Indian Institute of Technology Kanpur

National Programme on Technology Enhanced Learning(NPTEL)

Course Title
Introduction to Experiments in Flight

Lecture -10
Sensors Part - II

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The fourth sensor which we will be discussing will be magnetometer. Now as the name suggests it has to be something with magnetic field something that site magnetometer basically measures your magnetic field, now suppose I have a conductor this is my conductor and I pass a current through it, this is current, this is your i there is a transmit flow from one side to another side if I apply a voltage, this is a simple phenomena when I apply a current to a conductor that across will flow from one side and it will come then the circuit will be completed.

But as you know if there is no magnetic field in this conductor and I have given a constant current to this, constant I am giving a constant current to this particular conductor. And if there is no magnetic field if I measure potential of this particular surface it will be zero. In presence of magnetic field this line will get distorted, so it will be something like this. As I am giving this constant current then voltage will be some Vh this is known as hall voltage.

And this whole phenomena is known as hall affect. Now your major magnetometer sensors which come in for your web searches you can call it or for your appreciations use this phenomena or hall affect for calculating your earth magnetic field. When you give application magnetometers are used to calculate or to find your magnetic north which is different from your actual note.

Now the magnetic north constantly varies according to your location magnetic north. Now this magnetic north will constantly vary according to a particular location where you have means, if you have GPS data then there are data's and label when you can give a connection factor to align your vehicle to true north. The major application of using magnetometer is that it has zero basing effect or means zero error hence if you have give your UAV to head to a particular direction say a particular heading we gave given.

So since your magnetometers have zero error so it will automatically concocted your heading your automatic at your heading angle so that is why it is very good for UAV application when your are focusing the focusing on particular direction in which your UAV as to follow but the defect of this magnetometers are since a magnetic field is involved.

So there are different instruments are different equipments in UAV or in plan itself which quite which have electrometric field such as you cannot mount a magnetometer near router because it as magnetic field so it can be start your readings and also when you have a large landing gyre which is metallic the problem comes of the magnetic field that is the mounting of magnetometer as to be consider where it should be mounted so your electromagnetic field does not vary now these where regarding to accelero gyro and magnetometers the three sensors which we discuss in our accelero.

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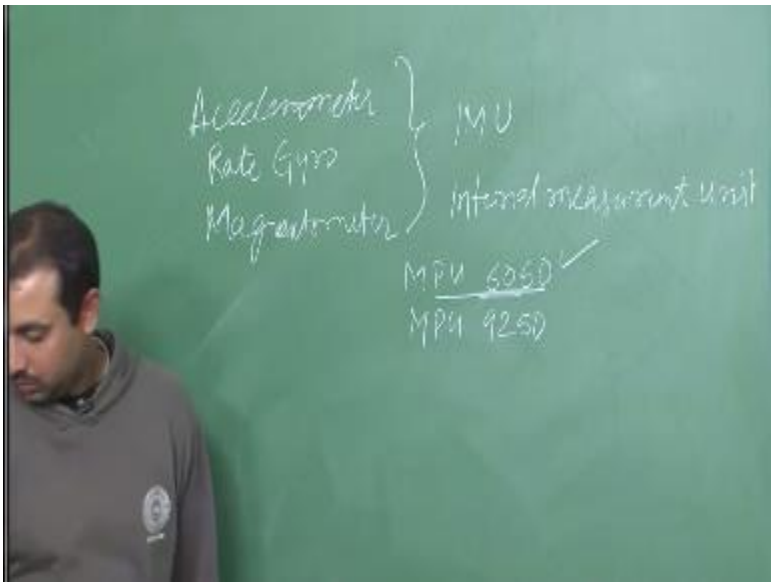

Rate gyro and magneto meters usually you will find circuits where the these all three are available on a single unit we usually name it as IMU or initial measurement unit for your experimental purpose we will be using MPU 6050 and 9250 these are the very simple IMUS which are available in the market and we will in our domain this lecture we will be showing you how to capture data using IMUs 6050 this was regarding to initial measurement unit now we will be seeing what are angle of act sensors and why angle of act sensors is need so the next sensor will be.

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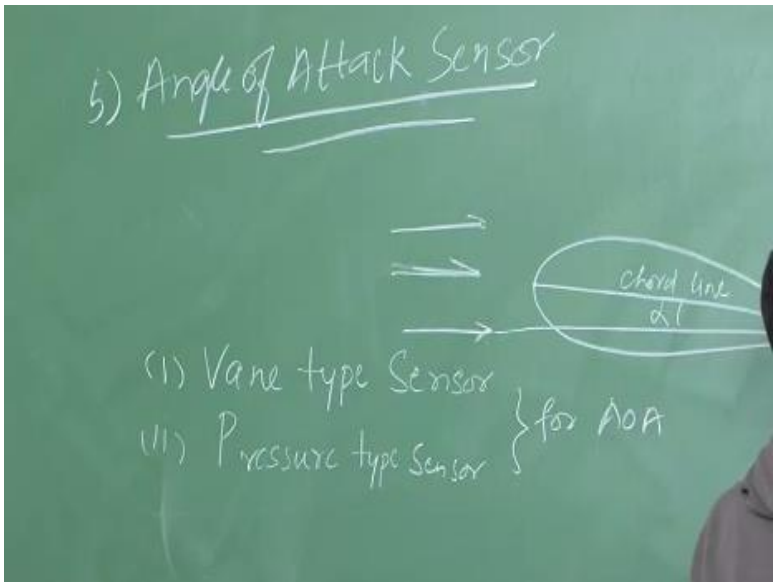

Angle of attack sensor. As you already know angle of attack is your angle between this is the section of your wing when I connect your leading edge to your training edge this is known as cord line this is your free sting velocity these are all parallel and the angle which this free stem velocity makes with your chord line that is your angle of attack represented by alpha now why we need to calculate angle of attack.

Because it helps in Stoll warning systems alpha angle of attacks sensors are basically of two forms first is Vane type sensors, second is your pressure sensor pressure type sensor now first we will be discussing what are value type of sensors and what are pressure type of sensor both angle for angle of attack.

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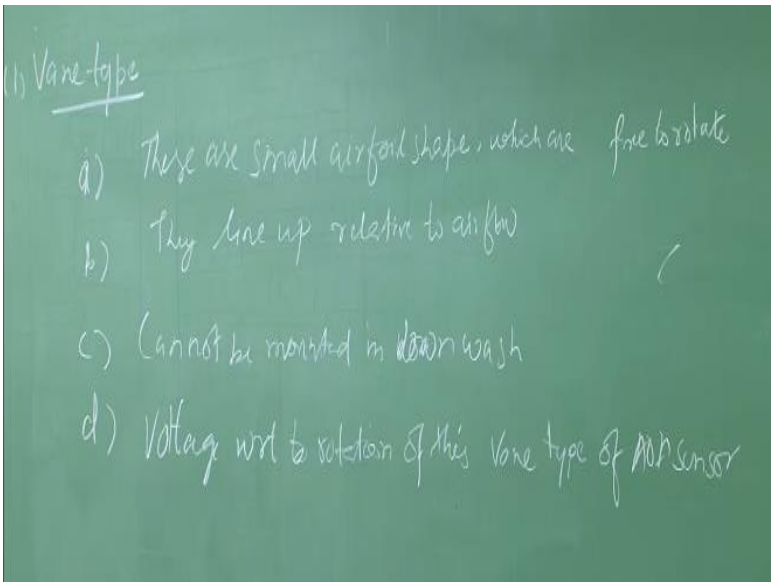

First vane type, vane type of angle of attacks sensor the properties are first A these are small F1 types small F1 shape which are free to rotate, second they line up relative to air flow, now since they line up relative to air flow so they cannot be mounted in down wash areas such as just behind your vane downwash and D as it is free to rotate the rotation is calibrated to a potential meter.

And we will be getting voltage with respect to rotation of this vane type of angle of attack sensor, this was for vane type of angle of attack sensor this is a small angle of attack sensors used for small wave is when small aircraft now the principle is same as of vane type of angle of attack sensor here instead of vane a small flag is there as you can see this will align when the aircraft will be more flowing moving in the air this will align according to particular air flow.

Now suppose it aligns in this particular direction, now you can see this is mounted and it can rotate and based on that rotation a potential will be generated which we can sense or calibrate according to this particular relation as you saw for while calibrating your control surfaces the same phenomenon was used while deflecting the control surface there was a potential meter involved and based on that a particular voltage we got in valve program same principle is used

here also, based on the deflection your rotation up potential meter the voltage will be generated and that can be calibrated according to particular angle of attack and as you know these angle of attack sensors is majorly used for false tall warnings.

So this is than efficient in that, now second type of sensors which will be using a second type of angle of attack sensors are pressure type sensor. Now what are pressure types of sensors?

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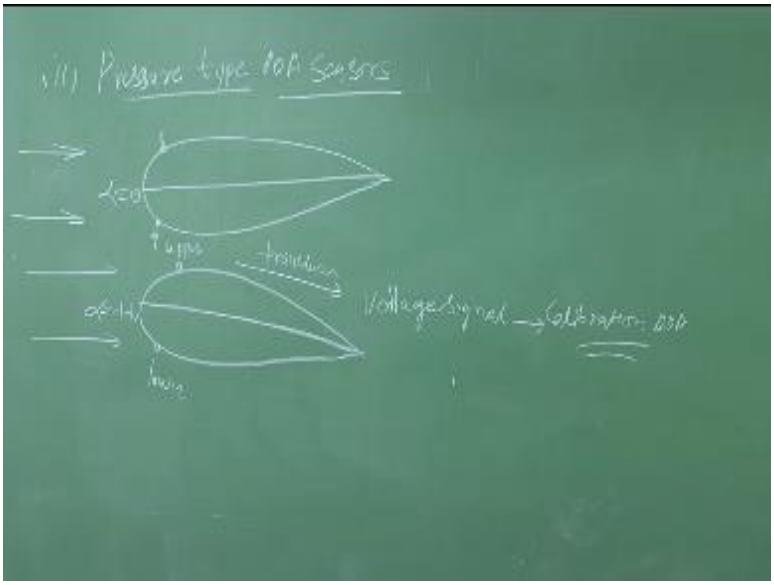

Pressure type, attack of sensors now pressure type of angle of attack sensors it involves air falls section blade and a holes are mounted at the leading H symmetrically below and above that particular surface now as air will flow this particular air as your angle of attack willing these will create a pressure difference, this is your chord line or this is your chord line here suppose angle of attack is 0 here angle some positive value.

This special difference can be transform in to a voltage signal using some trans cursers and that can be calibrated voltage signal through transistors and this voltage signal can be calibrated for angle of high back, so these are two types of angle of a tax sensor now most of this small UAB is

do not use angle of a tax sensor because this not much need usually they are fly at much lower angle of attack so they do not reached at high of a stall value.

So this is not required in small UAB applications but for commercially we have cove this is important sensor so we cannot just neglect this sensor.

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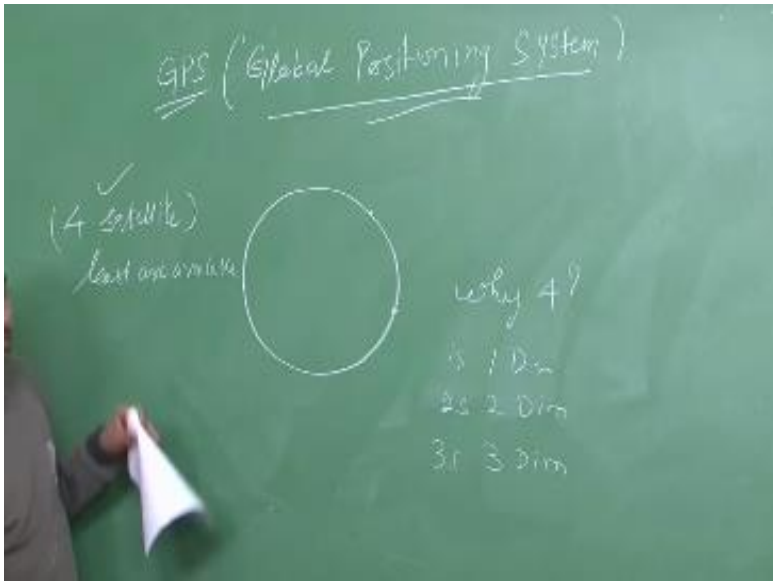

Now so far this were the sensor which you saw ion flight data recorder rather than your magneto meter now one more type of sensor which I want to discuss is your GPS because now a days it has quite a lot of applications starting from your UAB operations to your smart phones you have GPS everywhere, and it is helping lot of people now what is GPS as commonly known as or all of you know that if it is global positioning system.

Yes this is the full form but what does this represent it is actually a consultation of many satellites which revolved along the earth in a fixed or width such that every each and every location on this earth has access to a t least of four of this satellites at least four are available for every position on this earth now question arises why four because if you have access to one

satellite you can determine appoint in one dimension with two satellite two dimension three dimension that is all we need.

So why this four satellite is required will be coming to that let us understand how GPS access a particular point and how avoid this four satellite are required, we will be coming to that, let us understand how GPS access a particular point and how, why this four satellites are required. Now the phenomena which is used to access the particular point is tri alteration, what do you mean by tri alteration, now all this satellites which are revolving around the world in particular orbits, have their clock synchronized every day, that is the accuracy these are atomic clocks, so accuracy is very high, these are as high accurate as one million thousand second, these are synchronized everyday from earth.

Now each and every satellite sense two data to receive a GPS receiver that is its location, second time, at what it was sent, time okay, it was sent. Now this satellite sends its location to particular receiver, so this is receiver, this is a satellite A, this is your satellite B, this is satellite C, when this satellite sends this signal to particular satellite, so it will calculate the distance of the satellite using this simple formula, distance = speed * time, here time will be time at which receiver got its signal – time at which the satellite send this signal, and speed is the speed of light, meters per second.

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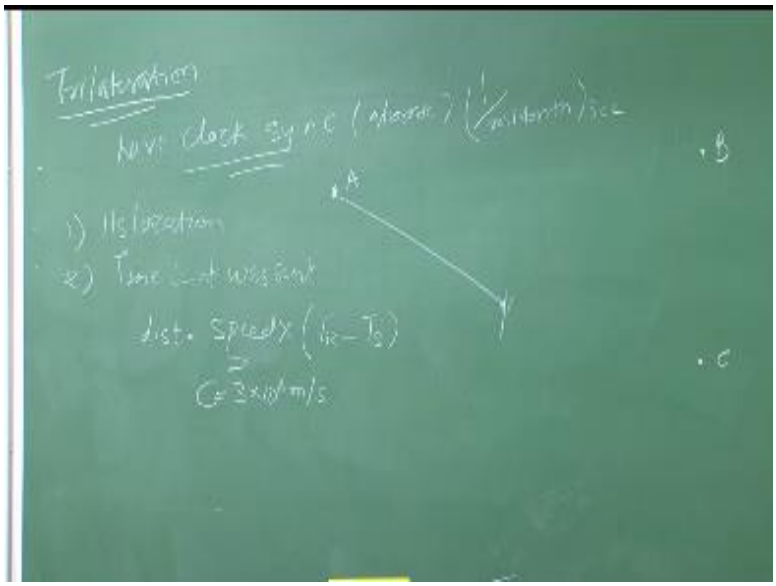

Now as you can see with one particular satellite it will be, now as you can see using this formula, it can calculate distance at which, from which it got its signal, the receiver got the signal, so for satellite A suppose a distance for D1, this is D1, so it can anywhere along this particular circle, this is the circle of radius D1, this is the circle of radius D1, so your pound can be anywhere in this particular circle. But since this is in space, so this will be a whole sphere.

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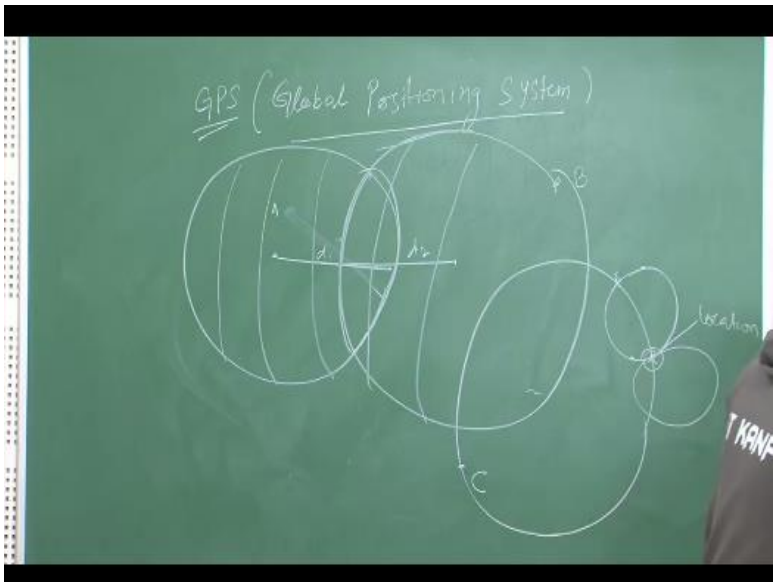

This a sphere so your point can be anywhere on this particular sphere. Now the distance between distances for satellite B that will be also calculated for the same formula suppose this will be distance T so another circle with distance d2. Now intersection of this sphere and sorry this sphere will give you.

This particular circle intersection of these two is will be a circle and you present if with a small circle that is say suppose this was a circle intersection of these two points. So we are both object can lie anywhere on this whole circle now suppose this C this is your third satellite and it will also the distance will be calculated using that formula and therefore it will be circle somewhere like that so you got two point. This and this now since your are on earth this will act as a forth point since you cannot travel in space so this is your location.

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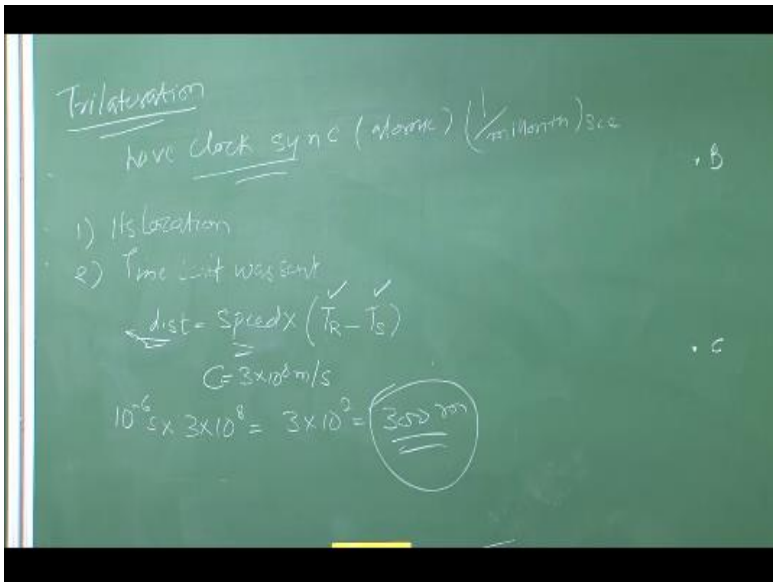

So form here it seems you only require three satellite to get your particular location so what is the need of forth satellite place are role of accuracy now you know that this is a time at which receiver got your signal. And this was the time at which your satellite send signal. Now even a small difference of say 10 to the power -6 delay of -6 second will result in three into 10 for 2 that is 300 meter error. So that is why you require at least four to.

At least four satellite so that this error is significantly reduced and the more number of satellites are connected to your receiver the more accurate will be your data and other parameters such as high and down speed can also be calculated using your GPS data. But that is not for this course so I will be concluding after this portion so as far for sensor part these are the major sensors which I want to discuss and let you have one idea how this sensors work.

What are general principle and how data position are data are acquired using sensors so that will be demonstrating you with a small example first we will also be sharing with a coat for extometer your red diaos as well as angle of attack I wish I already showed you a small angle of attack we will be sharing the code and showing how it is done you acquire data using an atrobots and m6 and 5 0 sensors and end of the attack sensor thank you.

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