Virtual Reality Engineering
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Lecture – 13-1
Tracking Systems (yaw drift correction)

Any questions about that? So, what about the yaw component?

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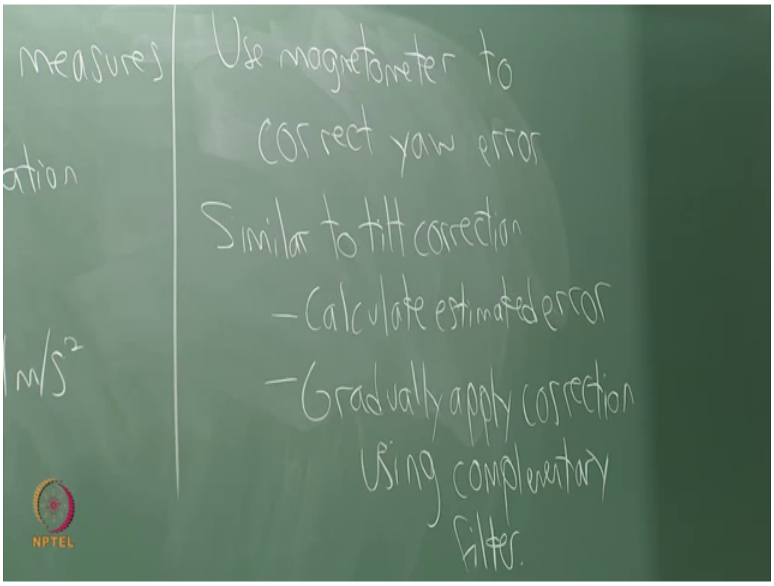

So for yaw we use the magnetometer to correct yaw error. So, this is similar to the way we did tilt correction, you have to take a measurement estimate the amount of air in yaw. And then apply corrections gradually again you can use a complimentary filter so, similar process so, similar to tilt correction.

Calculate estimated error estimated drift error and then gradually apply correction using a complementary filter. Well what problems do we have here? So, it may be very natural for us to think of a magnetometer as being a compass, but we have to really go back and think about what it is measuring just; like the accelerometer is not an up sensor a magnetometer is not exactly a compass what it is measuring is a 3 dimensional magnetic field.

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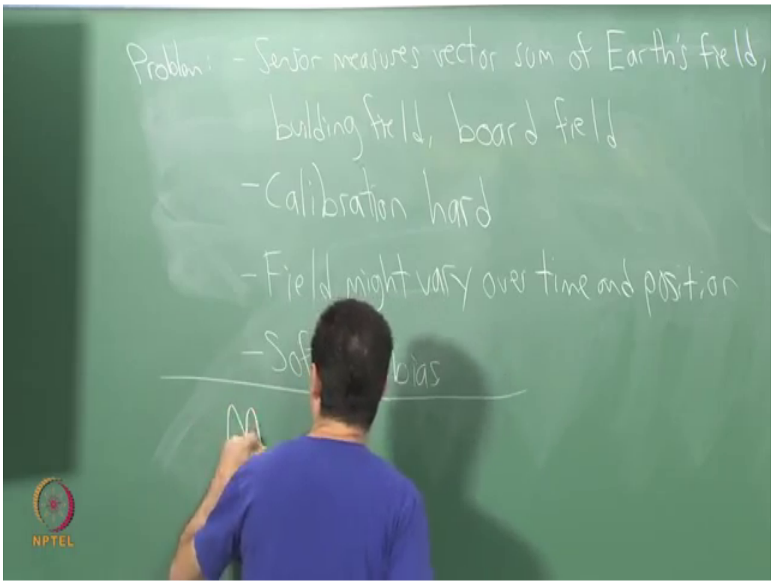

So, the problem with such an approach is that the sensor that is a magnetometer measures the vector sum just like this vector sum, but is a vector sum of the earth's field ; that is the part that we are normally interested in right. The simplest assumption is that perhaps if I have perhaps the magnetic field as I as I grab a magnetometer for the earth is always arranged in such a way that the vector field lines just point north right; that is something that naively believed a long time ago.

It turns out that in most places of the world there is a strong vertical component and so, mostly for example in the US when I was in California doing oculus development it was about 60 degrees downward is where the vector mainly points. When I was doing development for oculus from Finland; it was close to like 75 degrees or so, 70 or so, is very close to vertical if the earth's magnetic vector field is pointing straight down, then it is going to be aligned with gravity and it is not going to provide any additional useful information right.

So, so that is something interesting it varies dramatically based on where you are at on the earth. And also the field lines do not exactly point north they could be off by a few degrees, it could be off by 10 to 20 degrees there are a few strange places in the earth where they are off by a lot they would not even point anywhere near north the point may be 90 degrees away.

So, the so, the earth's field is first of all 3 dimensional and quite strange and you just want the horizontal component of it you do not want the vertical component. So, if most of the field is in the vertical component; you are just essentially wasting that information, you already know the vertical component reasonably well do the accelerometer. You are trying to find this horizontal component that is parallel to the surface of the earth. So, you can correct which way you are facing.

The next problem is that in addition to the earth's field; there' is a field inside of the building if you are indoors which most people are all right. So, there is a building field which is generated by whatever ferrous materials there are indoors; it is very interesting to grab an expensive magnetometer and go around and just try to see what the fields are inside of a building is they vary dramatically their entire startup companies that just provide services for mapping out buildings just using the magnetic field inside of the building. So, it varies so, much that you could build reasonable maps not down to millimeter level accuracy, but it varies quite a bit over on the scale of meters let us say as you go through the building.

Also on the circuit board itself there is there is a field. So, there may be ferrous materials on the circuit board. So, every time you install the magnetometer on the board it will behave differently than it would on some other board. Now it may be consistent for the board that you have designed so, that is good. So, you could do a calibration procedure to try to compensate for that, it may just add some constant offset based on the materials around the board.

So, those are three main fields and what is very interesting is that you could get so, unfortunate that when you are inside of the building in some location, the building's field might cancel off the earth's field. So, the two vectors may be in nearly opposite directions and you get a horizontal component that is very close to 0 in which case is useless so, these are some frustrations with dealing with magnetometers. So, there are calibration challenges you may actually have to ask the user to perform calibrations; you may have done this before with your smart phones or calibration programs for your magnetometer field might vary over time and position.

You would like to have it is that if you move your head a half meter to the side, you do not get a completely different orientation of the field because that would cause great confusion. So, you need to feel to be mostly constant; it could be bending in some ways especially if you are unfortunate and there is also something called soft iron bias which I will not cover here.

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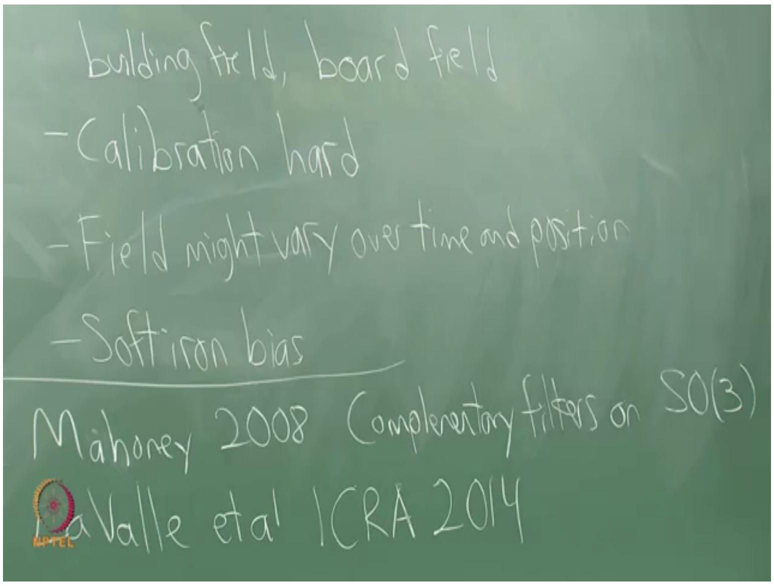

But which induces a kind of elliptical distortion on the magnetic field readings based on ferrous materials in the vicinity of the sensor.

So, all these end up being complicated challenges we founds we were able to get accuracy down to around five degrees or so; which is not great, but most of the time things were working fine and on down around 5 degrees or so, is not too painful at least it keeps your cockpit from drifting away indefinitely. So, it more or less gives you a consistent sense of forward it is not as critical to get this write down exactly as it was for tilt.

Human beings can detect till here is down to about half of a degree. So, if the world's tilted we end up being not very comfortable if the world starts drifting a little bit to where we are facing a different direction a couple of degrees of error and that is not much of an issue; it does not cause the sickness of any kind and usually we are kind of quickly fooled by small errors and can compensate for that.

If you want to read more on these things I have talked about here there is a paper by Mahoney 2008 and it is all about complimentary filters on the space of transformations that arise for rigid bodies. So, like; SO 3 which is the space of 3 D rotation. So, I think this is an excellent paper to look at that talks about how to combine measurements from multiple sources and perform drift corrections, select the coefficients in such a way that everything globally converges it has mathematical analysis as well. So, I think it is both practical and mathematically sounds it is a very nice source.

Ah I have also co authored a paper at the International Conference on Robotics and Automation 2014 that covers oculus rift head tracking up to up to this and the rest after that was not public so, all right questions or comments on that yes.

Student: (Refer Time: 08:28).

All the camera.

Student: Yeah.

Yeah that is great that is so, part two. So, so that is a very good question that is just leading into the next part of the lecture. So, I am I am only talking about orientation tracking right.