Today I would like to show you how digital cameras work.

You will learn about

the historical background,

the components of a digital camera,

and why digital cameras are important for us.

Digital cameras are all around us, and are

used in a variety of different fields.

You will find them nowadays not just in our

smartphones, but also in surveillance applications,

traffic monitoring, medicine, modern production lines and many other industries.

So how did it all begin?

The first camera was a pinhole camera, known as the 'camera obscura.'

It involved nothing more than a black box

with a small hole in it.

No lens.

No film.

Nothing.

The camera projected a poor dark image onto the screen.

There was no way to record the image permanently.

To actually preserve the image permanently, you needed a person to trace the image.

The invention of analog film provided the

chance to record an image permanently,

albeit using a complicated treatment process and many chemicals.

At some later point, electron tubes were used to record images electronically and to transfer that information.

Actual storage of the images was still handled using purely analog technology, namely as a video signal.

One option for importing those images to a computer and processing them

would come later by digitizing analog video data using a framegrabber card and a PC.

A few years later during the 70s, for example

the Kodak Company made the initial steps towards

a proper digital camera.

The image data was recorded and

transmitted digitally , the same processes

are still used today.

Over the course of time, our 'black box' has

undergone a massive transformation,

not least through the components that are now used.

Instead of the pinhole, we use a lens.

It allows us to keep the object in focus and

prominent at the image level within the camera,

despite working with different focal lengths

and settings.

Yet it should be noted that this works the

same way on an analog camera.

The image sensor is another distinct component.

It is used to convert image information from the lens into a digital image

without the detour of tracing paper or chemicals.

Standard cameras use a memory card to store

the image digitally.

Digital industrial cameras require what is

known as an interface.

This interface connects the camera to the

PC via a cable and is used to transmit data

to the computer for further processing or

simply to be stored.

The image sensor, the heart of any digital

camera, is composed of many tiny light-sensitive areas known as pixels.

These pixels are later collated to form the

digital image.

The more light, or photons, strike a pixel,

the brighter that portion of the image becomes.

The lighter brighter the spot, the higher

the digital value produced by the electronics

within the sensor.

We describe this value as the gray value.

For a digital color image, we need the color

value for each individual pixel in the image.

There are two common ways to calculate this

color value.

Visible light is actually comprised of a mixture

of pure colors, described by their wavelength,

ranging from red to green and blue.

One option is to channel different portions

of the RGB color mixture to different portions

of the sensor.

The red portion of the light strikes certain

pixels, the green share strikes other pixels,

and the blue portion strikes yet another portion

of the sensor.

At the technical level, this is achieved through

a mesh of tiny filters, known as the color filter array,

that is placed in front of the

light sensitive cells, namely the sensor's pixels.

As the different portions of the light pass

through, each color is channeled to the relevant portion of the sensor.

As such, the individual pixels on the sensor

can record brightness information for a specific color of light.

Those values are run through a complicated

formula that produces three separate matrices of gray values:

one for red, one for green

and one for blue.

These are then ultimately combined into

a color image.

The other common way to produce color images is separating the colors outside the sensor using optical components.

meaning the entire

sensor is only struck by the red, green or blue light.

The image can be recorded all at once, then you need 3 sensors

or in a sequence, using just one sensor and a color filter wheel.

The final result is the same: the technique

ultimately produces one digital color image.

When you take a picture with your digital

camera or your smartphone,

it is not much of an issue if it takes a quarter to half a second for the picture to move into the device's memory.

When it comes to monitoring production processes

moving too fast for the human eye to follow,

however, a quarter second is far too long.

Images need to be created in just a few microseconds.

There are many different applications that

place special requirements on digital industrial cameras:

factory automation, traffic monitoring

and special medical techniques

Digital cameras for industry are just one

part of what is known as a 'Vision System.'

The components of that kind of system will

be the subject of an upcoming video.

Stay tuned!