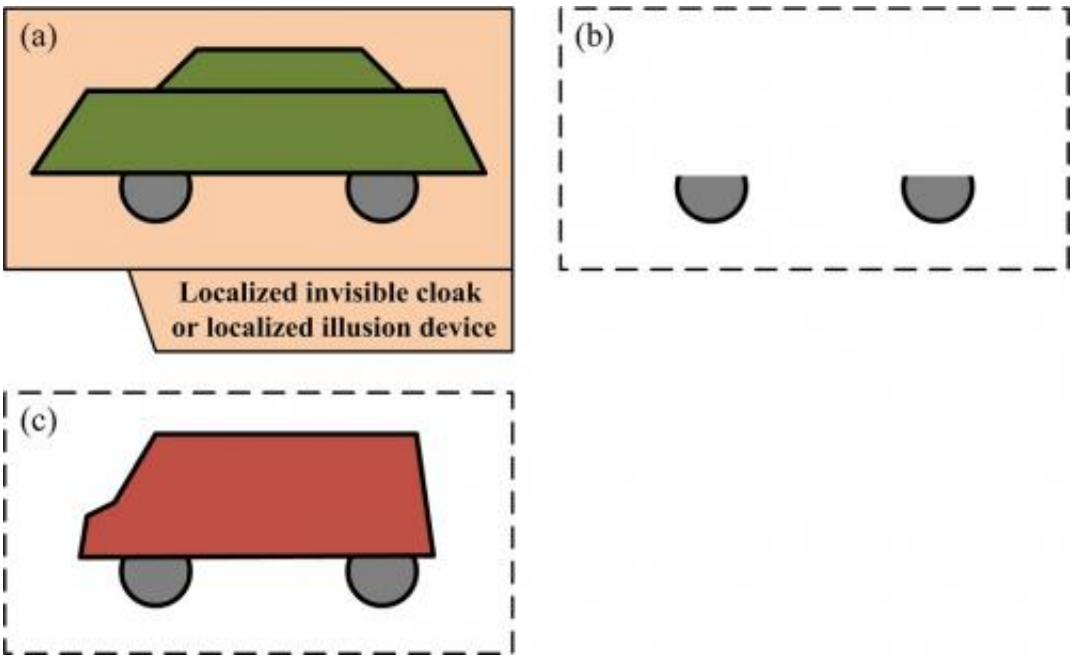
Invisibility cloak hides parts of objects, leaves other parts visible

December 2 2013, by Lisa Zyga



(a) The original object (a car) can be enclosed by (b) a localized invisibility cloak so that part of the car is invisible or (c) a localized illusion device so that the part that was invisible in (b) appears as a minivan. Credit: Jiang, et al. ©2013 AIP Publishing LLC

(Phys.org) —When Harry Potter walks around with a visible head but an invisible body, the performance seems strongly rooted in fantasy. But in a new study, scientists have designed and fabricated an invisibility cloak that may make such a feat possible. The new cloak can conceal some arbitrarily chosen parts of objects while leaving other parts visible,

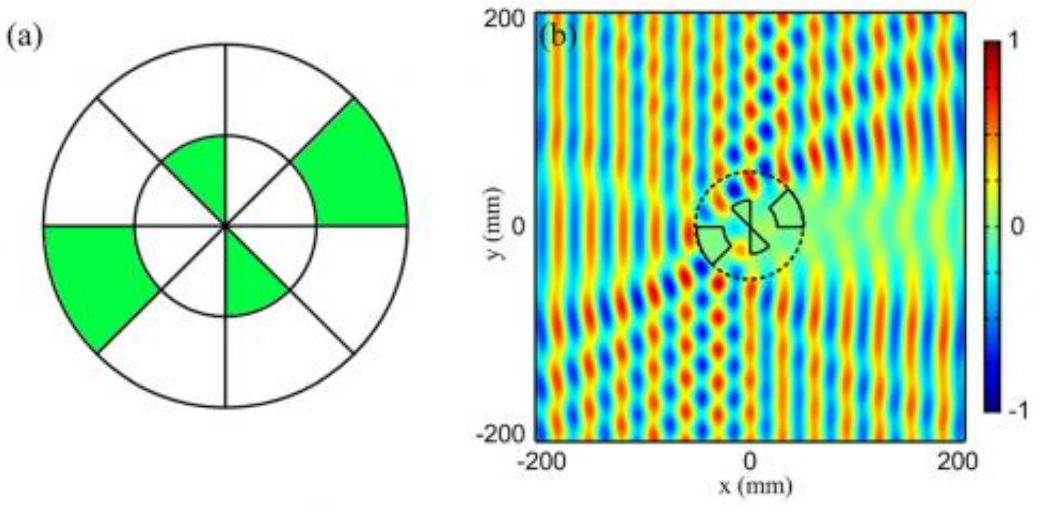
making it a localized invisibility cloak.

The researchers, led by Professor Tie Jun Cui at Southeast University in Nanjing, China, have published their paper on localized transformation optics devices in a recent issue of *Applied Physics Letters*.

"The potential application of a localized invisibility cloak is to make an object partly invisible and leave other parts visible," Cui told *Phys.org*. "Although it is difficult to allow a person to be partly visible and partly invisible in current technology, we believe it is completely possible in the future."

Transformation optics devices, which control and guide electromagnetic fields, have been fabricated in many different forms since the concept was first proposed by John Pendry, et al., in 2006. For example, there are invisibility cloaks for microwave, infrared, and optical frequencies; ground-plane or carpet cloaks for hiding objects on a flat plane; and cloaks (also called illusion optical devices) for changing the scattering signals of objects so they appear as different objects.

However, all of the devices that have been fabricated so far conceal and change the scattering signals of whole objects. As such, they can be thought of as global invisibility cloaks and illusion devices.



(a) Illustration of a locally invisible object, in which the green subregions are visible and the white subregions are invisible. (b) The near-field distribution of the object enclosed by the localized invisibility cloak shows that the white subregions look like the background, while the green subregions have a solid (visible) appearance. Credit: Jiang, et al. ©2013 AIP Publishing LLC

The new study marks the first time that scientists have designed and fabricated localized invisibility cloaks and illusion devices that cloak or change only the desired parts of an object, leaving the other parts visible.

To do this, the researchers explain how they first divide the physical space to be cloaked into many subregions (because invisibility cloaks operate on circular regions, the space is divided along azimuthal and radial lines, like the lines of a dart board). Any of the subregions can be chosen to be cloaked or not cloaked.

Next, the researchers map the subregions of the real object to the corresponding subregions in a localized cloak. To make a subregion invisible, the researchers fill it with a cloaking material. As in global invisibility cloaks, this cloaking material is an artificially engineered metamaterial that has the key properties of being inhomogeneous and

anistropic. To make a subregion visible, the researchers fill it with a material that is related to the original object, to generate the scattering signals of some parts of the object.

The researchers demonstrated the feasibility of localized cloaking through numerical simulations and experimental demonstrations, and plan to continue with more experiments in the future.

"We proposed the idea of localized transformation optics devices in all parts of the electromagnetic spectrum, including microwave, optical, etc.," Cui said. "As a special example, we fabricated and tested a direct-current localized invisibility cloak in circuits. In the near future, we plan to fabricate a localized invisibility cloak in microwave frequencies and design some more complex transformation optics devices."

More information: Wei Xiang Jiang, et al. "Localized transformation optics devices." *Applied Physics Letters*. DOI: 10.1063/1.4833279