World Journal of Research and Review (WJRR)
ISSN:2455-3956, Volume-1, Issue-2, December 2015 Pages 09-12

Optical Camouflage - Review

Shrishti Sharma,Meetu Singh

Abstract— **Fiber optic systems are important telecommunication infrastructure for world-wide broadband networks. Wide band width signal transmission with low delay is a key requirement in present day applications. Optical fibers provide enormous and unsurpassed transmission bandwidth with negligible latency, and are now the transmission medium of choice for long distance and high data rate transmission in telecommunication networks. This paper focused on the creation of invisibility with the help of technologies like Optical camouflage; Image based rendering and Retro reflective projection. The object that needs to be made transparent or invisible is painted or covered with retro reflective material. There are some beneficial applications for this simple but astonishing technology. The different methods of optical camouflage provide invisibility in the visible site of spectrum. One of the most promising applications of this technology, however, has less to do with making objects invisible and more about making them visible.**

Index Terms— **Optical Camouflage Technology, Retro-Reflective material, Head Mounted Projector (HMP), Phased array optics, active camouflage.**

I. INTRODUCTION

Various methods have been proposed to integrate the visual space. In the field of Mixed Reality, one of the most popular topics is about displaying a virtual object into real world. Camouflage is a form of deception. The word camouflage comes from the French word 'camoufler' meaning 'to disguise'. Optical camouflage is a hypothetical type of active camouflage. The idea is relatively straightforward: to create the illusion of invisibility by covering an object with something that projects the scene directly behind that object.

Types Of Camouflage

Camouflage is basically a method which makes a otherwise visible organism or object to remain indifferent from the surrounding environment.

Natural Camouflage

In nature, it can be seen very often that animals blend into the surrounding environment to hide from predators and survive. It is the best method which these creatures have adopted by inheritance.[1]

Military Camouflage

This can be seen in military warfare when men, helicopters have been digitally printed with broad patterns so as to misguide the enemy, intend to daunt enemy.

Shrishti Sharma, Department of Electronics and Communication, Rajasthan Technical University ,Rajasthan College of Engineering for Women, Jaipur , India
Meetu Singh, Department of Electronics and Communication, Rajasthan Technical University ,Rajasthan College of Engineering for Women, Jaipur , India

Active camouflage or adaptive camouflage is a group of camouflage technologies which allow an object to blend into its surroundings by use of panels or coatings capable of altering their appearance, color, luminance and reflective properties. With the addition of a camera, an object may not be made completely invisible, but may in theory mimic enough of its surrounding background to avoid detection by the human eye as well as optical sensors. As motion may still be noticeable, an object might not be rendered undetectable under this circumstance but potentially more difficult to hit. Optical camouflage is a kind of active camouflage. This idea is very simple. If you project background image onto the masked object, you can observe the masked object just as if it were virtually transparent. The cloak that enables optical camouflage to work is made from a special material known as retro-reflective material. To create invisibility or transparent illusion we need a video camera, computer, projector and a combiner.

Fig 1 :- Optical Camouflage

II. OPERATION

Creating complete optical camouflage across the visible light spectrum would require a coating or suit covered in tiny cameras and projectors, programmed to gather visual data from a multitude of different angles and project the gathered images outwards in an equally large number of different directions to give the illusion of invisibility from all angles. For a surface subject to bending like a flexible suit, a massive amount of computing power and embedded sensors would be necessary to continuously project the correct images in all directions.

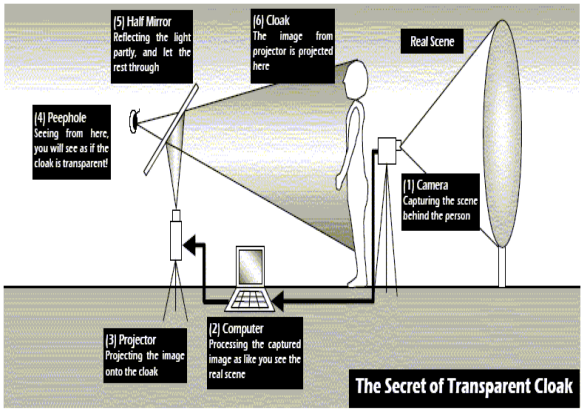

Fig 2:- Camouflage Operation

First, putting the video camera behind the person in the cloak, and capturing his background. Then, projecting the captured image onto the cloak from the projector. So, if we see from the peephole, we will see as if the cloak is transparent. Because the image is projected by the technology called Retro-reflective Projection Technology (RPT), we can see the reflection only on the cloak and clearly even in brightness.

III. TECHNOLOGY FOCUS

Optical camouflage uses technology RPT/Xtal vision which uses optical projection, while using STHMD (See through head mounted display) to blend virtual and real environments [5]. The operator will observe image of the object which is actually located behind the object .This contradicts the intuition of depth , since the projected image of the object located behind another object in one's field will be obstructed. This is called occlusion, to solve this problem we use RPT technology these are-

1.Use a object which is covered by retro reflective material.
2.Projector should be placed optically conjugated with observer's eye by using half mirror.
3.Projector's iris should be made as small as possible (pin hole). This leads to the following:

The image of virtual object is projected through pin hole, image is reflected by half mirror at a right angle and retro reflected by the screen.

The three key techniques of RPT are the followings:

- To use an object covered by retro-reflective material as a screen;
- To place a projector into a position optically conjugated with the observer's eye by using a half-mirror;
- To make the projector's iris as small as possible (by using a pinhole).

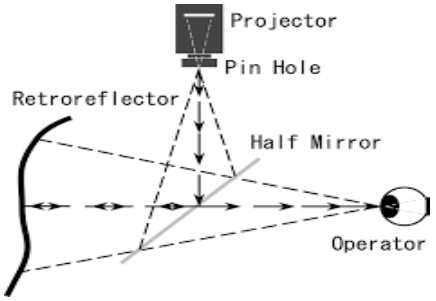

Fig 3:- RPT Principle

IV. COMPONENTS OF OPTICAL CAMOUFLAGE

A. *Retro-Reflective Material*

The cloak that enables optical camouflage to work is made from a special material known as retro-reflective material. A retro-reflective material is covered with thousands and thousands of small beads. When light strikes one of these beads, the light rays bounce back exactly in the same direction from which they came. A rough surface creates a diffused reflection because the incident (incoming) light rays get scattered in many different directions. A perfectly smooth surface, like that of a mirror, creates what is known as a specular reflection -- a reflection in which incident light rays and reflected light rays form the exact same angle with the mirror surface. In retro reflection, the glass beads act like prisms, bending the light rays by a process known as refraction. This causes the reflected light rays to travel back along the same path as the incident light rays. The result: An observer situated at the light source receives more of the reflected light and therefore sees a brighter reflection.[5]

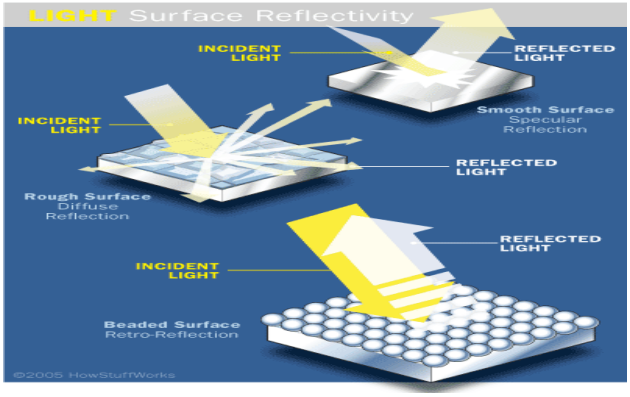

Fig 4 :-Retro-reflective material

B. *Video Camera*

The retro-reflective garment doesn't actually make a person invisible -- in fact, it's perfectly opaque. Garment creates an illusion of invisibility by acting like a movie screen onto which an image from the background is projected. Capturing the background image requires a video camera, which sits behind the person wearing the cloak.

C. *The Projector*

The modified image produced by the computer must be shown onto the garment, which acts like a movie screen. This is done by shining a light beam through an opening which must be the size of a pinhole. This ensures a larger depth of field so that the screen can be located any distance from the projector.

D. *The Combiner*

The system requires a special mirror to both reflect the projected image toward the cloak and to let light rays bouncing off the cloak return to the user's eye. This special mirror is called a beam splitter, or a combiner -- a half-silvered mirror that both reflects light (the silvered half) and transmits light (the transparent half). If properly positioned in front of the user's eye, the combiner allows the

user to perceive both the image enhanced by the computer and light from the surrounding world. The user has to look through a peephole in this mirror to see the augmented reality.[2]

E. Phased Array Optics

A phased-array optics system is essentially a group of arrays which can steer a light beam's direction and they can manipulate its phase of light. Creating complete optical camouflage across the visible light spectrum would require a coating or suit covered in tiny cameras and projectors, programmed to gather visual data from a multitude of different angles and project the gathered images outwards in an equally large number of different directions to give the illusion of invisibility from all angles. For a surface subject to bending like a flexible suit, a massive amount of computing power and embedded sensors would be necessary to continuously project the correct images in all directions.[6]

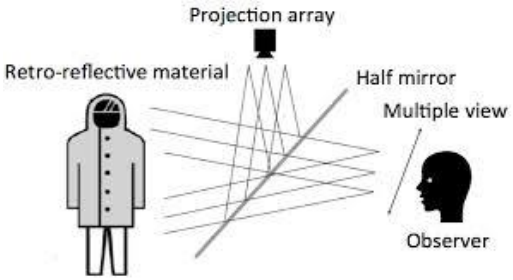

Fig 5:-Phased Array Optics

F. Head-Mounted Displays

Making the observer stand behind a stationary combiner is not very pragmatic -- no augmented reality system would be of much practical use if the user had to stand in a fixed location. That's why most systems require that the user carry the computer on his or her person, either in a backpack or clipped on the Hip. It's also why most systems take advantage of head-mounted displays, or HMDs, which assemble the combiner and optics in a wearable device.[3]

There are two types of HMDs :
1. Optical see-through displays
2. Video see-through displays

1. Optical see through displays, it look like high-tech goggles, sort of like the goggles Cyclops wears in the X-Men comic books and movies. These goggles provide a display and optics for each eye, so the user sees the augmented reality in stereo.[3,4]

2. Video see-through displays, it uses video mixing technology to combine the image from a head-worn camera with computer-generated graphics. In this arrangement, video of the real world is mixed with synthesized graphics and then presented on a liquid crystal display. The great advantage of video see-through displays is that virtual objects can fully obscure real-world objects and vice versa.[3,4]

G. *HAPTIC DISPLAY*

Haptic display (real object) hiding the virtual object but by using optical camouflage technique we can make object transparent whereas the operator's hand is not made transparent hence it suggests that this technique can be selectively used.

Fig 6:-Haptic Display

V. THE COMPLETE SYSTEM

The following figure shows the typical arrangement of all of the various devices and pieces of equipment.

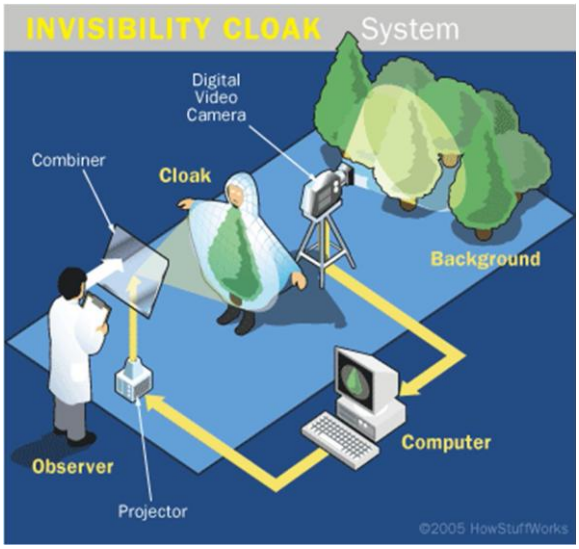

Fig 7:- Invisibility Cloak System

Once a person puts on the cloak made with the retro reflective material, the sequence of events would be:

1. A digital video camera captures the scene behind the person wearing the cloak.
2. The computer processes the captured image and makes the calculations necessary to adjust the still image or video so it will look realistic when it is projected.
3. The projector receives the enhanced image from the computer and shines the image through a pinhole-sized opening onto the combiner.
4. The silvered half of the mirror, which is completely reflective, bounces the projected image toward the person wearing the cloak.
5. The cloak acts like a movie screen, reflecting light directly back to the source, which in this case is the mirror.
6. Light rays bouncing off of the cloak pass through the transparent part of the mirror and fall on the user's eyes. The light rays bouncing off of the cloak contain the image of the scene that exists behind the person wearing the cloak. The person wearing the cloak appears invisible because the background scene is being displayed onto the retro-reflective material. At the same time, light rays from the rest of the world are allowed reach the user's eye, making it seems as if

an invisible person exists in an otherwise normal-looking world.

VI. REAL WORLD APPLICATION

Used in Stealth technology, to make airplane invisible to Radar.[7] Used in medical, automation ,aviation etc.
Utilization of this technology also has three important secondary energy saving by products:

(a) As a security instrument it can protect national strategic resources from theft and sabotage by concealing both the resource and a much reduced security force from view by either presenting the natural background on the screen or by presenting an artificial image of the resource on the screen.

(b) Its variable reflective capability could assist in heating or cooling the facility, thus realizing considerable energy savings; and

(c) Environmental enhancement of industrial facilities using Chameleo screens in lieu of artificial buildings/landscaping and enhancement of working spaces allowing artificial scenes on the wall and/or outside views without the need for windows.

VII. FUTURE SCOPE

The weak point of this technique is that the observer needs to look through a half-mirror. The current system needs a half-mirror and projectors, which were fixed on the ground. Research is currently going on to enable a person to observe the background image from various viewpoints with H.M.P. (Head-Mounted Projector)

VIII. CONCLUSION

This amazing technology creates objects or human beings invisible or transparent. One of the most promising applications of this technology, however, has less to do with making objects invisible and more about making them visible. The concept is called Mutual Telexistence, working and perceiving with the feeling that you are in several places at once**.** Pervasive gaming is another application where players with mobile displays move through the world while sensors capture information about their environment, including their location. This information is used to deliver users a gaming experience that changes according to where they are and what they are doing.

Creating a truly realistic optical illusion would likely require Phase Array Optics, which would project light of a specific amplitude and phase and therefore provide even greater levels of invisibility. The weak point of this technique is that the observer needs to look through a half-mirror. The current system needs a half-mirror and projectors, which were fixed on the ground. We may end up finding optical camouflage to be most useful in the environment of space, where any given background is generally less complex than earthly backdrops and therefore easier to record, process, and project. We have developed an Optical Camouflage system. Optical Camouflage can be used on surgical globes or equipments so they don't block surgeon's view during delicate operations. In aviation, cockpit floors could become 'invisible' to assist pilots during landing. The weak point of this technique is that the observer needs to look through a half-mirror. The current system needs a half-mirror and projectors, which were fixed on the ground. In the next step of our research, an observer would be able to observe the background image from various viewpoint with H.M.P. (Head-Mounted Projector).

REFERENCES

.
[1]."Project Chameleo-Cloaking Using Electro-Optical Camouflage,"by Richard N. Schowengerdt and Felix Schweizar, Association of Old Crows Fiestacrow Symposium, San Antinio. April 1993.
[2] R. Azuma and J. Rolland, A Survey of Augmented Reality, Presence: Tele operators and Virtual Environments, Vol.6, No.4, pp.355 – 385, 1997.
[3] M. Inami, N. Kawakami, D. Sekiguchi, Y.Yanagida, T. Maeda and S. Tachi, "Visuo-Haptic Display Using Head-Mounted Projector", Proceedings of IEEE Virtual
Reality 2000, pp.233-240, 2000
[4]. Display Using Head-Mounted Projector, Proceedings of IEEE Virtual Reality 2000, pp.233-240, 2000.
[5]S. Tachi, Telexistence and Retro-reflective Projection Technology (RPT), Proceedings of the 5th Virtual Reality

Vandana Sharma M.tech Scholar in Rajasthan College of Engineering for Women.
Shrishti Sharma M.tech Scholar in Rajasthan College of Engineering for Women.
Meetu Singh M.tech Scholar in Rajasthan College of Engineering for Women.