Exercise & Sports Biomechanics
Dr. Viswanath Sundar
Department of Physical Education & Sport Science
Visva-Bharati University, Shantiniketan (WB)
Week 04
Lecture 19
Kinovea (Continued)

[Hello, everyone! Welcome back to this course].

In the previous video, we covered how to import and calibrate the video using different tools. In addition, we covered all the basic functionalities in Kinovea.

[Next, we move on to the **Angle tool**]

Before that, the basic step is to calibrate the video. I will go to the line tool. Zoom in the video. You know the point from A to point B. Right-click on the line. Press calibrate. Choose the meters, i.e. 5 meters, and press the button to apply.

Imagine that if the plane of motion is not perpendicular, then we need to use the perspective grid first and then go for angle measurement. Click on the angle tool. There are multiple options there. The first one at the bottom is the simple angle tool. The above one is the goniometer, and the first tool was used to measure the angle with reference to the vertical and horizontal.

First, we are going with the simple **angle tool**. We need a minimum of three points to identify the angles. I will click on the knee marker, use the hand tool, drag it, and place one marker on the hip and another marker on the ankle.

By default, the angle will be in the counter-clockwise direction. If you wish to change the counter-clockwise, you have to uncheck the counter-clockwise. You can see the negative symbol over there, which indicates the clockwise direction. If you do not want it, you can click on the counterclockwise again. If you want to track the angle, right-click on the tool, and there is an option called tracking; press the button to start tracking.

Play the video frame by frame to check whether all three markers are tracking perfectly or not. If you find any mistake, you have to reposition the marker. We have tracked the knee angle for one repetition. If you want to change the color of the angle tool, right-click and go to the configuration, and then choose the color.

You can choose the color and press apply. In addition to clockwise and counterclockwise joint angles, you can choose the supplementary angle. What is meant by that? When we add two joint angles, it should be equal to 180 degrees. For example, here you are seeing 67.7 degrees. If I remove the supplementary angle, the counterclockwise angle is 112.3 degrees. If we add both angles, we will get 180 degrees, which forms a straight line along the joint axis.

The next tool is **the Goniometer**:

It helps to measure either flexion or extension of a body segment relative to a referenced anatomical position.

Steps: Right-click, go to the configuration, and first change the color. In Kilovea, we have three lines to differentiate the goniometer. The first one is the thick line; this is the stationary arm. The line with the arrow is the movable arm, and there is a dashed line. It helps to define the reference axis. So, the foot is the stationary arm, and the shank is the movable arm. So, the angle between the foot and shank, the movement is dorsiflexion. The angle is 65.5 degrees.

The next tool is **the angle to vertical**:

Angle to vertical is the relative angle with reference to the vertical axis.

Steps: go to the angle tool, choose the angle to vertical, and click on the image. The first step is to right-click on the tool, configure it, and change the color of the tool. Here, the dashed line is the reference axis.

In cricket bowling, lateral flexion plays a crucial role in generating the pace of the bowling. The upper body is bending toward the non-bowling side. We should know how many degrees the bowler is performing. Here, the example is 138.7 degrees. This data will help the coaches and sports scientists enhance performance and prevent injuries.

 The next tool is **the angle to horizontal:**

Angle to horizontal is the relative angle with reference to the horizontal axis.

Steps: Go to the angle tool, select the angle to horizontal, and click on the image. First, change the color of the tool and apply it. The dashed line is the reference axis. In shot put, the release angle is measured relative to the horizontal axis. Here, in this example, the angle of release is 44.1 degrees. Based on this information, Coaches can provide better feedback for the athletes.

Next, we move on to **advanced biomechanical tools in Kinovia:**

The first one is the **human model**-

Steps: Click on the human model and click on the image. You can see a stick figure of the human model. So, we have to drag all these points. For example, the left shoulder. Elbow and wrist, right shoulder, right elbow and wrist. So, this is the hip marker, right knee, left knee, foot, and then toe point. Similarly, for the right leg. Once you complete the mapping of the points, right-click on the tool, go to options, and lock segment length. Right-click, go to options, and you can click on display knee angles. So, you can see the knee angle in this perspective. Basically, this model is the replica of pose estimation.

Based on a single point, you can measure the joint angles from the specific image. I will go to the tools again. Click on the human model. In this model, you can see some extra points in the human segment. For example, in the pelvis and in the foot markers.

If you look very carefully at this model, you can see there is one blue-coloured line. It defines the center of mass. I will right-click on the model, go to the options, and click on the button called 'Display Coordinates of Center of Mass.' Right now, you can notice that this is in pixels. I hope you can calibrate the video and get the data out of this model.

The next tool is for **Bike Fitting. What is the purpose of this?**

It ensures an optimal riding position by adjusting the bike's saddle height, handlebar, and pedal alignment to maximize efficiency and prevent injury. In turn, it helps the athlete physiologically to improve power output and reduce strain on the joints. For example, the knee angle should be around 25 to 35 degrees at full extension to avoid excessive strain on the patellofemoral joint.

We move on to the next tool **called Archery:**

Steps: click on the tool, select the archery button and click on the screen. Next, right-click the configuration and change the colour of the model first so that it will be visible very clearly. Now, the orientation of the tool is not perfect, so for that, I have to right-click on the tool. And click on flip vertically. And you can try flipping horizontally one more time. Now, the arrow is pointing to this side and head. So, I will map the shoulder point. Left shoulder, right shoulder, and elbow. Again, align the shoulder and elbow. There are two important things in this. The first, the dotted line, is the line of force, and outside that is one line, which is the shoulder line. As and when the angle between the elbow and the line of force is increasing, it is very difficult to execute the arrow effectively.

It is advisable that the line of force and elbow joint angle be lower. With a simple tool, the coach and biomechanist can provide feedback to the athletes.

Next, we will explore **the scatter diagram:**

It displays the position of the marker in the video. For that, the **first step** is to click on the grid. Perspective grid. Identify the area. The axes are based on the calibrated coordinate system. So, right-click that and then calibrate. For this example, I will just give 20 meters by 20 meters and then press apply. Now, I am going to use the marker tool and track the basketball player. I will click on the player. Next step.

So, I will click on all the points. So that we can visualize that in the scatter plot. The caution here is when you are performing this scatter plot, the video should not be panned. The camera should be fixed. If you change the perspective of the camera, there will be an error. Once it is completed, go to the tools, and there is an option called scatter diagram. Click on that. Now, you can see the path of the player. Similarly, you can plot the object, plot the ball and even plot the player's movement. On the right-hand side, you can export the graph or export the data. For example, if I click the button 'Copy to Clipboard,' I go to PowerPoint and then paste it. So, I go back again if I want to save the file, click on that. NPTEL Kinovia video, and then I save here a scatter plot. There is an option to export the data also. I will copy the data, go to PowerPoint, and paste it so that you can visualize the raw data. I can export the data in CSV format.

Next, we move on to **Linear and Angular kinematics**:

The **first step** is calibration. I will take the perspective grid and identify the markers: right bottom corner, right top corner, and left top corner. Once it is done, right-click on the grid and press 'Calibrate.' The width is 6, and the length is 15 meters, and then press 'Apply.' I will right-click on the grid again. Make the visibility a custom fading.

Immediately after the two frames, it fades. I will play the video. Now, we are going to use the angle tool. I will zoom in a little bit. I am clicking on the knee marker, one to the hip and the other one to the ankle marker. Right-click on the angle tool and press the button 'Start Tracking.' I will play the video frame by frame, and if there are any mistakes in the angle, we have to reposition that. We will do one repetition for the knee angle. Next, I will click on the angle tool again and create one more angle in the shoulder joint. So, I have already created an angle in the shoulder joint, and it was tracked for one repetition of the squat. Now, go to the tools, and there is an option called 'Linear Kinematics.' Here, you have the option of Angle 1 and Angle 2, and we have three markers for that. I can choose either one, and in the data there is an option for all the kinematical parameters. For example, I will take only one marker, and I will plot the horizontal position. In the time, we can change from absolute to relative, or it can be normalized. The advantage here is that you will get the horizontal position, vertical position and total distance covered, Relative horizontal displacement, Relative vertical displacement, Speed of the particular marker, Horizontal velocity, Vertical velocity, Acceleration, Horizontal acceleration, And vertical acceleration. These many kinematical parameters can be analyzed in Kinovea.

A similar process, which we have done before, you can copy to the clipboard and save the image or data to a file. Now, I am going to choose again and click on the angular kinematics. You can see Angle 1 and Angle 2. Here, I am able to check the angle data. Maybe I can choose only one, and I can change it to normalize. Or relative. Or absolute. So, I will go back to normalized, and I will go for total displacement. Similarly, we have angular velocity, tangential velocity, angular acceleration, centripetal acceleration, and resultant acceleration.

All this information can be retrieved from angular kinematics, and you can export the data to the clipboard or save the file to your specific folder. I will close this and again go to the tools, where there is an option called angle-angle diagram. What is meant by that?

It is a graphical representation that shows the relationship between the angles of two joints during a specific movement. It helps to analyze the coordination and joint interaction in all dynamic activities. By combining angles 1 and 2, you can identify the angle, the angular velocity, and the tangential velocity. You can export the graph and data as we discussed before.

So far, we have learned about different tools for analyzing videos. At the beginning of the video, we explored how to import the video into the Kinovea software. So, initially, we used one playback screen or two playback screens. Now, let us explore how to make a live video recording. For that, we need to go and click on one capture screen. You can see a violet line at the top.

Currently, no video source has been identified. For that, we need to go to the camera explorer. You can see that one is the laptop camera, and the other one is the web camera I

am using. So, I will use the web camera and then drag it onto the screen. It will take a few seconds to bring the video live.

Right now, you can see me live with no lag in the video. Now, you can explore There are a few functionalities available below the video screen. We have already explored all these tools and we can apply them live. For example, I can calibrate the video that is running live, and I can do the measurement.

Below that, there is an option where I can take a snapshot of it. The image is already saved in the keyframe. If needed, I can record a video. You can notice that the violet color band is now converted into red, indicating that the video is recording. Once the movement is completed, we can stop recording.

So, the recorded video will be displayed in the keyframe. We can replay the video from here or stop it. On the left-hand side, there is an option called capture history. Below that, all the recorded videos will be listed out and you can go for a replay.

Next, we move on to **live delay**:

This functionality is highly beneficial for coaches who wish to provide feedback immediately. For example, if I am performing any movement, and as soon as the movement is completed, I can come back and watch the same action so that the coach can provide me with better feedback. There is an option for delay at the bottom. You can increase the seconds or you can use the slider bar.

If you are using the slider bar, you can see the time has changed. Now, it is already the voice is not synced because the video is playing on delay. Now, I brought the video back to live. If I am performing any movement, if I am making a delay, you can see the action was repeated.

During live or in delay, you can record a video and provide resources for the athletes. I hope you understand how the delay function is working. You can try with your simple laptop web camera and Try to provide feedback for the athletes.

Next, we move on to **the 2-play tab screen:**

2-play tab screen means you can compare the video and overlay the video to provide feedback. You can drag the videos to the screen. First video and second video. I hope you remember all the functionalities we have discussed before. And now, we need to first sync the video. For that, we need to identify the specific moment where we can sync it.

In the left-hand video, I need to identify where the drawing is initiated. It is initiated at the beginning. In the right-hand side video, the athlete is bringing the bow down, and then he is initiating the drawing movement. Once the point is identified, a red icon will appear that helps us to synchronize the video with this current frame.

So, I will click on that. You can see a red icon in the time frame. Now, I will play the video. I will go frame by frame so that you can compare if there is any difference. Though the athlete is right now in the aim position.

On the left-hand side, the athlete has already released the arrow, but on the right-hand side, the aim time is a bit longer. In addition, you can swap the video from left to right or right to left. There is another option called **superposition,** where you can overlay the video one above the other and you can compare the differences. Now, I will play the video.

You can see there are two videos moving, and from there, we can clearly provide feedback for the athletes. I will go frame by frame. Now, you can clearly see that in one video, the aim time is much longer compared to the other. And finally, there is an option to export both images. Or you can export both videos together.

The last one is we will explore how to export the images and videos. For that, we will take simple keyframes. We will identify how many steps the basketball player is taking (1,2,3,4). Right now, we have four key images. In the bottom right corner, we have five different options. The first one is to save an image. So, I will click on save image. A new window will pop up. If you notice, the file name we are going to save is the file name of the video. And the time frame, currently, we are going to save the image. In the Kinovea software, you can see we are at 1.27 seconds. It is reflected in the file name. Press save, it will be saved in the folder. The second option is to save in the sequence of images. Click on the icon.

The name of the file is Basketball. I will give it as adding 123, and you can save it as JPEG, PNG, or Bitmap, and then press save. A new window will pop up for configuring how many images need to be exported. For example, here, currently, you are seeing 18 images. If I increase every image after 500 milliseconds, then it is reduced to 10 images. So, I will increase it to the maximum so that we will minimize the numbers for educational purposes. So, you have to do trial and error before saving these images so that you can provide better feedback and reports based on these images. So, if I press save, it will take a few seconds to export the images.

Let me check how the videos are converted into sequences of images. You can notice that there are four images with the name of basketball 1, 2, 3. So, the first image, second, third, and the fourth image. It was exported perfectly.

 Next, we move on to **export the video**:

A new window will pop up in the name of basketball. I will give a ref, and you can save it in multiple formats. I will take MP4 and then press the save button. Before exporting, a new window will pop up, and it will ask for the configuration of the playback speed of the video. Right now, we did not change the playback speed, and then there is no option to modify it. So, I will save the video. It will take a few seconds to export the video. I will cancel it. I will reduce the speed of the video and then export the video again.

Basketball slow motion, and then I will press save. Now, if you notice, there is a configuration to use the current playback speed of 60 percent. So, if I click that, it will save in slow motion mode, or if you uncheck that, it will save as a normal video. So, I will check that and then save the video.

It will take a few seconds to export the video. The next option is you can export the slideshow from the key images. I will click on that. I will change to slideshow and save.

A new window is popping up, and it is asking for the configuration. What should be the duration of each key image? So, it is mentioned as 2 seconds. Right now, I will reduce it to almost 1 second, and then save.

Now, you are watching how the key images are exported in the slideshow format. All the images are played for one second. Finally, you can export the video with the pass of each keyframe. I will write pass and then save the video. So, again it is asking for the configuration. How many seconds the video has to be passed. So, I will make it one second and then save. It will take a few seconds to export. Now you can watch the video as it passes in all four key images.

[We have covered almost all the tools and functionalities in Kinovea. Now, it is time for you to explore and practically implement them].

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