

Charge-Coupled Device

August 22, 2025 • vajiramandravi.com



Charge-Coupled Device Latest News

A charge-coupled device (CCD) is a remarkable electronic component whose invention marked a significant milestone in technology and influenced many fields.

About Charge-Coupled Device

- It was a **pioneering technology** that **converted light into electrical signals** using an array of capacitors that transferred electric charges in a sequence.
- A CCD consists of an **integrated circuit** made up of an array of **small picture elements** called pixels.
- Each pixel acts like a small light sensor that collects photons (the particles of light) and converts them into electrical charges.
- These **charges are then transferred across the device**, one pixel at a time, to be read and processed **into a digital image**.

Working of Charge-Coupled Device

- It operates **using the photoelectric effect**, where light that falls on the device generates electron-hole pairs in the semiconductor material.
- Specifically, when photons enter a CCD, they strike the **semiconductor material** beneath each pixel.
- This energy **knocks electrons loose**, creating a small group of electrons proportional to the intensity of light in that pixel.
- Each pixel is **essentially a small capacitor** that holds these electrons. The amount of charge in each pixel varies depending on how much light the pixel has received.
- A voltage is applied to electrodes placed over the pixels in a sequence that moves the charges from one pixel to the next, like passing buckets of water along a line.
- This is why it's **called a "charge-coupled" device**, and this process continues until all the charge has reached a readout register.
- The accumulated charge from each **pixel is then converted into a voltage signal**, which can be amplified and digitised by connected **electronics to form a digital image**.
- This sequential transfer and reading process allows the CCD to create a precise and high-quality representation of a scene being captured.

Applications of Charge-Coupled Device

- **Household:** CCDs made possible the rise of digital cameras by replacing film with sensors that captured images electronically. They're also **used in CCTV cameras** to provide high-quality video feeds for security in places like banks, shopping malls, and hospitals.
- **Medical diagnostics:** CCDs play a vital role in **medical diagnostics**, including in X-ray imaging, computed tomography (CT) scans, and endoscopy.
- These CCDs are also used in microscopes, spectrometers, and particle detectors where they allow scientists to analyse images in detail.
- **Astronomy:** Telescopes fit with CCDs can **capture faint and distant celestial objects** with more sensitivity and accuracy than traditional photographic plates.

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