

# Task04: Camera Sensor and Digital Image

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## **Q1. What is a good image sensor? Why are the high-end DSLR cameras expensive?**

A good image sensor is a sensor that detects sufficient light with sufficient clarity and less noise for its application. The most important aspect of a good image sensor is its sensor size. The image quality also depends on how many pixels fit on it and the size of pixels. High-end DSLR cameras are expensive because the larger sensors with more pixels tend to collect more light (dynamic range, less noise, greater low light performance) but their size results in a greater cost.

## **Q2. What is the difference between optical and digital zooms?**

Optical zoom is achieved using your camera lens, whereas a digital zoom is effectively cropping the photo. The key difference is the quality of the image you have at the end, as a result optical zoom is much preferred.

## **Q3. Why did the apple make "stove-top" iPhone 11 Pro?**

Apple made the "stove-top" to incorporate three cameras in its iPhone 11 Pro, a 20 mm f/1.8, 52 mm f/2.0, and 13 mm f/2.4. These cameras are considered "wide", "telephoto", and "ultra wide", with their focal lengths, optical zoom can be used instead of digital zoom. Therefore, better image quality can be achieved. In addition, by combining information from each of the cameras which have a slightly different perspective, the device can better determine depth data allowing it to refine its portrait mode and achieve solid bokeh.

## **Q4. Can you search for the unique design or function of the smartphone camera module (not software)? Please rank five cameras and make a short explanation of why they are unique or special.**

The following phone cameras are ranked from best to worst.

### **Samsung Galaxy S21 Ultra**

#### **SPECIALTY: 2 TELEPHOTO CAMERAS**

The Samsung Galaxy S21 ultra has a 108 MP f/1.8 camera, a 12 MP f/2.2 ultrawide camera, and two 10 MP telephoto cameras (one with an aperture of f/2.4 with a 3x optical zoom and the other with f/4.9 and 10x optical zoom). This means that it can easily zoom in. It also comes with a 40MP front camera.

### **Huawei Mate 40 Pro**

### **SPECIALTY: PERISCOPE CAMERA**

The Huawei Mate 40 Pro has a 50 MP f/1.9 main camera, a 12 MP f/3.4 periscope camera with 5x optical zoom, and a 20 MP f/1.8 ultra-wide one. the variety of lenses covers the key ones most people would use in their everyday life. The periscope camera allows for better zoom capabilities with less image noise than digital zoom.

### **iPhone 12 Pro Max**

#### **SPECIALTY: LIDAR SENSOR AND LOW LIGHT**

The iPhone 12 Pro Max has three cameras, a 12MP f/1.6, 12MP f/2.2 telephoto (with 2.5x optical zoom), and a 12MP f/2.4 ultra wide camera, along with a LiDAR scanner. The LiDAR scanner is effective at determining depth of fields which can help with portrait mode in low light situations and portrait mode in general.

### **Samsung Galaxy Note S20 Ultra**

#### **SPECIALTY: STRONG TELEPHOTO LENS**

The Samsung Galaxy S21 Ultra has an amazing telephoto lens. It uses a 12 MP f/3.0 with 5x optical zoom and 50x digital zoom. It does all this while remaining relatively focused and noise-free with its wide aperture and large pixels. In addition to the telephoto camera, it has a 108 MP f/1.8 main camera and 12 MP f/2.2 ultra-wide camera.

### **Huawei P40 Pro**

#### **SPECIALTY: LEICA LENS AND LOW LIGHT**

The Huawei P40 Pro uses Leica's imaging system with a 50MP sensor and RYYB (red yellow blue) sub-pixel formation, along with a f/1.9 aperture. Because of this, it has amazing low light performance. In addition, it has a 40 MP f/1.8 ultra wide camera, a 12 MP telephoto camera, and a time-of-flight (ToF) sensor for creating bokeh effects.

## **Q5. What kind of phone cameras or phone camera technologies will be introduced in next five years? Talk freely**

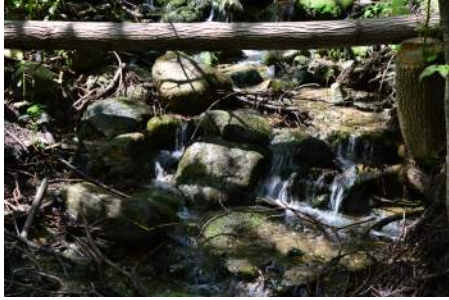

In the next 5 years, I think that a few key developments will occur for phone cameras. The first would be an increase to the megapixel count. Currently, phones are reaching 108MP, but I think it will continue to rise. In addition, LiDAR or TOF sensors are being implemented to high end phones, but I think they will be widely available for both front facing and rear facing cameras in the next 5 years. They will allow cameras to take better portraits and allow for better bokeh in the finalized photos.

## **(Q6~Q12) Please explain and demonstrate the following functions/effects using your own images. Also, you need to explain when and why you change their values on a camera.**

### **Q6 Shutter Speed**



Shutter speed is basically how long the sensor is exposed to light (how long your shutter stays open). The larger the value, the more light is let in. In broad daylight, having an extremely long shutter speed can lead to an over exposed image. It can be useful to capture motion if objects move in frame. I would play around with the shutter speed if I am trying to achieve a long exposure photo (waterfalls, car tail lights, etc.) As you can see in the following photos, I was trying to capture the flow of the waterfall, hence I used a longer shutter speed in order to capture the motion of the water in the second photo.

**Note:** The following images were taken with shutter priority, therefore the aperture was changed automatically by the camera in order to compensate and ensure that the second image was not completely over exposed. However, the effect of shutter speed can be seen.

Metadata	Image 1	Image 2
Image		
Make	NIKON	NIKON
Model	NIKON D3200	NIKON D3200
Date and Time	2017-08-05 12:33 PM	2017-08-05 12:36 PM
Image File Type	JPEG	JPEG
Resolution	6016 x 4000	6016 x 4000
Focal Length	55 mm	55 mm
Exposure	<b>1/50 sec</b>	<b>4 sec</b>
ISO	100	100
F-stop	f/5.6	f/14
GPS	NONE	NONE
Flash	OFF	OFF



## Q7 Aperture

Aperture dictates the size of the opening that lets light in. It is represented by the f-stop value, a lower f-stop means a greater aperture and more light is let in. I would play around with the aperture (f-stop) mainly in two scenarios. The first would be in portrait scenarios where I'm trying to get nice bokeh and I'm trying to get a shallow depth of field. In a more generalized term, I would change the aperture depending on what depth of field I want and what I want to keep in focus in the photo. The second is if I were in an aquarium or other low light setting where I need to let in more light so my camera would be able to take a non-blurry photo while having a fast shutter speed so that the objects (fish) don't appear blurry. As you can see in the following images, a smaller f-stop number, which corresponds to a higher aperture results in a shallower depth of field

Metadata	Image 1	Image 2
Image		
Make	HUAWEI	HUAWEI
Model	HUAWEI P30	HUAWEI P30
Date and Time	2021-01-15 3:15 PM	2021-01-15 3:13 PM
Image File Type	JPEG	JPEG
Resolution	1536 x 2048	1536 x 2048
Focal Length	54 mm	54 mm
Exposure	1/100 sec	1/100 sec
ISO	100	100
<b>F-stop</b>	<b>f/16</b>	<b>f/0.95</b>
GPS	NONE	NONE
Flash	OFF	OFF



## Q8 ISO

In effect, ISO denotes how sensitive the sensor is to light. A higher ISO means that the camera sensor is more sensitive. Digital cameras convert the light that falls on the image sensor into electrical signals for processing, ISO sensitivity is raised by amplifying the signal. I would change the ISO settings on my camera if I were in low light scenarios such as taking pictures of fireworks, light shows, aquariums, etc. In normal day time shooting, I would try to keep my ISO as low as possible because a high ISO when it is not needed causes the photo to appear very grainy and noisy.

Metadata	Image 1	Image 2
Image		
Make	HUAWEI	HUAWEI
Model	HUAWEI P30	HUAWEI P30
Date and Time	2021-01-15 3:25 PM	2021-01-15 3:23 PM
Image File Type	JPEG	JPEG
Resolution	1536 x 2048	1536 x 2048
Focal Length	27 mm	27 mm
Exposure	1/125 sec	1/125 sec
ISO	100	3200
F-stop	f/1.8	f/1.8
GPS	NONE	NONE
Flash	OFF	OFF



## Q9 Flash

Flash is additional light that the camera or an external tool produces to provide more light in dark areas. Adding flash is typically pretty obvious as the final photo looks fairly artificial. I typically wouldn't use flash if possible, this is because it messes with the final photo and reflections in glass can mess the whole photo as well as cause red eye effects. It could be useful in controlled product or wedding shoots with a flash diffuser which spreads the light out and makes it less artificial.

Metadata	Image 1	Image 2
Image		
Make	HUAWEI	HUAWEI
Model	HUAWEI P30	HUAWEI P30
Date and Time	2021-01-15 4:21 PM	2021-01-15 4:22 PM
Image File Type	JPEG	JPEG
Resolution	1536 x 2048	1536 x 2048
Focal Length	27 mm	27 mm
Exposure	1/200 sec	1/200 sec
ISO	100	100
F-stop	f/1.8	f/1.8
GPS	NONE	NONE
Flash	OFF	ON

## Q10 Focal Length



Focal length is the optical distance from the point where the light rays converge to form a sharp image of an object on the digital sensor. It is usually listed on the lens of a DSLR. Depending on the lens (whether is a prime lens or zoom lens) this value will change.

Metadata	Image 1	Image 2
Image		
Make	HUAWEI	HUAWEI
Model	HUAWEI P30	HUAWEI P30
Date and Time	2021-01-15 5:15 PM	2021-01-15 5:13 PM
Image File Type	JPEG	JPEG
Resolution	1536 x 2048	1536 x 2048
<b>Focal Length</b>	<b>27 mm</b>	<b>130 mm</b>
Exposure	1/60 sec	1/60 sec
ISO	160	160
F-stop	f/1.8	f/1.8
GPS	NONE	NONE
Flash	OFF	OFF

## Q11 Field of View

Field of view is the part of your surroundings that is visible to the camera. Objects outside of your field of view are not recorded by the camera. It is dependent on the focal length and size of the sensor. For example, my current camera is a Nikon D3200 which is an APS-C or crop sensor. If I buy a full frame lens which is 50 mm f/1.8, my field of view through my camera would be different than if I used the same lens on a full frame Nikon. The focal length of the lens didn't change, but the fact that my sensor is smaller means that I have a smaller field of view. The crop factor for Nikon APS-C cameras is 1.5, so in reality I'm getting the same field of view as if I were to use a 75 mm crop sensor lens on my camera.

The images below simulate its effect, with the same focal length (lens in front) the field of view still can change.

Metadata	Image 1	Image 2
Image		
Make	NIKON	NIKON
Model	NIKON D7500	NIKON D3200
Date and Time	2021-01-15 5:50 PM	2021-01-15 5:49 PM
Image File Type	JPEG	JPEG
Resolution	1536 x 2048	1536 x 2048
Focal Length	50 mm	50 mm
Exposure	1/33 sec	1/33 sec
ISO	400	400
F-stop	f/1.8	f/1.8
GPS	NONE	NONE
Flash	OFF	OFF



## Q12 Aperture and shutter speed priority (A- and S-mode)

Aperture and shutter priority are camera settings that you can use when you want to achieve a certain effect. Instead of going through all the nuances of perfecting both the aperture and shutter speed for a shot, if I know what aperture I want, the camera will automatically use a shutter speed that will ensure the object is not under or over exposed. This is very useful when you want a specific type of shot but aren't familiar enough with cameras to know what values for each you will need.

Using the same photos as I did for shutter speed, you can see shutter priority in action here. I wanted to get the flow of the water, so I knew I needed a long exposure. I set the shutter speed at 4 seconds and I let the camera set the f-stop or aperture. If I had left the aperture at f/5.6, the photo would likely be entirely over exposed and useless to me. But using shutter priority allowed the camera to reduce the size of the opening, controlling the light that was let through to account for the fact that the shutter would be open longer and hence let more light in that way.

In general, a key part of photography is lighting and we as photographers have three key ways to control it naturally in our photos - ISO, shutter speed, and aperture. Its always a balance between the three and what composition you're ultimately trying to achieve, so the aperture and shutter priority settings on your camera help with that.



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<b>F-stop</b>	<b>f/5.6</b>	<b>f/14</b>
GPS	NONE	NONE
Flash	OFF	OFF