Optical Camouflage
THIS IS WHAT IT IS REALLY
WHAT IS OPTICAL CAMOUFLAGE?

- Optical camouflage is a hypothetical type of active camouflage currently only in a very primitive stage of development. 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.

- Optical camouflage is a kind of active camouflage which completely envelopes the wearer. It displays an image of the scene on the side opposite the viewer on it, so that the viewer can "see through" the wearer, rendering the wearer invisible.

- 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. Prototype examples and proposed designs of optical camouflage devices range back to the late eighties at least, and the concept began to appear in fiction in the late nineties.
The Secret of Transparent Cloak

1. Camera: Capturing the scene behind the person
2. Computer: Processing the captured image as if you see the real scene
3. Projector: Projecting the image onto the cloak
4. Peephole: Seeing from here, you will see as if the cloak is transparent!
5. Half Mirror: Reflecting the light partly, and let the rest through
6. Cloak: The image from projector is projected here

Real Scene

[Diagram showing the operation of a transparent cloak system]
HOW DOES IT WORK?

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.
Secret of Invisibility Cloak

- If you're a fan of Harry Potter, then you're quite familiar with the concept of an invisibility cloak With optical-camouflage technology developed by scientists at the University of Tokyo, the invisibility cloak is already a reality.
INVISIBILITY CLOAK

- 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.
To understand why this is unique, look at how light reflects off of 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.
WHAT DO WE NEED FOR AN INVISIBILITY CLOAK?

- Optical camouflage doesn't work by way of magic. It works by taking advantage of something called augmented-reality technology.
- Augmented-reality systems add computer-generated information to a user's sensory perceptions.
- 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 a 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 retro-reflective material
  - A video camera
  - A computer
  - A projector
  - A special, half-silvered mirror called a combiner
More Invisibility Cloak Components

Video Camera

- 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 it can be sent to a computer for processing.

Computer

- For optical camouflage to work, the hardware/software combo must take the captured image from the video camera, calculate the appropriate perspective to simulate reality and transform the captured image into the image that will be projected onto the retro-reflective material.
INVISIBILITY CLOAK System

Combiner

Cloak

Digital Video Camera

Background

Observer

Projector

Computer

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Once a person puts on the cloak made with the retro-reflective material, here's the sequence of events:

- A digital video camera captures the scene behind the person wearing the cloak.
- 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.
- The projector receives the enhanced image from the computer and shines the image through a pinhole-sized opening onto the combiner.
- The silvered half of the mirror, which is completely reflective, bounces the projected image toward the person wearing the cloak.
- The cloak acts like a movie screen, reflecting light directly back to the source, which in this case is the mirror.
- Light rays bouncing off of the cloak pass through the transparent part of the mirror and fall on the user's eyes. Remember that 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 seem as if an invisible person exists in an otherwise normal-looking world.
MUTUAL TELEXISTENCE

INVISIBILITY CLOAK

Telexistence

Human User A

Digital Video Camera

Location One

Telexistence Robot B

Projector

Computer

Human User B

Telexistence Robot A

Digital Video Camera

Location Two

Projector

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HOW MUTUAL TELEXISTENCE WORKS

- Human user A is at one location while his telexistence robot A is at another location with human user B.
- Human user B is at one location while his telexistence robot B is at another location with human user A.
- Both telexistence robots are covered in retro-reflective material so that they act like screens.
- 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 telexistence is science fiction, but it won't be for long as scientists continue to push the boundaries of the technology.
Real-World Applications

- 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.
- 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.
- 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.
WHERE HAVE U SEEN OPTICAL CAMOUFLAGE????

- *Ghost in the Shell*.
- 2000 video game *Deus Ex*.
- 2002 *James Bond* movie *Die Another Day*.
- *Metal Gear Solid* and Halo video game series.
- The video game *Phantom Crash*.
- The *Predator* movie.
RECOGNITION OF OPTICAL CAMOUFLAGE

• In 2003, three professors at University of Tokyo — Susumu Tachi, Masahiko Inami and Naoki Kawakami — created a prototypical camouflage system in which a video camera takes a shot of the background and displays it on a cloth using an external projector. The same year Time magazine named it the coolest invention of 2003. [1] With flexible electronics such as a flexible liquid crystal display that would permit display of the background image by the material itself, this form of optical camouflage may closely resemble its fictional counterparts.
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<tr>
<th>ADVANTAGE</th>
<th>DISADVANTAGE</th>
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<td>• Optical Camouflage can be used on surgical globes or equipments so they don’t block surgeon’s view during delicate operations.</td>
<td>• 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.</td>
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<td>• In aviation, cockpit floors could become 'invisible' to assist pilots during landing.</td>
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CONCLUSION

- Now all of us have had a small tour of the interesting world of optical camouflage.

- A lot of interesting things have been done and already we have seen that anyone can be almost invisible with this technology.

- But the future promises us a lot more.

- Research work is going on and soon we will have even more astonishing results.
THANK YOU