Advanced IOT Applications

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Lecture – 18
Building blocks for autonomous vehicles – 1

Let us start this module by discussing the different Building blocks, that make up a an autonomous vehicle. So, the level of autonomy is actually well defined in these standards. So, the highest level indeed is that; there is no more steering and there are just human sitting inside and the vehicle is moving all by itself. If, you have to build a complex system like that, you have to break it down into manageable parts first and you have to look at module by module, manageable unit by unit, get into the detail of each one of these units and understand it's linkages to other modules and other subsystems, which makeup this complex vehicle.

So, it isn't that autonomous vehicles are anything has happened overnight. In fact, the level at which engineers have been working, particularly automotive companies been working dates back to 1970s.

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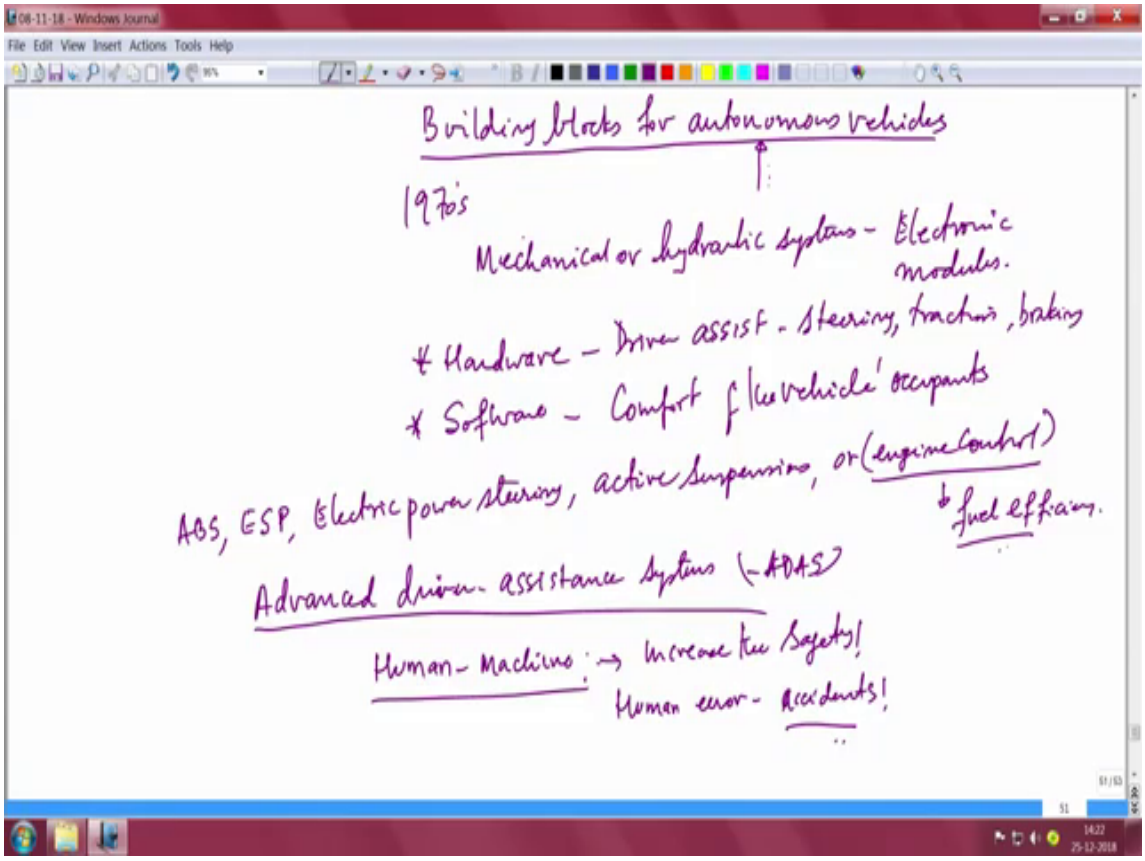

Where, they said that autonomy is a very important aspect of replacing mechanical or I hydraulic systems with electronic units or electronic modules. This is already the start of going towards building autonomous vehicles, this is the most important thing you have to bear in mind, which clearly indicates that the hardware components and the possibilities.

So, look at what happened with respect to hardware of electronic modules. The software that makes up the whole electronic system has become very complex. The functions which this software can do particularly to improve comfort; to improve comfort of the vehicles occupants basically people were sitting inside and assisting driver to control the vehicle through several functions. So, this electronic modules and hardware modules assisted driver through several functions like steering traction and so on.

So, all these has been happening for quite some time and the way the things are progressing, you can see that even braking is electronically operated. And, now a day in modern cars, where we talk about ABS, you say anti lock braking system, is around

,electronic stability program ESP is around, then you have electric power steering (EPS); Active suspensions are around now and also many parts of engine control. Now, this is critical because it has improved fuel efficiency; all of these actually leading to building the autonomous vehicles, semi-autonomous to fully autonomous.

So, the highest level is indeed the autonomous vehicle; fully autonomous vehicles and different gradations, which allow you to different levels of autonomy that you can bring in. So, when you say ADAS you actually mean Advanced Driver Assistance Systems; driver assistance systems you also called ADAS, which are basically systems that help the driver in the driving process. So, when you look at the whole system you will be actually wondering, it is all about human and the machine and a nice interface between the human and the machine. If done very nicely you basically increase the safety. Not only safety of the car, but also safety on the roads when people are there. So, it because most of the times, human negligence or human error, that there are accidents. And if machines can do that well, you are that much more better. So, let us now show you what I actually mean by this by giving you a very simple picture of what has been around for a long time now.

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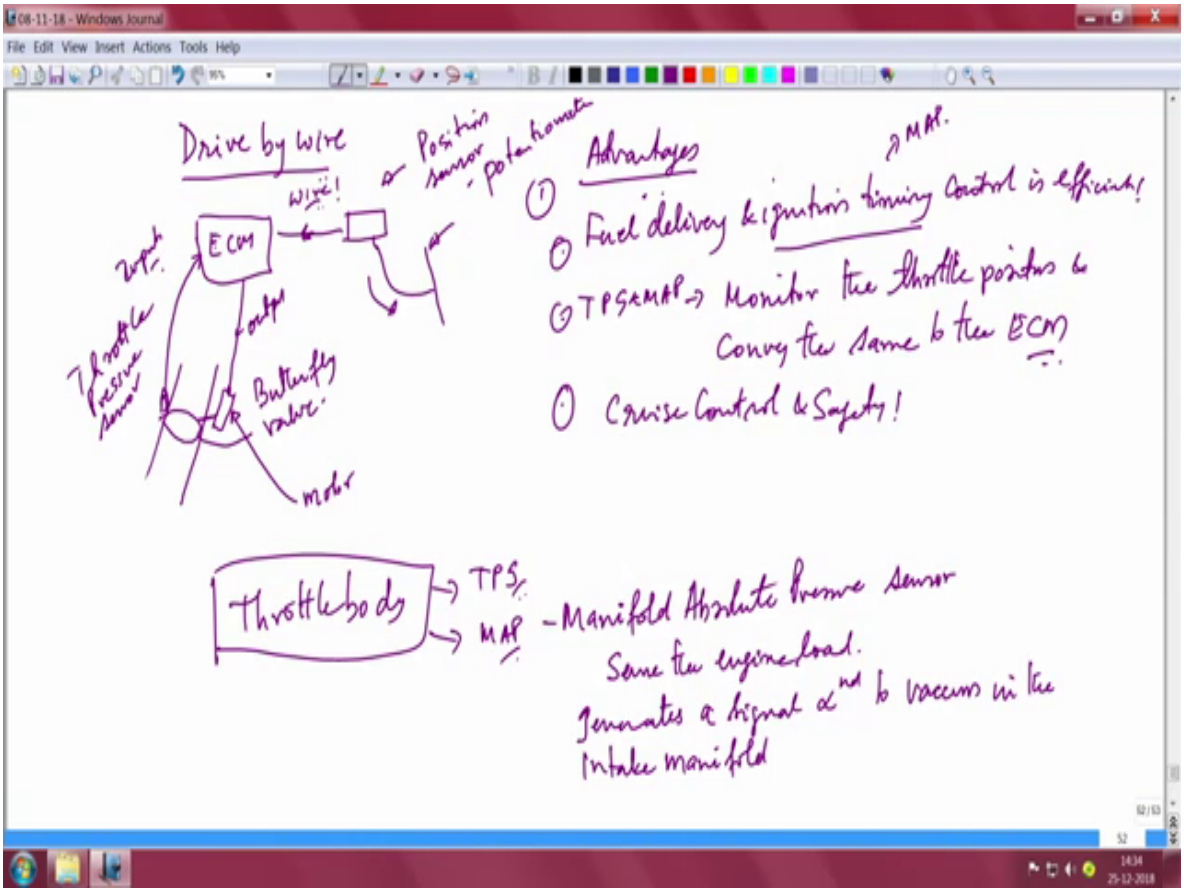

Not actually very long time, but something that people have been talking about for a long time. And that is drive by wire actually also called drive by x, means, x can be replaced with several things.

And here we are just talking about drive by wire. Let me give you a very simple feel of what I mean by this. You actually throttle where the leg is sitting, and which is your famous accelerator. This accelerator is connected to ECM. If you now start looking at drive by wire all the mechanical linkages and all of that, which I mentioned previously like mechanica, hydraulic systems being replaced by electronic modules. So the accelerometer or Throttle system included position sensor and potentiometer, which is already electronic.

It be connected to the engine control module which in turn will connect to the engine. Inside the engine is the butterfly valve, which has motor, the ECM is connected to the motor, the motor in turn is connected to this butterfly valve. So, how to imagine this butterfly valve? If you have not seen one and if you are not electronic engineers;

consider a pen cap. Inside the pen cap suppose put a disc; which is exactly the same diameter as the pen cap. The clip is a motor or actuator. Now, supposing I connect the clip to that disc and I lift it , what had happened? From a vertical position it will go to some angle and settle down. So, essentially the more you lift the disc inside will start becoming more horizontal, it goes from a vertical position to a horizontal position. Very simple way that the disc inside is nothing, but the butterfly valve. The amount of opening will depend on the amount of air flow. As the air flow increases the fuel that has to be injected for mixing air will also have to increase.

And when you do more air flow and more fuel what will be the power? The power will be much higher, so, it will be going at a much faster speed. So, how do you increase the speed? So, you keep pressing the accelerator and that in turn will do all of this by opening this butterfly valve, allowing more air and more fuel and mix optimal mixing will give you high fuel efficiency.

So, fuel control, engine control all this is part of an engine control. So, you need to have high fuel efficiency, if you want to do that the mixing of air with fuel is a very important aspect. Of course, there is an air filter and all that is to remove the dust components and all are one part, but then ultimately it is about mixing amount of fuel that you feed and the amount of air they have to be optimally mixed. So, that the amount of a power that you derive from the engine is higher and then the vehicle can move faster. Where one can move at a much higher speed.

As you seen in the above picture there is a butterfly valve and there is a motor. Originally there was no position sensor, there was no potentiometer and perhaps you would have your leg directly controlling the butterfly valve, which would be opening the butterfly valve directly perhaps or you may be wiring it to an electronic control module or engine control module sometimes called which in turn is doing this.

So, right now you can see what is your ultimate feel? what is the feel you are getting to the leg? Which nothing to do with the valve at all. No pressure is coming, no return, no feedback is coming from pressing the valve or no actuating the motor; you are not getting that feel, its all wire.

You are replacing all controls mechanical and hydraulic with wires. Now, you may ask what happens if these wire snaps and will I have a risk and all that, well its not at all

anywhere close to what you can imagine the amount of reliability that the system provide. In fact, you can have problem or the other way, that when you press accelerator and if you did not have wires and you were actuating the butterfly valve directly either via the ECM or directly there is a good chance that system might jam. If, it jams the vehicle is out of control right. Either it jams by opening more fuel and air or it might simply get jammed in that position and does not come back, when you release your leg from the accelerator.

It supposed to come back, it is supposed to cut speed but does not happen what will you do? So, in that sense wire base systems are much more reliable. There is a throttle pressure sensor as input to ECM reading throttle status. Now, you can see the TPS is input, control signal to valve is an output. So, everything is happening with respect to leg position. If you press more, something happens and then you get back what is known as the throttle pressure sensor giving you the a position at what position the valve is.

So, all of this essentially means, if you do drive by wire you will have the following advantages. Fuel delivery and ignition timing control is accurate means efficient and much better. The throttle pressure sensor is used to monitor the throttle position. So, what we will do, what will you do monitor the throttle position and what will it do? It will convey the position of the accelerator pedal.

So, it will convey the position to the ECM monitor the throttle position. Engine Control Module, or Electronic Control Module. Then there is also other sensors I did not put that, which is called the MAP sensor.

See these are all part of what is known as in a broad sense it is called the throttle body, when you say throttle body; throttle body will have all the sensors, it will have the TPS sensor, it will also have the MAP sensor, we will go into a detail of this the MAP sensor. In throttle body, there is a butterfly valve located between the air intake filter and the intake manifold. So, the MAP sensor is nothing but the manifold absolute pressure and, this ones job is essentially to sense the engine load in a way it will sense the engine load. So, the sensor what it does is generates the signal proportional to the amount of vacuum in the intake manifold vaccum.

So, this is another important thing. So, what this sensor does is it will give that information to the engine computer which will then adjust the I mentioned to you about

the ignition timing right. So, MAP indeed in something that is required along with TPS. So, TPS is more like a feedback what is the position of the butterfly valve will be known to the ECM, it is like more like a feedback. It give a command ECM, it will give a command to move tilt the butterfly valve to some degree, that should happen through the motor which is expected to rotate.

Because, it is coupled directly to the valve. Once it moves the position is recorded by the throttle pressure but the MAP sensor is the one that will generate, give a sense of the engine load and it degenerates a signal proportional to the vacuum in the intake manifold. So, t the ignition timing and fuel enrichment happens properly.

So, when I say the advantages of drive by wire, it is because of this fact that the sensors are present. This is the key take away from what I was trying to tell you. Also, that is one thing, then as I said the cruise control part becomes easy now. TPS and MAP give advantage. The third advantage of doing drive by wire indeed is safety, as I said cruise control and safety become prime if you do it this way.

So, now, you see what you are driving at? A very complex system where human was pressing something and the basically the accelerator and the engine either increasing its fuel intake and taking a lot of air and giving you a lot more power or the other way all of this is getting now replaced with this drive by wire. Very minute step but a very important step in moving towards autonomous driving. This is the point I wanted to convey. It has been a revolution from 1970s by replacing all that with all these ECU's. And today a modern vehicle can have anywhere between 70 to 90 ECU's, you can have 70 to 90 ECU's 70 to 90 ECU's.

Now, you may ask what are they doing? what is the function of these ECU's,? why do you need so many of them?.