

Creation of digital imaging sensors: Judges' citation

A picture is worth a thousand words, a medium of communication that transcends languages. The Queen Elizabeth Prize for Engineering 2017 is awarded to four engineers who have revolutionised the way we capture and analyse visual information. Digital imaging now enables society to access a vast array of intricately detailed pictures and video, ranging from the minute scale of cell structures to images of far-flung stars and galaxies, billions of light years from Earth.

This ground-breaking engineering story begins in 1970 when Willard Boyle (now deceased) and George Smith demonstrated the 'charge coupling principle' as a form of computer memory. It was not until Michael Tompsett and his team realised the potential of the technology that the first imaging circuits using a charge-coupled device (CCD) were made. This was enhanced in 1980 by Nobukazu Teranishi who invented the modern pinned photodiode (PPD) that improved image quality significantly and underpins today's sensors. Eric Fossum's invention of the complementary metal oxide semiconductor (CMOS) image sensor in 1992 enabled the realization of the "camera on a chip". Thanks to this series of engineering innovations, today's cameras can fit on a fingertip and are found in countless portable devices worldwide.

CCD imagers kick started the digital camera industry, and are to this day the sensor of choice in high-end cameras, particularly in science laboratories on Earth and spacecraft orbiting other planets. CMOS sensors use much less power while still producing excellent images, making them ideal for use in affordable digital cameras and mobile phones.

Digital sensors have enabled high-speed, low-cost colour imaging at a resolution and sensitivity that can exceed that of the human eye. They have dramatically changed the way we communicate, enabling us to share information instantaneously and communicate around the world in real-time, even on our phones.

Image sensor technology has transformed society. Billions of sensors are produced each year to be used in medicine, environmental monitoring, the frontiers of space,

transport, security, scientific research, personal communication and entertainment - from sharing photos on social media, to enabling autonomous vehicles, to reporting live video from disaster zones using the small camera on a smartphone. The growing breadth of application to this engineering innovation is breathtaking.