Exercise & Sports Biomechanics
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Lecture 39
Experiment With Optical Motion Capture System

[Now, we are going to see the experiments with the optical motion capture system. First, we discuss walking gait analysis].

Walking gait analysis:

In walking gait analysis, you can see the subject walking, followed by the QTM software tracking the object or the subject, and once the movement is captured, the file is stored as a QTM file, and the QTM file can be used to further analyze the athlete's movements using Visual 3D. So, here you can see the process of us capturing. So, the camera captures both video and the marker-based component, and the marker-based file is imported into third-party software to analyze and extract the key performance indicators. So, this is the workflow during the gait analysis. So, once it is done, what do we get? You can find out the lower body angles, particularly the pelvic.

The pelvic tilt can be identified, as well as pelvic obliquity and pelvic rotation. So, these are the three metrics which are given in graphical form, and at the same time, the hip. So, the lower body joint angles can be found from the hip, hip flexion, hip adduction, and hip rotation can be found through the graph, then comes the knee. In the knee, you can observe knee flexion, knee adduction, and knee rotation.

Next comes the ankle. You can find the graph. Then come the upper body joint angles. So, first, the thorax; then the pelvis, shoulder, and elbow. If you see all these graphs, it will be easy to understand how a joint moves.

Next comes the **countermovement jump analysis**. Here, you can see the subject perform a countermovement jump. The same is captured using a mocap system, and the mocap file is further processed using Visual3D software.

Here are the graphical results of the countermovement jump. You can find the pelvic tilt, pelvic obliquity, and pelvic rotation. The same applies to the hip. Then come the knee and ankle.

We are going to see the **practical way of fixing the markers on the subject:**

Here we have an athlete, an eight-hundred-meter runner, studying third-year B.Sc. Sports Biomechanics. His name is Sujal. We have four types of markers here just to make you understand.

We have one big-size marker, as we already discussed. It is a 19 mm marker. And the second one is a 16 mm marker, as you can see here. The third marker is an 8.5 mm marker, and the smallest one is a 6.5 mm marker.

Here we are going to fix a 16 mm marker on the subject's body. Before that, you can see the array of markers, which is arranged with the double-sided marker as stated. So, now we are going to take this marker, and we are fixing the marker above the ear. So, we have a headband - on the headband we have the marker on the foreheads and marker on the earlobe. On the right side as well as the left side. So ensure that the markers are fixed equally on the same side.

Next, we fix the marker on the acromion process that is solder. So, this is the right side of the subject and we keep the marker one on the right side solder and then we have to check the anatomical level mark. So, this is the acromion process. And we keep one more marker on the left side shoulder. So, totally we have fixed now 3 plus 2 markers, 5 markers plus totally we have fixed.

We are now fixing on the lateral malleolus of the subject - we have already fixed some of the markers on the upper body. And now we have the marker on the vertical levels and another one is at the heel. That is calcaneus base of the calcaneus. We will have two more markers on the foot. One is at the second metatarsal phalanges joint here. So, we have one, two, three, four markers on the front. Similarly, we have to fix the markers on the right side also. We can have two volunteers who are well trained to fix the markers because if one person is fixing the marker, so they may not be able to complete the process quickly. So, we can have two trained volunteers where we can fix the markers. We have one more volunteer, we can see him fixing the markers on the right knee out.

That means lateral left contact of the knee. So when one subject is fixing the markers on the right side, so I am fixing the marker on the left side of it. So, this is how we can save the time. So, we have to palpate the bony landmark and fix the markers. So, now I am fixing on the left side, lateral epicondyle, outside in as per.

We do have a marker on the medial side of the knee. We have to palpate the medial epicondyle and then fix the marker. So, one more marker is on the thigh, another marker is on the anterior superior iliac spine. So, we have to palpate and fix the marker. Now we have the subject with all the markers. A minimum of 41 markers have been fixed on all the body landmarks. You can see how the subject turns.

Both the anterior and posterior sides can be viewed. As I already told you, we have markers on both heels, the lateral side, the L5, and the posterior side. This is to denote the body segments. These markers will be captured by the IR camera, the infrared camera. So, now we are going to take the subject to the field, and we will check the calibration value as well as perform calibrations.

The important thing when we get ready for the motion capture system optical based laser. So first we have to keep the camera steady and connect place the cameras ensure the calibration volume and then connect the cameras then you have to calibrate the entire volume. So once that is done simultaneously you have to make your subject to warm up

and at the same time the subject must be there in a separate room where comfortably the marker has to be placed on the body segments. So, as I already told there should be minimum two trianed volunteers to fix the markers and the marker has to be placed in the ideal place at the same time with the minimum time.

Once the subject is ready, already simultaneously we have done the camera placing and calibration has been completed. Now, we are going to the analysis area for further process. So, we are going to fix the camera. We have kept the camera. This is a video camera. So now we are going to connect the cable. The first cable is data power cable. You can see the moment I connect the cable with this camera. So, you can see the camera switching on. So you can see the lights blinking the moment I connect the data power cable.

Now we are going to fix the data cable, to create the daisy chain system. So, we have two cables connected with this video. So, as far as the hardware part is concerned, so we have to use the camera the tripod the cables and one more important hardware is sync unit. So, this sync unit is used to synchronize all the cameras at the same time you can see two ports one is data port another one is power port and you can see the other side of the sync unit where there are multiple channels are there. So, these channels are used to integrate the other hardware say for example EMG force plate can be integrated with the motion capture system. So, the sync unit is an important hardware which will sync all the cameras as well as the hardwares with time frame and we have one more hardware, so this is data power injector. So, this is used in the daisy chain and the cable which is connected from here so is on the other end it is connected with the poe and from the poe one cable goes to the camera line the other cable is connected with the computer system. So, we have kept all the cameras in position and you can see the moment the system is switched on first the cameras will come with an orange light.

So the orange light is an indication the camera is booting. And after the orange light is on, and next the camera will come to change over to the green light. So green light means the cameras are taking in its order. For example, which is the first camera and which one is second, third, subsequently. And once the green light is on and the camera is in order,

Then it is ready for its function. The next step is calibration. So we have to use the calibration wand and calibrate the area of the capturing volume. We have connected all the cameras and now the cables are being adjusted and connected. The camera height is being adjusted so as to see the calibrated area.

So, the capture volume has to be covered by the optimal positioning of the cameras. So, now you can see the cameras are adjusted, and all the cables are correctly fixed. Both the data power and the height of the cameras are being adjusted. And also, you can see the number of cameras in each daisy chain. So, in one power cable, we use four IR cameras, and similarly, for every four cameras, we use one power unit. First, we have to position all the cameras accordingly, and when we have

multiple or multiplanar movement. So, we need to keep more cameras in the zone where the athlete is performing a complex movement. So, the purpose is to capture each marker

with at least two cameras. So, now we have switched on the system, and all the cameras are ordered and synchronized. Now, it is time for

calibrating the capture volume. So, for calibration, we have two pieces of equipment. One is a calibration wand, as you can see, and another one is an L-frame. So, in this L-frame, you can see two arms. One is a short arm, and another one is a long arm.

So, the long arm represents the Y-axis and the short arm represents the X-axis. and the vertical axis is represented by Z. So now we are going to keep the L frame at the center of the capturing volume and followed by the calibration process. So, now we have kept the L frame center of the capturing volume, and now we are going to share the calibration process. So, the calibration process is nothing but so the wands be paved so in the designated calibration area, so as to ensure that each camera can see the market so before the capturing itself this is the important process and vital process of any motion capture system.

So, now we are going to start the calibration. So, the calibration duration is 200 seconds. So, if we do 200 seconds, we are going to the calibration process. So, then the system is ready. Now, I am going to start the calibration.

So, I am going to start the calibration. So, we are waiting, waiting for the moment. So, this is process of Calibrate with the mode of capturing volume, so that the camera can understand that this is the calibration media. So once calibration duration is over, so you can check

The system screen will show whether the calibration is successful or not. The system screen will display the calibration status, whether it is successful or not, along with the standard deviation value. The lower the standard deviation value, the better the calibration. Now you can see the calibration is being performed. So,

When using a motion capture system, a minimum number of personnel must be present to ensure the workflow and assessment are carried out properly. Whether it is camera fixation or cabling, all personnel must be adequately trained to perform the task. Here, you can see Mr. Tamil Chalwan, a sports biomechanist from our Center of Excellence in Biomechanics at the High Performance Center for Tamil Nadu Sports University, performing the calibration. The purpose of showing this practical component is to help you understand. We have already explained this in PowerPoint mode, but PowerPoint alone may not

be sufficient for understanding, which is why we included this practical session. Now, the cameras are off, indicating the calibration duration is over, and we can check whether the calibration was successful. The calibration is now successful with a standard deviation of 2.1, but the calibration value can still be improved. If the calibration value is not sufficient with a lower number, you can perform another calibration. Once the calibration is complete, The cameras or any hardware, particularly the cameras, should not be moved.

The cameras should not be disturbed. At the same time, the calibration can be powered. So, once the calibration is done, you have to remove the L-frame. So, now the analysis area is ready for motion capture so now you can bring the subject for the analysis

So, now we have done the calibration process and calibration is successful. Now the subject is ready. So the subject is going for a gait assessment first. And second one is counter movement jump. So, first we will ask the subject to go for walking.

So, the purpose of this assessment is to make everyone to understand the basic walking. And the moment he is performing walking, the IR cameras will be capturing the markers. Okay. So, and before that, before we start the actual capturing of the movement, the first thing we have to do is static and dynamic trail. So, the static and dynamic trail.

So, that is going to be performed by Mr. Sujal. He will go to the center of the calibration area and perform the static trial. No, no, no, we will push it for a static analysis. Now we are going to perform the dynamic trial. So the subject is performing a dynamic trial.

Yes, you can perform a dynamic trial. The subject is performing, and it is being captured. And it goes to the other side. So, this is to ensure all the markers are visible to the cameras. Now, we are going to start the actual capturing of the movement.

First, we are going to capture the walking pattern, that is the gait of the motion. So, the child starts now; the subject can walk and start. It is being captured. So, again, the subject has to go and come back. So, on this day, we are

So, the subject has completed one trial, and you can take the submission of problem X. Once the trial is over, you can save the data. So, you have the named file. So, the Q-tip software, called a fact manager, captures the movement, and the file is stored in the system. Hi everyone, we have Tamil Selvan, the biomechanicist of our lab, and we have the assistant who is going to be a future biomechanicist, studying in the third year of B.Sc. sports biomechanics.

I thank both of them for coming and volunteering for this NPTL course. So, we will definitely meet you all in different practical sessions in the coming weeks.

Thank you, and we will meet you in the next video.