Invisibility cloak closer to becoming a reality

September 18 2017

Credit: Charles Parker from Pexels

Photonics is a rapidly growing field in which some of the most sci-fi ideas of the not-so-distant past, are taking form. Now EU-funded research is bringing the notion of an invisibility cloak closer by using microscopic structures that can bend light.

Optical devices are undergoing a revolution: they are shrinking, being integrated more effectively, with advances increasingly available to mass markets. Whereas traditional optics are measured in centimetres, the latest innovations use nanoscale objects to control, guide, and focus light.

Our ability to shape metallic materials has led to the field of nanophotonics. 3-D metamaterials contribute to the development of high-resolution lenses and cloaking devices. But they have disadvantages. They struggle to bend light in waves that are visible to the naked eye, they absorb light causing shadows, they are cumbersome to carry and impractical to manufacture.

Now EU-funded research is helping to create a new material: 2-D lenses coated with gallium nitride, which shines blue under LED. These the FLATLIGHT project refers to as 'metasurfaces'. In a paper published recently, metasurfaces are described as thin and lightweight compared to traditional optics and yet straightforward to fabricate compared to three-dimensional metamaterials.

The gallium nitride is carved into pillars that are small enough to create delays in how light waves flow through them. Having studied how different-shaped pillars distort light, the project can now design lenses that force light in any direction, looping it sideways or backwards on demand. This adaptability, along with an easier production process and greater portability, opens up scope for a wide range of applications.

Although the process is being refined, the fact that the technology is so lightweight is attracting interest. Space is an area in which weight constraints are crucial and the Gaia spacecraft uses similar materials in its efforts to split light and help measure the composition of stars more precisely.

However, each array of pillars only works within a narrow range of colours, meaning that the object it cloaks remains visible in all others. Although this might mean invisibility cloaks are a way off, the metasurfaces have great potential in other applications. By combining them with optically active semiconductors such as indium gallium aluminum nitride, so-called InGaAlN, the project will add optical gain and modulation capability to the system to create new, efficient optoelectronic devices.

That's not to say the project has lost sight of the possibility of developing an invisibility cloak! It has developed a concept of Conformal Boundary Transformation which is described as, 'an analytical method – based on first principle derivations – which allows us to engineer transmission and reflection of light for any interface geometry and any given incident wave.'

They state the concept provides a wide range of new design opportunities, for example, to hide objects behind an 'optical curtain', to create optical illusions by reflecting virtual images, or to suppress the diffraction generally occurring during light scattering at corrugated interfaces.

More information: Project page: cordis.europa.eu/project/rcn/193626_en.html

Provided by CORDIS

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