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So, last time we had this alternate world generator, maybe I can just abbreviate it this time as AWG alternate world generator and we have let us say an input side get this out of the way here; we have an input side and an output side and on the input side we get information from let us say a tracker.

Let us say maybe just a head tracker, I can make that go into this AWG maybe a game controller, does not matter what in particular I am putting in here I just want to give you kind of a high level view of the of the system keyboard maybe, I can put a hand tracker in whatever else.

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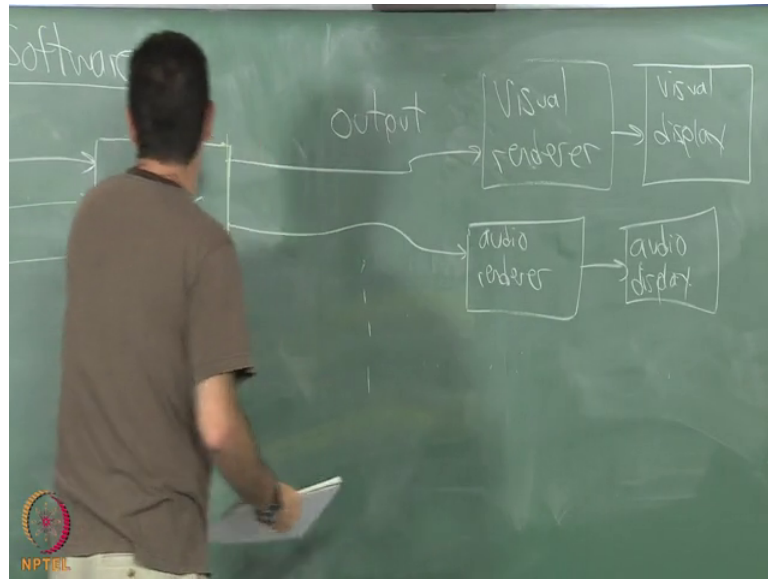
So, there is information going into this the alternate world generator has to use this information, to make some kind of updates to the renderers. So, for output see there could be a hope for me right at first visual renderer and then eventually this goes out to a visual display and we talked about different examples of that and it does not really matter which sense.

So, we can have another 1 that is an audio renderer and we get an audio display and I want this to continue onward for other senses. So, if you want to have a haptic renderer you can have a haptic display, that gives you force feedback if you like right. So, the job of the alternate world generator is to maintain this kind of fictitious or remote or recorded whatever kind of world it is, it has to kind of maintain a lot of the physics of that world a lot of the geometry and physics of that world in such a way, so that you can output to these renderers which then output to the displays, which then output to your sense organs which then fool your brain right, so that is the idea. So, we have to figure out what goes into this alternate world generator that is the main part of the software challenge here.
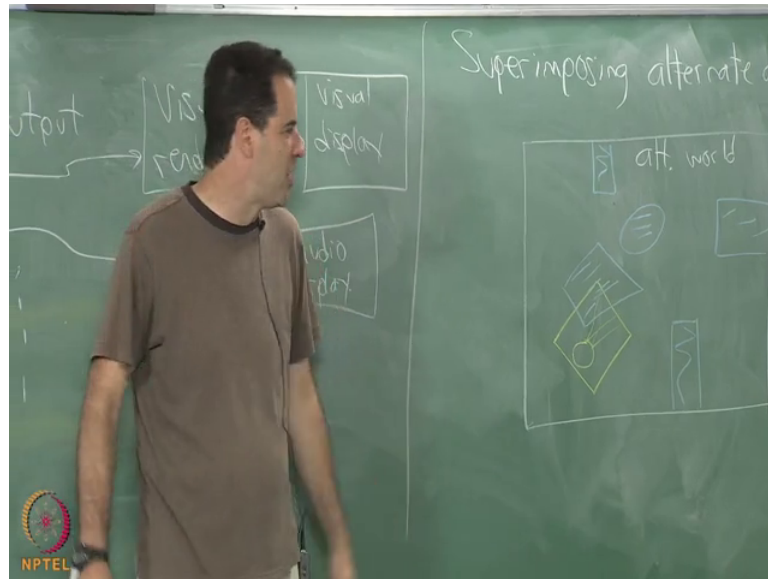
So, here is another way to look at it, if we had a little bit of geometry I can say imagine we are superimposing, I am alternate and not really sure what to call the world that you are actually in.

So, the alternate world and the local world maybe I will say local real, world kind of emphasizing local the non alternate world all right. So, think about superimposing so somehow there is an alternate world that is being generated by the alternate world generator; I want this to be really geometry here. So, there is an alternate world and in this world there are you know maybe pieces of furniture around obstacles of some kind right.

So, there is stuff in the world in this alternate world and then this kind of story is being maintained that is fooling your brain, that you are being placed into this world. So, somewhere you appear in this world. So, you maybe have your own kind of region where you are able to move around, so your head has been transformed into this world and embedded into this alternate world.

So, your head is here and you have your eyes looking out in some direction here and they are kind of like virtual cameras looking out and as you take your head here and move around, there should be a kind of perfect correspondence you are moving around inside of here this yellow zone is, where there is a kind of superposition or overlay between the local real world and this alternate world or kind of virtual world that you may be

constructing it could be virtual could be real. But it is the alternate world, so there should be a kind of overlay here between the 2 and there interesting things happen; if for example, you are moving your head and all of a sudden maybe this is 1 of the obstacles here this would be a top down view.

So, all of a sudden there is an obstacle in the world some big piece of furniture or wall and you decide to move your head into it what should happen, if you have haptic feedback it could smack you on the head right. If you do not what is supposed to happen it is a difficult problem. So, you have to figure these things out right or maybe you just want to grab on to the controller and move your character around, move your virtual self around; if you do that what happens when you come to these you need collision detection you need something that will tell you know you cannot go that way or maybe you want to move right, through it that is the physics of this alternate world, you have to decide on what the physics of this world is going to be based on your task and based on things like comfort.

It might not be very comfortable to just start passing through walls all of a sudden or it may not be comfortable to just have your virtual self abruptly stop in the virtual world, because there is a wall that may not be comfortable; this is difficult problem and I hope you would understand why that is as we go along. In fact, I started talking about motion. So, imagine this yellow rectangle that is like your zone in the virtual reality system you may be you may be sitting down in a chair, you have the headset on you can move around like this right.

If you are on a rotating chair you could rotate around, so you are moving around inside the virtual world, but in the physical world you are also moving around that is this yellow zone here and maybe you cannot leave the yellow zone in the physical world; if you can then you have a larger super position problem right. Maybe you are in an enormous region in the physical world and you can walk around in there with a headset on you are being tracked that is fine, you have to deal with again this whole problem of if you can really walk around.

So, this yellow region is larger then you could interact with all kinds of obstacles it ends up being an interesting challenge right, maybe a better experience overall but you have more challenges. So, I want to talk about different kinds of self motions and then we will

get onto the sensation and perception part which is the final part of the bird's eye view. So, self motion is a very important concept in virtual reality call ego motion or self motion.
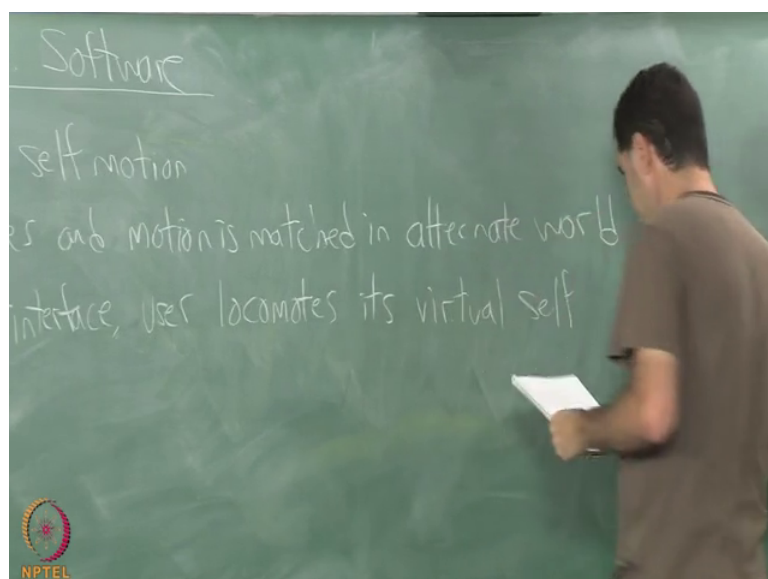
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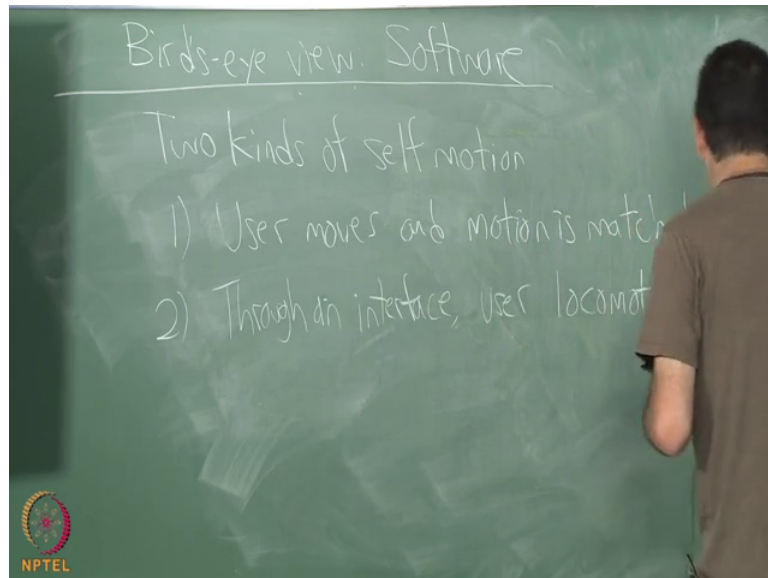
So, there are 2 kinds of self motion, 1 the user moves and the motion is masked in the alternate world.

So, if I turn my head in the real world, in this alternate world I am also turning my virtual head and the 2 should match perfectly right.

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If you do that all with 0 latency there is no delays everything is very accurate, everything is optically done correctly audios done correctly; if all the things are done perfectly that should be very comfortable and very convincing to your brain; the other motion is not through an interface an example would be a game controller the user loco mote or moves it is virtual self.

So, in this case you are not moving in the physical world, you are just grabbing onto a controller and maybe moving a joystick. So, a little bit of motion, but then you are moving your virtual body through space perhaps very quickly. So, this case you can see it is quite different right so; that means, you are you are doing it all artificially it is not a perfect correspondence, that would correspond in this picture too moving the rectangle around using a controller, but you have convinced your brain.

That you are actually there so that means, you are convincing your brain that you are actually accelerating moving along at different velocities and that is where the discomfort part comes from and that is where simulator sickness starts to get really bad. So, to distinguish between the 2 if you do faithful reproduction of the motions perfect in the local real world and match that to the alternate world, you get the number 1 case here which is considered generally very comfortable and if you do the other case where you grab on to a controller and move then it can be quite uncomfortable and there is a lot of interesting research and how to make it comfortable because, you would like to be able to sit in a chair and travel over long distances in virtual reality rather, than having to walk there right.

So, there is a lot of motivation, but it does cause sickness in many cases if you do not do it well and it is it is very difficult almost impossible to solve in many cases, to make it completely comfortable; so that is 1 of the things that people are struggling with. So, case number 1 to summarise that is where the head is moving inside of this box, in case number 2 if when you are moving the entire box right, in inside of this alternate world. Questions about that some examples of alternate world generators a game engines are the number 1 example that people are using right.

So, we are going to use 1 game engine in the lab unity 3 d unreal engine is another 1. So, game engines great there is other possibilities you can make your own game engine and

what if we are our own simulator right, you can make your own alternate world generator as just a kind of simple simulation environment.

Now, you may want to hack it up in python for example, you do not have to do something that is as complete as a game engine and also keep in mind that if you choose to use a game engine for virtual reality, you are abusing the game engine the game engine, was designed to make games on screens and there are virtual reality integrations of those; but fundamentally it took many years to develop game engines a lot of trial and error and now that is being adapted to VR, they were not optimized for VR on a screen. You can do this number 2 motion very easily and nobody complains too much, but in virtual reality people are complaining a lot.

So, it was not designed for the entire experiences need to be redesigned what we would like to have is not a not a game engine, but a VR engine a virtual reality engine; I do not think anybody knows what that is going to look like yet, but that is what is really needed and if we have a virtual reality engine that can support the kinds of things we want to do over and over again in virtual reality experiences we will be in very good shape. For the time being we are just leveraging the existence of game engines to make the software easy.

So, the game engine is this AWG I talked about the alternate world generator, if you have a robot with a camera and you want to do telepresence, then you do not have exactly the situation do you do not need a game engine; what you need is some way to maintain a panoramic representation while you are out moving around. So, that is different it is not going to be a game engine, you probably want to hack something special for it.

So, there are a lot of different possibilities and you should really think about when you need to start from scratch or when it is best at issues a game engine; since this is a 2 week course we will just use a game engine and make it easy, but if you want to for your project use something much more lower level and optimize it all yourself, then I would say go for it you know and get the experience you.