

# How Digital Cameras Work



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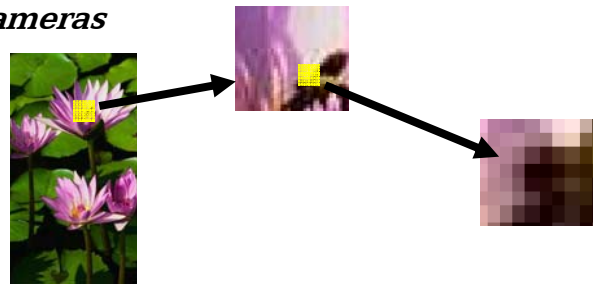
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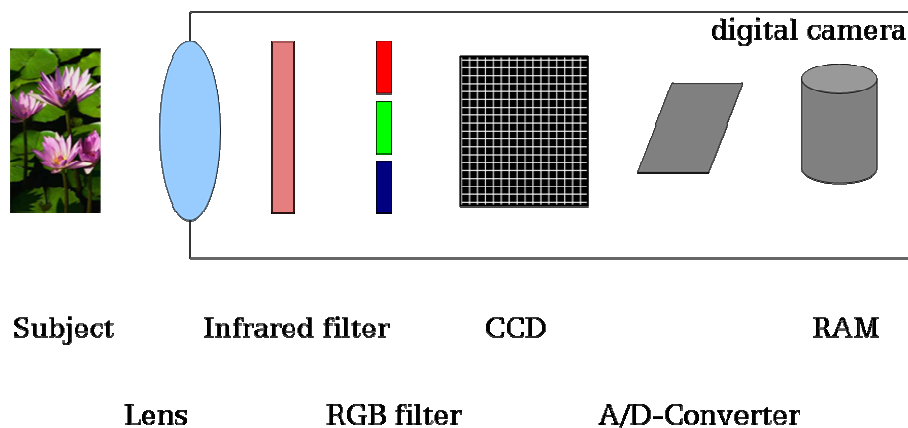
## 1. Basics about digital images and digital cameras

If you want a computer to show a photo, you need a language that computer understands. A digital image is just a long string of 1s and 0s that represent tiny coloured dots (called *pixels*) that all together make up the image.



## 2. Technology and Assembly of digital cameras

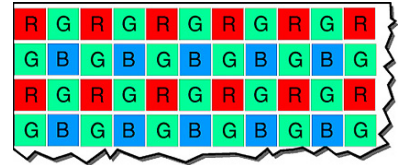
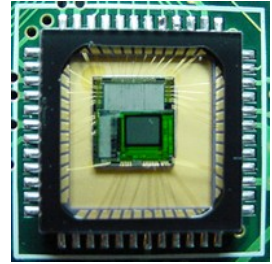
Conventional cameras depend entirely on chemical and mechanical processes. Like a conventional camera, a digital camera has a series of lenses that focus light to create an image of a scene. But instead of focusing this light onto a piece of film, it focuses it onto a semiconductor device that records light electronically. A built-in computer then breaks this electronic information down into digital data.



- **Lens**
  - The lens work the same way conventional cameras do.
- **Infrared filter**
  - This is special for digital cameras, because the CCD is very sensitive to red light a filter is needed to weaken the intensity of the infrared spectrum.
- **RGB filter**
  - RGB = A common system of primary colours is based on mixing the whole spectrum of colours from red, green and blue.
  - Because CCDs are colour-blind a filter is needed to divide the arriving light in the three RGB parts (only light of the appropriate colour can pass the filter!). Then the intensity can be measured for each colour.

- **CCD (Charge Coupled Device)**

- Replaces the film in conventional cameras.
  - The CCD is a collection of tiny light-sensitive diodes, which convert photons (light) into electrons (electrical charge). These diodes are called *photosites*. In a nutshell, each photosite is sensitive to light - the brighter the light that hits a single photosite, the greater the electrical charge that will accumulate at that site.
  - A CCD is a 2-D array of millions of photosites. Each photosite represents 1 primary colour (red, green or blue).
  - When a Bayer filter (see picture) is used for the array, *interpolation* is needed to calculate the missing two colour values for each pixel. The simplest technique is to determine the mean value of the surrounding pixels of the appropriate colour.
  - A CCD is adjusted to human sense. Because of that there is the same amount of green photosites as there are red and blue ones together. Human eyes are more sensitive to green and the photo seems more clearly and detailed if it is greener.
- **A/D-Converter**
    - An analog-to-digital converter turns each pixel's analog value (electrical charge) into a digital value. Wandelt die analogen Signale der CCD-Zellen in digitale Werte um
    - Interpolation & Compression
  - **RAM**
    - Saves the digital data (common: CompactFlash, Smartcard etc.)



### 3. *Types of digital cameras*

- **Array-Sensor**
  - **One-Shot camera**
    - CCD records red, green and blue simultaneously
    - Interpolation, because there is only one CCD
  - **Three-Shot camera**
    - CCD records red, green and blue in succession
    - No interpolation
  - **Three-In-One-Shot camera**
    - CCD records red, green and blue simultaneously
    - No interpolation, because there are three separate CCDs
- **Row-Sensor**
  - Shoots the picture row by row (works like a scanner)
  - Especially for studio and high-quality photos
  - Last a long time to take (12 min.)

### 4. *Outlook on the future*

- **SuperCCD**
  - SuperCCDs develop the CCD further. Here photosites have special shapes, e.g. like honeycomb. They bring higher resolutions, are more light-sensitive and get better results using interpolation, because special algorithms can be used.
- **CMOS**
  - Like CCDs this semiconductor works with a photovoltaic reaction.
  - The manufacturing process is very cheap; because factories that can produce normal computer chips work on CMOS-Technology.
  - CMOS have less energy consumption (1/10) and are smaller than CCDs, because functions can be implemented directly within the photosite.

### 5. *Literature:*

1. design publishing imaging: Digitales Fotografieren, 2. Auflage 1998 → (UB-Signatur: TE D 354)
2. Markt und Technik: Fotos und PC, 1998 → (UB-Signatur: TE D 356)