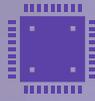


# Image Sensor Technology

The 2017 QEPrize celebrates the evolution of three innovations which have revolutionised the way we take photographs; the charge-coupled device (CCD); the pinned photodiode (PPD) and the complementary metal oxide semiconductor (CMOS).



## Charge-coupled device (CCD)

The CCD was developed in the 1970s. It was improved in 1980 by the PPD and the invention of the CMOS, in 1992, enabled a "camera on a chip".



A CCD is an image sensor that converts light into electricity. They were found inside all early digital cameras. The sensor is made up of lots of light-capturing cells called pixels.



When particles of light (photons) hit these pixels, they produce an electrical signal. The strength of the signal is proportional to the intensity of the light. The charge is transported across the sensor and measured at the corner of the array.



The underlying principle was co-invented by George Smith and Willard Boyle (deceased). British-born Michael Tompsett invented the imaging semiconductor circuit we know as the CCD, including its analogue-to-digital converter.



Nobuzaku Teranishi's pinned photodiode was more efficient and more sensitive than the photodiodes originally used in the CCD. This meant more, smaller pixels could fit onto the same sensor, resulting in higher resolution images.



In 1993, while working at NASA's Jet Propulsion Laboratory, Eric Fossum and his team invented a new imaging semiconductor, the Complementary Metal Oxide Semiconductor (CMOS).



High energy cosmic particles can destroy image sensors on space craft. The CMOS sensors improved the reliability of CCD imagers in space and paved the way for smaller cameras.



It is NASA's Jet Propulsion Laboratory that is responsible for the development of the 'camera on a chip' which allows cameras to be shrunk to the size of a tablet and swallowed. The medical camera can be used to detect cancers.



CMOS sensors use much less power and are much cheaper to produce than CCD sensors. CMOS cameras are not as high quality as those using CCDs but are usually cheaper and have a longer battery life.



CMOS sensors are even integrated into the fingerprint recognition on your smartphones and are used for identification in biometric passport booths for border control.



## Pinned photodiode (PPD)

The next revolutionary innovation, the pinned photodiode (PPD), was developed by Nobukazu Teranishi in Japan in 1980.

A photodiode is a semiconductor which, when exposed to light, allows current to flow in one direction only.