

Exercise & Sports Biomechanics
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Lecture 40
MOKKA – An Open-Source Software for 3D Analysis

[Hello everyone! Welcome back to this course. In this video, you will explore a new software called Mokka].

What is meant by Mokka?

It is a motion kinematic and kinetic analyzer. In the previous lectures, you have explored what an optical imaging system is. For example, you might have explored the QUALISYS motion capture system or if you are recording a video from any motion capture system, there is one common file which we can export from the motion capture system: the C3D file. It is the raw data from all motion capture systems which helps us to work across platforms for further analysis.

If you go to biomechanicaltoolkit.github.io, you can explore the website of Mokka:

The first step is you need to download the software by clicking this blue button. Once you have downloaded the software, you can see the Mokka exe file. You can right-click on the application and press 'Run as administrator.' Click on 'Yes,' and the Mokka software will open immediately. Before exploring the Mokka software in detail, let us open one sample C3D file. For that, we need to go to 'File' and press 'Open.' It will direct you to the folder where you have saved all the C3D files. You can see the screen. I have 'n' number of C3D files which are downloaded from the website and are free to use. Among them, I am going to choose one gait data, so I will choose any one and then press 'Open.' Now you can see the data on the screen. [Right now], it is in the perspective view, which means I can able to see a particular data in a different perspective. I can see from the top view or I can see from the front view. It is up to the biomechanist or the coach. For the example purpose, we have taken a simple walking gait, so that you can able to understand the entire user interface and you can able to take the data out. When it comes to visualization other than perspective there are one more perspective is there which is known as orthogonal, where we can able to see from the top view or you can see from the bottom view, you can see from the left and then right.

Multiple views are there and I will go back to the 3D view in the perspective so that we can able to work comfortably. The first step is I am using my left mouse button by clicking that I can able to pan the entire 3D data so that I can able to see from any angle. If I am using my scroll bar in the mouse, I can able to zoom in and I can able to zoom out. At the top, which you are seeing like file, edit, view, these are all the menu bar. And in the right hand side, you can able to see all the markers name, which is known as acquisition explorer. It is written at the top. It is an acquisition explorer. At the bottom, you can able to see the timeline. That is why it is known as time bar. From the previous lectures, you have understood what is marker and what the different sizes of the marker are. So, now you are

exactly exploring how you can analyze the three-dimensional data from the motion capture system.

Next, let us understand the lower body marker set:

The first one at the top, which you are seeing, is the pelvis marker. Here it is written as LPSIS, RPSIS, LASIS, and RASIS, which stands for right anterior and posterior superior iliac spine. So, we have four markers at the pelvis.

If I want to change the color of the particular markers, if I select all four markers at the bottom, there is an option called Properties. I can increase the size of the marker in the visualization, and below that, there is an option called Color. If I select that, a new window will pop up, and you can choose any color you wish and then press OK. Now you can clearly see which the pelvis markers are.

Following that, you can see there are four markers on the right side and on the left side. So, those markers are cluster markers, and they are placed on the thigh on both the right and left sides. So, I will select the thigh markers on the right. I am going to the color, and I am choosing the blue color so that it will be visible, and I am choosing the right shank, and I am replicating the same color.

If you look at the foot, there are three markers there. One at the heel, which is the RH. And if you see RF, M and L, which are the medial and lateral. So this is the medial marker, and this is the lateral marker. So I am choosing all three markers on the right. And I am giving them the same color. Now, I am going to replicate the same steps on the left-hand side. Now I can choose the cluster markers on the tie and shank markers together. I can choose a color, maybe dark blue, and then press OK. So there are 3 more markers there on the foot. I am selecting that and then changing the color. Now it is very easy for us to visualize, and we can identify which is the right side and which is the left side without any error.

Now at the bottom, you can see the time bar. If I press the play button, you can see the subject walking. If I play the animation you can see a line popping up, which is the ground reaction force. If you go to the file again, below Open, there is an option called Open Recent. So, there will be 10 recent files ready for your visualization. If you wish to reload the same model, it can be reloaded so that if you want to delete or change anything, once you press reload, everything will reset. Once it is saved using this button, we can identify the file location. Next one is Import. Right now, we have imported the C3D file from one of the motion capture systems.

There are specific files which is supporting through the Mokka. For example, motion analysis, BTS motion capture, Coda motion, force plates, AMTI force plates and lot more. Even EMG data can be imported and we can able to do further analysis. Lastly, there is an option to import the video files also where we can able to sync the motion capture data and the video files.

Next, we move on to edit - In simple, you can able to copy, paste, undo and redo as we have explored in the previous softwares. In addition, if you click option, a new window will pop up. The first thing is general, where you can able to change the ground orientation and at the time bar, if you want to display the frame or you can display the time. If you are going to the visualization the first thing is on background, you can change the background color, the grid color.

The next one is of **segment** which will be in white color by default, if you wish you can change it and the marker colors by default it is white but we have currently changed according to our need. The last one is the **force platform**, if you wish to show the force axis you can show otherwise you can press the no button. Similarly for the index you can change the color of the force plate and there are two options are there which is the butterfly diagram and the force path.

The next one is the **view button** - in that the first one is the acquisition explorer, where you can able to see all the markers names and analog channels. If I uncheck that it will disappear and if you wish you can keep it on the right side. The second one is the information. It will give the information about the C3D file. What is the file size and other related information.

Next one is the **metadata** - So in this there are so many informations about the points, analog signals, segments and what type of manufacture the data was recorded. For example, this one was recorded in QUALYSIS and regarding the force platform.

The next one, we are moving to **settings** -The first one is the visual configurations, you can deselect it or clear all the configurations which we made so far and the next one is the playback speed, right now if I am playing the animation, it is going a normal speed, so I will go to the playback and then I will reduce the speed, now you can see the drastic change in the animation right.

Next one is the **orientation of the ground** - For example, currently it is in the plane x and y, we can not go with y z and z x because if i select you can see the orientation is totally different, we cannot able to analyze the data with this orientation. So that is why we have to check what the right orientation for the analysis is.

Next, we are moving into **toggle GRF butterfly** - If I click that, you can able to see what the pattern of walking on the force plate is. So, you can able to see as and when the athlete or the subject is placing the foot on the force plate, there is a excess of forces are there. As and when the mid-stands are coming, the force production is less and when the push-off phase is there again, the force is increasing. But when you see the comparison between the heel strike and push-off, obviously the heel strike is having more impact than the toe-off.

Next, we move on to the **tools** - the first one is the model where we can be able to create a new segment. For that, we are going to select minimum of three markers. Otherwise, it is very difficult to create a new segment. For example, I am taking all the four pelvis markers and then right click on the marker. There is an option called new segment or if I am going with the tools, if I go to the model, again you can create a new segment. So, either way you can able to create a new segment. So, in the label I will type this is pelvis. In the segment definition you can able to choose any of the three markers to create a segment, why?

At the bottom of the segment definition you can see the note is given very clearly. Only three markers can be selected at the same time. In addition there are two options are there in the keyboard where if we press the button 'E' then it will create the edges only and if you press 'F' it will create an face and the corresponding edges. Okay, now I will choose three markers and I will press the button 'E', you can able to see the edges and I will press the 'F', you can able to see the shadow.

Similarly, I will choose the other three markers and then I will give 'E' and then 'F'. Now, it gets the shape of the pelvis. Once it is done, you have to press OK so that at the right top corner, you can able to see ennumber of segments are generating, right now we have created a pelvis.

Next we move on to the **thigh segment** - where we need a three markers to create a new segment, I will type right thigh and select all the three markers and press 'E' and 'F' for the shape, moving on to the shank, right click new segment right shank and then press 'E' and 'F' press ok and coming back to the foot you can able to see there are three markers are there and I am going to give as a foot, select the three markers press ok. Now we have to replica the same thing on the left hand side. So, let me first select the marker on the left side and then type this is left, I select the markers 'E' and 'F' creating the edges will give you a better visualization, otherwise it will be very difficult. Right click, new segment, left shank, select the markers and then press 'E' and 'F'.

So, similarly we will go with the foot markers. Create a new segment. Left foot. Select the markers. E and F. And press OK. Now when you play. It is very easy for you to understand based on the segments. So I have reloaded the model because if we go to the tools and marker. We are going to create an average marker.

Previously we have already created segments. So between the segments it is very difficult to create an average marker. So let us go into deep. I will zoom in. I will select one marker on the tie and another marker on the shank. If I go to tools and on the marker if I click the create average marker now you can able to see one marker exactly placed in the middle. So, I will do the same on the left hand side, go to the tools, marker and create average marker. So, we have a two average markers now.

Next we move on to the **tools in the marker** - we will identify the compute distance between two markers. So, I will choose the two markers which we have created and then go to the tools, marker and create a distance between two markers. Now you can able to see - what is the distance between the right knee and the left knee.

But if I want to create an angle, then I need to go to marker. I have to choose compute angle between three markers. So for that, I will choose the one marker on the pelvis, second marker which we have created and the last marker is on the ankle. So, three markers were selected, now I am going to tool, marker and compute angle between three markers. So, now you can see the knee angle. So, now if we want to interpret that in a better way in the walking gait we can able to identify the gait events. For example, heel strike and toe off. For that, I have to identify the specific instant and then I need to go to the tool, event and then insert event and it is asking for which foot strike. So, I will tell it is a insert right foot

strike. In the label, it has clearly mentioned it is a foot strike on the right side and then press OK.

In the time bar, you can able to see there is a small icon over there to indicate the right foot strike. If we do it manually, it is a time consuming process. For that, I can go to the tools and again events and there is an option called gait event detection. In that, it is asking based on the vertical ground reaction force, we are going to map that manually based on the force platform 1 and 2 which foot is striking on that particular force plate. For example, the force platform 1 has been strucked by the right foot.

Similarly, left foot for the force platform 2. If this information is correct, and then once we press OK, you can able to see all the gait events popped up in the time bar. In addition, if you notice the graph, previously all these gait events are not there. So, now it has been identified in the graphs also for the better interpretation.

Lastly, in the tools, there is an option called analog where we are having the force data and analog channels are there. We can able to do a Butterworth filter. If I click on that, you can able to see there are 'n' number of channels and I can go for butterworth, low pass or high pass or band pass and I can able to change the cutoff frequencies also. For that I will go to different perspective instead of having a perspective, we will choose the analog and we will expand the analog channels. It will take the last one where you can able to see there is a good movement is there based on the force data. Now I am going to the tools, analog and picking on the butterworth. I will just stick on to the low pass and six heads. Now watch very carefully, I am going to press ok. Now the data, filter data has came a different one. Now you can see the data is completely filtered and now the data is very smooth, even the signal processing can be done via Mokka. So, that is the advantage of using this open source software.

The next one is we will go to the **tools and analog** - there is an option called a rectification, it is asking which channel we have to do the rectification. So, I will make a create a new analog channel and then press ok and there will be a rectified data. If you notice that, all the data which is in the negative, now it has been transferred to the positive. What happens exactly, the entire data is trying to square the values so that all the negative value will become the positive value that is what rectification is.

Sometimes if the data is in negative value it is very hard to interpret the information, if it is positive and if we are adding the gait cycles then it is very easy for us to understand entire parameters. So, this is the 16th channel which we have taken. Now I will take the 8th channel. Now you can see we are having left foot and the right foot. Once you have completed the entire analysis. Now change to the perspective, and we can go for exporting the data, why?

We have added one extra marker in the knee. If we want to use this C3D file in different software, we have to export the C3D file. Still, we can export in a different format in terms of motion analysis company. In addition, we can export all the data into ASCII. These ASCII files can be imported into Excel, and we can do the calculations in Excel. And the last one is the image series. If I click the image series, it asks whether we have to export all the images, all the frames, selected frames, or the current frame.

I will take only the current frame. There are multiple options there. I will go with PNG and then press OK. So, the file was exported immediately. So, you can see the exported image for further analysis.

In short, with the help of this open-source software, we can analyze all the biomechanical data, both kinematics and kinetics.

[Thank you, and see you in the next video].