Usability Engineering
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Module - 06
Lecture - 21
Demonstration of an Eye Tracking device

Hello everyone, this is Rahul, now we will go through lecture 21 module 6 Demonstration of an Eye Tracking device.

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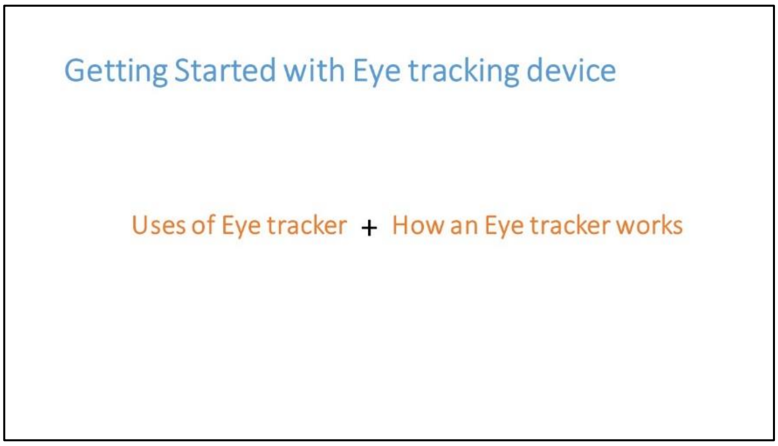

In this lecture we will specifically go through how an eye tracking is used.

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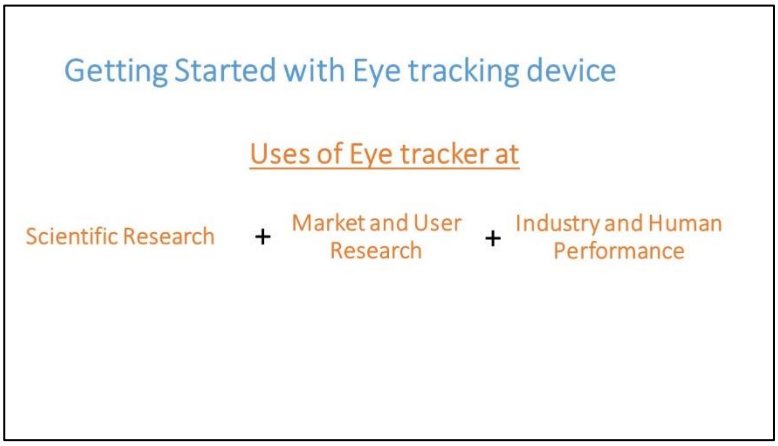

And how an eye tracking can be used to measure something or analyze a context in usability and also understand the usability of a product or analyzing the psychological features of a user. Before going through how an eye tracking device works, we will first continue with what an eye tracking device does.

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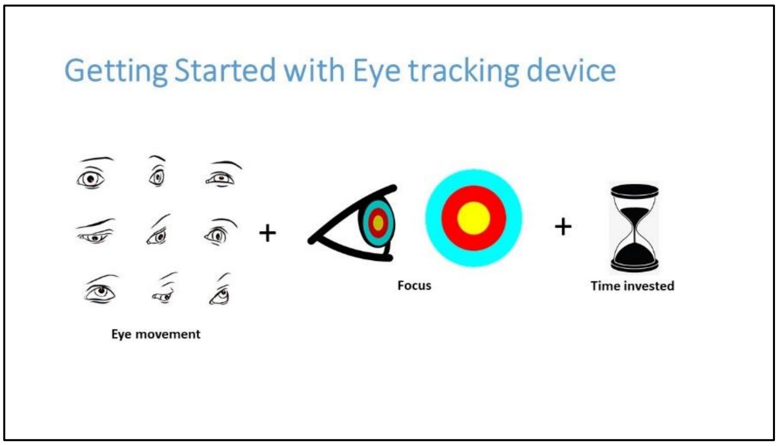

An eye tracking device actually measures the eye moment and where we see through using our eyes where is the attention that we are paying or how much time do we pay attention at a point, these are the basic things that are measured. And these basic things actually provide information regarding how a human psychology is or how a personality is, how a human's behaviour is and how a product is used in a context by a user these can actually be analyzed by using eye tracker.

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So, today we will move forward by discussing the eye tracking device, this is a head mounted eye tracking device and the maker is Pupil Labs.

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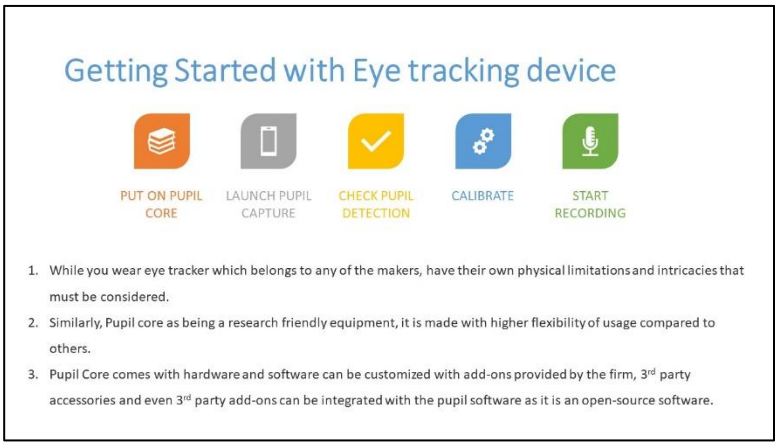

And most of the material that has been included in this lecture are animated videos or any of the pictures that are taken for this reference are from Pupil Labs. Today we are using a product called Pupil Core this is a product Pupil Core and for every eye tracking device by any maker even in a single maker for a eye tracking device there are different specifications that are involved, some eye tracking devices are auto focused automated.

But this eye tracking device that we have just seen is a device that is actually is very research friendly and also for a user to use it in daily life. He can customize it in many ways it is actually programmable and even the software that is provided with this is customizable and this actually benefits a lot many researchers.

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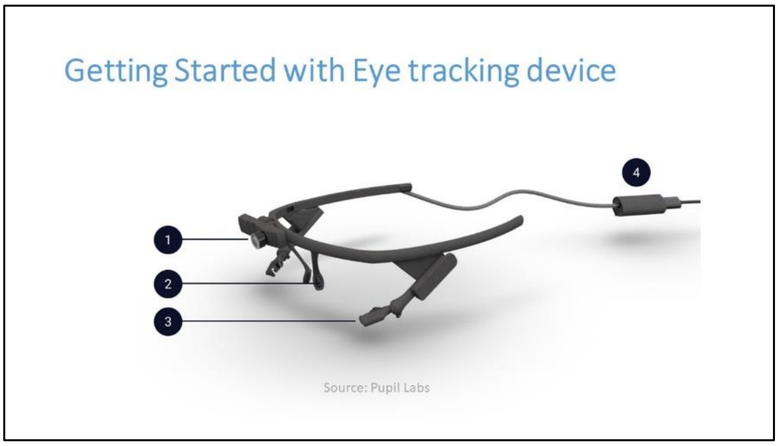

So, now, we will get start with eye tracking device. In an eye tracking device, it consists majorly of four different parts 1 is the world camera, the 2nd one is the eye camera, which actually is normal to the eyes and actually it identifies the pupil centre and the corneal reflection and it maps the corneal reflection through these pupil centre and corneal reflection it actually finds out the coordinates of the attention or where we are looking.

So, this actually tells a lot more things as we have already seen or discussed. And if we look at it this is the world camera this is this small thing is eye camera which actually is focused on pupil and this has a ball socket joint which let us it moves in 3D three different directions, but is restricted to go backwards because in the back if we if something moves back it actually cannot measure the pupil.

So, this is placed in such a way that it actually measures the pupil in a very accurate way or with higher accuracy. It is placed it is attached to the eye tracker by using some arms this small structure are a actually provided along with this eye tracker, which can actually be attached to the frame and then the pupil or eye recognizing cameras or eye catching cameras they are actually placed or connected here.

The negative part of this structure is very much defined and actually designed for this. So, it actually does not move it will not slip. So, it is designed in such a way and there is one more thing that is nose support, we may think that this is the least attentive part of the eye tracker, but this is the most important part because when you are doing an experiment the eye tracker should not slip from your nose; nose bridge.

So, to maintain it at that position there is a nose support that is provided here and this nose support actually is very helpful for continuing a research or a test 20, 30 minutes long and there is the most important part that is the fourth part which is a connecting device or processing unit which connects it to the CPU and where the processing is done.

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As we have just seen how an eye tracker is made. We will just go through some animated videos and live videos which actually helps us understand what an eye tracker and how an eye tracker can be used, how to adjust it, how to use it in real life. It slides the how an eye tracker eye tracking device is made how eye camera is slides over the frame and how it rotates just we have seen the ball socket joint how it can rotate is actually shown here.

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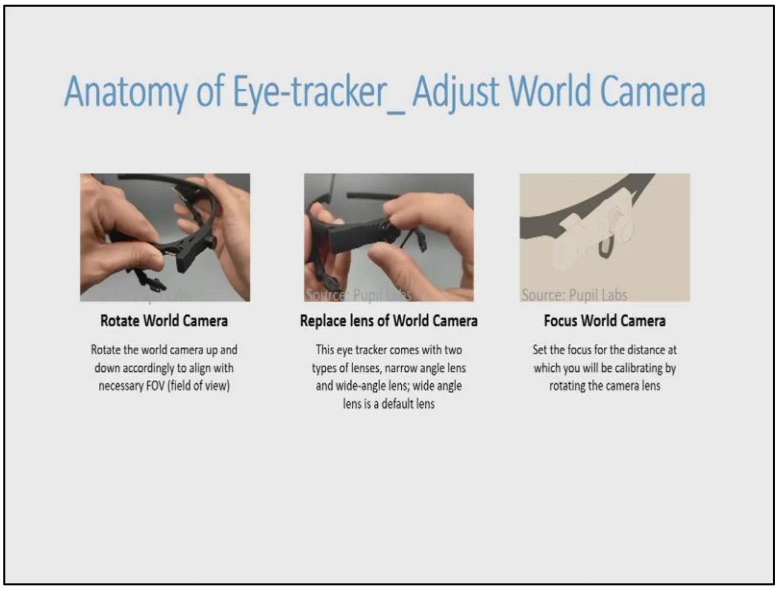

It is not just the eye camera that is important and that is movable even the world camera is the important thing and it has to be adjustable. The head mount eye trackers are made for a very specific purpose or made to actually satisfy a purpose that is even when we move the eye tracker should be able to actually analyze what we are looking at and where we are paying the attention.

So, the major thing while the world camera has to be adjustable is because of field of view; field of view how much can we see? What is the range of vision? So, in that range of vision only in that range of vision the things are measured. So, how do we define that field of vision in the eye tracker? That is done by using calibration. Now, we can see where it can move and how it can move there is one more part that actually have to discuss.

This eye tracking device actually comes with lens a default lens that is wide range lens and it also comes along with a narrow and long range lens. So, we have already seen how eye tracker actually works and how it can be used and there is one more important thing that is how a focus can be changed. Here the lens can be rotated clockwise and anti-clockwise to actually attain the highest focus that can be achieved.

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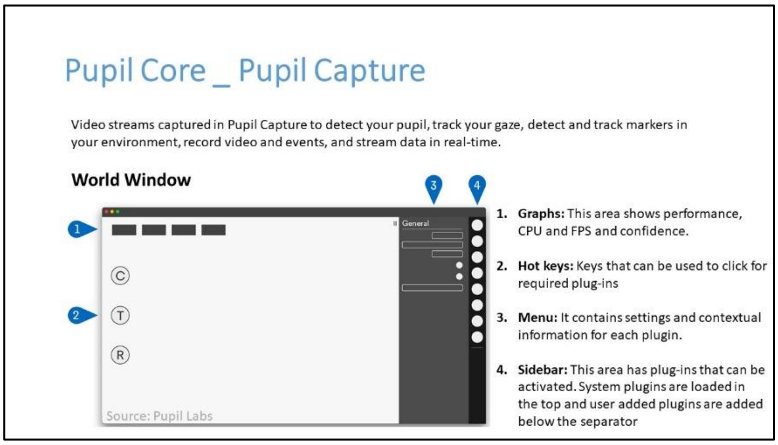

Now, we are looking at Pupil Core capture. So, this is a software that is provided with this Pupil Core eye tracker and this software actually shows and records data from the context. So, in this software the major thing that we always look at is world window along with that there are some other options like graphs, hot keys, menu keys, side bar and all. And graphs, graphs actually show how much of CPU is being worked how much of frames per second is being used.

And how much of your eye confidence is measured like what is the eye confidence that is measured and in the hot keys hot keys are something that which includes the add ons plug ins where you can actually click and where you can actually use those plug ins to actually understand the context. For example, C that is shown in this picture is calibrate.

So, when you press C or when you click on this C you can actually calibrate your eye tracker. It is the T that is shown is actually is used to validate that calibration how much of accuracy is there in the eye tracker when you are using world camera and eye camera pupil camera.

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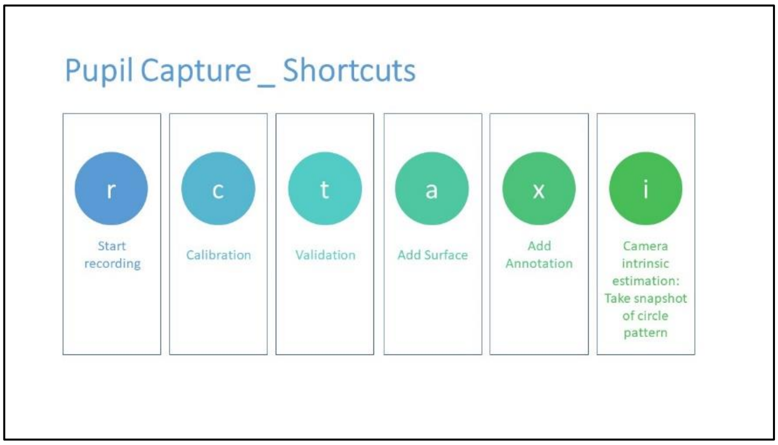

These are such shortcuts or the add on plug in shortcuts that are provided in this software r is for start recording, c is for calibration, t is for validation, a is for add surface, x is for add annotation, i is for camera intrinsic estimation or take snapshot of circle pattern.

In these things the most important shortcuts are calibration, recording, validation, add surface and annotation where annotation is not so important, but when you are doing a very long research or very long test then this annotation actually helps and it specifies what is the important moment that you have captured is actually marked by using annotation.

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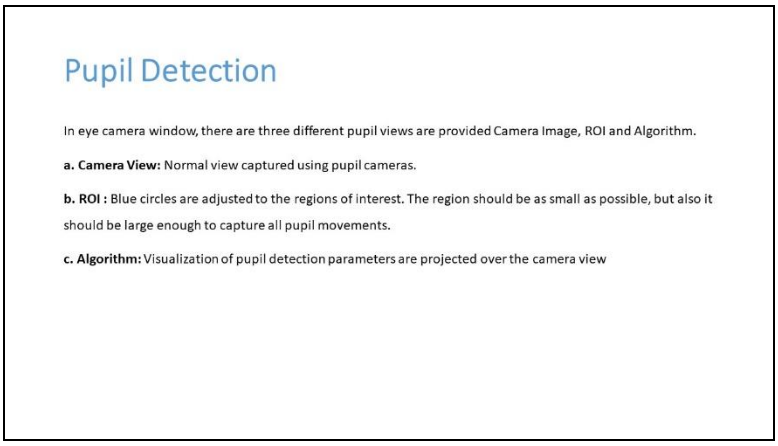

Now we will see what actually happens. The major part of this eye tracker is detecting the pupil. So, what happens or how pupil can be detected and if you look at it I have already said that corneal reflection is the most important thing along with identification of the pupil centre that is defined. And how an eye tracker at least this eye tracker works, but that is not the complete answer for this the complete answer lies at how accurately you measure that, it is not just measuring.

It is at how much of accuracy you are doing it. So, if you are at that point where you are quantifying the physiological data, so you need the accuracy. So, how to do it? For that in this Pupil Core they have provided three different options camera view, ROI, algorithm. Camera view is the very normal view that it only captures and shows how your eye is moving and how much of pupil is detect that is shown.

In ROI it shows how much of pixels are being adjusted to that pupil and how much of pixels are being mapped to the coordinates that are on the world camera algorithm algorithmic view is visualization of pupil detection parameters that are projected on the camera view.

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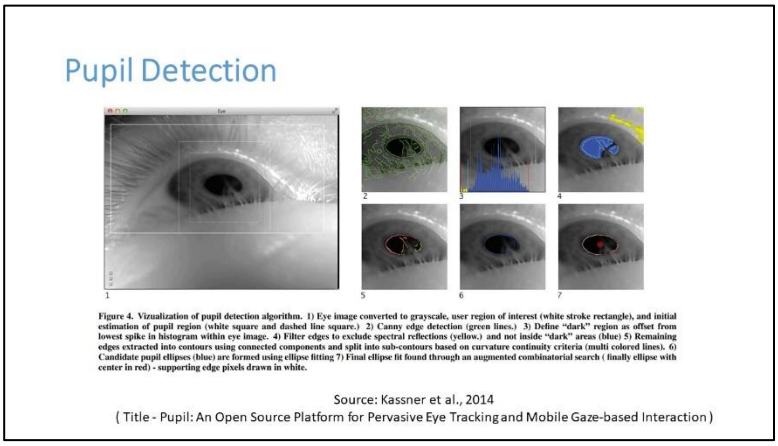

This is the pupil detection and this is taken from a source Kassner et al, 2014 which is a Pupil Labs publication. Here we can see the this is the camera view and this is ROI and this is camera view with pupil detection. Even though the algorithmic view is not given in the algorithmic view you can actually also see how much of detection has been happened or how much of accuracy is there, how much of leakage is there it shows it.

So, you can say like here it shows like this like this and it also shows the leakage like 20, 30 or something. So, those are the most important things when you do this because the leakage itself shows like how much of data has been lost or how much of accuracy has been lost.

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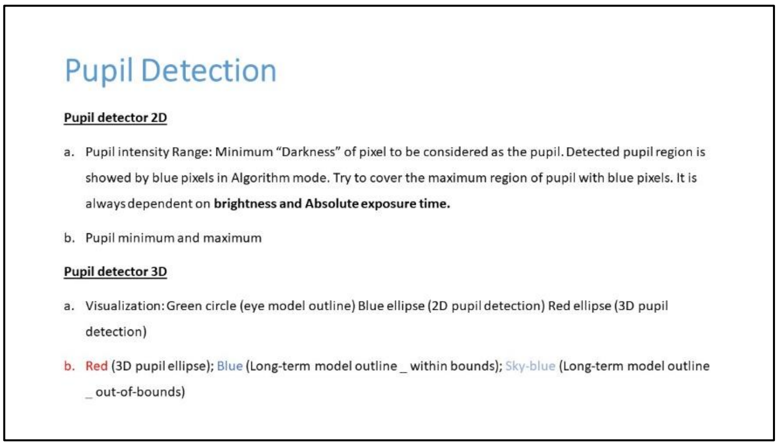

Pupil detector when you look at it has 2D view and 3D view and as it is a camera it is it captures 2D vision, but the frames are merged together and to build a 3D model of the pupil and 3D models pupils' diameter can be estimated. And even the radius is estimated and even the depth and even the coordinates are measured, but it is not advisable for a short research or test to use the 3D mapping it is advisable to use 2D mapping as 2D mapping is the least added.

So, in the pupil detected 2D that we have we are about to discuss it shows like how much of darkness is there in the background how much of a contrast is needed. How much of saturation is needed these are all there in the 2D. It actually analyzes this thing and actually places the pupil accordingly and even identifies the pupil.

So, better be in the brightness bright region to actually do this 2D experiment, but if you are using the 3D modelled experiment then you can actually move in the normal environment you can actually move or you can actually do anything while wearing this eye tracker. Most important thing that you have to remember is the eye tracker should not sleep unless until the eye tracker sleeps you can actually use this to measure the pupil detection or to identify the pupil detection.

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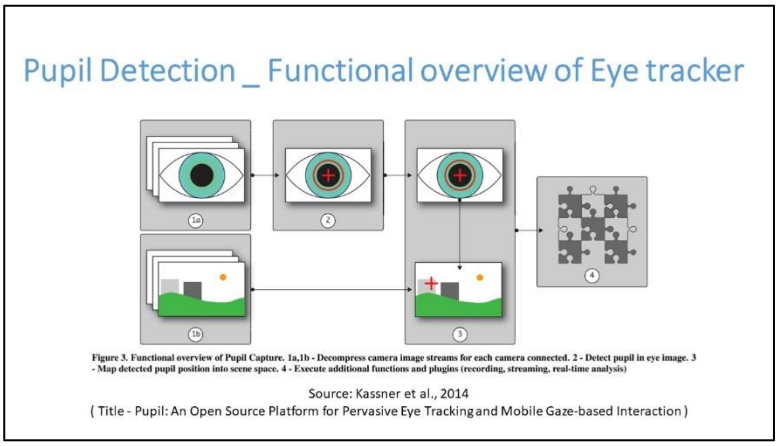

This is the functional overview of eye tracker how pupil detection happens, how eye tracker measures and what kind of plug ins can be added, this is a Kassners research which we have already seen before. This Kassners paper also includes this model how a pupil lapse eye tracker works.

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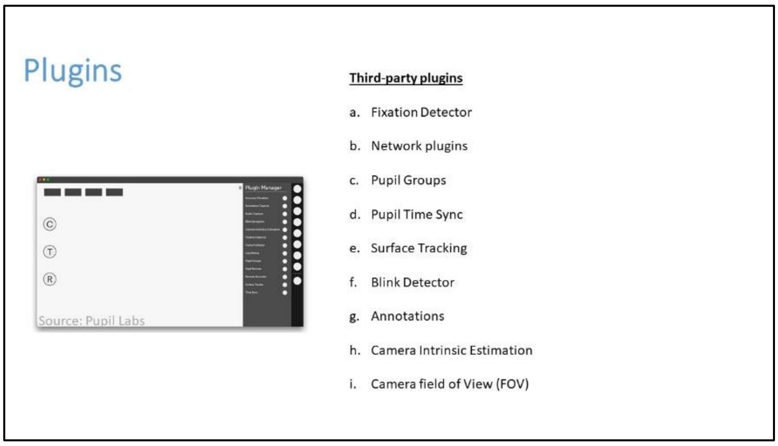

So, these are some of the third-party plugins that are shown here. So, fixation detector, fixation is something where if we are looking at something if our attention is fixed at some point and if it exceeds some 300 milliseconds or 200 milliseconds then it is recorded as 1 fixation.

So, this is a plug in which actually calculates how much of fixation is happening and how many times a fixation happened and where at what coordinates a fixation happened. Network API is something that actually helps to connect mobile recorded data using eye tracker to PC. Surface tracking is where heat maps are generated, it is kind of like fixation detector, but it actually overlaps the fixations and shows us, which is the most attentive part of a website of a scene.

Blink detector as the name suggests, it detects how many times blinks happened? And at what time a blink happened, at which position a blink happened, these all things can be identified using blink detector. Annotation we have already discussed it actually marks an important scene marks important scenes or contests where we are looking.

Camera intrinsic estimation is a plug in which actually is used to recalibrate the model. The model that I just said is a 3D model that is developed out of the 2D generated maps. Here the 3D model is generated and this 3D model is actually estimated and reorganized using camera intrinsic estimation. Cameras field of view as we have seen like how much of vision can we see what is the vision range that we can actually see is in camera field of view.

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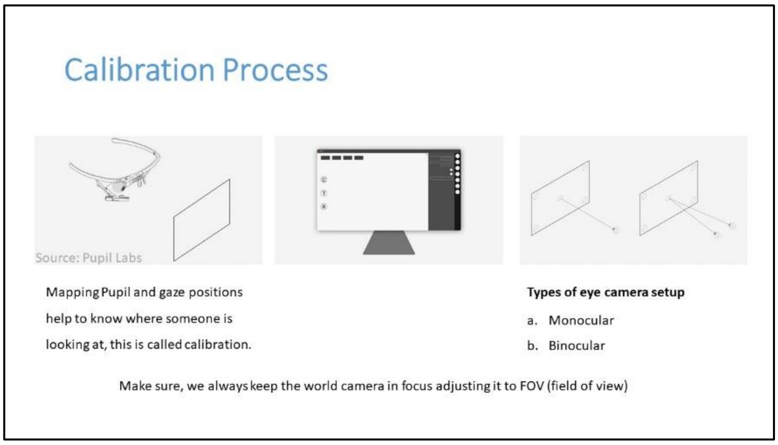

So, now we will see how a calibration is done what is involved in calibration while you are using an eye tracker and how to practice it in a better way we will discuss it now. When you are using eye tracker let us just see, how we should do this?

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So, first you have to wear the eye tracker and when you wear the eye tracker adjust these pupils, so that it has highest confidence. Confidence is it shows how much of accuracy or how much of pupil is being detected and how much of pupil is not being detected.

So, it ranges between 0 to 1 it is always advisable that only take those measures or only consider those coordinates where the confidence is above 0.6 it is always advisable if it is towards 1 as it is the highest confidence that is achieved. So, now we will see the videos the source is Pupil Core again now you can see this is how a calibration is done.

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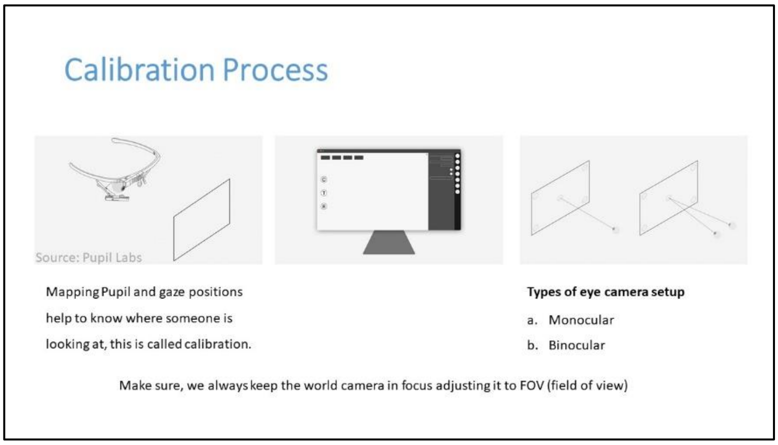

So, when you press C this kind of markers are being shown and these markers these kinds of markers are the ones that are detected by the world camera then by using the pupil camera the gaze is mapped and the calibration is done. It actually finds out the field of view for that specific setting. In the calibration if there are eye trackers which only has one pupil camera or one eye camera which is a monocular, but this is a binocular even this there is a setting where monocular and binocular can be done.

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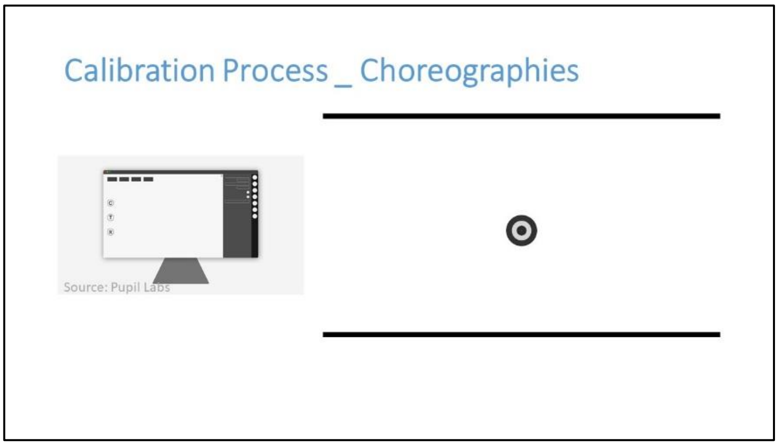

For doing this calibration there are specific choreographies or specific process or specific method that is designed by pupil they are kind of like these small concentric circles are being shown and they can be they are seen and they are actually used to measure the field of view.

Now, you can see yeah, besides the Pupil Labs video or animation there is one video that is here that which actually shows a live recorded calibration process when you are doing the calibration it actually blinks like in at the centre there is a green and red, if it continuously blinks for green then it is considered as ok; ok then actually it moves, it moves to the next point.

So, only after completing all this then you can see that this kind of box is formed this is our field of vision this is a at this only at this measure and at this distance this is the field of vision that we have and only in this region things are measured.

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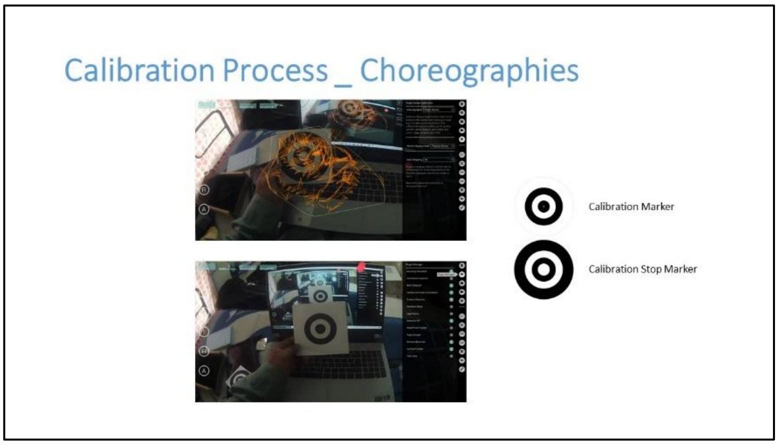

This is one more type of choreography what we have just seen is screen marker choreography. And this type of choreography is called single marker choreography in the live scenarios you cannot keep the markers and you cannot move your head. So or that actually hampers the system.

So, they have generated a new choreography which actually involves a big marker which can be printed out and which can be seen from a distance, which is actually is very much convenient for the participant.

So, only at that distance when this marker is shown and if it detects the marker it shows the green colour ring you can see it here see it has not shown because we have not yet started the C calibration when we have started the C you can clearly observe that there is a green circle that is being formed over the marker.

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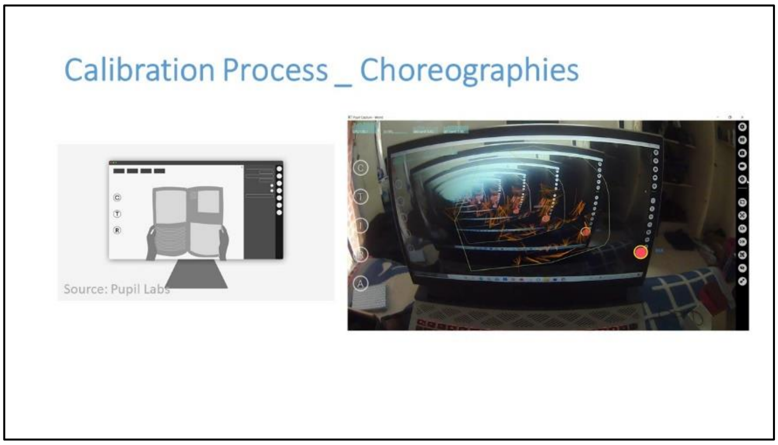

There is one more different type of choreography which is much more flexible and which actually informs us how much of normal vision that we have at this range. In a normal environment if we want to do it we can do it by making a field of view of our own which is very convenient to us this is what I can actually observe if we know what is our convenient field of vision we can actually do that by using this natural marker.

Here you can see that by using mouse we can actually click on the different areas of field of view which is convenient for us then we can actually mark them. Here we can later see a small box that is being formed, here you can see wherever the finger is being moved the eye also is being trapped because I am focusing on my finger and my pointing finger and I can now see that it is being there. So, there is a higher accuracy. So, there is accuracy of 1.710 we are using 3D gaze mapping in the 3D gaze mapping it is between 1 1 2 2.

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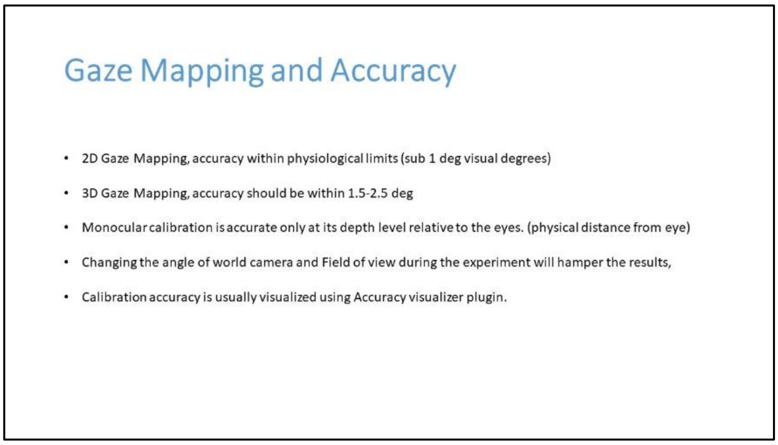

So, it is a acceptable range. So, in the gaze mapping, 2D gaze mapping, and 3D gaze mapping exists. 3D gaze mapping has 1.5 to 2.5 degrees range it can go below one also monocular calibration is accurate only at its depth relative to the eyes. So, physical distance from the eye, but we usually have two different pupil cameras.

So, we by default go with binocular vision. In the binocular vision it actually also makes a model of the pupil and actually defines the diameter and coordinates which are actually projected coordinates that are being made from the frames that are captured through the camera.

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This is one example how heat maps are generated in nowadays in the lifestyle people are watching animes, comics or any of these things. So, let us say if they see a wallpaper and which of the character is more attractive or which of the things are more attractive or attention grabbing. To identify those things such markers are being placed these are the markers that are provided by the maker.

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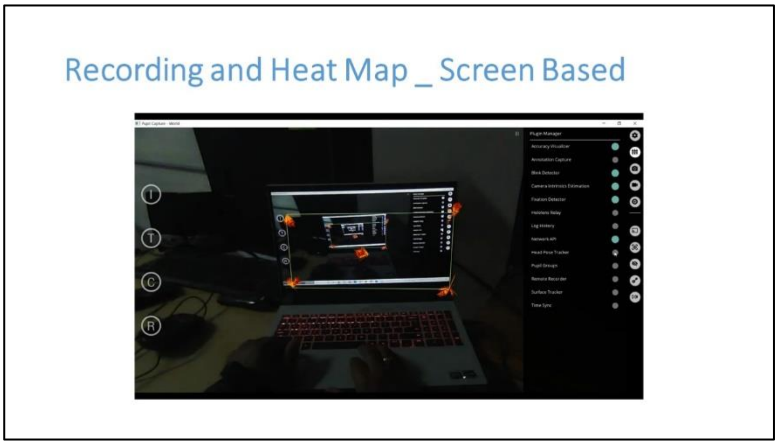

And these are placed at different areas of the wallpaper and these markers are used to form surfaces.

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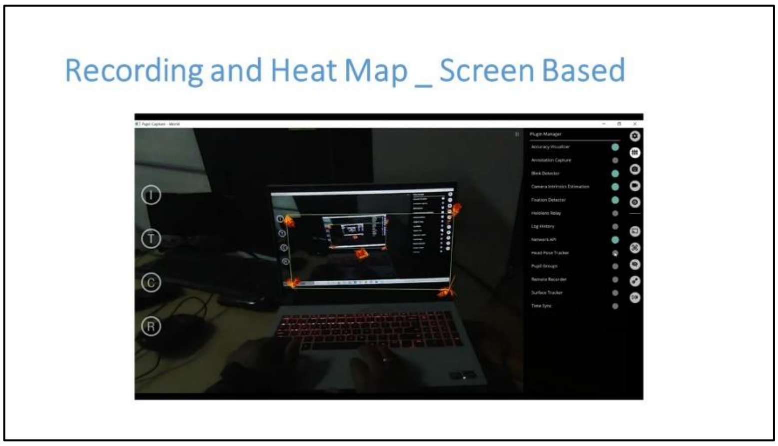

So, this blue screen that you are seeing is the surface. We can actually edit a surface accordingly.

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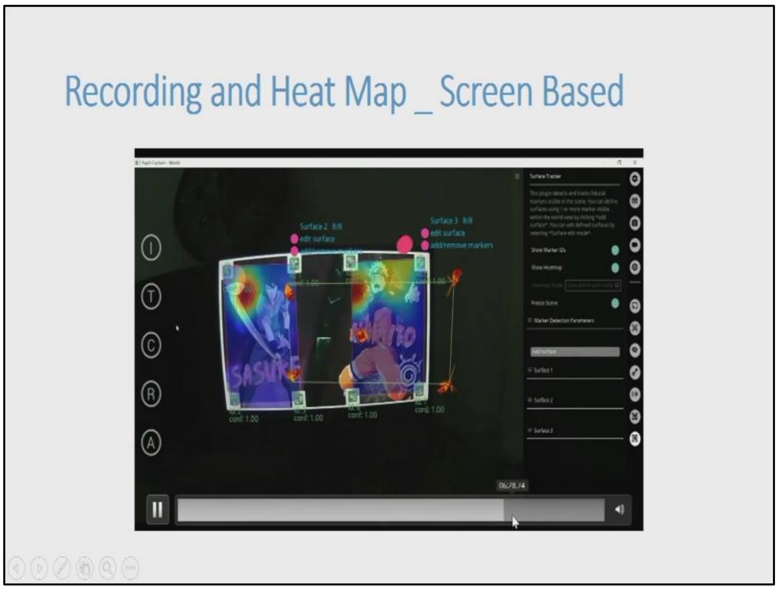

And after editing we can see that a heat map is being generated.

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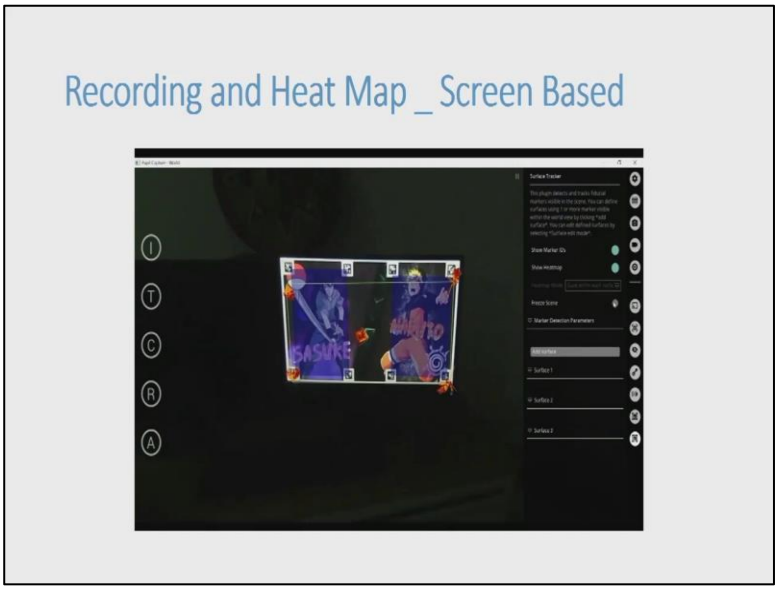

Now, we can see that a heat map is being generated in that we can also freeze the vision where we are looking at or freeze the video source as an image then see what areas are being more attention grabbing or more interesting for the user.

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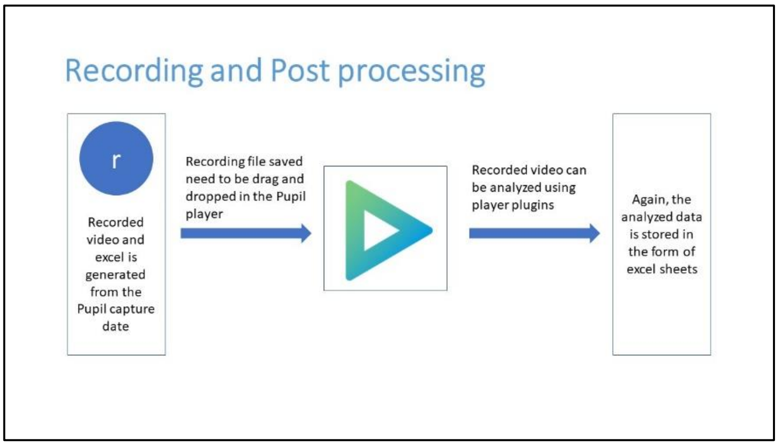

So, after doing this or while doing this we have to use record. Recording has to be pressed because if you are not recording things that you have done will not be stored. So, after recording the post processing involves that the data has to be thrown into player software this is also a Pupil Core software which is provided with the headset and this software is called player which actually analyses the data that is recorded in capture.

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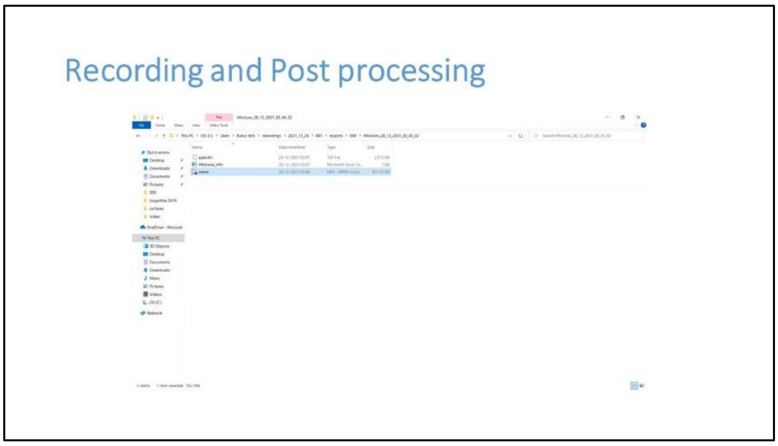

And it actually generates excel sheets and videos of world view and pupil view, pupil camera and along with the gaze positions, gaze mappings all of these things are being provided fixations are provided.

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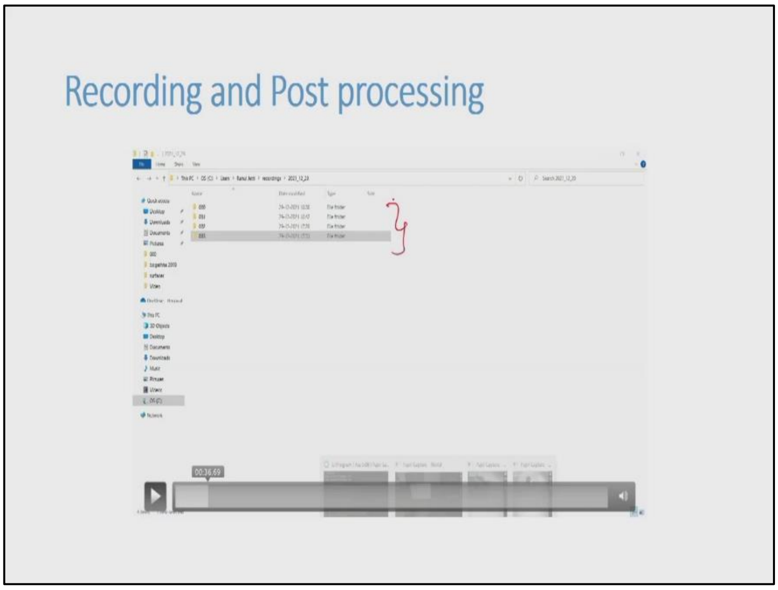

So, the things are generated in this way like 001, 002, 003 these are all the different recordings that are done or that are made.

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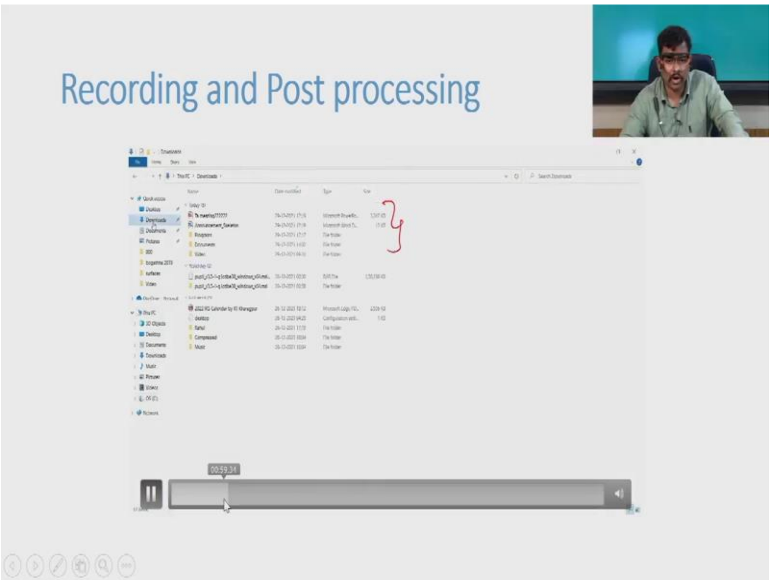

So, after a recording is identified which has to be analyzed?

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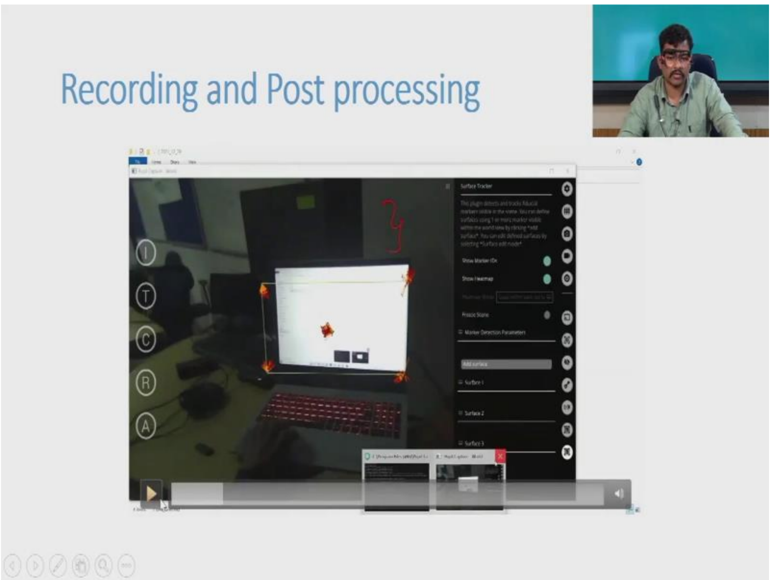

That recording is actually dragged.

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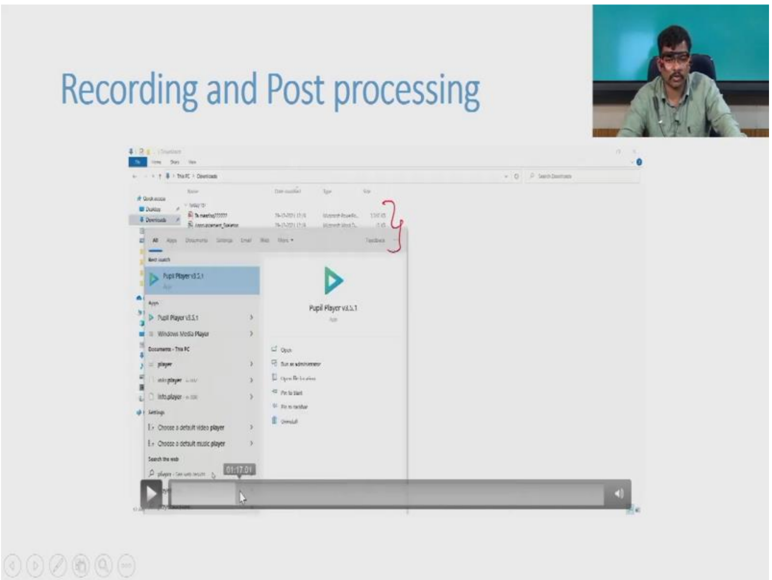

And dropped into pupil player.

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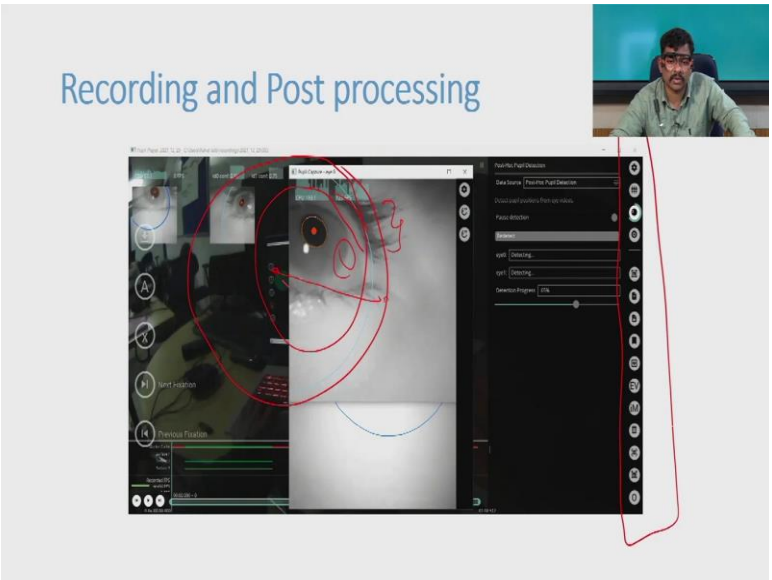

These are the pupils that are detected and you can see a blue circle it is a blue circle is the outer corneal mapping and this is the pupil that is detected. This is the circumference of a model that is generated 3D model that is generated.

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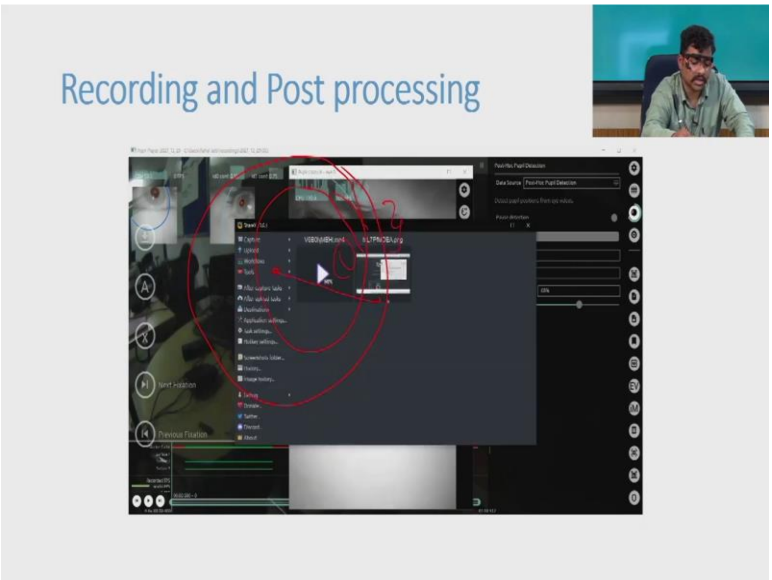

Now, you can clearly see what kind of fixations are generated the right side panel that is visible here are the add ons which actual plug ins or which actually helps us to analyze the context that is recorded from using the world camera and the pupil camera.

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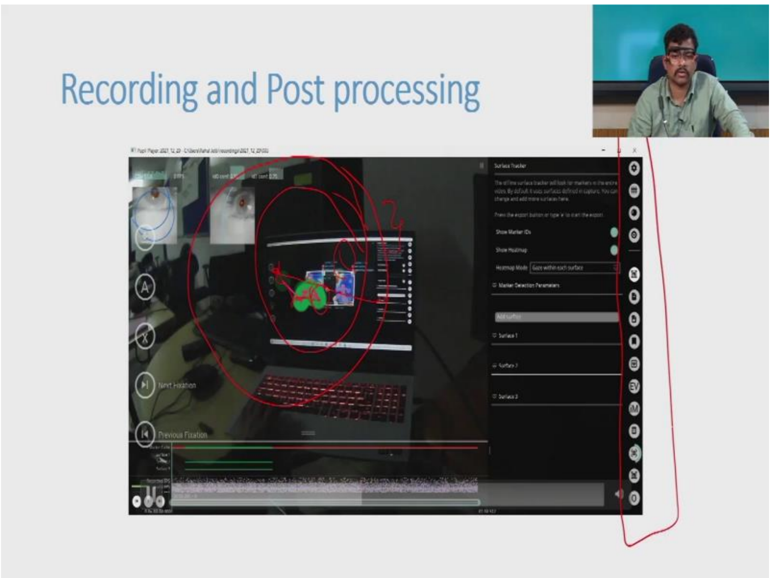

You can see some green things that is being moved on the surface.

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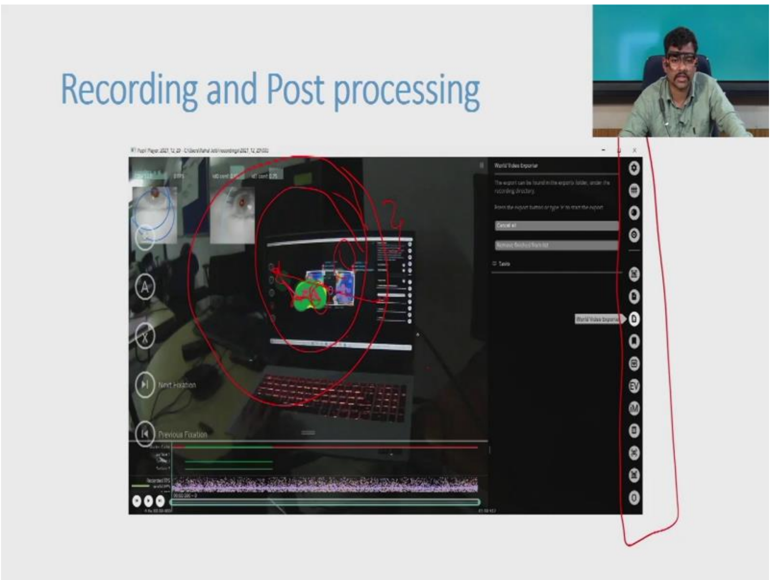

These are fixations gaze points which actually gets connected. So, the fixation to a fixation how it is being connected, what is the flow of a fixation and how a gaze is being mapped?

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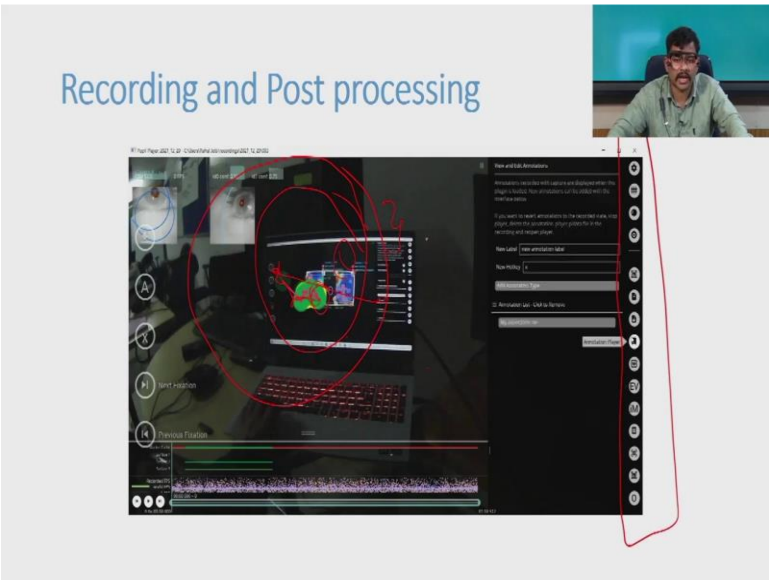

So, these all things can be actually seen.

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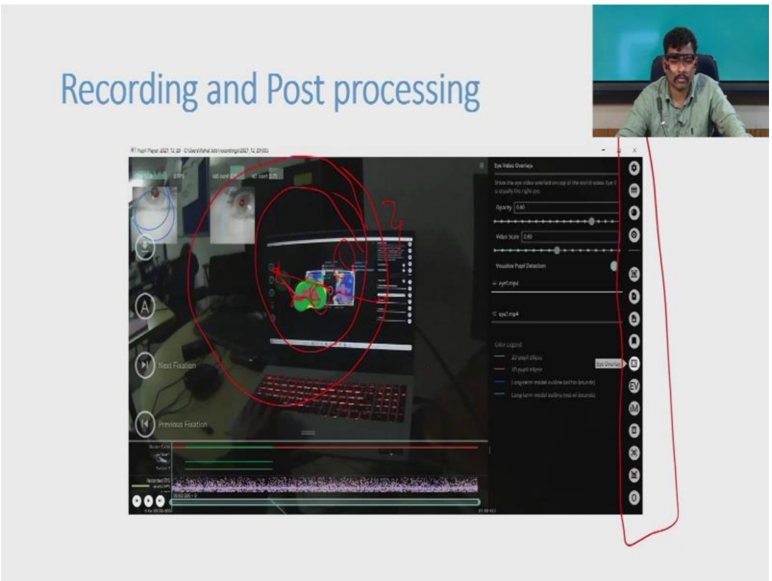

And can be generated as excel sheets using this pupil player.

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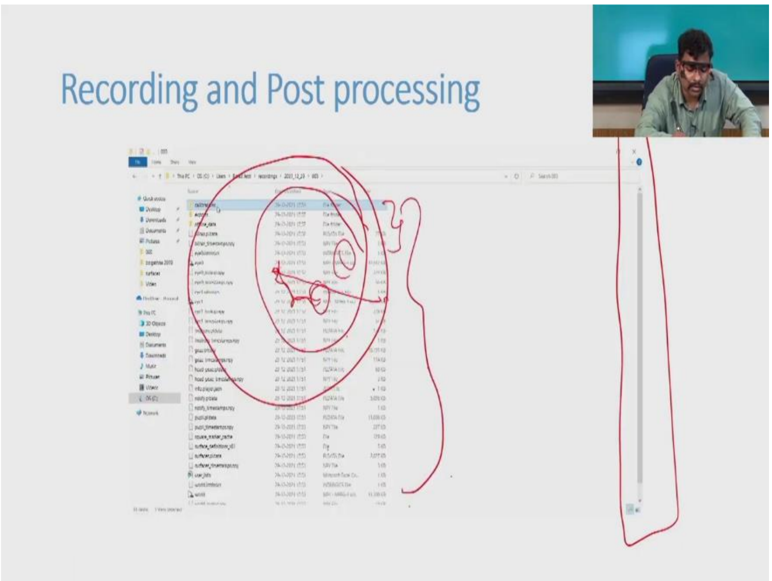

These are some of the files that are generated.

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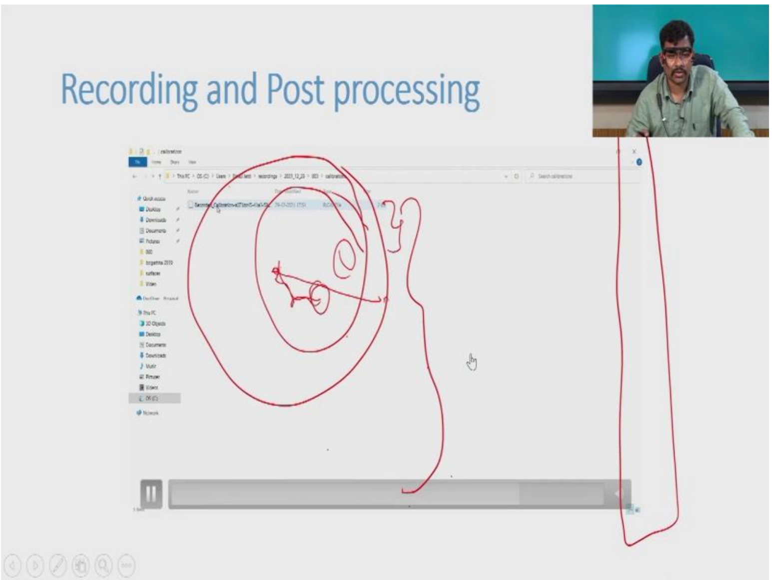

After the player is used.

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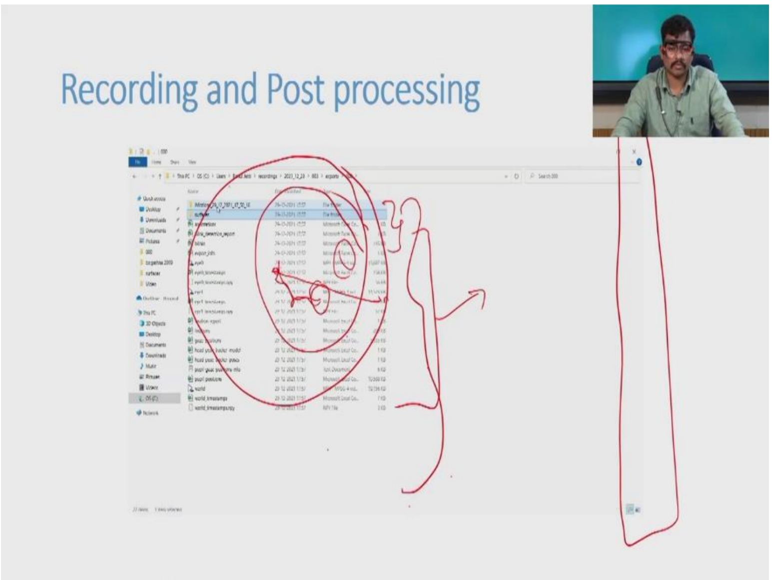

You can see the excel sheets that are generated, blinks are there and time stamps also available, fixation report is available, gaze positions are available, head pose tracker how your head pose is there, how it moved, did it change? All things are available here. These are all the things that are generated out of the plug ins that are involved in the world camera or pupil capture.

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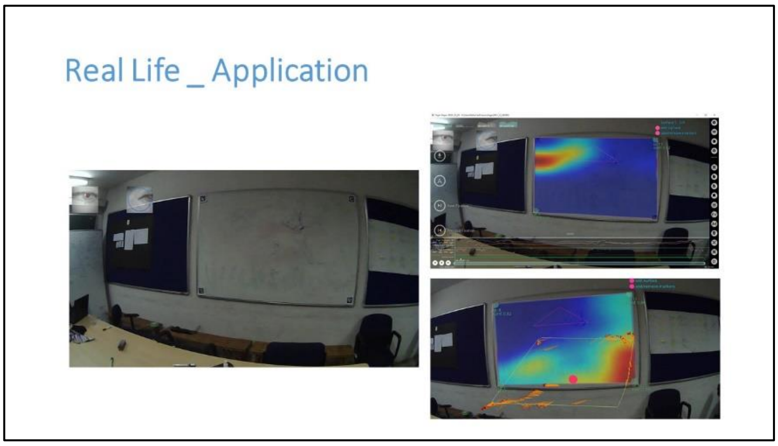

Now we move on to the next slide, where real life application is being shown. This is a drawing made by one of the kids and this drawing drawn on the board. And now this drawing and there are some documents besides or there are some brainstorming things that are besides this, but where is the attention that is being focused or how can a surface be tracked, how can a heat map is generated in a real life we can see that here.

Here our focus or we have created a surface that is present here we can see that blue and red, yellow screen which actually shows where our focus is at the corner. There is one picture which is being shown here a sun like this. So, such sun is the focus at that moment and at the end of the session the focus was here. So, this is the generated heat map we can also see how fixations are being moved, how a gaze position is being moved.

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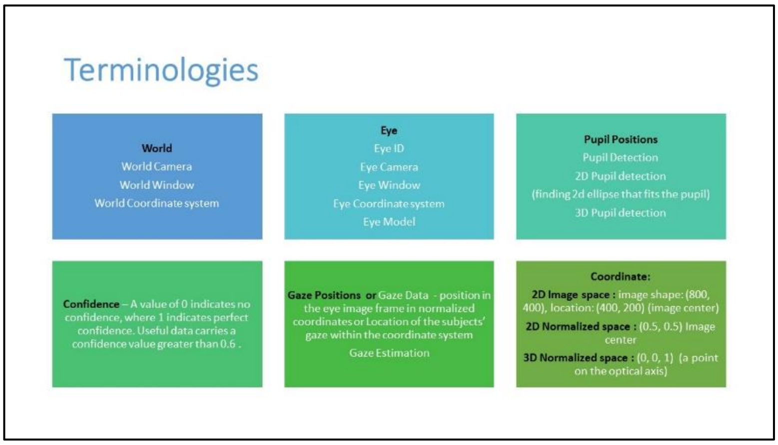

Next the important things that we have to understand is terminologies. So, related to world. So, there is world camera, world window, world coordinate system. World camera is something which you can see here this is a physical structure which actually identifies your field of view how much of things you can see even the recorded thing is more or less like fisheye or a radial vision these two are the visions that are actually we provided, which are usually human very much natural to human.

And when we are talking of world window; world window is we have already seen this in pupil capture the region where we can actually see what we are actually looking at so that is world window. World coordinate system world coordinate system is nothing but it is a coordinate system that positions where your world camera is being seen or where your eye is being pointed.

The next part is eye in the eye ID. So, for the left it is 0 for the right it is 1 in the excel sheets that are generated it actually shows which eye or which pupil has how much of confidence or how much of accuracy and it also shows which pupil has blinks and how many times. So, these all things can be identified using eye ID. Eye camera eye camera is this small structure which includes IR reflection inside.

This camera actually detects that IR reflection and mild IR reflection then those reflections are mapped along with the world camera. So, the eye window is a pop-up window which is actually shown in the pupil capture, which shows how your eye ball is being moved or how your pupil is being detected, eye coordinate system; eye coordinate system it tells us where our pupil is being moved.

If it is a binocular it actually is the centre of these two centres or how a corneal reflection is being done which direction it is being moved what is the coordinate like 0001 if it is a 3D mapping it is it also includes steps. So, it is 001 or 002 or 003 so, it depends. Eye model is more or less hypothetically formed from the frames that are recorded or from the images that are being recorded from the pupil camera.

Pupil detection like we have already discussed about it 2D pupil detection is also discussed 3D pupil discussed this it is also discussed. So, 2D and 3D are parallelly done pupil detection in the pupil detection it is parallelly done at the two pipelines exist, but it depends which one you want to focus on. If you want to stop the 3D pupil detection you can do that if you want to stop the 2D pupil detection you can do that.

But it is advised you do both because for short tests or experiments 2D pupil detection is one of the best ways to do it or gaze mapping 2D gaze mapping is one of the best ways of doing it, but 3D gaze mapping is best for longer freeway experiments usability testing of a product or a live environment analysis this all can be done using 3D pupil detection, 3D gaze mapping.

Confidence: Confidence a value of 0 indicates no confidence where 1 indicates the highest perfect confidence, which means your pupil is completely detected. So, confidence is the most important thing that you have to always be aware of when you are going to do the calibration. Before you do the calibration you have to make sure that you have highest confidence that you can achieve as I have said.

Coordinates, 2D coordinates are in this way image shape it is 800 2 3 a 400 let us say and location if it is 400 by 200 if it is a image center. So, 2D image space is more or less is a pixel based coordinate system, but if it is a 2D normalized space then it is not pixel based system, but the pixels are converted to coordinates of 0, 0 1, 1.

So, 0, 0 will be here 1, 1 will be at the end of your field of view. So, this is how it is made the pixels it is also the same as 0, 0 800 by 400 or 400 by 800, but 3D normalized space it is made out of 2D normalized space with the model of eye pupil that is made and how much of projected coordinates are being formed.

So, those projected coordinates are shown here in the 3D normalized space timestamps there are two different types of timestamps. Timestamps is nothing but at what time have you seen this is being show this is shown in timestamps, but there are two different types of timestamps that are involved with this eye tracker.

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One is system timestamp the other one is a pupil timestamp. System timestamp is something that is involved with your PC or your mobile or your laptop or any of the processor unit, but pupil timestamp is with the software it is always additive, it can start even at negative it is very much unique to this software which actually prevents it from being hampered by the data or by the let us say if I am moving from one place to another place my time zones can change.

If my time zones changed and the internet catches it and my location of and my PCs clock is changed then if timestamps if these two timestamps have the only have only the system stamp as the main then their timings can be hampered. So, it is better that we have two different clocks one is a system clock the other one is a pupil clock, but these are also can these can also be synchronised in the pupil player.

Blinks it is just what we can see, we can close the eye and open it is so fast like we cannot actually recognize the difference when we are seeing something because it happens in a swift way. It is a reflexive activity that is that happens with in our body. Calibration as we have seen how much of field of view exists with yours and how much of how much can you see with the accuracy.

So, these all things can be seen in calibration, which actually maps your world cameras vision and the pupil cameras vision it maps both of them fixations you have seen it surface coordinate system or AOI. AOI is area of interest in this software is surface even in any other software it is called surface, which actually generates you a defined area of interest where if let us say if I have three different regions to analyze.

But the middle region is more or less like not required not actually observed then we can actually skip that region and move to the two different areas part a like area a area b. And area a you can measure different fix you can place different fixations here like you can identify different fixations and what is the first fixation that happens and how many times a fixation happened.

How many times a gaze moved there and for how many, how much long did it stay there? So, these all things can be stored using AOI the area of interest surface coordinate system camera intrinsic as I have said when you are making a model it can actually be hampered by slippage or it can actually if you are moving it can actually be hampered, if distance move distance changes.

So, if the distance changes if your camera intrinsic is activated then it actually adjust a minute errors that happens, but if it is if the error is too big to normalize or to actually average things. So, it a so it hampered it gets hampered.

So, its better you stay in a fixed space or at least a fixed distance when you are using 2D pupil detection this actually helps in 3D pupil detection modelling. So, when it a 3D gaze is mapped. So, it actually helps.

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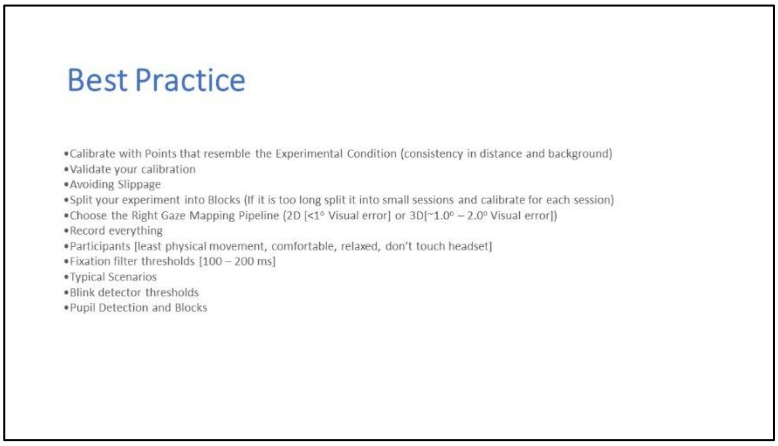

So, best practice best practice is calibration with points that resemble the experimental condition consistency in distance and background. So, let us say if I have a different background now and if I am moving to a different background. So, now, it is green or blue or whatever it is. So, if I move on to some black background if the room is dark then pupil detection becomes much more difficult.

At that time, you have to adjust the you have to change the pupil camera settings and even the world camera settings like contrast, saturation, brightness all these things has to be changed. So, it actually hampers the test results. So, it is better you fix a background you fix a bright you fix a room for your test if you are moving outside you better maintain a constant brightness constant background or similar backgrounds, which does not actually hamper your test results.

Validate your calibration after every calibration it is very important that we actually validate things validate to validate in this software it is t, a shortcut is t. It actually has different markers different placement of markers compared to calibration. Calibration has markers here, here, here, here at here, but the validation markers are different it is like this avoiding slippage. So, it should not be touched.

Its better you inform the participants that you should not should never be touched and it should not you should not moves in such a way that it falls off your from your head it fixes to your head in a very nice way, but comfortable way, but be careful that when you move this much of movement is fine, but do not move your head so, heavily or so speedily that the eye tracker falls from your head.

Even a small slippage actually can hamper your results when you are using 2D gaze mapping. Split your experiment into blocks if you have a long experiment then its better you make that experiment into three different blocks or four different blocks and numerous different blocks or different sessions. So, that you can have better results if it is a constant long test then participants can get stressed.

Participants can get bored and these things small minute things actually change the results of your test. Choose the right gaze mapping pipeline as I have said 2D gaze mapping pipeline is better for short test and 3D gaze mapping pipeline is better for long tests or a move when you are moving the 3D gaze mapping is better when you are sitting at a position for a shorter spare span of time and doing the test then 2D is better.

Record everything every minute feature that you have tweaked or every minute thing that you have changed that you have noticed in the test space has to be or in the experiment zone has to be recorded because even the minute thing as I have said even the brightness actually can hamper your results. Participants so, least physical movement is needed when you are using 2D gaze mapping pipeline.

But still when you are also moving in the even you are using 3D you have to be careful to not move your head. So, randomly that it hampers your results make the participants comfortable it is very much important to make the participants comfortable because when you are not comfortable enough then your eyes can eye may change eye positions may change your focus will be different your focus is not on the test or on the subject that we are going to analyse.

But the participants focus will be somewhere else which is not advisable they have to be relaxed and they never should touch their headset fixation filter thresholds. So, fixation filters as I have said fixations are one of the important things which let us know, which is the most attentive part of the experiment. So, in that fixation filter thresholds it has to be around 100 to 200 on an average it is around 100.

So, in some physiological situation scenarios it can go more than 200 or it can go below 200. So, accordingly you have to change this fixation thresholds. So, I have already discussed the typical scenarios what happens when you moving around what kind of gaze mapping has to be used and what kind of blink range has to be there or what kind of fixation thresholds has to be there. And in a normal scenario the software itself comes with default values you can use them.

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But better you understand what are the typical scenarios from the literature let us just say I am understanding the physiological situation of a autistic person then my participant may not focus or may not see some things in a social environment. So, how do I know that and for how many how much long does he see a situation and how many how much long can he focus on something.

So, these all things if you want to calculate then going through the literature helps you a lot this informs you what is the normal fixation time how much of time can they focus on one coordinate or one region then those actually helps you to fix these thresholds or to fix what kind of range you have to set. So, there even there is even threshold to decide like what is the pupil maximum and minimum that has to be there.

What is the minimum like maybe 10 pixels what is the maximum maybe 100 pixels. So, in such way that you have to define them if it is much more big the range is big or large then what really happens then you were data actually may not fall in the or may not actually be accurate enough to understand the scenario that you wish to see. Blink detected thresholds as similar to fixation thresholds there are also blink disc detector thresholds which can be changed.

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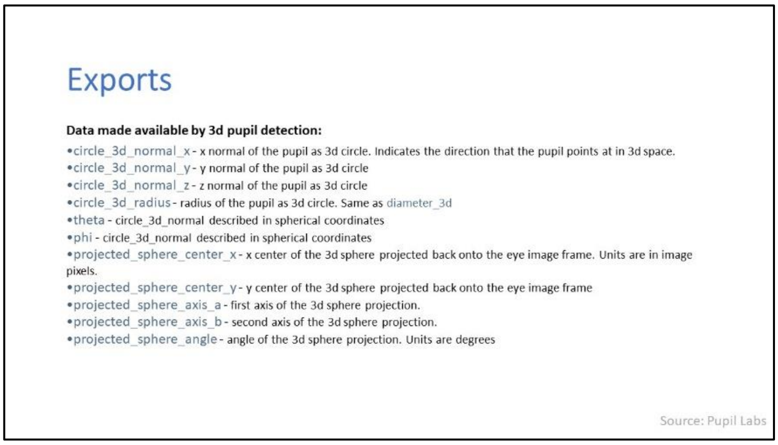

So, these are some of the different export parameters that are shown in the excel sheets that are generated out of the pupil player. So, diameter 3D, diameter 3D is eyeball is made a 3D spherical eyeball is made then this diameter is being calculated model confidence as I have said it lies between 0 to 1 model ID it is maybe 0 1 so, it depends.

So, if my eye tracker moves then from here to here then a different model is formed altogether. So, that different model is recorded as maybe 1 if it is 1 hundredth slipping then it is 100 ID 100. So, sphere center so, as I said this is the sphere center. So, these are all the parameters that are more or less 3D coordinate system parameters that are shown here.

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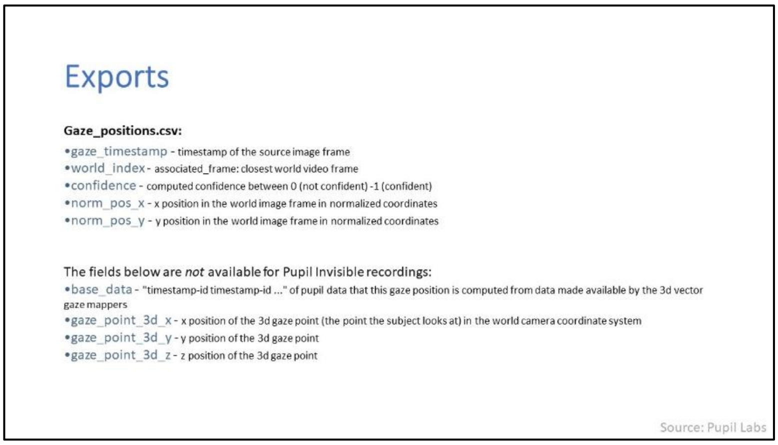

So, pupil position pupil timestamp that we have already discussed a timestamp that is in the software, a clock that is in the software is actually stored at here which actually defines when and where the pupil moved world index associated frame closest video. So, when you are seeing this the pupil actually is also mapped and associated frame. So, at which frame it is being mapped.

So, FPS like we have already seen like we have already discussed in the second slide I think. So, in that we have seen that in the graphs there is FPS. So, this FPS means Frames Per Second. So, let us say if I have done a test or experiment which lasts long for a 1 hour then you have to see like 1 hour that is 1 into 60 into 60; 60 minutes into 60 seconds. So, these many seconds are there in 1 hour.

So, these many frames, so let us say if it is 10 frames 30 frames. So, usually it is 30 to 60 frames per second. So, we can actually change that from 30 to 60. So, let us say if I have made it as 60 frames then for 1 hour it is 60 into 60 into 60 frames. So, you have to define which frame is the frame that you are that you are addressing.

So, this world index defines which frame that you are addressing. Eye ID left eye 0 right eye 1 that is how it is identified, confidence we have already discussed it and normal position x normal, position y. So, the coordinate normal's, so that is maybe 0.5 by 0.6 or something diameter is the method is whether it is 2D or 3D.

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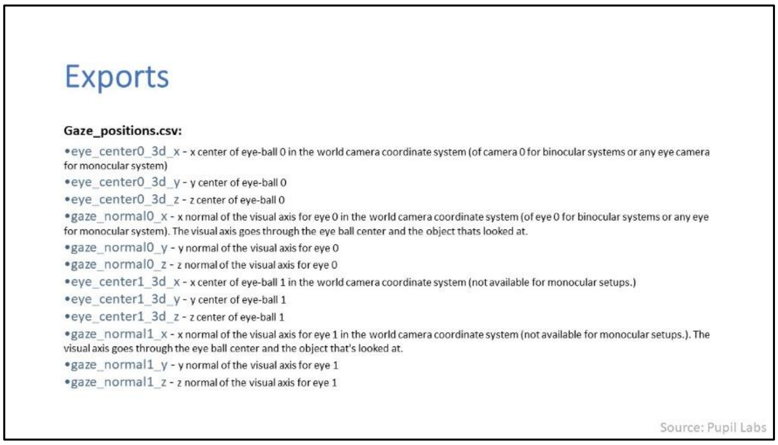

So, similarly there are many more parameters that are given here.

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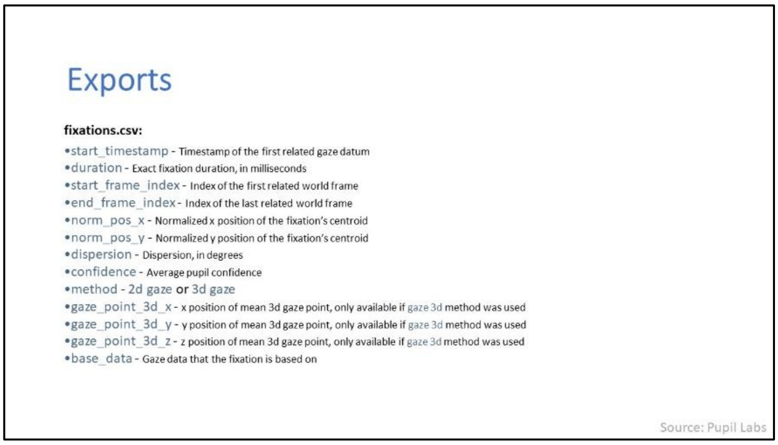

Even gaze positions are similar like world index gaze timestamp. These are all being generated after you have recorded it and after you have analyzed it using player. And this is the end of this lecture and where we have already seen like how eye tracker is used how eye tracker is used to analyze a context.

And this a can actually help you in defining or in understanding a scenario it is very helpful when you are let us take an example like if I want to use computer a PC or if I am going to buy a PC laptop in a shop then there are 10 different models which is the most attractive one out of this 10 can be identified using eye tracker.

Even an eye tracker can be used actually to move things to actually as an input. Even in the games world they are using these eye trackers as an input and even for the especially abled people they can use these eye trackers for actually moving things around them or actually interacting with things around them.

So, in future we can actually we may actually see aye trackers in the daily lives where eye trackers can actually be taken as a input eye tracker input can be taken as measure or can be used to actually move things or maybe actually use to normally analyze and store things which we can actually, which we are now using a camera or a CC camera or maybe a mobile phone to actually record things can actually become redundant in maybe in the future. So, future can be taken over by a tracker we do not know that yet and.

Thank you.