

**Exercise & Sports Biomechanics**  
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**Week 07**  
**Lecture 35**  
**Camera Settings**

[Hello, everyone! Welcome back to this course]

From the previous lecture, you have started exploring the hardware that is applicable in exercise and sports biomechanics. In this video, we will explore the next hardware tool: videography. Before going into the depth of videography, you need to understand the difference between an image and a video. For that, I have opened the Kinovea software, and as we discussed before, you can see the number of cameras connected to my laptop. I will connect one of the cameras available here to display the medium. Immediately, you can see me via the Kinovea software. Now, we need to understand what an image is.

**What is image?**

An image is a single captured moment with respect to time. So, that particular moment will be frozen, for example, there is the camera icon at the bottom of the software. If I click that, immediately one image pops up below the video screen. If I double-click that, another window will pop up with that particular image, so from here I can do further analysis, similar to what we discussed in another software, DirtFish. If you are analyzing an entire scale, we can able to segregate the particular faces with the N number of images using the tool called strobe motion.

**What is video?**

Video is a series of images which is played sequentially to create a movement. In normal cameras, the videos will be recorded either in 25 fps or 30 fps.

**What is mean by FPS?**

FPS means frames per second. The number of images the camera captures per second is known as FPS. If your camera is recording with NTSC video format, then it will be recorded in 30 FPS. Or if your camera is recording in PAL format, It will be recording in 25 FPS.

Let us explore in the software. If you click the settings icon, there will be an another window will pop up. You can able to see the what is the streaming format and what is the image size. It's a full HD and here comes the frame rate, which is the FPS. If you click the drop down, you can able to see 30 frame rate or 25. In addition it has given 24 frame rate also, as and when this frame rate is increasing then the movement of the speed will decrease that is what exactly we need in sports biomechanics. In addition, there is a option called device property pages if you click that there will be an another window will pop up in that go to the camera control. There are multiple options out there. The first one is zoom in. I can able to zoom in the image and I can zoom out the image. The second one is the focus.

Right now the camera is focusing on me as a subject. If you change the values, it will start focusing on the objects which is behind me.

Next, there is a provision in this camera to pan, tilt, and roll which means you can able to change the camera to the left right. So, if all the settings are fine then press apply and then okay, so you can able to record any sporting movements. Now we will close this camera and now i will open my laptop's web camera on this Kinovea software. Now you can able to see a very big difference in the clarity of the images. Again I will go to the settings. Now you can able to see a two different options which is exposure and gain.

### **What is mean by exposure?**

It defines the amount of light which enters into the camera. Right now, it is in auto exposure. If I uncheck that, you can see how my background has totally changed. Now, the excess light is entering the camera. If I reduce the exposure, now you can see the amount of light is very low, and it has become dark. So, as I increase the exposure, the light enters the camera, and you can see me very clearly. If I choose auto, you can see me very clearly. If not, there will be some glitches. So, again, I will go to exposure and reduce the exposure.

### **There is another option called Gain. So, what does that mean?**

If the environment is in a darker condition or low light condition, you can artificially gain the light. So, I am going to increase the gain. Now, you can see the difference. Now, the image is getting brighter compared to the previous one. So, I am going to set the maximum gain, but if you notice that there is some kind of noise in the video which is known as grains. So, as and when if you are increasing the gain there will be a noise if you want to reduce the noise you can reduce the gain and increase the exposure level, so that there will not be any noise in the images or videos. To understand the exposure in depth, you need to know the concept called the exposure triangle. Which is the aperture, shutter speed and the ISO. This is the crux of the camera for video recording.

First, let us understand how the camera works. In olden days, there is no such provision to record these images. The first camera idea came from ancient China and Greece. It was just a dot box with a small hole that project an image in an upside down manner. All the artist needs to trace them manually. Even in India, there is a Shiva temple which resembles the same technology, which is pinhole camera or camera obscura.

### **What is meant by pinhole camera or camera obscura?**

A pinhole camera is a simple box with a tiny hole on one side. The light enters through through the hole and creates an upside down images on the opposite side of the box. It does not use any lenses. It is just light enters through a hole and project an image. In this slide, you can see there is a hole on the left side of the image which is taken from the temple. If we look into the hole, we can able to see the temple. As we discussed, the light enters into the hole and project the inverted image of the temple. This temple was constructed almost 1000 years back. This is how the pinhole camera works.

[Next, we move on to cameras which is either DSLR or camcorder]

### **DSLR or camcorder:**

It works similarly like the pin hole camera works. The light enters through the lens and there will be an aperture which helps to control the amount of light enters and it reaches the Mirror. It will be placed in an angle, So that it redirects the light. To the prism. This is the prism which helps us to see the person or object through the eyepiece. This is the eyepiece. What do we usually do? When we press the capture button, we immediately get the picture. So, what exactly happens in this phase?

Once we press the button, the mirror lifts up. You can see the mirror lift up and see the shutter. Behind the shutter, there is a sensor to record the image. Every time we press, the shutter opens so the sensor can record the image. This is how the camera works. Once it is done, you can see the mirror will return to the same position. If you click again, the mirror will lift up, the shutter will open, and the sensor will record the image.

### **Nowadays, cameras come with mirrorless technology. What does that mean?**

In this, the process is very simple and similar to normal cameras, but there will not be any mirror or prism for viewing through the eyepiece. If you see this image, there will be only the shutter and the sensor. When you press the capture button, the shutter will open, and the sensor will record the images. This is applicable for both images and videos.

### **Next, let us explore the camera in more detail, using our human eye as an analogy for comparison:**

Imagine, your eyes and the camera work the same way. Both capture light, focus on objects, and create a clear image. Your eye and the camera both have parts that control light and focus. For example, the camera lens is like the cornea in your eye. The aperture in the camera is like the pupil in your eye. The eye and the camera both need light to see or capture a picture. Without light, neither your eyes nor a camera can work properly.

[Next, we move on to aperture].

### **Aperture:**

Aperture is simply the opening of the camera lens that controls how much light enters the camera. Think of it like the pupil of your eye. I am sure everyone has been to the cinema theater, right? Imagine you are entering the theater when the hall is dark. Initially, you cannot see anything. But after some time, your eyes will adjust, and you begin to see things in the dark. This happens because your pupil expands to let in more light. Now, when you step outside into bright sunlight, at first, you will definitely struggle to keep your eyes open. They try to reduce the amount of light entering your eyes. After a few moments, your pupil shrinks to block excessive light.

The camera lens works exactly the same way, adjusting the aperture to control amount of light that enters the camera. just like your eyes adapt to different lighting conditions. In simple, if you are taking a picture or recording a video in a dark place the aperture needs

to be wider to let in more light. Alternatively, If you are going to take a picture or recording a video on a brighter sunny day, the aperture needs to be smaller to avoid overexposure. The aperture is measured in f-stop numbers. At the bottom, you can able to see the aperture which is highlighted by the green color and you can see the values, currently, it has written as f by 8.0. In the cameras, you will exactly see the same. For example, like f by 2.8, f by 4, f by 8, f by 22, etc. The most important thing to remember here is the smaller the f number, the bigger the aperture opening. Let me show you here. Now currently the F value is 8.0. If I am increasing the aperture value, the aperture opening will be so small and vice versa if I am decreasing the value, the aperture opening will be bigger.

As we discussed before, you can able to see currently the F value is 2.8 which means the aperture opening is bigger where the excess of light is entering into the camera. That is why the apple is overexposed. If I am reducing to F by 8.0 which means it is evenly the light is distributed if i am increasing the aperture then the apple looks darker because the amount of light entering into the camera is less. Now, as like a camera if i want to take a snapshot, i have taken a photo but you can see it has clearly mentioned the photo is still overexposed.

So, what exactly I need to do? I need to increase the aperture where f by 8.0 in this the light is evenly distributed. If I am taking a snapshot now you can see the exposure is optimal with the aperture f by 8.0. There is another example with the human where you can try with decreasing the aperture value you can see the background is dark and the skin texture is lost. If i am keeping f 8.0 you can able to see the color of the skin is become natural. If I am increasing the aperture value, you can able to see the amount of light entering into the camera is less and we can not able to see the image very clearly.

If this is the case in sports application, it is very hard for the biomechanist to digitize the information in a specific sports analysis. So, the aperture not only controls the brightness of the image. It also affects the depth of field, which determines how much of your image is in focus. Let us explore this in detail.

When you use a bigger aperture like 1.4 or 1.6, the background becomes blurry. You can see on the screen, the first column is very clear, and as it goes behind, the background is very blurry. This is called a **shallow depth of field**. For example, in football, if you want to capture only the football player dribbling with the ball, you need to use a bigger aperture. That will make the player sharp and the background blurred. Now, if you use a smaller aperture where the numbers will be like F11 to F22, Then the entire image will be sharp and clear. This is called a **deep depth of field**. For example, in football, if you want to capture the entire stadium with the players, the crowd, and the field, everything should be in focus. Then we need to use a smaller aperture. So in simple terms, A bigger aperture means there will be a blurry background, while a smaller aperture means everything will be in focus. If the focus position changes—for example, if it is currently closer to the camera or further away—what exactly happens? If it is closer, and if the aperture is big, you can see the blurry background. As and when if I am reducing the aperture, you can able to see all the cubes very clearly. If I am changing the focus position to far, and currently the aperture value is less, you can able to clearly see all the cubes if I am increasing the aperture then you can able to see which cube was in focus, which means if you are even manually focusing on a specific person or an object with the help of aperture

we can able to blur the background to get the clearer information of the particular person or object.

[Next, we move on to shutter speed, which is the most important component in sports biomechanics].

### **Shutter speed:**

The shutter speed is also known as exposure time. Shutter speed is the amount of time your camera shutters stay open to allow the light to reach the sensor. In this image, you can able to see when the sensor is opening, so that the light enters into the sensor to capture the movement.

In simple, we need to know how long your camera takes to capture a single image. Think of your eyes. What happens when you blink? The faster you blink, the less time your eyes are open. The slower you blink, the longer your eyes are open.

This is exactly how shutter speed works in camera. Shutter speed is measured in seconds or fraction of seconds. For example, if your shutter speed may be 10 seconds long which means the camera sensor is exposed for a full 10 seconds or it could be much faster, for example 1 by 1000th of second and it can go up to 1 by 8000th of second.

### **Why shutter speed is so important?**

Because shutter speed controls two important things in videography. How much light enters the camera which is exposure. We have already discussed in Kinovea software practically, and then how motion is captured. If you do not understand the shutter speed then the video will be blurred, which is known as motion blur in videography.

[Next, let us understand **how this shutter speed affects the exposure**].

### **Fast shutter speed:**

Fast shutter speed means we are going to record the video or an image with 1 by 1000th of a second or up to 1 by 8000th of a second. If you look at this image, the highest shutter speed which they have recorded was 1 by 2000th of a second. In the fast shutter speed, the shutter opens and closes very quickly, allowing only little bit of light into the sensor. That is why you are seeing the last image a little bit of dark. For example, if you are taking a photo or a video in a dim light room or in the late evening, with the fast shutter speed, your photo or video may come out too dark.

### **Slow shutter speed :**

The other one is the **slow shutter speed** which means the video will be recorded 1 by 4th of the second as minimum as possible. In this image you can able to see it was recorded by 1 by 60th of the second. What exactly it means? In this slow shutter speed, the shutter stay open a bit longer which allows more light into the sensor. For example, even in the low light condition, if you are using a slow shutter speed, it will help you to get bright images and videos for further analysis.

[Next, we will explore **how does shutter speed influence motion**].

The major role of shutter speed is to freeze the movement or create a motion blur effect, it all depends on shutter speed. When the shutter speed is very fast it captures the moving subject without any blur. In the image you can see the spinning pinwheel, which is recorded with 1 by 500th of the second you can able to see the image very clearly. So, in the fast shutter speed everything looks short and it can be frozen in particular time and that is why this shutter speed is very much important in sporting movements. For example, in athletics, the athlete's leg and body appears completely frozen in motion when we take a snapshot or record a video in faster shutter speed. Alternatively, if you are using a slow shutter speed, which means the shutter stays open for a longer time, it captures the motion blur which you can see in the first spinning pinwheel. For example, in athletics, if you are replicating the same movement and if you are recording the video with the slow shutter speed, the legs and body will not appear completely in motion because it was recorded in the slow shutter speed. With this type of video, we can not do any kind of biomechanical analysis.

Let us apply the shutter speed in the sporting movement. Now, the skater is performing where you can able to see the shutter speed is 1 by 250th of a second. Here, the motion is completely frozen and the image is sharp. If I am reducing the shutter speed, as and when I reach 1 by 60th of a second you can able to see the blurriness in the foot and the face and I will reduce further you can able to see the motion blur very clearly. If I am moving further, we can not able to even see the athlete. So, that is why in sports biomechanics, the shutter speed is going to be the important tool to analyze any kind of sporting movement. Higher the shutter speed, we will get the frozen image and sharp image.

[Next, we move on to another important concept in the camera setting called ISO].

### **ISO controls:**

ISO controls how sensitive your camera is to light and it plays a big role in videography, especially in low light situation. What is ISO? ISO is a setting that controls how much light your camera sensors can pick up. A low ISO means less sensitive to light while high ISO makes the camera more sensitive to light.

ISO values range from 100 to 6400, but some cameras go even higher or lower depending on their technology. Then, how does this ISO affect the photo or video? When we adjust the ISO, we are telling the camera how bright or dark we want the image to be. At a low ISO, for example, ISO 100 or 200, there is less light sensitivity.

But for the camera, we need more light to get a clear image, right? So, a low ISO can be best used in daylight conditions where too much sensitivity is not needed. Alternatively, a high ISO, maybe ISO 3500, has more light sensitivity, where the camera becomes more sensitive to light, so you can take pictures in dark places even without a flash. But the downside is that when you increase the ISO, it also creates image noise, which is known as grain. I hope you remember we have already discussed a similar concept in the Kinovea software practically, but in different terminology, which is known as gain.

Let us explore how ISO works with the help of this application. As we discussed before, the values range from 200 to 6400, but here we have 3200. Since this photograph is in

daylight, we can choose a lower ISO value. Right now it is ISO 200, with this we can able to see the skin color is normal and the background is very clear. As and when if I am increasing the ISO value you can able to see there is a change in the texture of the skin and there is some noise already started in the image. If I am increasing to the maximum level up to 3200 you can able to see some kind of dots over there. Those are known as grains.

Even if I am zooming in to a specific phase or the cloth, it even very clearly shows that the ISO values will create more noise in the images. So, if you are working on the daylight situation, then you have a low ISO value, to have a good quality images or videos.

[Next, we move on to focal length].

### **What is focal length?**

It is the distance between the camera sensor and the lens when focusing on a subject. In simple, with the help of focal length, we can decide how much of a scene you can capture in a single frame. Imagine, if you are choosing a shorter focal length, for example, 16mm, it captures the wide area. This is called wide angle lens. In this image, you can able to see that it covered a vast area. Alternatively, we will go to the right hand maximum which is the longer focal length for example 50 mm it captures the narrow area this makes the subject looks like a it zoomed in. let us explore with this application, so as we discussed if the focal length is less you are having a wide area because it is using the wide length. As and when it increases the focus length it is narrowing down the particular place like it is zooming in, that is why the focal length is so important if you are recording a specific spot where you want to zoom in this focal length will definitely help you to choose whether you have to choose the short focal length or longer focal length.

The advantage in the focal length if you fix the focal length once even if you pan the video the focal length will not change that is the advantage of the camera. Because, in sports application we need to pan the video, tilt the video, so that we can able to capture the entire movement of an athlete.

In summary, the exposure triangle makes a big impact on how you record the sporting movements. So, choose the right camera which is the hardware, record the video and analyze the performance.