**Exercise & Sports Biomechanics**
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**Week 04**
**Lecture 18**
**Kinovea**

[Hello, everyone! Welcome back to this course. In this video, you will explore the open-source software Kinovea].

**Kinovea: an open-source software**

Kinovea is designed for motion analysis and biomechanical research. In this, you can capture the video, slow it down, and compare the performance of the athlete. Further, you can annotate the important information as we discussed in qualitative analysis. Finally, there are some interesting tools to measure movement. Let us dive into it.

**First, let us explore the software's graphical user interface:**

Open the Kinovea application. This is the software's home screen. At the top, you can see File, Edit, and View, known as the menu bar, and below that, you can find a few tools for recording, known as the toolbar. On the left-hand side, you can find the different folders and video files, which are known as the Explorer panel. On the right-hand side, you can find the images listed in the Explorer panel.

All this information will be displayed on the right side, which is known as the thumbnail panel. If you click on any tool on the playback screen or capture screen, the screen panel will be displayed by replacing the thumbnail panel. Next, we will explore how to import the video. I have already created a folder named Kinovea.

Once I click that, you can see all the files listed in the explorer panel. Once I close the screen, the thumbnail panel will pop up, and you can see all the videos and images present in the specific folder. In the top right corner, you can see the blue boxes which help us change the size of the thumbnail.

In addition, if you right-click in the thumbnail panel, you can sort all the information in descending or ascending order. Again, if you right-click on the properties, you can see the different information that will be displayed over the image. For example, the size of the image is 1920 x 1080.

Next is the frame rate, 60 fps, and the duration of the video, 13.89. If you need the creation time, you can click on that, and it will be displayed over the image itself. If you do not want it, you can uncheck that.

Now you can double-click the image or the video that is displayed in the thumbnail panel. For example, I will take this squat. It is clearly labelled as an image. I will double-click that. You can see the image in the screen panel.

You can also use all the tools at the bottom. You can still annotate and provide feedback from this image itself. I will close the screen. And I will open the basketball video. You can play the video and you can provide feedback. It is as simple as that, as we have discussed in the Dartfish application. The advantage here is that the video you are seeing is not actually a video. It is a GIF image. In Kinovea, we can play the GIF image and provide feedback for the athletes.

Alternatively, you can open the video by clicking on the file and opening the video. A new window will pop up. It will help us to navigate where the videos are exactly, and then press open. The video will appear in the screen panel.

Once the video is opened, if you click on the image, the first thing is the **aspect ratio**. It will auto-detect, and if you want to reduce the size, you can reduce it to 4:3. And if you wish to increase it forcefully, you can make it 16:9. The next option is rotation. You can rotate the video. Sometimes when you record a video on a mobile, it might be in a vertical position. So, you may need to rotate the video accordingly.

The next option is the **mirro**r. Once you click that, you can see the exact mirror of that particular video. The last option is **Deinterlace**. As we discussed before, some capture devices store video using an interlaced format, which causes artefacts when the movements are too fast.

By clicking this, it will reconstruct full images by combining them. That is why deinterlacing is so important in biomechanical analysis. In the screen panel, you can see the size of the video: 3840 x 2160. The unit is pixels.

The entire video is now in pixels. And, **what is the frame rate?** It is 29.97. At the bottom, you can see the timing parameters and the total time of the video. I will play the video, go to the time option, and choose the first one.

This is already there by default. So, if I change to the frame number, you can clearly notice that instead of time, it is now displaying only the frame number. And we have multiple options. We will go only for milliseconds, and we can go for microseconds.

Lastly, there is an option to combine the time and the frame number. You can clearly see the information below the timeline. Both the time and the frame number are within the bracket.

**Moving on to the toolbar**. The first one is the open video. A new window will pop up. Navigate to the specific video you want to analyze and click open. The second one is the save annotation. If you have drawn any annotations on the screen, they can be saved but only in the Kinovea file. The third one is the explorer panel. Once you click that, it will hide the explorer panel. If you click again, it will appear on the screen.

The fourth one is the thumbnail button. If you click that, from the screen panel, it will direct you to the thumbnail panel.

The fifth one is the single playback screen where you can import the video. And do the analysis. The sixth one is the two playback screens. I will drag the same video but from a

different perspective for further analysis. Here you can compare the video, overlay the video, sync both the videos, and provide feedback to the athletes.

The next one is the capture screen. Where you can capture the video live. The next option is the two capture screens. If you have two devices, you can capture both videos live and provide feedback live using the tools below. The last one is one capture screen and one playback screen.

This means that on one screen, I can do the live video, and on the second, I can drag the existing video. And lastly, if you are going to capture a screen, you need to connect with the cameras. For that, below, there is a camera explorer. Once I click that, I can drag the camera to the screen and go for live recording.

**Next, we move on to drawing tools and other functionalities below the screen panel**:

First, press the play button to play the video, and you can click the same button to pause the video. The next button on either side is for going to the next frame. On the right side, for every click, the frame will move forward, and on the left-hand side, for every click, the frame will move backwards. Similarly, you can use the keyboard's right arrow and left arrow buttons to move forward and backward.

The subsequent button on either side is to either go to the end of the video or, if you press on the left side, it will return to the beginning of the video. Next to all these buttons, you can find a slider. You can increase the speed of the video or decrease the speed of the video. Let me play the video in slow motion and then make it faster.

Next, we move on to general tools. The first one is the hand tool. It helps us to move a specific line. For example, if I am drawing an arrow, with the help of the hand tool, I can move the arrow wherever it is required. The next one is the keyframe.

If I find that this is the important key position that needs to explain the information to the player or the coach, I will pass the video, and the second button is to add a key image. I can add a key image, and the third button is to provide comments for it. So, I can provide a comment on this. For example, the position of the player with reference to the ring was good. Once it is done, I can press the comment button again so that the window will close. If I wish to provide a comment for the first keyframe, I can select that particular frame, and then if I press the comment button, I can type comments for the players. If you want to delete the specific keyframes that we have created, just go to the key images, and there will be a cross symbol. Click on that so that all the key images will be removed.

**Next, we move on to the Tools**:

The first one is the **text tool**. If you notice that above the letters A and B at the top left corner, there is a small arrow. If I right-click that, it will show what other tools are available in that particular button, or if you click that button for a longer duration, again it will pop up, and the list of tools will be displayed. First, I will use the text tool. I can click anywhere on the screen and type the information that exactly the coaches or players need to see. I just typed the number of steps.

If you take your hand tool near to that text box, you can maximize the size of the text or minimize it. With the help of the hand tool, I can move this text anywhere on the screen. I will long-press this button and go for the second tool called Auto Numbers. Now I am going to identify how many steps the player has taken. For that, I will click on the screen with the right foot first, and I will play the video.

Second one, third, fourth, so the player has taken four steps. Now I will go back to the beginning of the video, and you can watch from the beginning. If you notice, the key images were generated at the bottom for each action.

The next one is the **pencil tool**. With this, we can create freehand diagrams. If you right-click on the line, there is an option called configuration. I can change the name of the circle, and I can change the color of it.

I can change the size and the line shape too. Once everything is done, click on apply. You can see the changes on the screen. And this one will be the specific key image for this. As a coach, if you need specific lines or colors which you need to maintain in the whole analysis, you can click on the color profile. On the left-hand side, it will pop up all the tools that we are going to explore, and on the right-hand side, you can choose the color of it and then press apply.

Next, we move on to the **magnifier tool**; for that, I have taken the fourth step, which we have done previously. And I will press the magnifier button. Now you can see the two boxes, the one which I am going to highlight and the other one which is going to zoom in on the particular object or a human. For example, if I am selecting this key position 4. On the left-hand side, you can drag this as a reference position anywhere on the screen. If I right-click that, I can zoom in up to 4x, and I can provide feedback to the coaches or athletes. If you want to play the video and track the player in the zoomed position, for that,

You need to right-click on the box and press the button 'Track Path.' Now, I will move the video frame by frame, and on the left-hand side of the magnifier image, you can see the tracked player based on the right side of the image. Further, if you want to explain the key position, play the rest of the video. For that, first, identify the key position, right-click on the image, and press the button 'Freeze.' So that the key position on the second image will not change, and now I will play the video frame by frame. You can notice that the image on the left is frozen. Alternatively, if you wish to magnify the video, you can press the 'Control' button and scroll up.

You can zoom in. With the hand tool, you can move the video according to your requirements and provide feedback to the athletes. If I press the 'Control' button and scroll down, it will zoom out again.

The next tool is the **spotlight**. It is used to highlight a particular area of the image by diminishing the rest of the image around it. If I want to track that particular player with the spotlight, I can right-click and click on 'Tracking.' If I play the video frame by frame, now you can see the entire movement was highlighted with the spotlight. The next important concept in biomechanics is time. Usually, in biomechanics, we will fix the origin point. From there, the video will be calibrated.

In Kinovea, We have an option to make the time an origin point. This means right now, we are at 0.93 seconds in the 28th frame. So, I will make this position the origin. So, the system will take this position as 00, and when I move forward, it will be in a positive direction, and if I move backwards beyond this one, it will be a negative value. You can see the timeline below; it mentioned negative 0.33 and minus 10 in the bracket. This is the 10th frame. You can see the red mark below the timeline, which is the origin time.

If I want to revert back to the zero position, I will go to the beginning and then click again to mark this current frame as the origin. If I want to reduce the working zone, I can identify where I need to start and where I need to end. If I play the video, in this video, the movement is initiated from the beginning. So, I will set the frame in from here. I will play the video.

As and when the ball enters the ring, I will set the last frame of the working zone. Now, if you see the timeline, the entire length was reduced to only 2.67 seconds. If I do not want to change it further, I can use the button to lock the work zone so that I cannot modify it. If I want to modify it again, I need to unlock the working zone, and only then can I edit all the functionalities.

**Next, we move on to Measurement and Analysis:**

First, I will zoom in on the video. We know that the distance from point A to point B is 5 meters. First, we need to calibrate the video. For that, we will use the line tool. Draw a line from point A to point B. If you notice, the measurements displayed on the video are in pixels. Now, I need to right-click on the line, and there is an option called Calibrate. Click on that. I will change it to meters, and this is a 5-meter line. Press Apply.

Now it is converted into 5 meters. Once the video is calibrated, we can measure the length of the segment. We will take the line tool again, zoom in a little bit, and mark it from the hip joint to the knee joint. I hope you can remember that even in Dartfish, we measured the length of the thigh segment, which is 0.80 meters, in line with the plane of motion. In addition to the line tool, there are multiple options to identify the length or distance parameter.

For example, we will take the arrow tool. We can draw an arrow from point A to point B. We can measure the thigh segment, or if I zoom out the video a little bit, I can draw an arrow from point A to point B to identify the length of the calibration. If I am doing this for point 2, you can notice that the values are decreasing as the lines move away from the plane of motion, which is the perspective error. We will go to the next tool, but before that, we will play the video and identify the lowest position in the squat. In the line tool, there is an option called distance horizontal.

I want to know the distance from the hip to the knee marker. So, if I click on the hip marker, I will drag the distance horizontal tool and place it exactly over the knee marker. Now, the distance between the hip and the knee marker is 0.51 meters. With this, we can interpret some of the information biomechanically.

Alternatively, we can calibrate using the arrow tool. Draw an arrow from point A to point B, and you can see that it is showing in pixels. Right-click on that. Go to calibrate, change

to meters or whatever unit you require, and we know the actual length is 5 meters; then press apply. If I use the arrow tool again, it can be used to measure the length or distance parameters.

**Next, we move to the Perspective Grid**:

Previously, we made a line calibration. With the help of the perspective grid, we can calibrate the entire space that we marked. For that, if you click the perspective grid on the screen, it will display a grid where we can calibrate and reposition the perspective grid according to the origin of the marker.

For better visualization, I will change the colour of the perspective grid to yellow and then apply it. Now, you can see the origin point. So, I will drag that to the marker and in all four corners. If you right-click the grid, there is an option called calibrate; a new window will pop up, and it will ask for the length and breadth measurements.

So, we know 6 x 10 meters. You change to meters and then apply. Now, we can use either the arrow tool, line tool, or distance tool. Now, we have three options to check the distance or the length parameters from one point to another point. So, we will take this distance tool.

If I click that, I will adjust the origin point and then check whether it is exactly 5 meters or not. Now, the perspective grid is working perfectly. So, for the purpose of the perspective grid, we have measured the two markers that are nearer to the camera. If we take it further, we already know that there will be a perspective error.

If you notice, it is 6.65. Since we have calibrated using the perspective grid, I will now bring this information to the specific marker. You can see this is approximately 5 meters. Even if I take it to the last marker, I can reduce the line, and you can see this is approximately 5 meters. This means that with the help of the perspective grid, we can minimize the camera's perspective error.

Next, in Kinovea, a new tool, known as the distance grid, was introduced. It works similarly to the perspective grid, but there is a small change in it. First, I will bring the marker to the origin point and connect all four markers. When you calibrate it, it asks for plane calibration.

Enter the distance from the origin of each marker. There is no width information. Only the length information is there. This means a starts at 0, and B will be 10 meters. In our example, if I apply it, you can see the origin point with 0, the middle with 5 meters, and the endpoint with 10 meters.

Now I will use the arrow tool to check whether it is calibrated to 5 meters or not. Now you can see from point A to point B is 5 meters. As I move away from the camera, I will check whether in the middle it is around 5 meters or not. It is approximately 5 meters. Again, at the end, I am checking if it is around 5 meters.

Even with the distance grid, we can minimize the perspective error. But only in the specific plane. We know from this point to this point that we have done 6 meters previously, but

the system is unable to detect that information. So, it is very important to know that the distance grid will work only in the specific plane of motion. The next one is the clock tool.

Once you select it, click anywhere on the screen to see the clock tool. As and when you start to play the video, by default, it will display the current video time. I will pause the video. You can see we are in the 388th frame, which is displaying on the screen. If I move somewhere in the middle, you can see the current time is 54.98, and it is reflected on the screen.

In addition, you can create multiple clocks based on the requirement. I will go back to the beginning. I will right-click on the clock, and there is an option called configuration. I will change the name to zero meter and press apply. Right-click on that, and there is an option called show label.

So, the first one is a zero marker. So, I will play the video. Make it a little bit faster until he moves to the next position. Now I wish to create another clock. Click on that tool again, make it a little bigger, and right-click on that configuration. Now I'm going to change this into This is from the third meter. Right-click, show the label and define the custom time origin.

For example, now I want to start a new timing for this three-meter position. Then right-click on the tool and click on 'Mark current time as time origin' for this clock. Now it becomes 00. Now I will play the video. Until it moves to the last position.

So, I can create another clock, with the new time origin. And I will play the video. If I bring the time back, now you can notice that from this origin time, it is coming to negative, which means it is in the second position. I will bring it even beyond the second position.

You can see it is again negative. So, this is the advantage of the clock tool. Imagine that if you are performing any kind of skill and if you want to define the exact execution as the zero point, all the preparatory phases will be in the negative, and execution follow-through will be in the positive.

**Next, we move on to the Stopwatch**:

As you know, we can measure the time interval, which is similar to a normal stopwatch. If I play the video, you can see the timing is not changing in the stopwatch. So, we have to start it manually. For that, right-click on the stopwatch, and there is an option called Action. Start a new time section on this frame.

Once you click that and play the video, you can see the changes in the stopwatch. I want to go for a split time; for that, as and when the player is moving to the 3-meter line from zero, I will right-click the stopwatch again and go to the action. There are two options: either I can stop the current time section on this frame, or I can split it and start a new one. I will go for the second option and play the video. When he starts the third one, I will go for the action again.

I will split the time again. And now you have three different split times. What is the time he has covered for the first 10 meters, the second 10 meters, and the third 10 meters? So

you will get the first 10 meters as 4.17 seconds, the second as 4.35 seconds, and by combining it is 8.52. The third one is 4.18, and by combining it is 12.70. So you know the distance and time information. Based on this, you can compute linear kinematic variables like speed, velocity, and acceleration.

**Next, we move on to an important tool called a Marker:**

I will click the marker anywhere on the screen. You can notice that the unit of the marker is in pixels, which means the video is not calibrated. I will go to the line tool. You know there are two markers over here. From this point to this point, I will right-click on the calibration. Calibrate. You know this is 5 meters now. And then press apply. So, you can immediately notice that the information in the pixels has changed.

I will click the marker again and zoom in a little bit. We know this is an origin point. If I place the marker randomly anywhere on the line of the calibration tool, you can see the number 1.15, which means the marker is 1.15 meters from the origin. Even when going exactly to the end, it is approximately 5.07 meters. So, based on the line calibration, we can identify exactly where the marker is located from the origin point. If you notice, the random marker we placed earlier was at 0.61 and 1.62 meters. According to the line calibration, 0.61 meters is correct, but the value of 1.62 meters for the width is not the correct value. So, pay close attention to this error. To address this, we need to perform perspective calibration. I am selecting the perspective grid. Changing the color first. Identify the area. Now, right-click and press the calibrate button. You know, 6 meters and 10 meters. Change to meters and then press apply. I will right-click again.

Make the visibility custom fading and change to fading after two frames, then play the video. Now I will choose the marker tool again. Now we know that this point is the origin 0. I will make one marker over here; you can see 0.06, and I will make a 5-meter mark. It is almost 4.90. Even if I go to the width, you can see this is 2.92 meters, which is 3 meters, as I already discussed. And I go to the right top corner, which is 10 meters and 6 meters. So, the width is 6 meters, and the length is 10 meters.

With the help of the perspective grid, we can identify the length and the breadth from the origin point for further analysis. In addition, there is one more option in the marker tool. I will click on the marker at the hip joint, right-click on the marker, and there is an option called tracking. Once I press the button to start tracking, the marker will be tracked throughout the movement. I will move the video frame by frame. You can see that the marker is tracking much better. Once the marker is out of focus, you can use the hand tool and bring it back to the marker position again. And play the video again. So, wherever there is an error, bring the marker position to the hip marker. So, we tracked one repetition of a squat only in the hip marker. With this, we can go for further analysis.

**Next, we move on to the Circle tool**:

Once you draw the circle, you can notice that the unit is in pixels. Which means the circle also requires calibration. I will go to the line tool again, and I will calibrate. You know, 5 meters apply, and you can see that it changed into meters. First, I will right-click that; I

will change the color of the circle, Go to the configuration and change it to yellow and apply. And again, right-click.

There is an option to press the show circle's center. Again, on the label, first, I will click on none. This means that you can use this circle for qualitative analysis. Now, Again, right-click on the circle and go to the label.

You can measure the radius, diameter, and circumference. First, I will click on the radius. Based on this calibration, this is 1.80 meters. Now, change to diameter, which is 3.61 meters, and the circumference is 11.34 meters. In addition, if you are using the same circle tool in the perspective grid, you need to identify the area first and calibrate the grid so you know 6 x 10 meters and apply. If you notice, the circle orientation was immediately changed. I am drawing a circle again, but if you notice, the orientation of the circle was completely changed. That is because of the perspective grid. Imagine that you can apply this type of circle in shot put and hammer throw.

[We have covered almost all the tools except the posture tool and the angle tool. So, try to practice with the sample video. If there are any queries, feel free to post them on the Q&A forum].

[So, thank you, and see you in the next video].