding the phenomenon of visual illusion, it is important to understand the system that we are using for seeing. Basically the act of seeing in human being is constituted of two different steps.

Definition of the visual system

The first step of seeing occurs with the help of the visual system and it is related with the human physiology. The first step in the visual system, is to transform the light entering the eye to electrical signal, which will be transmitted to the brain through the optical nerves. Peter F. Sharp and Russell Philips define the role of the eyes as; "…the optical interface between the environment and the neural elements of the visual system" (Sharp & Philips 1997: 1). The light entering into the eye through the lens is projected to the retina. Photoreceptors which are located on the retina convert light energy into electrical impulses. These electrical signals are sent to the visual cortex of the brain by passing through the complex retinal neural network (Sharp & Philips 1997: 1).

Transformation of light to electical signal

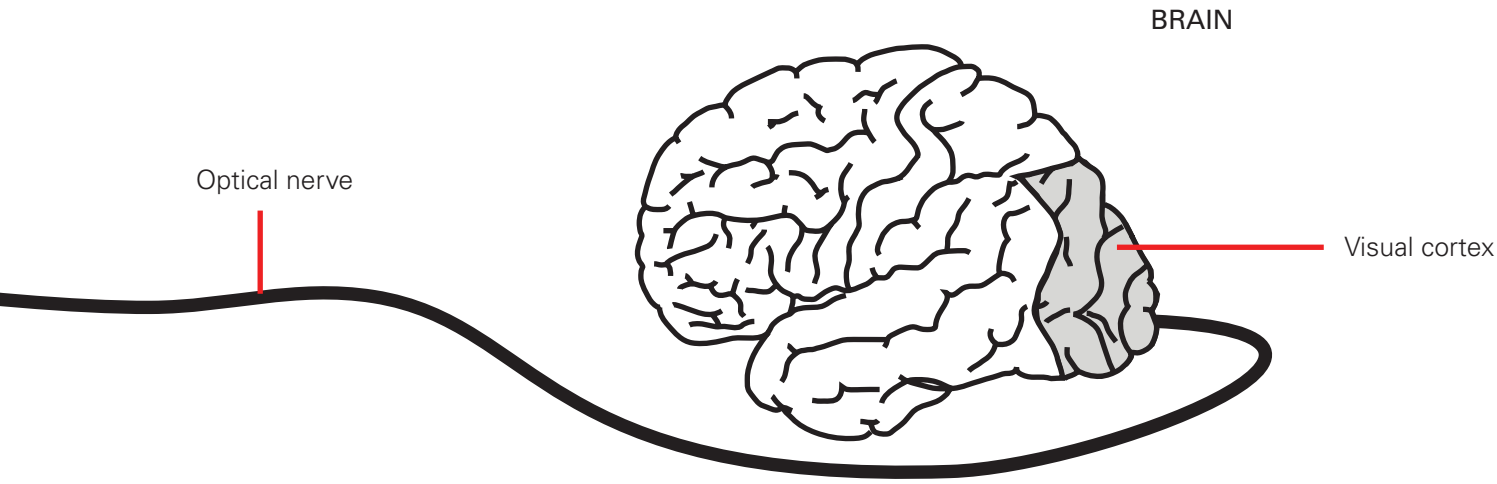


Definition of the visual perception

The second step is the visual perception and it can be defined by the interpretation of the electrical signal send by the eyes. This step is not related with the human physiology but with the psychology, and in a very simple way it can be defined as the process of giving meaning to data received. The visual cortex of the brain processed the information and sent some signal to other part of the brain (Sharp & Philips 1997: 1).Related with this second stage of visual perception Herman von Helmoltz introduced the notion that visual perceptions are unconscious inferences. According to him human being need knowledge and experiences to give sense to the sensory signal (Gregory 1997: 1)

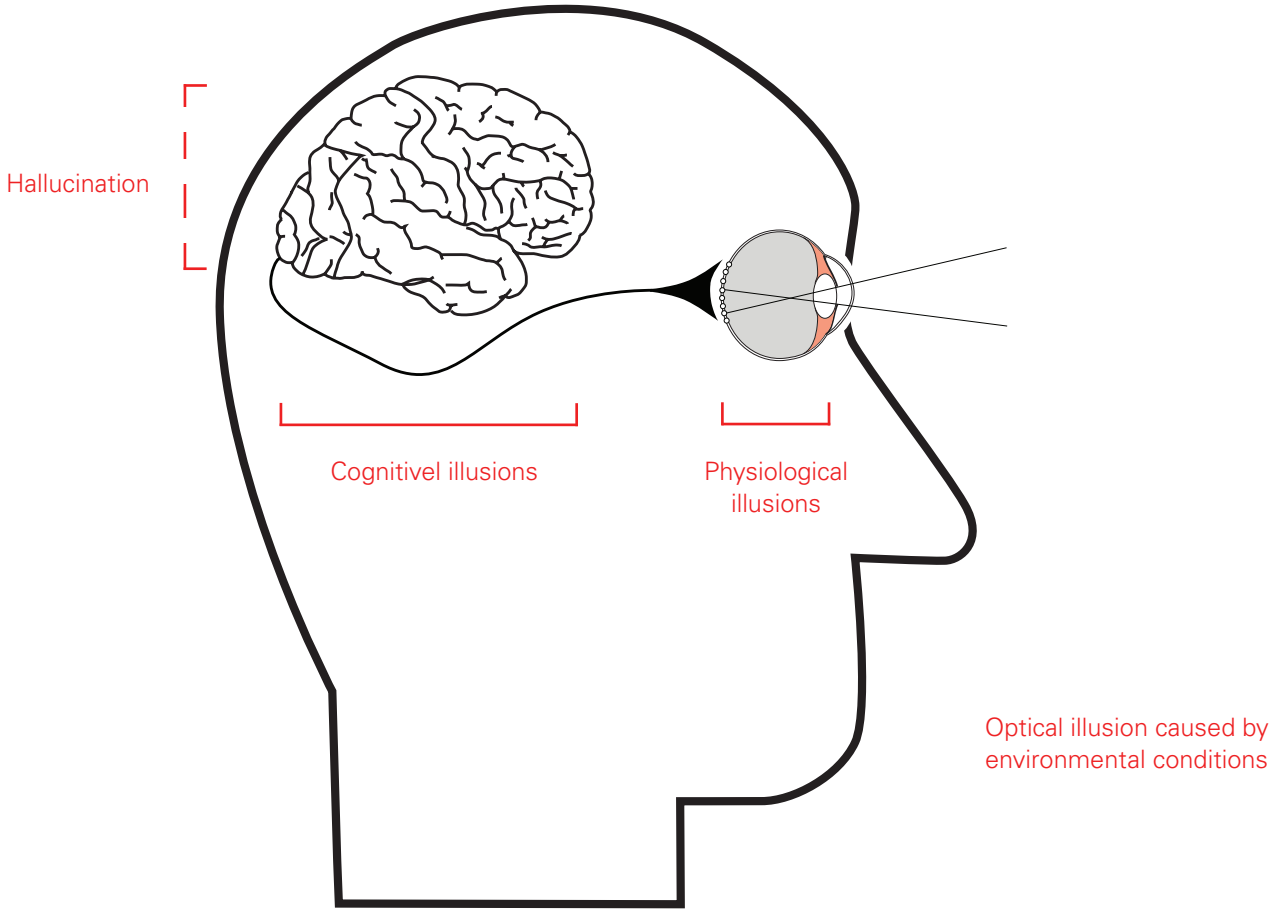
As it is mentioned before optical illusion is a wrong interpretation of visual images, so if we consider this wrong interpretation as a problem, this problem can occur in two different places. Either it occurs in the first step of seeing process, in the visual system, in this way it is a physiological illusion or it can be caused in the second step, in the interpretation of visual signal stage, in this case it is a cognitive illusion.

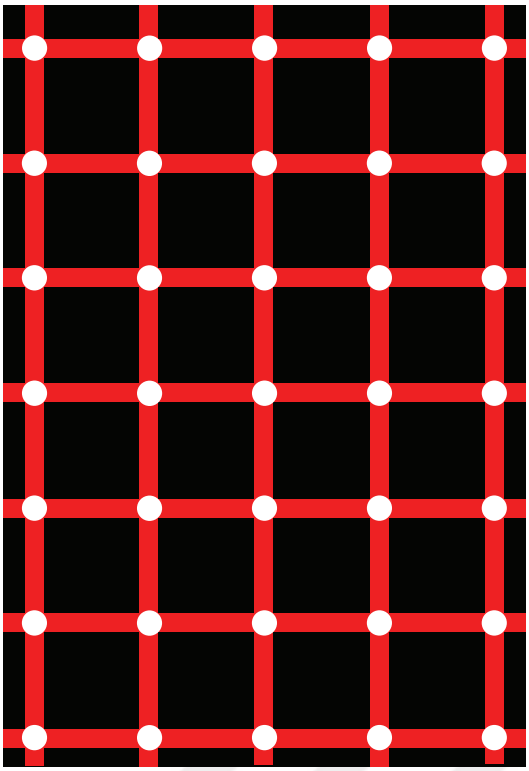
Interpretation of the electrical signal



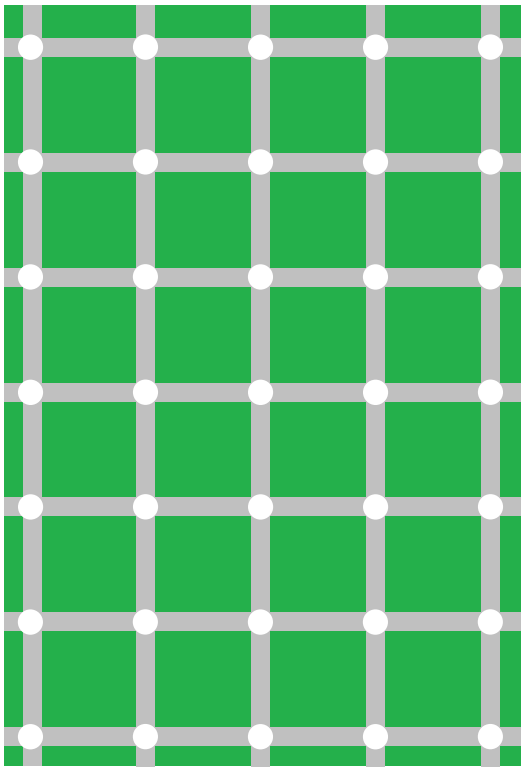
FOUR MAIN REASONS

An optical illusion is a false interpretation of an image that we see. As Richard L Gregory mentioned in his article *Knowledge in perception and illusion*; for saying that there are an optical illusion the phenomena has to be explained and classified. In other words it has to be an awareness of an illusion and the reason should be explained. In his article about perception and illusion Gregory wrote that: "Visual illusions can provide evidence of object knowledge and working rules for vision, but only when the phenomena are explained and classified." (Gregory 1997: 1). Basically there are four main reasons of optical illusion: one of them is the biological sensory structures within the human body (physiological illusions). It is basically related with the formation and biological structure of our eyes. Another cause of optical illusion is related with the general assumptions that occurs in the brain during perception (cognitive illusion), it is mostly related with how our brain is functioning during recognition and interpretation of images. Thirdly an optical illusion can occur due to psychological reason such as an illness or hallucinogen where the person can see images in the absence of stimulus. In this case this distortion is not called optical illusion but hallucination. Finally, as a fourth reason our vision can be disturbed by conditions outside of the body; therefore an optical illusion can be formed due to physical environmental conditions in the surrounding of the person. As we listed all four main reason of optical illusion now we can begin to analyze in a more detailed way.





Hermann-grid illusion



Note that dots appear and disappear at the crossings. The color of the dots change according to the background used.

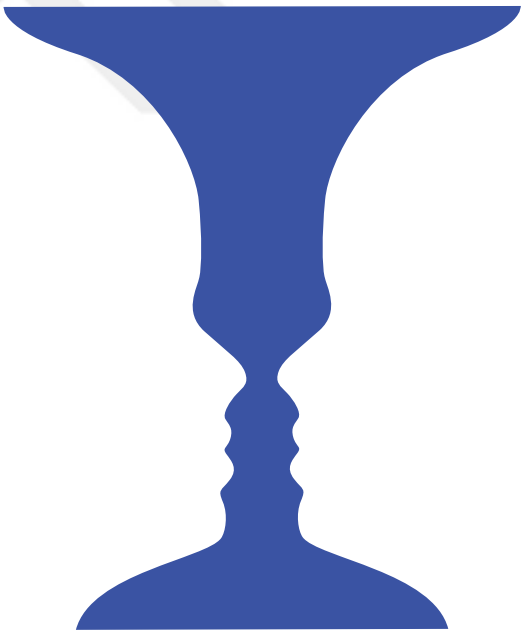
2.5.1 Physiological illusion

Physiological illusion occurs in the visual system. It happen due to an imbalance occurred in some organs like the eyes, where due to its physical structure in some cases the eye become incompetent to manage the light entering through the iris, and sends "wrong" information to the brain. In this case the term wrong is used in the way that the information is misleading or different than the reality. For example one the most important optical illusion occurred due to physiological reason is the luminance and contrast perception of the cells in the eye. (Backus and Oruc 2005) "For example, after images that remain after viewing a particular bright object (e.g., an intense light) are caused by a temporary desensitization of the retina following overstimulation." (Hendee 1997: 159). In following chapters, some examples related with physiological illusion will be analyzed deeply.

2.5.2 Cognitive illusion

Cognitive illusion occurs on the second stage of the visual perception process and it is not related to the physiological reasons but it is related with the wrong interpretation of signals send from the eyes. In this case the use of principles such as the Gestalt theory depth perception principles leads us to a wrong interpretation of the image thus an optical illusion occurs. "Vision need knowledge", in traditional approach of sciences and philosophy the intelligence were separated from perception however in our days it is accepted that "perception, especially vision, requires intelligent problem solving based on knowledge" (Gregory 1997: 1). As Gregory expresses that, "Cognitive illusions reveal knowledge and assumptions for vision,(…) but they must be understood and also classified. Classifying is important for the natural sciences: it should be equally important for the unnatural science of illusions." (Gregory 1997: 1).

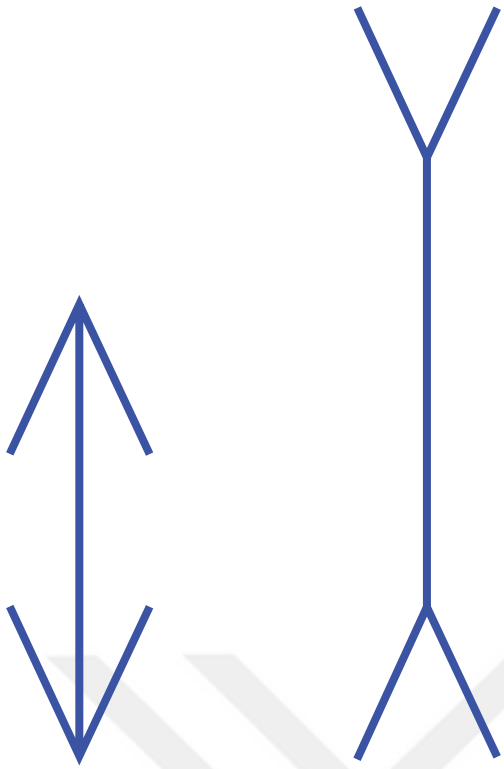
Basically cognitive illusion is divided into ambiguous illusion, distorting illusion, paradox illusion and fictional illusion.



Robin Vase

2.5.2.1 Ambiguous illusion

It is a picture which has two different interpretations, while the observer can switch between both images. "Ambiguities result when multiple interpretations are possible and the image does not favor any particular one over another." (The perception of visual information p159) As an example of ambiguous **Rubin's Vase** (sometimes known as the **Rubin Face**) is a good example. In this image which was developed around 1915 by the Danish psychologist Edgar Rubin, two different images can be seen; a vase or two human faces looking to each other, both images switch by considering one as a figure and the other as the ground or vice versa.



Equal length lines

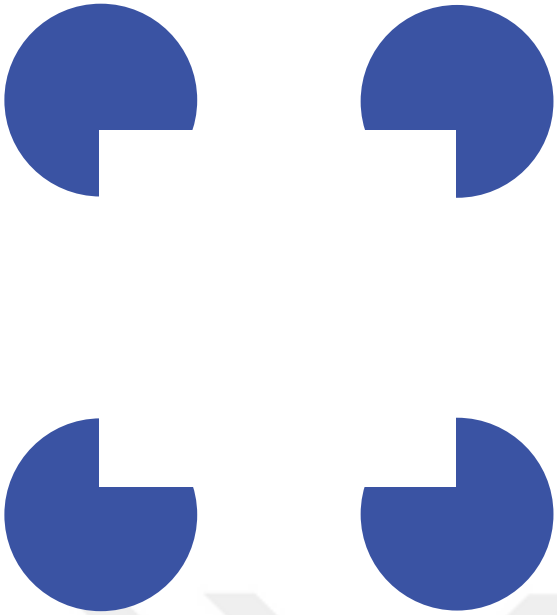
2.5.2.2 Distorting illusion

The illusion is caused due to an imbalance on the image; "Images often present distortions of size, length or curvature that are confusing to the observer and challenging to interpret. (…)Some distortions are caused by misinterpretations of visual cues of depth extract from images." (Hendee 1997: 160). For example, objects that are thought to be at a distance are expanded in size mentally to reflect the viewers understanding of their true size. When the depth cues are misleading, this automatic cognitive process can lead to distortions (Hendee 1997: 160).

Waterfall, M.C. Escher

2.5.2.3 Paradox illusion

It is generated by objects that are paradoxical or impossible. In some cases with the use of the shadows or "wrong" edge lines some objects are drawn but in reality they can not exist in real three dimensional spaces. Certain images present illusions that are known to be impossible even though they are clearly apparent in the image. Paradoxes provide a conflict between appearance and knowledge; we know that the image, although visually obvious, cannot be correct (Hendee 1997: 160).



2.5.2.4 Fictional illusion

It is generated by the imagination of shapes where there is not. Often objects are assumed to be present in images when in fact they are figments of the imaginations. (…) some illusory edges and surfaces, that are occluded by some nearer objects or surfaces. The cognitive recognition of external reality depends in part on the projection of certain shapes onto visual images. Occasionally this projection leads to fictional representations that are not present in images (Hendee 1997: 162).

2.5.3 Illusion due to psychological disease

It is a category which has to be separated from other illusions because this illusion occurs with the absence of stimulus, and the person see objects or events which are not there or does not occur. One of the characteristics of it is that the illusion is not shared by everyone but only from a single person, in this case the illusion is not classified as an optical illusion but an hallucination. The basic difference than a cognitive illusion is that: cognitive illusion is an error of judgment on the other hand if an object appears while it is not present, in this case the term is defined as hallucination (Luckiesh 1965: 4). There are several reasons of hallucination; it can be caused by psychosis or neurological illness. In other cases it can also occur due to drug use, especially hallucinogenic drugs.

2.5.4 Illusion occurred due to environmental conditions

The fourth and final reason of an optical illusion is not related with the physiology or psychology of the human being but with the external conditions outside of the body. Sometimes due to natural optical phenomenon, occurred in the surrounding of the human being some illusions can be seen. In this case this event is due to the disturbance of light between objects and the eyes which is different than the disturbance of sensory signals of eye which is called physiological illusion (Gregory 1997: 2). This illusion occurred naturally in the environment when specific conditions take place and they are called mirage. It occur when light rays are bent and reflect a displaced image located far-away or the sky. The reason of this phenomenon is related with the temperature differences between cold and warm air. The light which passes from colder to warmer air has a tendency to bend. For example in a sunny day when the air near the ground is warmer than the higher up we can see the image of a pool on the road. In this case the "image of the sky" is coming from the ground. In reality there is no water, what we see is not the light coming directly from the sky but a banded light.

Mirage in the desert

Mirage in the runway

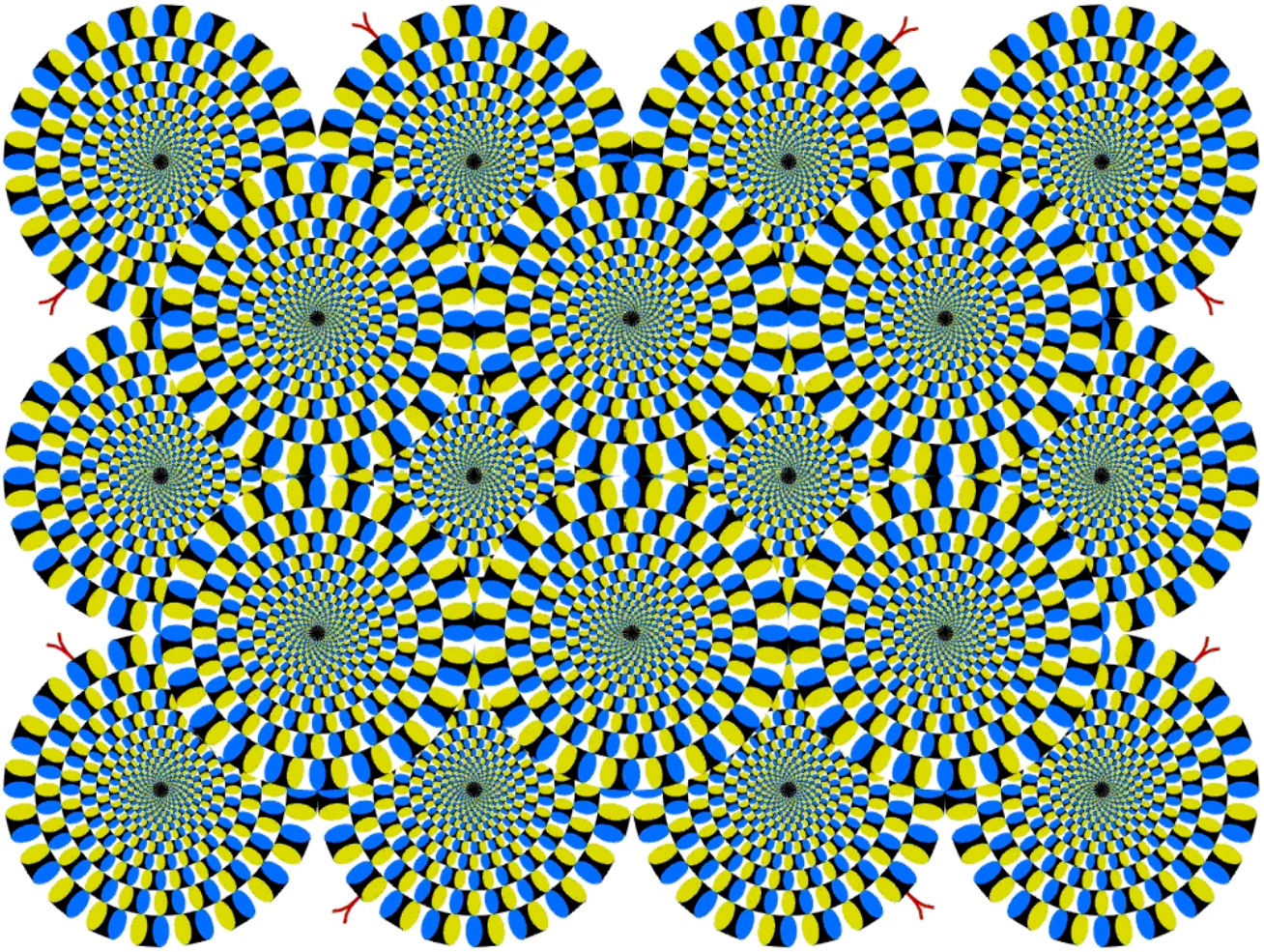
The Rotating Snack is an example of a physiological illusion, in which it is caused due to functional characteristic of the visual system. In this example many people has the sensation of motion when they are looking to the static image. For understanding, this phenomenon in a better way, firstly a brief observation of *The Rotating Snack* will be made than the reason of the illusion will be explained.

2.6.1 Observation

According to Backus and Oruc repeated asymmetric patterns (RAPs) cause many people's visual systems to infer the presence of motion where there is none. In their researches Backus and Oruc mention that most people see rotation in the disks, especially when they fixate elsewhere. The direction of motion depends on the order of the colors within the circles. "Most people see a rotary movement that runs in the black-blue-white-yellow direction" (Backus & Oruc 2005: 1055) or more precisely from dark colors to light colors.

According to the findings of Backus and Oruc:

- The motion stop after 6-8 s of steady fixation.
- The eyes don't need to move to refresh the motion.
- Motion is restarted by moderating eye movement, but neither by very small ones nor by small amounts of image jitter.
- Motion stoppage after monocular viewing does not completely transfer to the other eye.
- The motion is more pronounced for binocular than monocular viewing.
- Different people see different speeds, and for some RAPs, different directions of motion (Fraser & Wilcox, 1979; Naor-Raz & Serkuler, 2000).
- Blur reduces the motion of "Rotating Snakes" in noncentral vision while increasing it in central vision.



The Rotating Snack, Akiyoshi Kitaoka

2.6.2 Causes

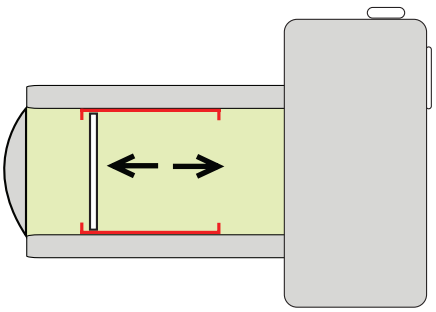
According to the researchers, this illusion is caused by two main reasons: The effects of motion can be caused due to the adaptation of neurons on the retina to the contrast or to the adaptation of the luminance. Backus and Oruc suggest that: most people's visual systems infer the presence of motion in static RAPs because static RAPs evoke a pattern of neural activity that normally occurs only when an object is really moving (Backus & Oruc 2005: 1066). The neuronal activity is similar in a real moving image and in a static RAP image, thus the confusion occurred on the retina. The "problem" occurred on the first stage of visual perception, as a result RAP illusion caused by neuronal activity can be categorized as a physiological illusion, because it occurs in the "first stage" and not on the "second stage" of visual perception.

III. Design

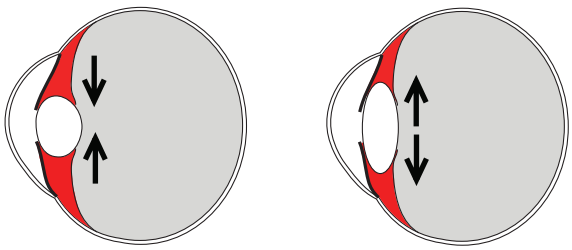
Using Optical Illusion as a Design Tool

In the previous parts of the thesis, illusions that can be occurred during the vision was analyzed. In this chapter the way of using optical illusion as a design tool will be examined.

Human being can see details much precisely when they are looking to object from close distance. On the contrary if the same object is far away, details can't be seen precisely anymore and only the overall shape of the object can be seen. "Fine scale boundary edges are notoriously noisy, and they present many confusing details that would not appear in edges measured at a coarser resolution. However, fine details are often still necessary for a complete description of the object, for example to distinguish it from similar object" (Oliva and Schyns 1997: 76). Due to physiological reasons human perception is not strong enough to see objects from distance. Eyes do not have the ability of zooming or focusing to objects like a camera. For taking a sharp picture, the photographer needs to focus the camera on the object by moving the lens forwards or backwards. However the lens position in the eye is fixed. Therefore to focus on a near object, some eye muscles change the shape of the lens and in this way the object that the person want to see become sharp. When an object is too far the lens and the muscle become incompetent to sharpen the object, for this reason the object become blurry (Online The Eye Digest Medical Dictionary 2003: Presbyopia). According to Oliva and Schyns from distance the boundary edges of an object could serve as a skeleton describing the coarse structure of an object and from a closer distance the skeleton can be fleshed by finer structure (Oliva and Schyns 1997: 76). The interesting part of this phenomenon is that; Psychology department of Universities research for decades about this characteristic of human vision. They try to find out an answer to "How human being recognize objects or faces from distance, or beside a blurry window". If the topic is taken into consideration from a design point of view the critical question is: The ability of image recognition from distance of human vision can be used for a specific design of visual media or not?

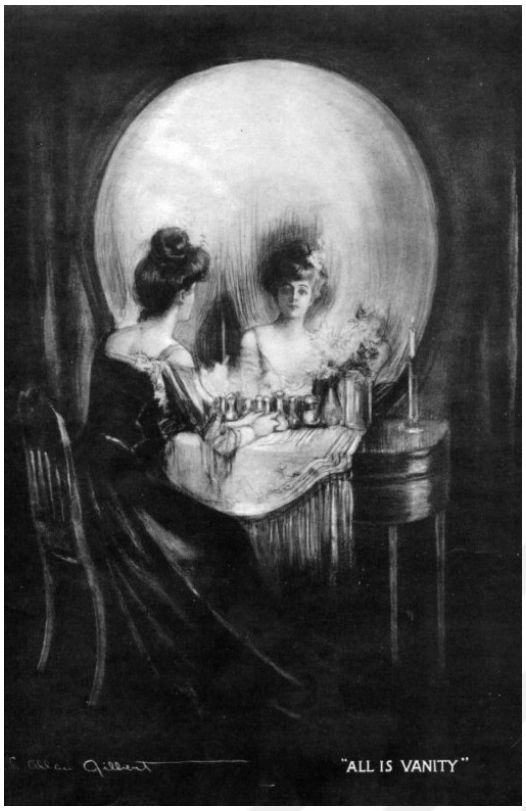


Camera Zooming



Close Vision

Distant Vision



All Is Vanity by Charles Allen Gilbert

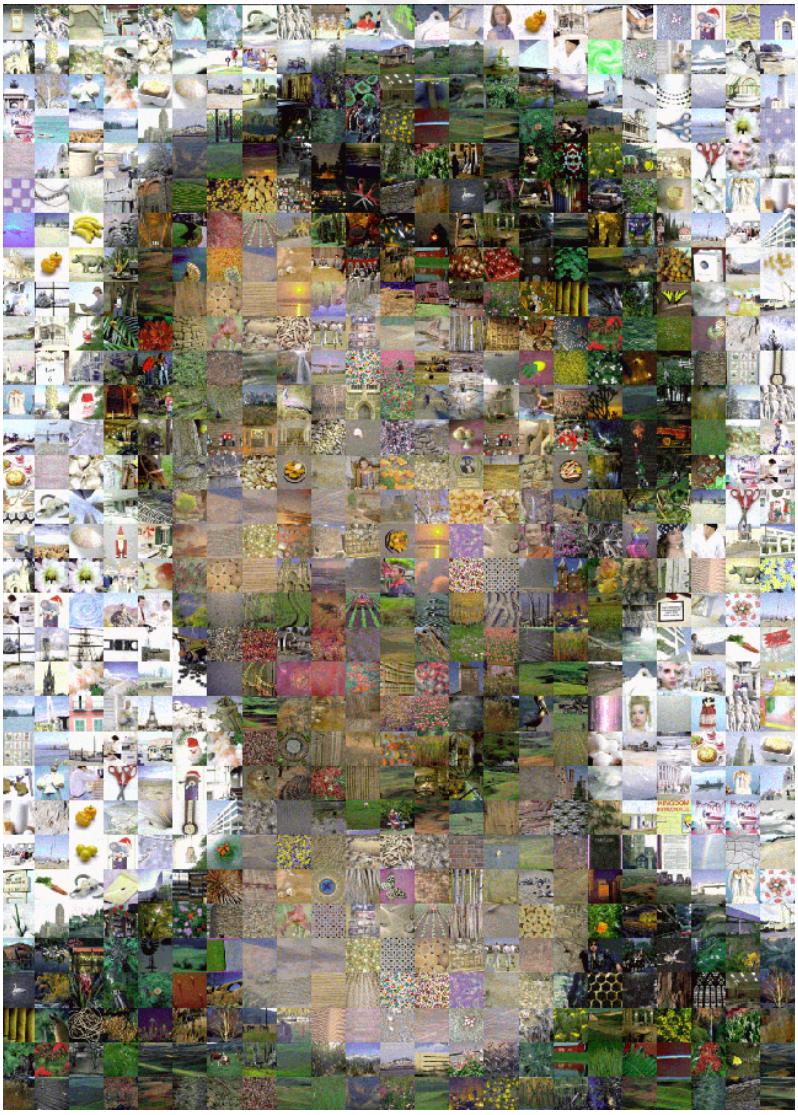
There are different types of images or paintings which deal with two type of interpretation. One of the examples is the paintings of Charles Allen Gilbert, *All Is Vanity* made in 1892. Although, it is a painting of a woman sitting in front of the mirror, if it is looked from a distance the image of the women turn into a skull.

In 1973 a researcher called Leon Harmon in the Bel Labs conduct a research on face recognition where for the first time he discovered that human being can recognize highly pixilated face. For his test of human perception he created a pixilated portrait of Abraham Lincoln. Tree years later Salvador Dali created his paintings Gala contemplating the Mediterranean Sea, which from 30 meters distance the painting become the portrait of Abraham Lincoln. Many pictures and paintings in which the interpretation changes with distance is created until now. However both interpretations is visible with any distance and the switch can also be made without changing the observation distance.

Gala contemplating the Mediterranean Sea by Salvador Dali

Researchers Philippe G. Schyns and Aude Oliva from Massachusset Institude of Technology and University of Glasgow, department of psychology, focus their researches on face recognition in rapid visual presentation. In their researches they used specific images called *hybrid images* for analyzing the human perception system. According to the definition of Schynes and Oliva an "*Hybrid images* is a technique that produce static images with two interpretations, which change as function of viewing distance. Hybrid images are based on the multiscale processing of images by the human visual system and are motivated by masking studies in visual perception." (Oliva, Torralba and Schyns 2006: 527). Hybrid images can be defined as an optical illusion because it is an image with two different understandings; hybrid images exploit the multiscale perceptual mechanisms of human vision to create visual illusion where two different interpretations of a picture can be perceived by changing the viewing distance or the presentation time (Oliva, Torralba and Schyns 2006: 527).

In this stage Schyns and Oliva remark that the hybrid image shouldn't be confused with the technique of picture mosaic where the picture is composed of small pictures. The picture mosaic has also two different interpretations changing with distance that the viewers see the picture. From close distance the content of the small picture which form the mosaic can be seen and from far distance the global image of the mosaic appear. However hybrid images contain two coherent global image interpretations, the effects of two different interpretation is also related with watching distance. On the other hand picture mosaic is created by using small pictures but Hybrid images is created by using different **spatial frequencies**. (Oliva, Torralba and Schyns 2006: 527).



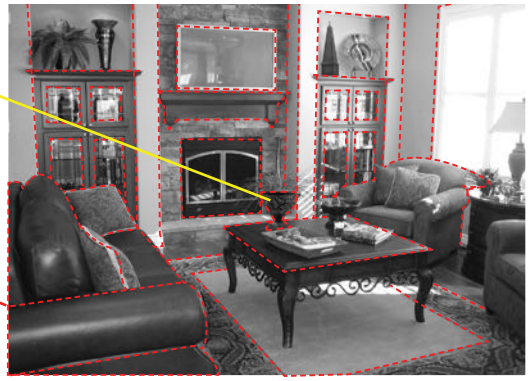
Picture mosaic

3.4.1 The working principles of Hybrid Images

Human being can hear sound frequencies which are between certain ranges. Like the sound frequencies any visual image has spatial frequencies and it can be mathematically analyzed as a composite of individual waves of singular spatial frequency, amplitude, and phase (Ginsburg and Hendee 1997: 60). By definition the two-dimensional sinusoidal composing visual signals are called spatial frequency and it is expressed by number of cycles per degree of visual angle.

In the human visual system, there are different types of cells located in the visual cortex which "respond to structures of different sizes (spatial frequency), contrast, and orientations" (Ginsburg and Hendee 1997: 60). Large size cells react to large size objects of low spatial frequency and provide visual information about the gross features of an object. However small size cells react to smaller size objects of higher spatial frequency and provide information on the fine details of an object (Ginsburg and Hendee 1997: 60). As P. Gins and R. Hendee mention that, during all stages of visual information processing, the visual system reduce the data collected. They define this filtering process as "the selective processing of certain types of visual information and the suppression of others" (Ginsburg and Hendee 1997: 60).

Vase with ornament



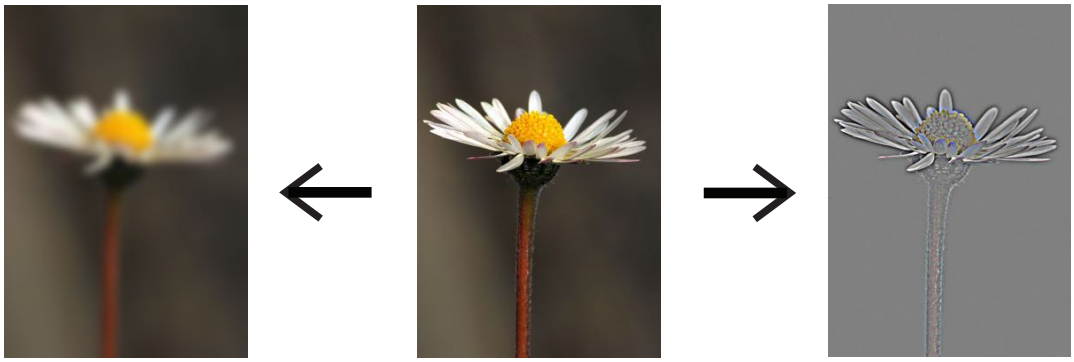
Gross features of an object

Example: Due to this information the visual information processing of an image will be as follow, if an observer look at a photography of 10 cm x 15 cm from reading distance (approximately 35 cm) small size cells will react and the photography will be seen clearly with all it's details, in other words it will be seen in high spatial frequency. If the same image will be seen from far distance (around 10 meters) the photography will be blurry and only blobs and edges of the photography will be visible, in this case the photography will be seen in low spatial frequency. According to this example from close distance an image will seen in high spatial frequency and from far distance the same image will be seen with a low spatial frequency. Hybrid images are created by using the same principle, with a simplified explanation hybrid images are created by combining two images which has two different spatial frequencies.

Low-pass image
(Low spatial frequency)

Original image
(within a restricted region of frequencies)

High-pass image
(High spatial frequency)



Spatial frequency channel: "It is a filtering mechanism […] a particular channel may transmit all the information that is bellow a particular spatial frequency (low-pass), above a particular frequency (high-pass), or within a restricted region of frequencies (band-pass)" (Oliva and Schyns 1997: 75).

Creation of Hybrid Images
by combining to images with different
spatial frequencies

For creating a hybrid image the low-spatial scales are obtained by filtering one image with a low-pass filter, these images are called **LSF images** (Low Spatial Frequency images). This filter reduces the precision of the image and as a result the image become blur. In contrast the high spatial scale is obtained by filtering a second image with a high-pass filter, these images are called **HSF images** (High Spatial Frequency images) contradictory with the low pass filter the high pass filter make appear only details. In the final step two images are superimposed, the HSF image is placed over the LSF image and in this way a hybrid image is created. Note that in the Hybrid image HSF image will only be visible from close distance in contrast the LSF will be seen from far distance.

Smiling face expression
(Original image A)

Filtering process

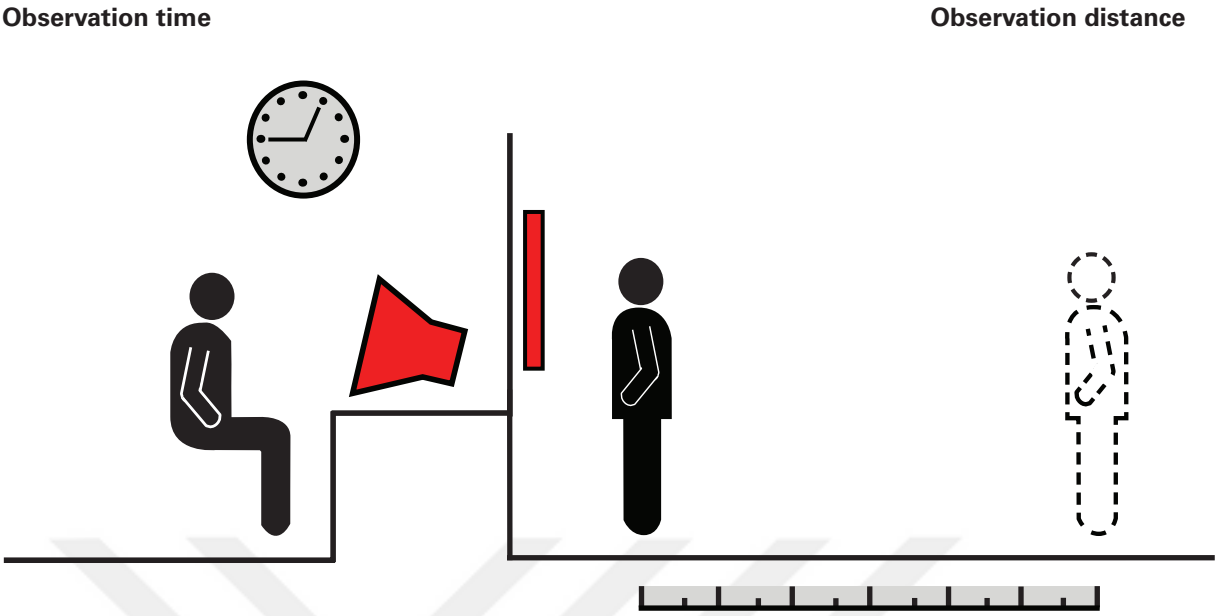
Filtering process

Neutral face expression
(Original image B)

High Spatial Frequency image
(Image filtered with a High Pass filter)

Low Spatial Frequency image
(Image filtered with a Low Pass filter)

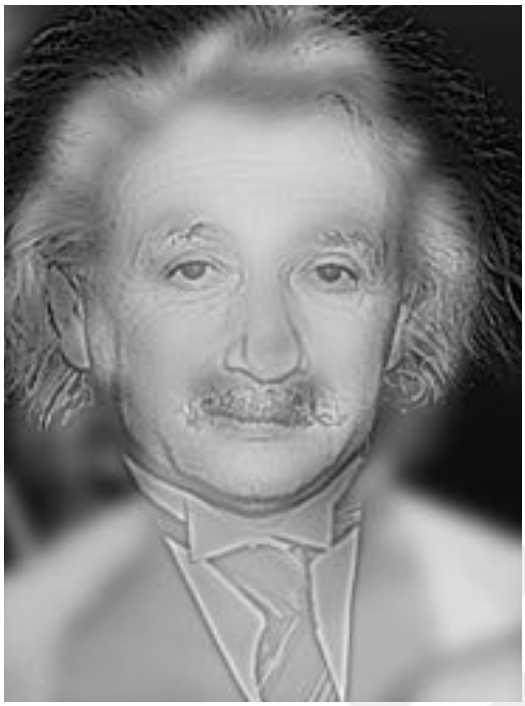
Hybrid image
The image has two different interpretation, from close distance the smiling face expression is visible, from far distance the neutral face expression is visible.



3.4.2 The perception of Hybrid Images

Human being can see and understand images that they see in very short durations. Visual psychophysics research has shown that human observers are able to comprehend the meaning of a novel image within a short glance (100 msec.) [Potter 1975] (Hybrid Image: 528) . For this reason we can understand the movies or music videos which use fast editing, where huge amount of image are screened very fast. Schyns and Oliva conducted a research on the role that spatial frequency bands play for the interpretation of natural images. Hybrid images were shown to people who participate the experience for 30 millisecond only, observers identified the low spatial frequency image. However when the same hybrid image was shown for 150 millisecond duration, they identified the high spatial frequency image. As a result researchers conclude as "the observer will perceive the global structure of the hybrid image first and take an additional hundred millisecond to organize the local information into a coherent percept" (Oliva, Torralba and Schyns 2006: 529).

According to the findings it can be concluded that hybrid image has two different interpretations where the switch between images is related with two different variables; the observing distance or the duration of the presentation time. However the presentation time such as 30 millisecond (identification time of the low spatial frequency image) or 150ms (identification of the high spatial frequency image) are very short durations, for this reason the presentation time can not be used as a tool for switching the interpretation from one to another if the hybrid image is used in visual media. In this way, it can be conclude that if the Hybrid Image will be used in a design, the only variable that can be used is the observing distance.



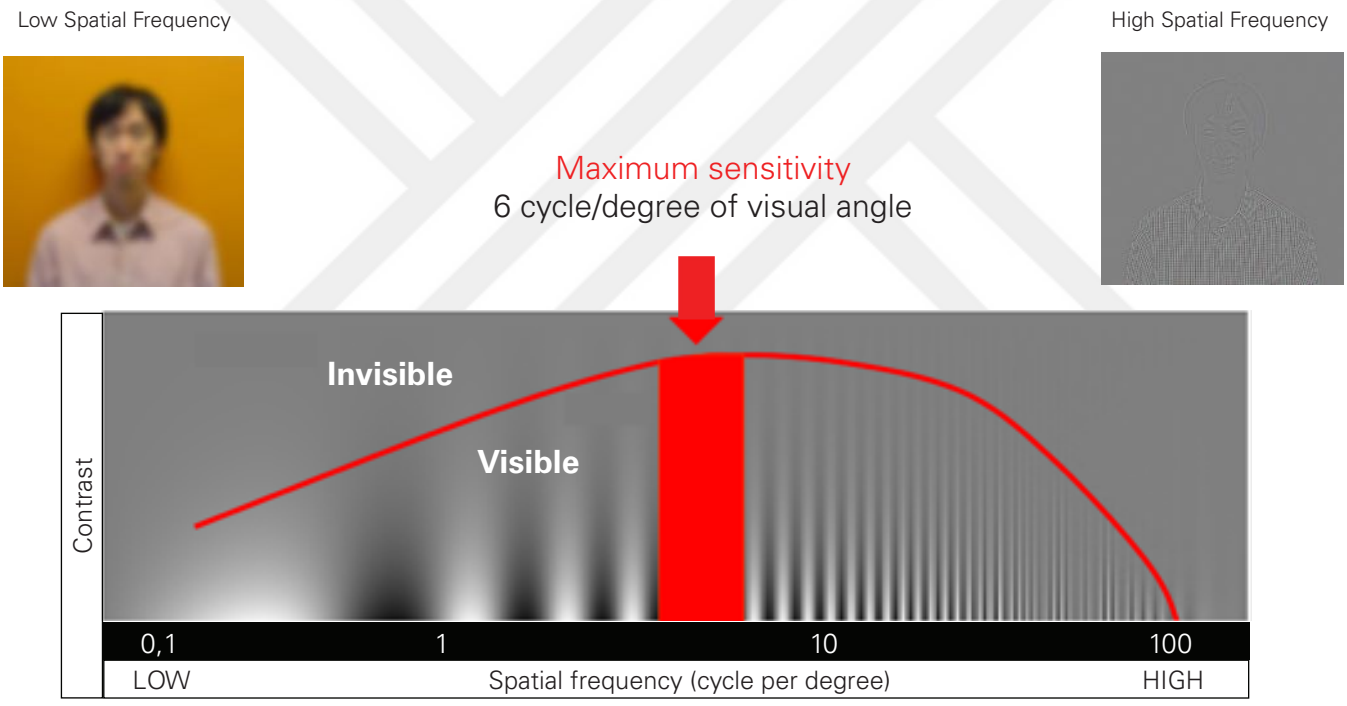
Hybrid Images created by Aude Oliva, MIT

Hybrid Images created by Aude Oliva and Antonio Toralba, MIT

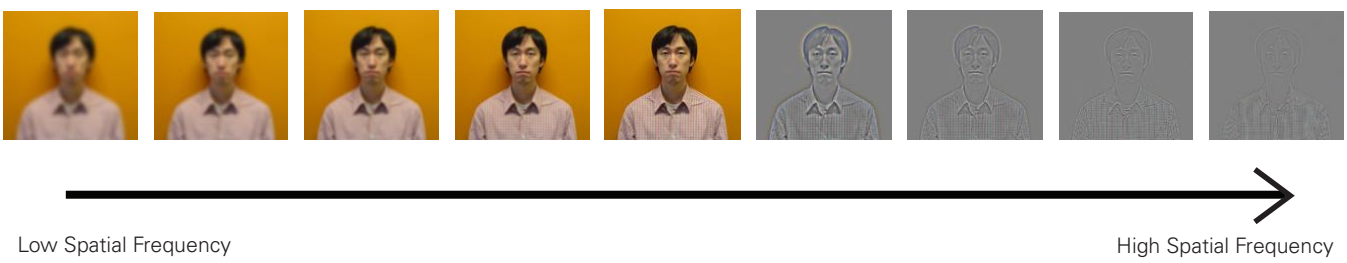
Hybrid Images created by Aude Oliva, MIT

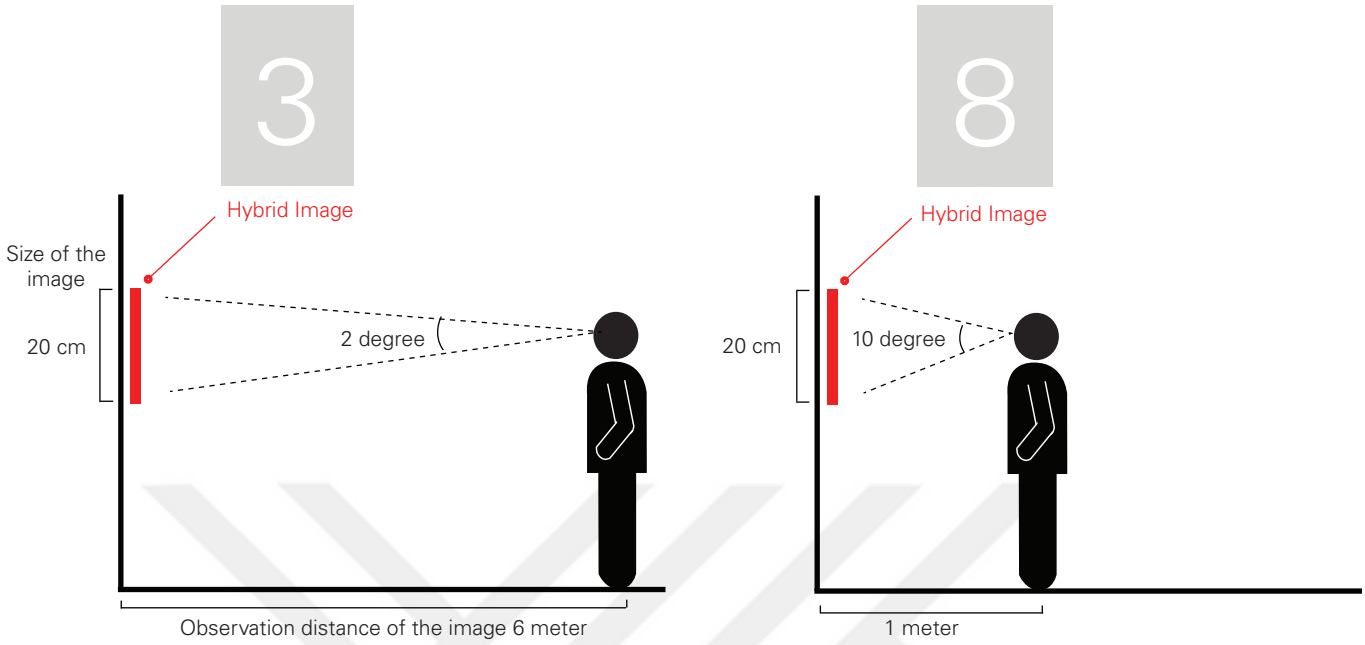
3.4.3 Observing distance of Hybrid Images

The image which is observed in a Hybrid Image switch according to the observation distance, but this distance is not the same for every images and it is related to the size of the image. According to the research of Blackmore & Campbell (1969) every image has a special frequency (Oliva, Torralba and Schyns 2006: 14). The spatial frequency in which the human being vision is the maximum sensitivity is around 6 cycle/degree of visual angle in other words human beings are able to see best with 6 c/deg. "under optimal conditions the highest spatial frequency passed by the optics of the eye is about 60 c/deg." (De Valois and De Valois 1990: 48) In this way when an image is filtered with a low pass filter, the spatial frequency of the image decreases (become blur) and when the image is filtered with a high pass filter the special frequency of the image increases (become sharp).



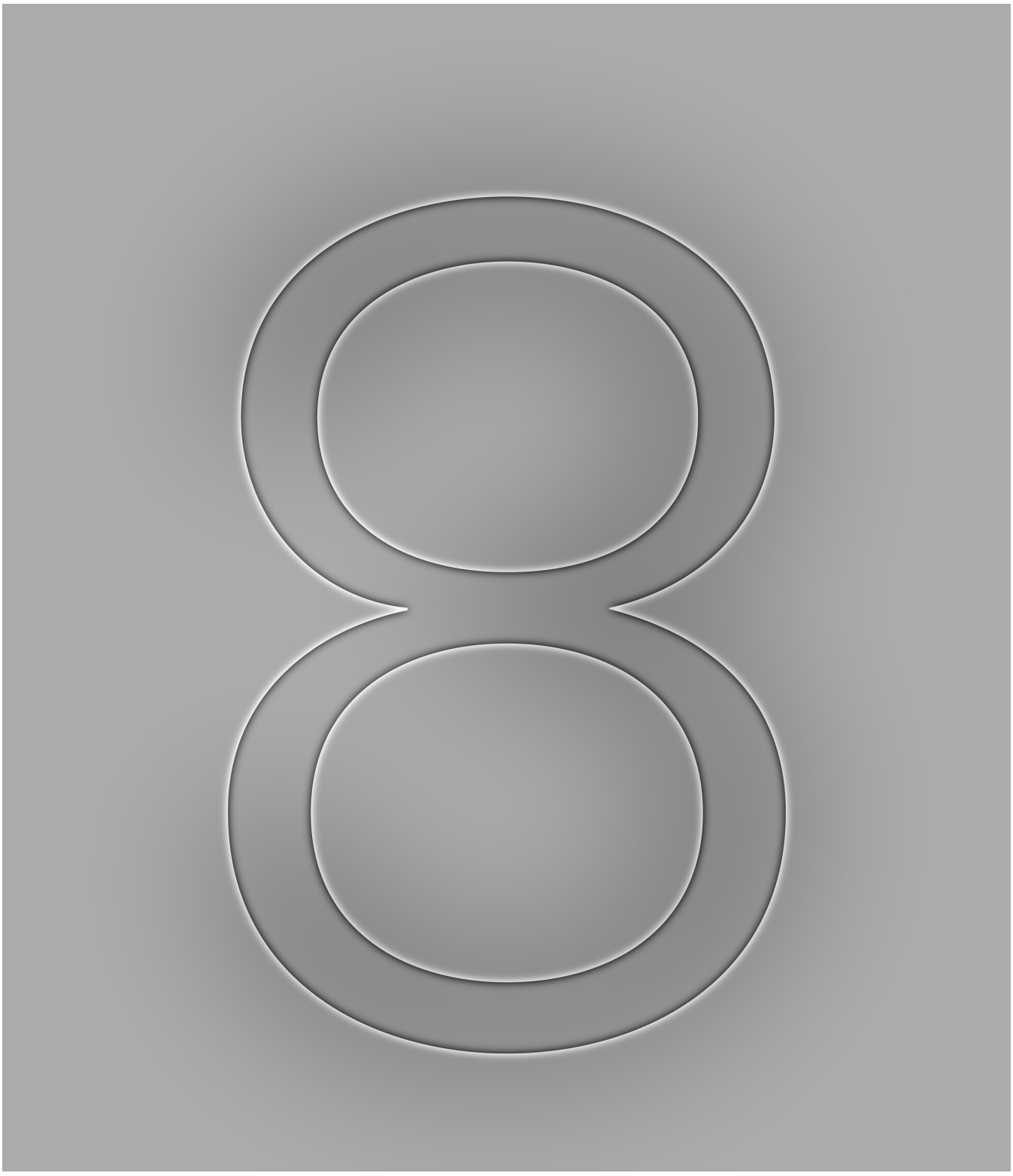
Oliva, Torralba Schyns siggraph 2006





As an example let's consider a person who reads his notes from his notebook and a person who observes a Hybrid Image printed in an A4 paper (In the Hybrid Image two different number is combined; the number "8" is filtered with a high pass filter and the number "3" is filtered with a low pass filter). The normal reading distance is considered to be about 35 cm, in this way when the person look at his note book from 35 cm he will read clearly his notes, the spatial frequency of the note will be around 6 c/d, with the same conditions the person who observe the Hybrid Images will see the number "3". However, if the person looks his note book from 10 cm, the spatial frequency will be increased and all the texture of the paper and the ink will be visible. In contrast if the not book will be observed from 4 meter, only some blurred line will be visible and it will impossible to read the text in this case the special frequency of the note book will be low, with the same conditions the observer of the hybrid images will only see the number "8". In conclusion the spatial frequency of an image is related to the size of the image and the distance that it is observed.

Finally it is important to mention that the reading distance of a Hybrid Image is calculated according to the equation of "6 c/deg. x degree of visual angle". The Hybrid Image observation is related to the degree of visual angle that the observer has while looking at the image. When the observer is close to the Hybrid Image the degree of visual angle will be higher (approximately 6 deg.) while the observer look at the same image from a distance the degree of visual angle will be narrow (approximately 2 deg.)



Hybrid Image

Please look to the image from far distance (approximately 5 meter) for observing the second interpretation.
The same image can also be seen on the thesis DVD.

3.4.4 Rules for creating successful Hybrid Images

Theoretically any two picture which were filtered as one with a low pass filter and the other with a high pass filter can be superimposed for creating a Hybrid Image however practically some rules has to be obeyed for creating successful hybrids. According to several suggestions of Schyns and Oliva (Oliva, Torralba and Schyns 2006: 529) the basic rules can be summarized as:

1. During the observation of Hybrid Images when one of the perceived layers is dominant the other one must appear as a **noise** and consciously switching to the alternative interpretation must be nearly impossible. The switch must be possible only by changing the viewing distance.

2. There must be an agreement between low and high special frequency images, boundaries and edges of different element have to match.

3. Observers prefer an arrangement having fewer elements than a surplus.

4. It is better to have a symmetry rather than asymmetry in the composition.

5. Symmetry and repetitiveness of a pattern in the low spatial frequencies are bad.

6. Color provides a very strong importance for grouping process of visual elements in this case one of the layers can be colored and the other none in this way a more successful illusion can be created.

In summary there are two fundamental mechanisms that can be used: "The first is maximizing the correlation between edges in the two scales so that they blend. The second resides in the fact that the remaining edges that do not correlate with other edges across scales can be perceived as noise (Oliva, Torralba and Schyns 2006: 529).

During their research at the University of Glasgow and in Massachusset Institude of Technology, researchers focus their research on Hybrid Images by combining two static images. More importantly they focus their research on face recognition and create diverse Hybrid Image of human or animal faces. According to their findings it can be concluded that Hybrid Images can be a powerful optical illusion. Until know the research conducted on Hybrid Images was psychologically based, and the main focus point was to understand the function of spatial frequency on human vision. Beside these, researchers that made experiment on Hybrid Images focus their experiment on static Hybrid Image. However Hybrid Images have a big potential for being used in different areas of visual communication such as; graphics design or interface design. Because of this reason, the creation of hybrid motion images such as Hybrid Motion Graphics or Hybrid Videos remained as an open issue.

Researchers, which deal with spatial frequencies, use image processing software such as Blue Nile, HIPS, MATLAB Image Processing Tool Box, Khoros or Visilog. The disadvantage of this software is; in some case they are developed by universities and they are not allowed to use by private users from outside or in some other cases they are designed for specific purposes and they are not "user friendly". The focus point of this thesis is to integrate optical illusion and design, that's why for further process the technique which is used should be practicable by the majority of designers. In this way the main aim of the following experiences is firstly to create Hybrid Images by using static pictures (photography) manipulated in the software **Adobe Photoshop** and secondly to create hybrid videos by superimposing two different digital video with different spatial frequencies. In this way the technique and rules for creating Hybrid Images will be used for creating hybrid videos. As the purpose is to find the rules for creating Hybrid Videos and to verify if the rules for static hybrid are also effectual for videos or not, it will be better to explain the experiment in detail.

Note that all the experiments made in this part can be found in the thesis DVD, especially for the Hybrid Videos and Hybrid Text it is important to the follow the text and the videos at the same time.

Subject 1

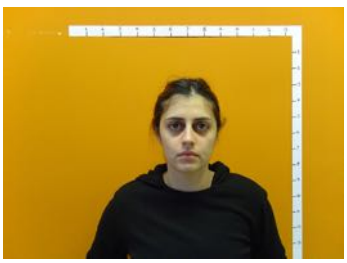
Subject 2

Subject 3

Subject 4

Subject 5

Subject 6



Subject 7

3.5.1 Experiment 1: Creation of Hybrid Images

The aim of this experiment is to create Hybrid Image with two static images. Firstly the portrait photography of different persons will be shot with a digital photo camera. In the second stage these photos will be filtered with HSF (High Spatial Frequency) and LSF (Low Spatial Frequency) filters and finally both pictures will be superimposed by using photo editing software Adobe Photoshop.

3.5.1.1 Methods

Subjects: For this experiment seven volunteer, from three different continents Asia, Africa and Europe and different gender (3 woman and 4 man) was used. The volunteers was In this way their faces, especially the eyes and shape of nose of the volunteers were quiet different than each other. To have the best results, each volunteer were photographed with different facial expressions (neutral, smiling and angry), and from tree different angle: full face, right and left side face.

Full face, neutral

Full face, smiling

Full face, angry

Left side, neutral face

Left side, smiling face

Left side, angry face

Right side, neutral face

Right side, smiling face

Right side, angry face

3.5.1.2 Shooting process

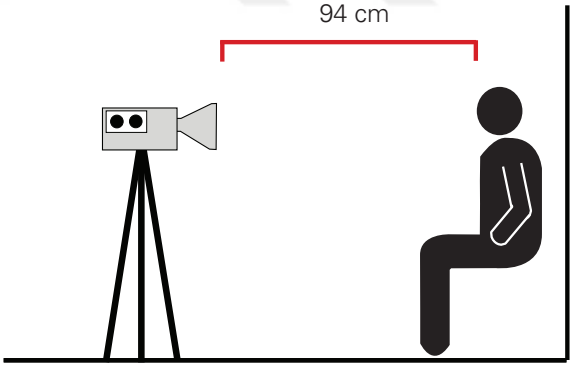
Camera: All the subjects were photographed with a digital camera with 3.2 Mega pixel resolutions.

Distance: Both subject portrait were shoot with the same distance to the camera. The distance between the camera and the subject was 92 cm and the distance between the camera and the background was 124 cm.

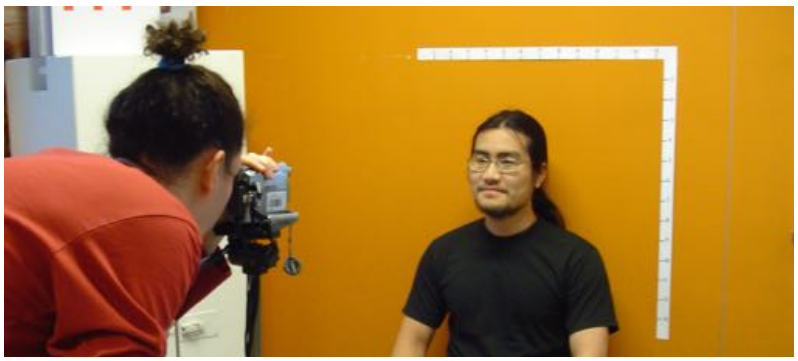
Proportion: The placement of the subjects on the screen was made with the help of a grid placed on the background. Every subject was placed in the same place according to the screen for facilitating the digital manipulation.

Background: For the background a unique color (orange) was used for avoiding any disturbance or confusion caused by a pattern on the background. The orange background color was used for a clear distinction of the subject.

Lighting: For all subjects a good lighting were used for avoiding any shadow or dark areas on the face, (key light is using from the top, and reflectors is used for illuminating shadows).



Shooting process



3.5.1.3 Digital computer manipulation

After the shooting process pictures were manipulated and superimposed with the digital image manipulation software Adobe Photoshop CS2 for creating Hybrid images. The picture of the first subject was filtered with a **HSF filter**. This process was made in the Adobe Photoshop CS2 by using the high pass filter. The second image was filtered with a **LSF filter**. This process was made in the Adobe Photoshop CS2 by using the Blur filter. Secondly the images were superimposed, LSF image on the back HSF on the front layer. And then, manipulations and some arrangements were done on the scale of the faces for superimposing the eyes, nose and mouth of both subjects in a better way. Finally transparency was applied to the HSF image.

Image before High Pass filter

Image before Low Pass filter

Hybrid Images 1
Please look to the image from far distance (approximately 5 m) for observing the second interpretation

Image before High Pass filter

Image before Low Pass filter

Hybrid Images 2
Please look to the image from far distance (approximately 5 m) for observing the second interpretation. The same image can also be seen on the thesis DVD.

This image is an example of a Hybrid Image which doesn't work properly. The hear of the subjects doesn't match properly for this reason the low spatial frequency image is also visible from close distance.

Image before High Pass filter

Image before Low Pass filter

Hybrid Images 3
Please look to the image from far distance (approximately 5 m) for observing the second interpretation. The same image can also be seen on the thesis DVD.

3.5.1.4 Results and discussion:

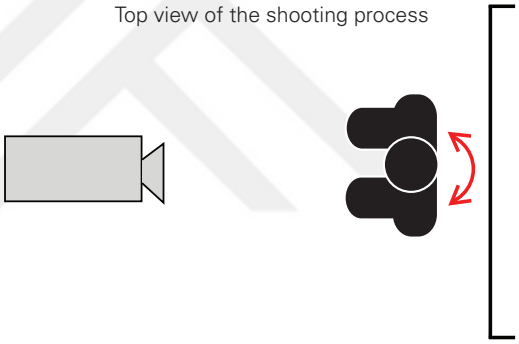
After the filtering process, Hybrid Images were created from two different static images. The images have two different interpretations. From close distance the observer see a woman with a neutral face, from far distance the observer see an angry woman. From the result obtained in the experiment 1 it can be conclude that the filtering process by using Adobe Photoshop was successful with static images, thus way it is proved that Hybrid Images can be created by a software that designer can easily use and there is no need to use special software in this stage. This result will lead; to the experiment 2 where the same experiment will be made with video (moving images) for creating Hybrid Videos.

3.5.2 Experiment 2: Creation of Hybrid Videos

The aim of this experiment is to create Hybrid Videos by manipulating the special frequency of two moving images (video). Firstly the face of subjects will be recorded with a digital video camera. In the second stage the videos will be filtered with HSF (High Spatial Frequency) and LSF (Low Spatial Frequency) filters, finally both videos will be superimposed by using video editing software. The basic aim of this experiment is to create Hybrid Videos (combined moving images) by using the same rules of creating Hybrid Images (combined static images). In this way Hybrid Image and Hybrid Videos can be compared, a list of rules for creating successful Hybrid Video can be developed and experienced if the same rules for creating Hybrid Images can be used for the creation of Hybrid Videos.

Note that all the experiments made in this part can be found in the thesis DVD, especially for the Hybrid Videos and Hybrid Text it is important to the follow the text and the videos at the same time.

Top view of the shooting process



Shooting process

3.5.2.1 Methods

Subjects: In this experiment the volunteers of experiment 1 were used again. Each volunteer was recorded to video and they were asked to rotate their head from left to right with different facial expression (neutral, smiling and angry).

3.5.2.2 Shooting process

For this experiment same shooting techniques as the Experiment 1 were used.

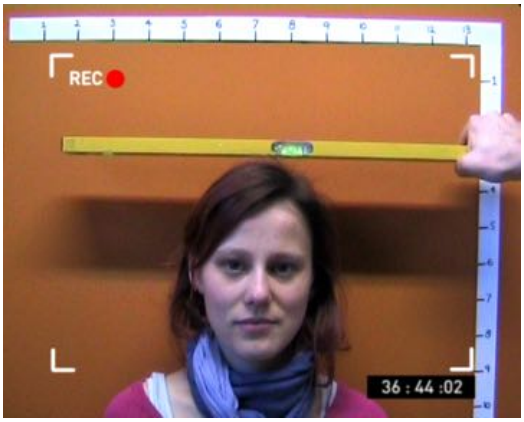
Camera: All the subjects were recorded with a digital video camera with 720 X 576 resolution (PAL).

Distance: All subjects portraits were shoot with the same distance to the video camera. The distance between the camera and the subject was 92 cm and the distance between the camera and the background was 124 cm.

Proportion: The placement of the subjects on the screen was made with the help of a grid placed on the background. Every subjects face was recorded by using a close up shot.

Background: For the background, a unique color (orange) was used for avoiding any disturbance or confusion caused by a pattern on the background. The orange background color was used for a clear distinction of the subject.

Lighting: For all subjects a good lighting were used for avoiding any shadow or dark areas on the face (key light is using from the top, and reflectors is used to illuminate shadows).



3.5.2.3 Digital computer manipulation

After the shooting process the videos were manipulated and superimposed with the digital video manipulation software by Adobe premiere, After Effects and Photoshop CS2 for creating Hybrid Videos. The video of the subject with the angry face was filtered with a HSF filter. Due to the lack of this filter in Adobe After Effects CS and Adobe Premiere 1,5, after capturing the videos into the computer, the videos were exported as "Frame set" and than modified by using the high pass filter in Photoshop CS2. Then, the second video (subject with neutral face) was filtered with a LSF filter. This process was made in the Adobe After Effects CS by using the Blur filter. Secondly images were superimposed; LSF image on the back HSF on the front layer. Some manipulation and arrangements were done on the scale of the faces for superimposing the eyes, nose and mouth in a better way. Finally transparency was applied to the HSF image.

Head rotation from right to left, neutral face

Head rotation from right to left, angry face

Hybrid Video

3.5.2.4 Results and discussion

After the filtering process of two different videos, Hybrid Video was successfully created. From close distance, the observer can see a woman with a neutral face, from far distance the observer see an angry woman. Compared to the result of the experiment 1, the creation of process of Hybrid Images from two different static images or two different videos are nearly similar. However compared to Hybrid Videos, Hybrid Images created from two static images were more successful. The reason of this difference is caused from superimposition of the videos. In Hybrid Images only two images were superimposed in a way that the counter of the eyes, nose and mouth were match. However in Hybrid Videos a constant superimposition of the counter of the eyes, nose and mouth were much more difficult. As the PAL video is composed of 25 fr/s each frame doesn't match perfectly with the superimposed one.

From the results obtained in the experience 2 it can be conclude that:

1. Hybrid Videos can be created by using the same procedure of Hybrid Images. However while creating Hybrid Videos a "match problem" occurs during the superimposition of the videos. This problem shows that the creation of Hybrid Video need more control during the shooting process.

2. Furthermore even if during the shooting process every measurement and details is taken into consideration two people can not repeat the same movement completely in the same way. As a result, this experience shows the importance of a perfect match of the frames while creating a hybrid from complex video images like face recognition.

3. A successful Hybrid Videos can be created with a combination of two different videos in which the motion of the element is under complete control. For this reason combining computer animation (2D or 3D) for creating Hybrid Videos can lead to more successful results.

Frame shot of the Hybrid Video
This image show that compared to static images the match between moving images are much more difficult with videos. The same image can also be seen on the thesis DVD.

3.5.3 Experiment 3: Creation of Hybrid Text

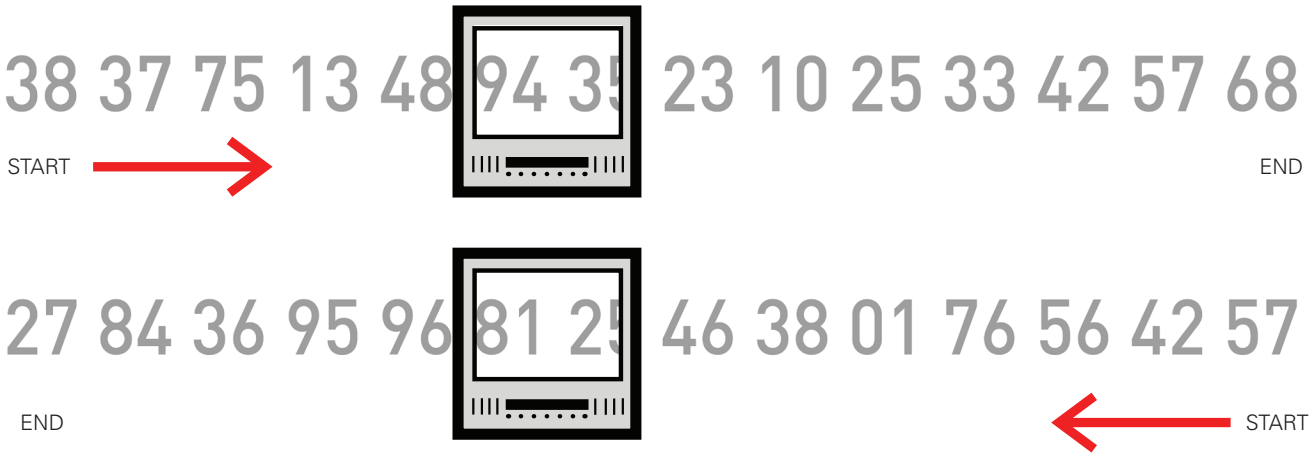
Another area where Hybrid Image technique can be used is text reading domain. Until this stage only static images and videos were combined, and an image which has two different interpretations was created. In this experiment, two different moving texts will be tried to combine for creating hybrid texts.

3.5.3.1 Methods

Text: Two different texts composed of binary numbers were written in two lines by using the DIN type font.

Size and proportion: The numbers in both texts were written with DIN font size 250 and placed in the center of a canvas of 720 x 576 (PAL TV screen) resolution.

Background: For the background a unique color (white) was used for avoiding any disturbance or confusion caused by a pattern on the background.



3.5.3.2 Digital computer manipulation

Each text was filtered with two different filters, one with a HSF filter the other one with a LSF filter (for further technical explanations see experiment 2 part…). In the second stage both texts were placed on the same line and transparency was applied to the HSF text which is located on the top. Finally the texts were moved into different directions and the results were compared.

Hybrid numbers

3.5.3.3 Observations

Exp. 3 A

Directions: LSF (Low Spatial Frequency video) Stable, HSF (High Spatial Frequency video) moving from right to left.

Observation: From close distance; the HSF filtered numbers are clearly seen without any disturbance. Nothing can be distinguished on the background of the numbers.

From far distance the LSF numbers "38" and "3" can be clearly distinguished, and the HSF frequency images which are moving over the static numbers are not distinguished.

Exp. 3 B

Directions: HSF moving from right to left, LSF moving left to right.

Observation: From close distance; the HSF filtered numbers are clearly seen, however on the background some blur shadows are moving from left to right.

From far distance; the LSF numbers can clearly be distinguished and the HSF frequency images which are moving over the static numbers are impossible to distinguish.

Exp. 3 C

Directions: HSF moving from right to left, LSF moving right to left.

Observation: From close distance; the HSF filtered numbers are clearly seen without any disturbance. Nothing can be distinguished on the background of the numbers.

From far distance; the LSF numbers can clearly be distinguished and the HSF frequency images which are moving over the HSF numbers are impossible to distinguish.

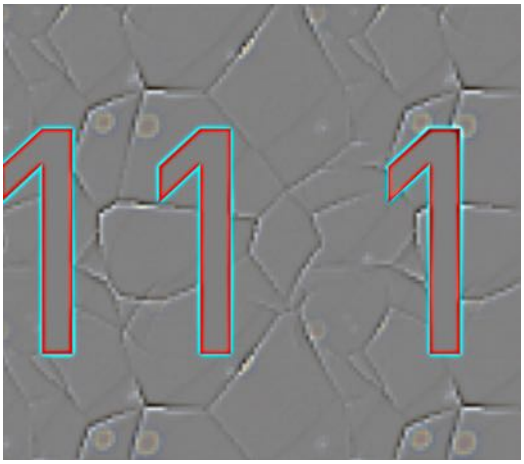
Exp. 3 D

Directions: HSF moving from right to left, a pattern is used on the background of HSF numbers and LSF is stable.

Observation: From close distance; The HSF numbers can be seen however distinguishing them from the HSF background is not easy.

From far distance; the LSF numbers can clearly be distinguished and the HSF frequency images which are moving over the HSF numbers are nearly impossible to distinguish. However the HSF background creates noise over the LSF numbers.

According to the results obtained, additional experiments were done, for combining text and number, image and texts and rotating 3 dimensional word. And compared to the previous experiments similar results were found.



Hybrid numbers with background

3.5.3.4 Result and Discussion

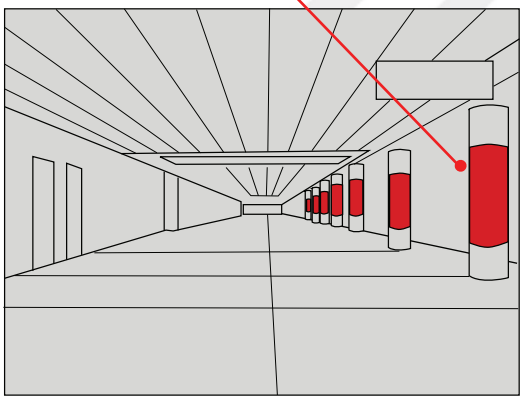
According to the results obtained in all experiments mentioned in the previous part, it can be concluded that Hybrid Videos can be created by changing the spatial frequency of videos with a filtering process. Hybrid Videos can be created by using nearly the same rules for creating successful Hybrid Images (See chapter 3.4.4 rules for creating successful Hybrid Images). Furthermore some of the rules such as the matching of the boundaries and edges of different elements in low and high special frequency images become much more important. In a Hybrid Video if boundaries and edges of both elements match in the first frame of the videos and than if this match is not constant till the end, then a chaotic video appear. As a result, two different interpretation become hard to distinguish.

In this chapter of the thesis the techniques of creating Hybrid Images and Videos were researched, in the next chapter design areas where Hybrid Images and Videos can be used will be researched.

Hybrid numbers with background

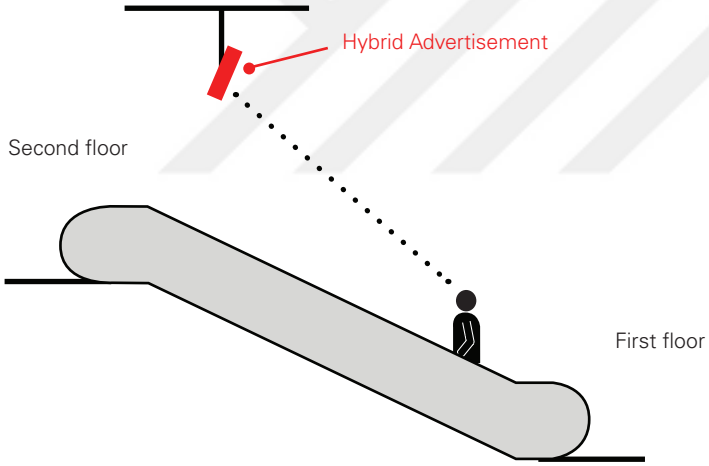
In the research made on image frequencies or during the development process of Hybrid Image at the psychology department of the University of Glascow, some special software was used. However during the experiments realized in the previous chapter, Hybrid Images and Hybrid videos were created by using "user friendly"software that designers can use (Adobe Photoshop or Adobe After effects). Furthermore the creation process was described in detail, on previous parts of the research. Hybrid Images and Hybrid Videos has two different interpretations and this special characteristics turn them into a powerful tool which can be used in various design areas. In this part of the research potential areas where Hybrid Images and Hybrid Videos can be used will be examined.

Hybrid Advertisement



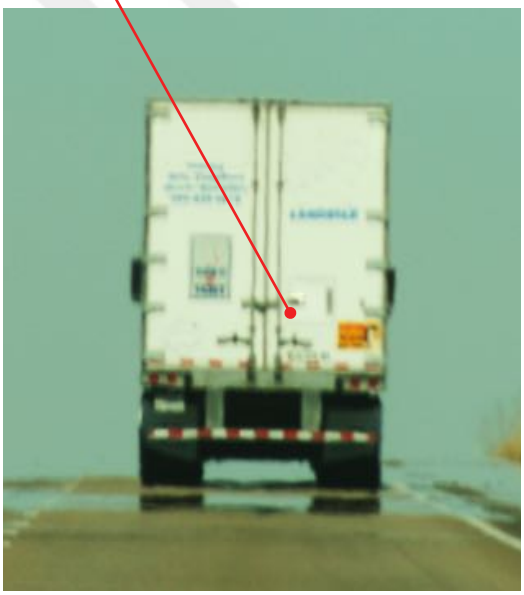
3.6.1 Advertisement

One of the areas that Hybrid Images can be used is the advertisement industry. Hybrid Images can be used in advertisement billboard. The layout and the design of the billboard advertisement can be created by using two different spatial frequencies. In this case the placement of the billboard will have a fundamental importance for the success of the technique. The billboard should be placed in an area where people can see the billboard from diverse distances. From far distance people will see the first interpretation, than while they are moving the observers will come closer to the advertisement and will see the second interpretation. As a result while they are moving, people have the chance to see the two different interpretations of the advertisement. This kind of billboards can be placed on the pedestrian way near the road, when cars are moving through the street the drivers can see two different interpretations easily both from far distance to close one. The billboards can also be used in public places such as train stations or airports. The crucial thing is that people should move trough the advertisements board, for this reason especially areas near the moving staircase or corridors can be used for this techniques.



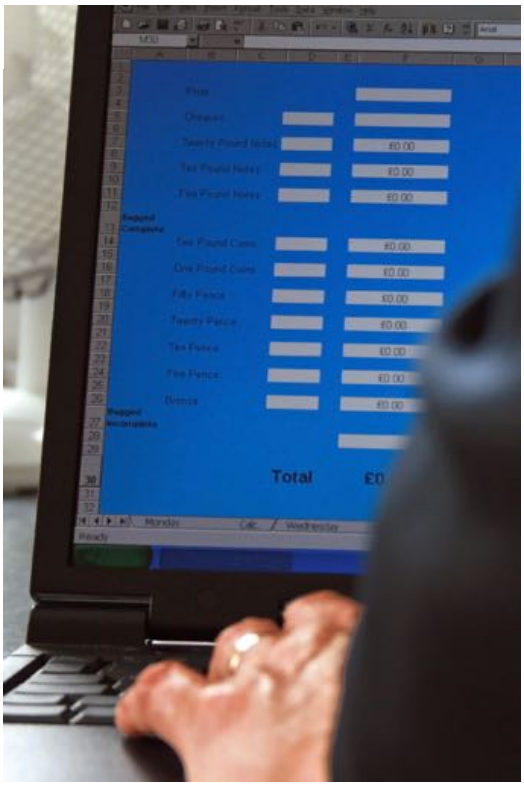
3.6.2 Safety distance

Hybrid Image can also be used as a helpful tool for the traffic. It can be used as a signage system for keeping the safety distance between cars and trucks in the traffic. The hybrid text will be placed on the back of a truck, if a car follow a truck from a close distance a warning message will be visible. For example a car follows a truck on highway. From distance the driver of the car will read the company name or the brand name of the truck, but if the car come too close to the truck the brand name located on the back side of the truck will switch to a message such as "please keep the distance". In this way the driver of the car will be alerted that the distance between the car and the truck is not safe enough.



3.6.3 Secure screen

Hybrid Images or videos can also be used for creating a safe screen for laptop or for ATM (automated teller machine) screens. For example for accessing their bank account from the internet the user need to type a password by using the keyboard located on the screen of their laptop. If the person is using the laptop in a public place, the code which is typed on the screen can be seen from people around. For this specific condition as described before, the screen of the laptop can become a hybrid screen. The numbers on the screen can be in high spatial frequency and with this way while typing the password people in the surrounding cannot see the numbers. The same principle can be used for ATM screens, by using a screen interface made with high spatial frequency; password or important informations can not be seen by people waiting on the line.



3.6.4 Information board

Another area where Hybrid Images or Vidoes can be used is the information board in the transition points such as airports, train stations, metro stations or bus stops. Usually metro maps cannot be read from distance, and people have to come closer for reading them. For this reason, it can be said that from far distances the spaces that are used for metro maps are unused spaces. However if the metro map is combined with a digital watch, from distance the board can show the time, and if people want to see the map, they can come close to the board and the map will be visible. From a technical point of view the watch will be shown with a low spatial frequency and the map will be shown with a high spatial frequency.

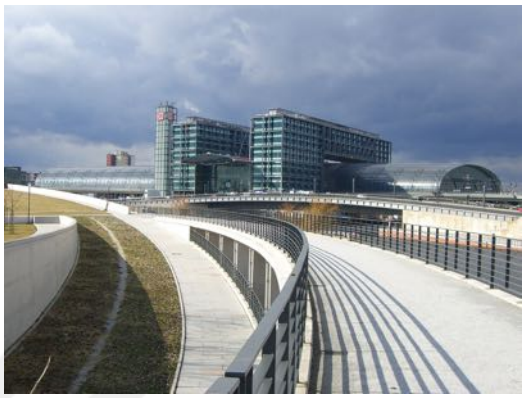
Information board

Hybrid Advertisement

Digital information board

The advantage of this design is that two different information can be used in one place at the same time and as a result there can be less signage boards and this can reduce the crowdedness and confusion. From distance it can be considered that the metro map is an unused space, with this technique this space can gain a meaning and a function.

The same style of design can be made for home use, a digital watch and a calendar can be combined. From distance the watch will be visible, from closer distance the calendar will be visible.



Main train station

Digital information board

Train platform

Signage system

IV. Conclusion

Results of the Research

In the previous parts optical illusions were analyzed deeply, some experiments were conducted, and ways of using optical illusion as a design tool were researched. In this final the answers of the problem expressed.

Optical Illusion was always a source of attraction for human being because they create a misinterpretation of the reality. That's why they are tricky and mysterious for many people. During the history Optical Illusion was mainly used in art and architecture, beginning with the last century it becomes an important source of research in psychology for understanding the human visual system. Generally it was used by artists, architects or scientists but never used by designers for solving problems. The focal point of this thesis was to prove that optical illusion is not only a source of entertainment or amusement, but it can also be used as a design tool for solving problems.

During the thesis, history of optical illusions and the areas that they were used was researched, beside this the main characteristics and causes of the phenomenon was analyzed. Furthermore as optical illusion is related to the vision, the human visual system and perception system was one of the research points of the thesis. According to findings, the thesis focused on a specific type of illusion, the *Hybrid Images.* This type of illusion deals with spatial frequencies, and different interpretations become possible by using divers spatial frequencies in one image. After the analysis of the working process of image frequencies, experiments were conducted on modification of image frequencies for creating static images (Hybrid Images) and moving images (Hybrid Videos) which has two different interpretations. In the last chapter potential areas where Hybrid Images and Hybrid Videos can be used was researched.

According to the results obtained in the

research and experiments it can be concluded that optical illusions, more specifically *Hybrid Images* can be used as a design tool. With the data collected from researches it is proved that; optical illusion is not only a tool or a phenomenon that can be used in art or in architecture but it can also be used in design for solving problems. Hybrid images and videos can be used to create "safe screen" for ATM's and cars on the traffic. At the same time they can be used for information boards or advertisements billboards. Its obvious that all the potential areas that this illusion can be used is not mentioned in the thesis but on the other hand experiments and results gave the chance to designers to understand the system of Hybrid Images. With the help of this knowledge, it is in the hand of designers to use these techniques for their individual projects in diverse fields.

Until now the main research on Hybrid Static Images and spatial frequencies was conducted in field of science and especially in psychology. In this thesis the research process was improved by looking to the topic from a design point of view. However still diverse point should be analyzed for conducting the research in further process. In this way the topic such as increasing the image quality in Hybrid Images and Hybrid Videos or the way of using color in a more efficient way remained as an open issue.

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Master Thesis 2008

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