Optical Camouflage

Have you seen the movies Predator, Ghost in the Shell, or almost any sci-fi series? Then you know what is cloaking. It is the bending of light around an object, or displaying the image behind an object on the other side, so as to give the illusion of there being nothing in the way. It's kind of being invisible so that a person standing in front of you can see the scene behind you, relating to a chameleon that changes its color according to the surrounding, so that it becomes invisible and can protect itself from predator. This process of invisibility basically relates to an upcoming technology called "Optical Camouflage". The author describes more about this technology.

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Optical camouflage is a hypothetical type of active camouflage currently only in a very primitive stage of development. Although optical is a term that technically refers to all forms of light, most proposed forms of optical camouflage would only provide invisibility in the visible portion of the spectrum. Here, one wears a fabric which has an image of the scene directly behind the wearer projected
onto it, so that the wearer appears invisible. With the advent of flexible electronics such as a flexible liquid crystal display, that would allow the background image to be displayed on the material itself, it is believed that this form of optical camouflage would closely resemble its fictional counterparts.
As science has both pros and cons, this developing technology apart from its advantages can also cause chaos in human life.

What is Optical Camouflage?

Optical camouflage is a kind of active camouflage in which one wears a fabric which has an image of the scene directly behind the wearer projected onto it, so that the wearer appears invisible. The concept exists for now only in theory and in proof-of-concept prototypes, although many experts consider it technically feasible. But however several

Fig.1. An example of optical camouflage

hands on experiments have been performed.
There are proofs and photographs based on optical camouflage. This is the primary definition of optical camouflage but the process carried out and the devices used will in detail be explained in the article.

What is Active Camouflage?

Before knowing the in-depth study of optical camouflage, here is given a brief explanation of the main branch active camouflage, of which the optical camouflage is a part of Active camouflage (or Adaptive camouflage) is a group of camouflage technologies which would allow an object (usually military in nature) to blend into its surroundings by use of panels or coatings capable of changing

color or luminosity. Active camouflage can be seen as having the potential to become the perfection of the art of camouflaging things from visual detection. Theoretically, active camouflage should differ from more conventional means of concealment in two important ways. First but less importantly it should replace the appearance of what is being masked with an appearance that is not simply similar to the surroundings (like in conventional camouflage) but with an exact representation of what is behind the masked object. Second and more importantly, active camouflage should also do so in real time. Ideally active camouflage would not only mimic nearby objects but also distant ones, potentially as far as the horizon, creating perfect visual concealment.

Fig. 2.

In principle, the effect should be similar to looking through a pane of glass making that which is hidden perfectly invisible.

Illustrating the concept, i.e. active capture and re-display, creates an "illusory transparency", also known as "computer mediated reality".

This technology is poised to develop at a rapid pace, with the development of organic light-emitting diodes (OLEDs) and other technologies which allow for images to be projected from oddly-shaped surfaces. With the addition of a camera, while not allowing an object to be made completely invisible, theoretically the object might project enough of the background to fool the ability of the human eye or other optical sensors to detect a specific location. As motion would still be noticeable, an object would merely be more difficult to hit, and not undetectable under this circumstance. This has been demonstrated with videos of "wearable" displays where the camera could see "through" the wearer.

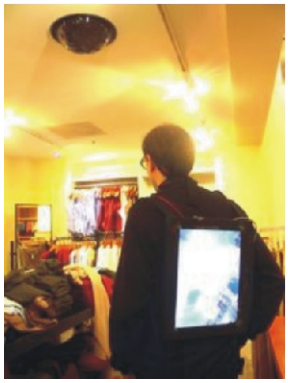

Fig . 3.

Wearable version of the illusory transparency, made from a tiling of wearable flat panel displays, wearable cameras, and computer vision system running on a wearable computer. This is a fully functioning prototype, but has limitations due to number of sensors and transducers. This is shown in fig.3.

Active camouflage is not a human invention. Many animals can change their color, among them the chameleon, but the ability is used primarily to communicate.

Demonstration of Optical Camouflage

The picture shown in fig.2 where one can see sky, there is a technique behind it. That scene it is basically a screen through which it is seen. But there is development of a transparent cloak (a sort of clothing) worn by a person that would make the subject invisible.

Fig. 4.

This transparent cloak makes you see as if the cloak is transparent.

By projecting the shooting image behind the person onto the cloak So, actually, the cloak is not really transparent. (fig.4)

How does it work?

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 (fig.5). Because the image is projected by the technology called Retro-reflective Projection Technology (RPT), you can see the reflection only on the cloak and clearly even in brightness.

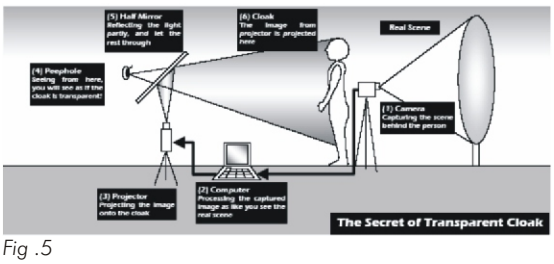

Fig .5

Cloak's secret!

The special material is used as screen for RPT. That's different from the screen in the cinemas. This material is called 'Retro-reflective Material', and also used for the cloak.

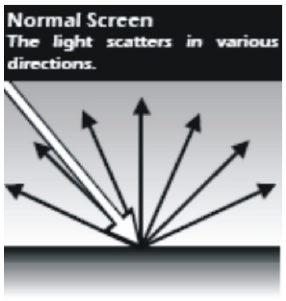

Fig . 6.

The surface of Retro-reflective Material is covered with very small beads. If the light strikes the material, the light reflects only in the same direction as it has come. So, the image is reflected clearly even in brightness.

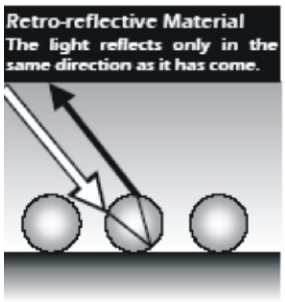

Fig . 7.

Infect you can find a lot of things around you using the retro-reflective material. Traffic signs, bicycle's reflector and the lighting part of the raincoat are made from Retro reflective Material. As, like the transparent cloak, it can be seen from far away because they shine brightly by little light of the cars.

The above shown (fig.6) is in case when we have a normal surface. But the retro-reflective surface is surface where-in the light is reflected back in the same direction as shown in fig .7.

Using it for what?

For example, if this technique is used in cockpit for making the floor transparent at landing, the pilot can land safely with seeing runway. Also, use for other vehicles like car. If you can see through the back of car, you will put the car into the garage successfully. This technique was invented from the study that skilfully mixing the real world and the world made artificially, and trying to let your life and work convenient. The above picture shows how a driver parks the car safely into garage.(fig 8)

Fig . 8.

How a person becomes transparent?

Light gets through things all the time. Visible light is not all the light there is. X-Rays for instance can travel through walls and clothing that is not transparent. They are light waves. Everything is mostly empty space (i.e. the space between the atoms, molecules, etc.).

Solidity is only a relative factor of one density to another. To make this work without any distortions, you must make sure that every photon that hits your suite is transported and then send out again, continues in the same direction. The path of the photon must for the observer be the same as the path it would go normally. Otherwise you get problems with the parallax. These problems mean that when you move head when you look for example at a desk with such a suit before it, the part of the desk with the suit before it will move more to the side than the rest of the desk.

Mirages are the bending of light because of heat. They can render stuff behind them virtually invisible. Electromagnetic radiation (including light), much like all waves suffer from convergent (adding) and destructive (breaking down) radiation (fringe separation experiment-proof). So as to destroy all visible radiation around you, you could emit destructive visible radiation.

How to photograph retro-reflective material?

Reflective Material returns light back to the original light source. When photographing reflective material with a flash camera the material will appear like it is "glowing" in the photograph.

To decrease the retro reflected light intensity (or "glow") obtained in photographs, makes one of the following adjustments.

1. Increase or decrease the light source using dimmer switches. Decreasing the light source will decrease the retro reflected light intensity, and increasing the light source will increase the retro reflected light intensity.
2. Increase or decrease the distance between the light source and the object being photographed. Moving the light source further away will decrease the retro reflected light intensity, and moving the

light source closer will increase the retro reflected light intensity.

3. Increase or decrease the observation angle formed between the camera lens and the light source, relative to the object being photographed. An observation angle of 0°provides maximum retro reflected light intensity in the photograph. An observation angle greater than about 2° will eliminate any retro reflected light from returning to the camera lens and therefore from showing in the pictures.

What RPT does?

The retro-reflector screen, together with the pinhole, ensures that the user always sees images with accurate occlusion relations. In the construction of an RPT system, screen shapes are arbitrary, i.e., any shape is possible (fig.10). This is due to the characteristics of the retro-reflector, and the pinhole in the conjugate optical system. By using the same characteristics of an RPT system, binocular stereovision becomes possible using only one screen with an arbitrary shape. The projector can be mounted on the head of a user, which we call an HMP (Head Mounted Projector) system(fig9)

Fig .9. Head Mounted Projector (HMP) with RPT

Fig .10. An optical Camouflage Application using RPT

Hands on Experiments

With recent advances in optics and computing, however, this elusive goal is no longer purely imaginary. Later, it was accomplished by Susumu Tachi, an engineering professor under the supervision of professors Masahiko Inami and Naoki Kawakami at the University of Tokyo, who demonstrated a crude invisibility cloak. Through the clever application of some dirt-cheap technology, the Japanese inventor has brought

Fig .11.

personal invisibility a step closer to reality.

Tachi's cloak - a shiny raincoat that serves as a movie screen, showing imagery from a video camera positioned behind the wearer - is more gimmick than practical prototype. Nonetheless, from the right angle and under controlled circumstances, it does make a sort of ghost of the wearer. And, unlike traditional camouflage, it's most effective when either the wearer or the background is moving (but not both). (fig .11)

It looks like three men walking behind are seen through the body of graduate student Kazutoshi Obana during a demonstration of optical

Fig .12.

Fig .13.

camouflage technology at the Tokyo University. (As shown in fig .12)

There is one more example (fig .13) showing the technology of optical camouflage. In picture given below a picture of the tempo standing behind the subject is seen by us.

More about Optical Camouflage

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. This would almost certainly require sophisticated nanotechnology, as our computers, projectors, and cameras are not yet miniaturized enough to meet these conditions.

Although the suit described above would provide a convincing illusion to the naked eye of a human observer, more sophisticated machinery would be necessary to create perfect illusions in other electromagnetic bands, such as the infrared band. Sophisticated target-tracking software could ensure that the majority of computing power is focused on projecting false images in those directions where observers are most likely to be present, creating the most realistic illusion possible. 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. 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.

Real Life Applications

This technology is basically used for invisibility purposes.

- Such technology is useful in defence for hiding from the enemies.
- The stealth planes have sort of this application that they absorb all the radar waves coming to it and as a result of which the radar stations cannot detect it. So it can attack any time because it is hidden. This is dangerous also. If this technique is used in cockpit for making the floor transparent at landing, the pilot can land safely with seeing runway. (fig .14)

Fig .14.

- Also, use for other vehicles like car. If you can see through the back of car, you will put the car into the garage successfully.

Conclusion

Each technology has its own pace of development. This technology is still at its developing state. Even though in movies, invisibility is narrated, but the common man does not know the concept behind it. This technology should be used in the right applications so that it can be explored in a better way and become useful for the betterment of the human life.

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