A

Seminar report

On

Invisibility Cloaks

Submitted in partial fulfillment of the requirement for the award of degree
Of CSE

SUBMITTED TO: **SUBMITTED BY:**

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Preface

I have made this report file on the topic **Invisibility Cloaks;** I have tried my best to elucidate all the relevant detail to the topic to be included in the report. While in the beginning I have tried to give a general view about this topic.

My efforts and wholehearted co-corporation of each and everyone has ended on a successful note. I express my sincere gratitude to …………..who assisting me throughout the preparation of this topic. I thank him for providing me the reinforcement, confidence and most importantly the track for the topic whenever I needed it.

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INTRODUCTION

Invisibility has been on humanity's wish list at least since Amun-Ra, a deity who could disappear and reappear at will, joined the Egyptian pantheon in the earlier BC. With recent advances in optics and computing, however, this elusive goal is no longer purely imaginary. Susumu Tachi, an engineering professor at the University of Tokyo, demonstrated a crude invisibility cloak. Through the clever application of some dirt-cheap technology, the Japanese inventor has brought 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. In addition, unlike traditional camouflage, it is most effective when either the wearer or the background is moving (but not both).

US Defense Department press releases citing "adaptive", "advanced" and "active" camouflage suggest that the government is working on devices like this. If so, it is keeping them secret. However, NASA's Jet Propulsion Laboratory has published a preliminary design for an invisible vehicle, and battalions of armchair engineers have weighed in with gusto on newsgroups and blogs. As it happens, most of the schemes that have been advanced overlook the complexities of the problem. Invisibility is not simple matter of sensors that read the light beams on one side of an object and, LEDs or LCDs that reproduce those beams on the other.

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1. SEEING (OR NOT SEEING) IS BELIEVING

Optical camouflage delivers a similar experience to Harry Potter's invisibility cloak, but using it requires a slightly more complicated arrangement. First, the person who wants to be invisible (let us call her person A) dons a garment that resembles a hooded raincoat. The garment is made of a special material that we will examine more closely in a moment. Next, an observer (person B) stands before person A at a specific location. At that location, instead of seeing person A wearing a hooded raincoat, Person B sees right through the cloak, making person A appear to be invisible. The photograph on the right below shows you what Person B would see. If person B were viewing from a slightly different location, he would simply see person A wearing a silver garment (left photograph below).

Still, despite its limitations, this is a cool piece of technology. Not only that, but it is also a technology that has been around for a while.

2. ALTERED REALITY

Optical camouflage does not work by way of magic. It works by taking advantage of something called augmented reality technology-a type of technology that first pioneered in the 1960s by Ivan Sutherland and his students at Harvard University and the University of Utah.

Augmented reality systems add computer generated information to a user's sensory perceptions. Imagine, for example, that you are walking down a city street. As you gaze at sites along the way, additional information appears to enhance and enrich your normal view. Perhaps it is the day's specials at a restaurant or the show times at a theater or the bus schedule at the station. What is critical to understand here is that augmented reality is not the same as virtual reality. While virtual reality aims to replace the world, augmented reality merely tries to supplement it with additional, helpful content.

Most augmented-reality systems require that users look through a special viewing apparatus to see a real-world scene enhanced with synthesized graphics. They also require powerful computer. Optical camouflage requires these things, as well, but it also requires several other components. Here's everything needed to make a person appear invisible:

- A garment made from highly reflective material
- A video camera
- A computer
- A projector
- A special, half-silvered mirror called combiner.

Let us look at each of these components in detail.

3. THE CLOAK

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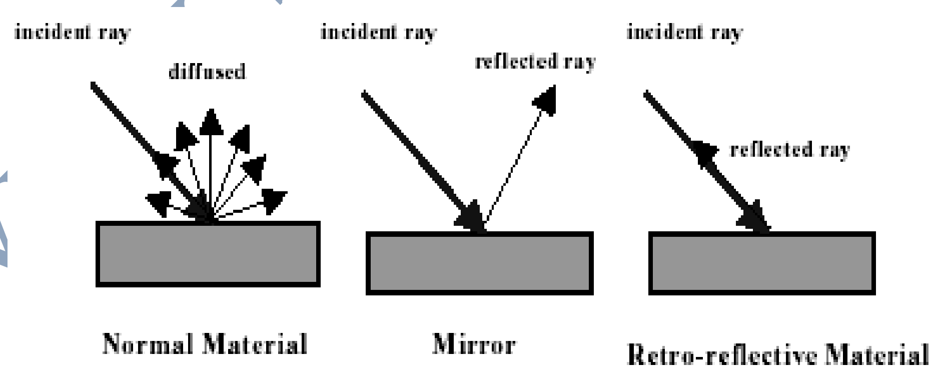
Professor Tachi's cloak works by projecting an image on to itself, which is behind the wearer. A computer generates the image that is projected so the viewer effectively sees through the cloak. The key element in the development of the cloak is a new material called retro reflective material. This material allows you to see a three-dimensional image. This material is the key to our technology.

A retro-reflective material contains 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.

It strongly depends on how light reflects from other types of surfaces. 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.



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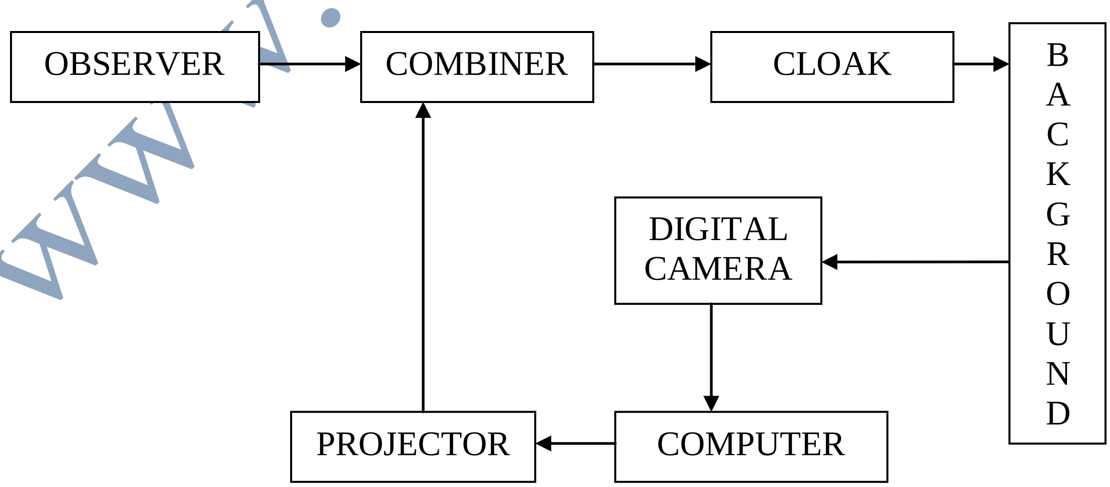
Retro-reflective materials are actually quite common. Traffic signs, road markers and bicycle reflectors all take advantage of retro-reflection to be more visible to people driving at night. Movie screens used in most modern commercial theaters also take advantage of this material because it allows for high brightness under dark conditions. In optical camouflage, the use of retro reflective material is critical because it can be seen from far away and outside in bright sunlight. The optical camouflage technology developed at the Tokyo University is shown above.

4. INVISIBILITY CLOAK COMPONENTS

For the illusion of invisibility, we need the following components. The diagram below shows the typical arrangement of all of the various devices and pieces of equipment.

BLOCK DIAGRAM



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4.1 Video Camera

The retro-reflective garment does not actually make a person invisible; in fact, it is perfectly opaque. What the garment does is create 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. The video from the camera must be in a digital format so that it can undergo processing within a computer.

4.2 Computer

All augmented reality systems rely on powerful computers to synthesize graphics and then superimpose them on a real - world image. For optical camouflage to work, the hardware/software combination must take the captured image from the video camera, calculate the appropriate perspective to simulate reality and transform the captured image into an image that is projected onto the retro-reflective material.

4.3 The projector

The modified image produced by the computer must be shone onto the garment, which acts like a movie screen. A projector accomplishes this task by shining a light beam through an opening controlled by a device called an "iris diaphragm". An iris diaphragm is made of thin, opaque plates, and turning a ring changes the diameter of the central opening. For optical camouflage to work properly, this opening must be the size of a pinhole. Because, this ensures a larger depth of field so that the screen (in this case, the cloak) can be located any distance from the projector.

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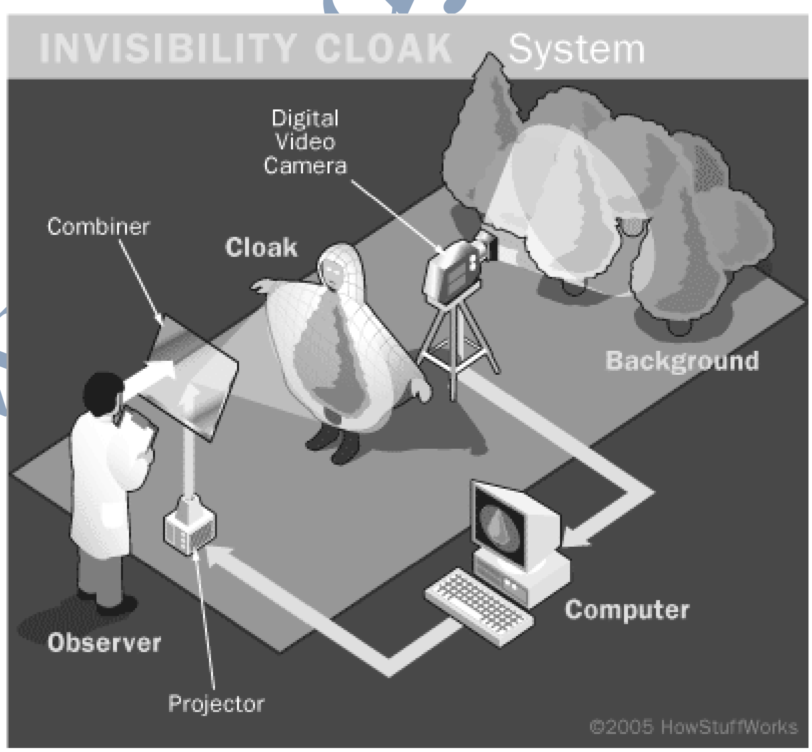
4.4 The combiner

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. This is critical because the computer generated image and the real world scene must be fully integrated for the illusion of invisibility to seem realistic. The user has to look through a peephole in this mirror to see the augmented reality.

Once a person puts on the cloak made with the retro reflective material, here is the sequence of events.



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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 the cloak pass through the transparent part of the mirror and fall on the user's eyes. Remember that the light rays bouncing off 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 to reach the user's eye, making it seem as if an invisible person exists in an otherwise normal looking world.

5. THE SUPER POWER ISSUE

5.1 INVISIBILITY TODAY…

Unlike those tales of fictional invisibility, the real-life technologies usually have a catch. Nevertheless, limited forms of invisibility might be available to the military sooner than you think. Several research teams are out there with ideas to make things invisible. One technology is using optical camouflage. The most exotic technologies involve "metamaterials", blends of polymers and tiny coils or wires that twist the paths of electromagnetic radiation.

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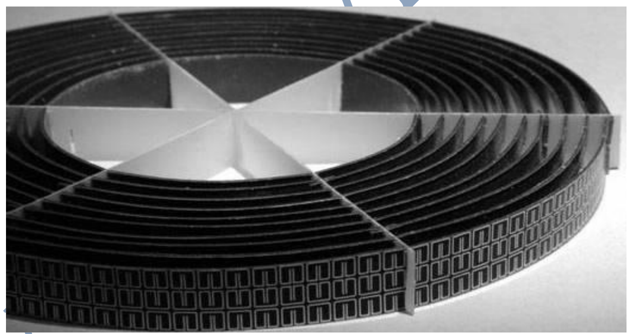
A US-British team of scientists has successfully tested a cloak of invisibility in the laboratory. The device mostly hid a small copper cylinder from microwaves in tests at Duke University, North California. It works by deflecting the microwaves around the object and restoring them on the other side, as if they had passed through empty space.

Although called a cloak, the device is not something that can be worn. It consists of 10 fiberglass rings covered with copper elements and is grouped as a "metamaterial"- an artificial composite that can be engineered to produce a desired change in the direction of electromagnetic waves. Like visible light waves, microwaves bounce off objects, making them apparent and creating a shadow. However, at microwave frequencies, the detection has to be made by instruments rather than the naked eye.



The tiny structures embedded in the metamaterial would have to be smaller than the wavelength of electromagnetic rays you want to blend. That is a tall order for optical invisibility, because the structures would have to be on the scale of nanometers, or billions of meters. The metamaterial cloak channeled the microwaves around the object like water flows around the rock. These metamaterial have opened a new chapter in electromagnetism.

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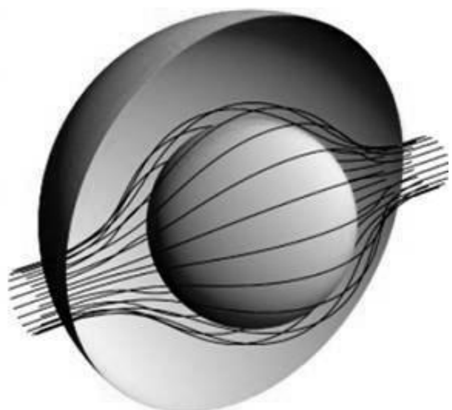
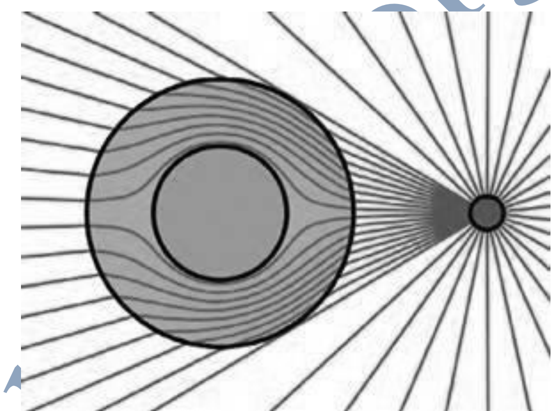
In the experiment, the scientists first measured microwaves travelling across a plane of view with no obstacles. Then they placed a copper cylinder in the same plane scattering, in the microwaves. Next, the researchers placed the invisibility cloak over the copper cylinder. The cloak did not completely iron out the disturbance, but it greatly reduced the microwaves being blocked or deflected.





5.2 Hidden from view

The invisibility cloak guides electromagnetic waves around a central region so that any object at all can be placed in that region and will not disturb the electromagnetic fields. There is reduced reflection from the object, and there is also reduced shadow. In principle, the same theoretical blueprint could be used to cloak objects from visible light. But this would require much more intricate and tiny metamaterial structures.

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6. REAL WORLD APPLICATIONS

While an invisibility clock is an interesting application of optical camouflage, it is not probably the most useful one. Here are some practical ways the technology might be applied.

- Pilots landing a plane could use this technology to make cockpit floors transparent. This would enable them to see the runway and the landing gear simply by glancing down.
- Doctors performing surgery could use optical camouflage to see through their hands and instruments to the underlying tissue.
- Providing a view of the outside in windowless rooms is one of the more fanciful applications of the technology, but one that might improve the psychological well being of people in such environments.
- Drivers backing up cars could benefit one day from optical camouflage. A quick glance backward through a transparent rear hatch or tailgate would make it easy to know when to stop.

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 tele-existence***: working and perceiving with the feeling that you are in several places at once. Here is how it works: Human user A is at one location while his tele-existence robot A is at another location with human user B.

- Human user B is at one location while his tele-existence robot B is at another location with human user A.
- Both tele-existence robots are covered in retro reflective material so that they act like screens.

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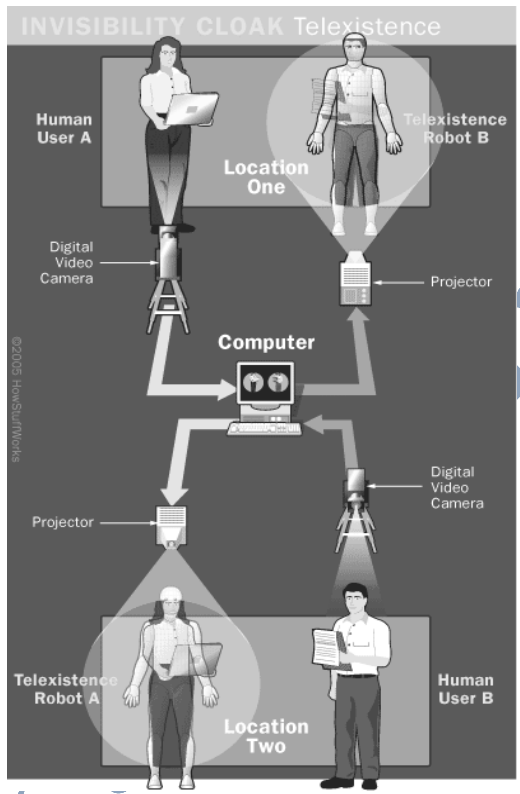
- With video cameras and projectors at each location, the images of the two human users are projected onto their respective robots in the remote locations.
- This gives each human the perception that he is working with another human instead of a robot.



Right now, mutual tele-existence is science fiction, but it will not be for long as scientists continue to push the boundaries of the technology. For example, pervasive gaming is already becoming a reality. Pervasive gaming extends gaming experiences out into the real world, whether on city streets or in remote wilderness. 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.

7. USE AND MISUSE

Use: There are many potential uses of the cloak, ranging from espionage and military purposes to helping pilots to see through the floor of the cockpit to the runway below.

Misuse: However, there are massive questions of potential misuse too, particularly surrounding the huge crime, implications. It could become hardily difficult to spot a thief, for example, if the terms they were taking were simply disappearing under the cloak.

8. LIMITATIONS

- Making a large building invisible so that the park on the other side can be seen
- Improving the range of wireless devices by allowing waves to bend and flow around obstructing objects
- Cloaked military vehicles and outposts
- Eliminating shadows and reflections (from a military plane, for example)
- Ultra-high capacity storage devices
- Lenses that have no blurring effect, resulting in ultra-sharp images
- People inside a cloaked area would not be able to see out because all visible light would be bending around where they are positioned. They would be invisible, but they would be blind, too.

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CONCLUSION

Several researches' are being carried out in different universities across the world to achieve the invisibility. The two flourishing technologies are being shortly discussed here. Despite the shortcomings, however, the new device is "a very good achievement". Until engineers find a way around these obstacles, true invisibility will remain just out of reach. So relax: The men in black are not leaning over your shoulder as you read this. Still, the technology is physically possible and likely on its way. As is the obvious countermeasure: a balloon full of screaming yellow paint. So being invisible, one of the ever-dreaming wish of humanity is going to happen. Therefore, I would like to conclude that nothing is impossible, but we have to work for it.

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