



FIP International Year of Light Student Fellow

3rd Place Winner

How have light technologies positively impacted you life?

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As a researcher in Quantum Optics today and a member of Optical Society of America student chapter at University of Virginia, saying that light and optics plays an important part in my life would obviously be a gross understatement. However, there is a reason I decided to be involved in a career with optics.

As a student in middle school, I was already interested in science. During high school however, I realized that it was not easy to decide between the sciences. I was just as drawn to evolutionary biology as to quantum physics, not to mention astronomy . It was clear to me that as far as interests went, I would not be able to pick a favourite.

Therefore I started reading deeper into these subjects. I wanted to read more into the past of these subjects, to see the possibilities that the future might hold.

And it is here that light and optics completely grabbed my attention versus every other field. Light, or electro magnetic field in general, is the most fascinating natural phenomenon I could imagine.

Light is probably the first and most obvious phenomenon every human is conscious of from the moment of birth. Too obvious perhaps, for light has been an enigma for most of human history. Maxwell's equations were formulated less than a century ago, and lasers invented barely half a century ago. We have scarcely begun to utilize light and its myriad properties.

Light is the fastest physical method of transferring energy and sending signals. That puts light in the most privileged position for use in communication and information. Light is massless and can travels through vacuum, air and many liquids and even a few solids. That makes it easy to generate, control and detect. It means that light can be the medium of information dissemination everywhere, even in outer space.

The use of light in information processing and communication is to me, the most exciting and promising, and indeed the most transformative. In the information age, speed and efficiency of data encoding, decoding and processing is of paramount importance. The internet is indispensable in every sphere of modern civilization, from entertainment to fundamental research, communication to national security.

Fiber optics has been the quiet revolution in the last decade. Internet and cell phone speeds have exploded. Surely this is the greatest impact that light and optic technologies have made in our lives and one of the driving forces behind the information revolution. However it is scarcely appreciated or even noticed, because the demand for information is growing even faster. But since we are now using the fastest natural phenomena to send signals, this means we have reached a physical ceiling on speed.

This has consequently led to a huge demand for efficient methods of encoding information in light, so as to pack more information in the same number of signals sent. Classical information theory fueled most of the advances in making highly efficient communication possible using the existing fiber optic technology.

My chosen field of research is quantum optics and quantum information. I believe that a second information revolution may well be unleashed in a next few decades as quantum information technologies come of age. The demand for information shows no signs of slowing down in the future. New demands on information transmission, such as information security and parallel processing are emerging that were previously not on the horizon. Quantum information, quantum cryptography and quantum computing are so far the most promising candidates available to tackle this demand. Optics will be the natural platform for quantum information processing and communication as all the reason for its emergence in classical communication will still be valid.

The use of frequency of light as a channel has a long history, back when radio waves were first used to transmit signals. In the quantum regime however control over frequency of light offers enormous potential. A medium can be transparent to one frequency, yet completely opaque to a different frequency. And what's more, if the medium itself is maintained in a quantum state, the light instead of being lost or reflected, can be stored in the medium to be released later on demand, making the medium a quantum memory.

The amazing ability of light to be absorbed, reflected, or pass unperturbed depending on its frequency exponentially increases the information capacity of this technology. If the enormous range of the electromagnetic spectrum is utilized, mankind is not likely to run out of bandwidth in the near, or distant, future.

Even without the distant promise of quantum information, there are many avenues for growth of classical optical technologies still left to be explored.

Recently announced initiatives for establishing a network of communication satellites to build a more comprehensive data network would, if implemented successfully, radically enhance the access and efficacy of information in every day life.

Many efforts are being made to use electro magnetic radiation to wirelessly power devices.

Frequency spectroscopy has made non destructive investigation of elements behind physical barriers, a modern version of x ray vision of science fiction lore.

Holographic interactive interfaces are a 'hot' field of research. If realized we might see a further contraction of sizes of our already incredibly mobile devices.

In conclusion, advances in optical technologies have made possible the information revolution on the past decade possible. Fiber optic and wireless internet can be held as the most under-appreciated of these examples. This is undoubtedly the biggest impact optical technology has had on my life. Quantum information is still a nascent idea, one that could be extremely powerful but is still at least a decade, if not more, away to be realized in a practical technological application.

Electro magnetic radiation is a most fascinating phenomena one that still amazes scientists today. We are far from having used its entire potential and it is already the greatest technological tool we have ever discovered. How true now is the old adage that knowledge and information is the light of the human mind.