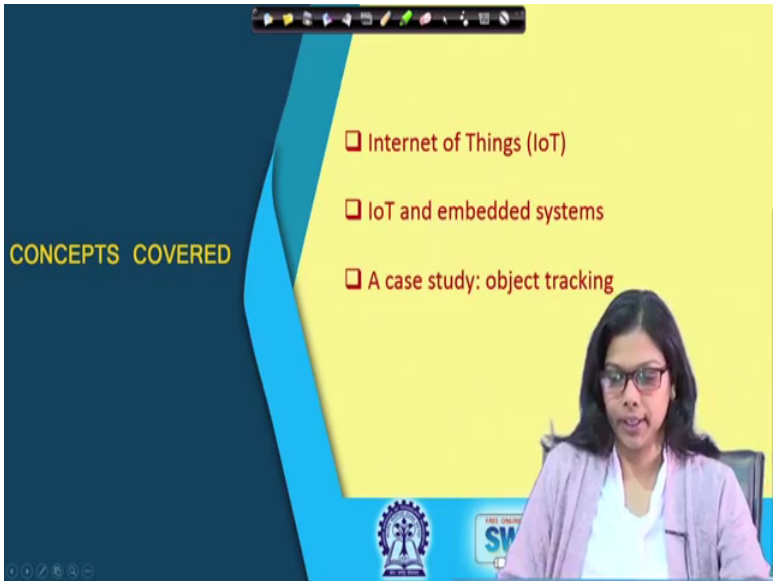
Embedded System Design with ARM
Prof. Kamalika Datta
Department of Computer Science and Engineering
National Institute of Technology, Meghalaya

Lecture - 34
Introduction to Internet of Things

Welcome to week-7. In this week, I will be introducing you to a concept called Internet of Things. Of course, I will be discussing about what is internet of things giving you some examples. Then we will be taking two examples. One is a small home automation system, where we will switch ON and OFF a light through SMS control.

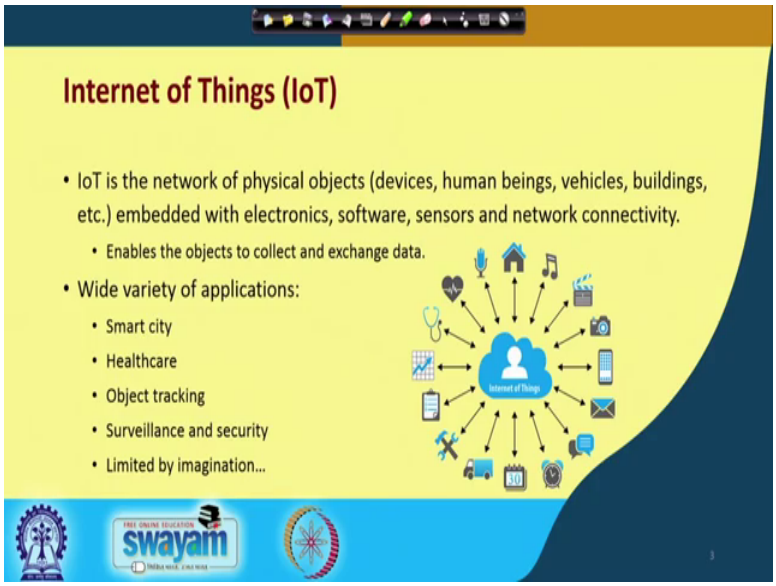
And in this week, we will also show you through a touch sensor, how we can sense some kind of alerts, if an unwanted people touches your screen ok. So, these are the two things two examples that we will look into this particular week. And in this lecture particularly, I will introduce you to the buzz word you can say internet of things ok.

(Refer Slide Time: 01:29)



So, the concepts that will be covered in this week is what is internet of things, how we relate IoT and embedded systems, and we have taken a case study of an object tracking ok.

(Refer Slide Time: 01:49)



So, coming to what is internet of things. Internet of things is the network of physical objects like it could be any device, it could be a human being or a vehicle, or it could be a building, embedded with electronics, software, sensors, and network connectivity. And what it enables, it enables the object to collect and exchange data. Let me give you an example.

In week 5, we discussed about temperature sensing module right. So, what we were doing in that example, there was a sensor that is LM 35 from where we were sensing some physical parameter that is temperature, and we were displaying it in the LCD ok. This is what we were doing that is an embedded system application, which is a standalone system. It has got a communication capability, but we were not transmitting the data that we received from the sensor to any other server or any other database right. So, we were not storing that temperature anywhere, we were just displaying it in the LCD.

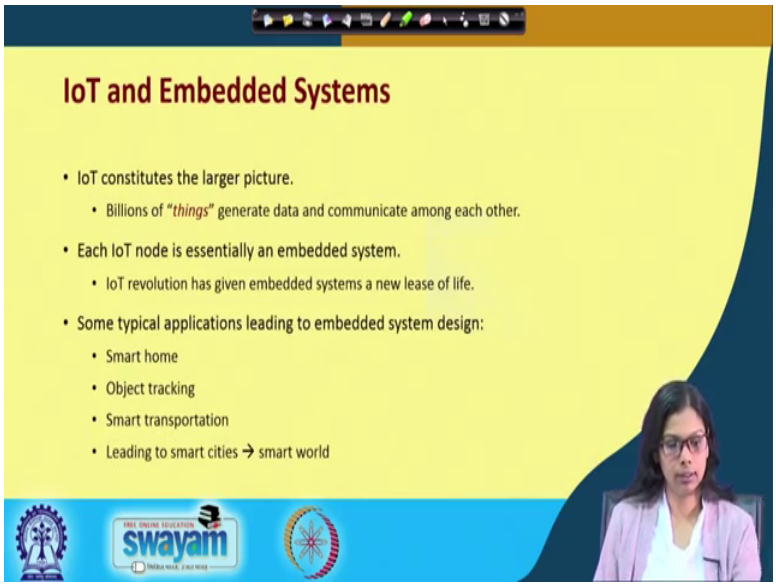
But, let us say a scenario where I gather that temperature from the sensor through micro controller, and I pass that information or store that information of the sensor in some database ok, which how we can do that. We if you want to save that into a database which is online, we need to have some communication capability as well along with the processing capability that it has got. It has got the processing capability earlier, but now

for sending the data or storing the data in some server or in some database, we need a communication capability as well ok.

So, whenever an embedded system not only has got the processing capability, but also has the communication capability, it becomes a internet of thing that means, that temperature sensing unit is not standalone anymore that it is not restricted to this particular place, where you are displaying the temperature only. I can also anywhere if somebody wants to know the temperature of this particular room, you can get it through the mechanism I told you ok. So, it enables the object to collect and as well as exchange data. So, you will have the processing capability, and you must have the communication capability as well ok.

So, there is a wide variety of application that we have one of which is smart city, another is in healthcare. Object tracking is one of the very major application, where nowadays people are using this the small modules to track any object, we will look into that we will take that as an case study further. Surveillance and security, in surveillance and security if you see, this IoT has got a very very good application. And for security I will be taking one example with that sensor, but it has got many other applications also in security if security is concerned. And of course, it is not limited just by imagination, it is there is a huge set of application that you whatever you can think of now, you can actually do it using this embedded system. When the embedded system also has got a communication capability, we call it as an IoT ok.

(Refer Slide Time: 06:13)



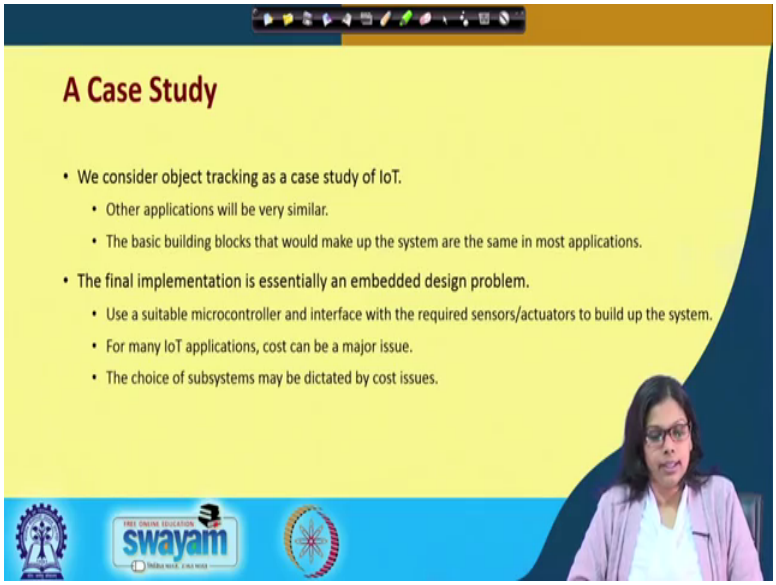
So, let me tell you this IoT and embedded system, I have already told you the relation between the two. So, IoT constitutes the larger picture, of course it is not only one embedded system, it is a collection of many embedded system which can communicate among each other as well.

So, there are billions of things that generate data and communicate among each other. It is generate data in the form of these sensors, this generates lot of data. And where this data will go, the data will be saved somewhere for further processing may be or it is not required it could be it could be you know you can delete those data, I mean there are so much data that gets generated, it is not very easy to also store that huge amount of data. Of course, you need to have that architecture in place to save the data properly. But, in some cases if the data, if the sensors are generating some unnecessary data which need not have to kept for you know for all the period, then you can simply delete those data.

Each IoT node is essentially an embedded system, I have already to you. And this IoT revolution has given this embedded system a new lease of life. Embedded system was not new, but this buzzword IoT is there for quite some time let us say last 5 years we are hearing about this IoT. So, this IoT this IoT revolution has given this embedded system, the old embedded system a new lease of life you can say. Some typical applications leading to embedded system design could be smart home, object tracking, smart

transportation, and of course if you combine many of the aspects of various IoT's, then it leads to a broader picture we call it smart city, and ultimately to smart world.

(Refer Slide Time: 08:27)



Now, we will consider a case study, where we will consider an object tracking module as a case study of IoT. So, firstly I will talk about that what exactly we are trying to say, when we say we track an object ok, I could be an object, my bag could be an object. Let us say I am sending something from one place to another let us say a medicine that could be also an object ok.

My children going outside for playing, I want to grant them as well, they can also be an object ok. So, or a cow which has gone to some field for having grasses, it can also be an object ok. So, there are other application which will be similar. But, in this we will see the basic building blocks that would make up the system and are the same in most of the applications.

So, the final implementation is essentially an embedded system problem. If you think of an overall system of object tracking, so the whole system first of all you have to build an embedded system. And then of course, it has got a communication capability, and how you want to make it, there are various kinds of ways through which you can make it.

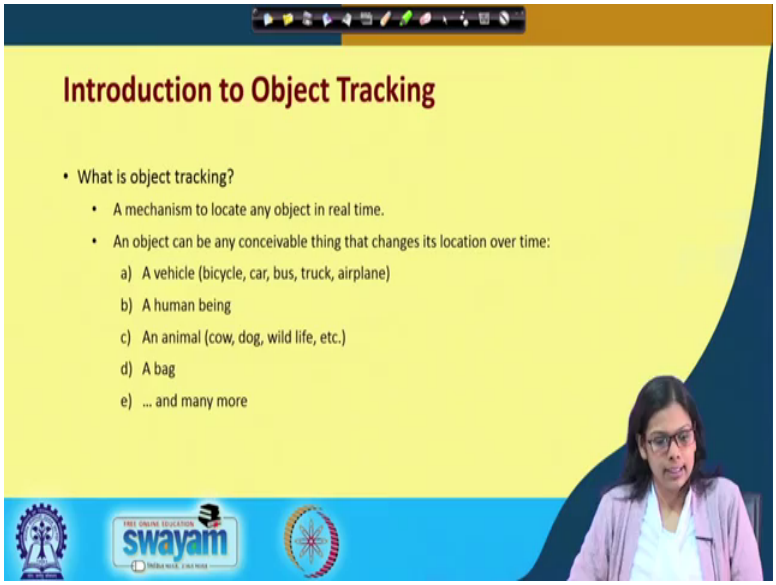
So, we in the first step, what we use we use a suitable microcontroller and interface with the required sensors or actuators to build up a system that is very straightforward we

have see, because we need a processing capability. So, we need a suitable microcontroller for the processing thing. So, and also we need some sensors or actuators to build up the entire system.

For many IoT application, the cost can be a major issue. Now, all these things we have already discussed in the previous weeks that cost depends on how many number of units you are actually generating. If you are really generating a very small amount of in unit, then the cost might be large. But, if the same kind of product is designed for a large number of unit, you are producing it in a bulk, then the cost always reduces.

So, the choice of the subsystem may be dictated by cost issue. So, it depends like for how many units you are producing, which community wants that device how will you market it such that the importance of the device goes to the huge customers the customer. If the customer wants to buy the I mean if you want your product to be sold to a huge customer, then you have to also do some kind of marketing strategies right. So, what kind of things you should do to sell your product in a more efficient, there are lot many things that are involved, but cost is also an important factor. People always goes for something if the same product if somebody gets in a lower cost, of course they will go for it ok. So, there is a trade off in that sense.

(Refer Slide Time: 12:07)



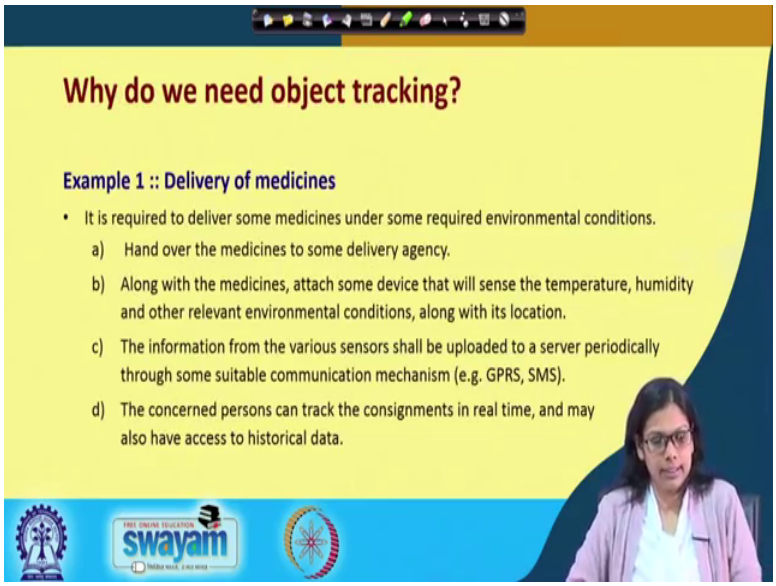
Now, let me come to the introduction to object tracking. Firstly, what is object tracking? So, it is a mechanism by which we can locate any object in real time meaning, let us say

my kid has went out for playing at any point of the time I wanted to know, where my kid is playing, whether he is inside the playground or he has moved out to some other place in real time. So, in this process we can have some kind of application maybe it as a web application or it is an app in your mobile phone, it should able to tell me that what is the current location of my child. So, what is required to be done, I will tell you one by one, but this is where I need this object tracker for ok.

An object can be any conceivable thing that changes its location over time, it could be a vehicle like it could be my bicycle, my car or a bus or a truck or an airplane or it could be a human being, as I said it could be a small kid or it could be your old parents, it could be any human being or an animal it would be a cow, your dog some wildlife etcetera. Or, it could be some things like my bag ok, and it could be any anything right that where you want that to be tracked ok.

So, it could be a bag, it could be your stuffs maybe you have kept a huge amount of pots outside your place, where you if you want to track that whoever is somebody is stealing out your pot, then you can attach that device with that pot as well. And you can know that where that pot is at a particular time ok, in real time you can track that.

(Refer Slide Time: 14:19)



So, why do we need object tracking? I think I have already motivated you like why do we need object tracking, but let me give you some more examples, where you will see that the object tracking along with just tracking the object may not make sense. We also

need some more some more other sensors to be attached to the object to receive some more data ok.

Let us say for the first example is delivery of medicine. Let us say it is required to deliver some medicine, under some required environmental condition. You know medicines are really it needs certain temperature. If you want to keep the medicine in a very hot place, it might get damaged. So, you need to keep the temperature, keep the medicine within some suitable temperature ok. So, in that case what could be done?

So, what is generally done, if you want to deli send a medicine from let us say place a to place b, we hand over the medicine to some delivery agent. Along with a medicine, we attach some device that will sense the temperature, humidity, and other relevant information let us say along with its location as well. So, it is not only sending the location that where this medicine is going through I mean, how the delivery is taking place from let us say it started from position a, then it moved to position a 1, a 2, a 3. And finally, before reaching b it crosses many other locations also, so that of course you can track apart from that I also wanted to know: what is the current temperature during that time ok. What is there are some other parameter, let us say: what is the humidity, amount humidity in that environment etcetera.

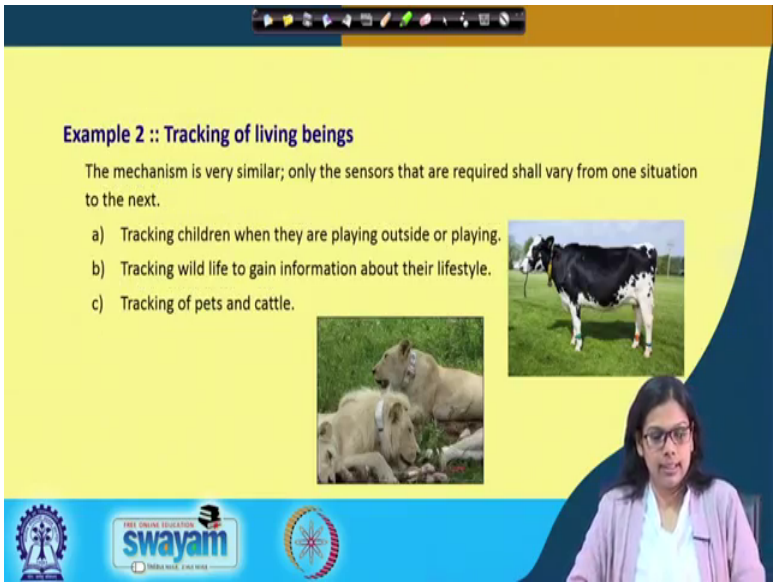
So, the information from the various sensors shall be uploaded to a server periodically through some suitable communication mechanism. The mechanism could be GPRS or SMS, we will look into these things. So, how we can do this in course of time, but so what is required I have my device in place, which tracks the location along with that I have some sensors attached to it. So, the device will sense the location, it will also sense the physical parameters like temperature, humidity etcetera.

And it will upload both the location along with these other parameters into some database ok. And that how we can do it, we can do of course through SMS through SMS it will be sent to some other mobile number. But, if you want to send it through to internet, then you have to use the GPRS service ok. So, this is how it basically works.

So, the concerned person can track the consignment in real time, of course if all the data is uploaded time to time let us say every 5-minutes, we are uploading the devices sending the data to a server, then the concerned person can easily track the consignment in real time; and may also have access to historical data, because we are storing it in a

database. So, you can also find out let us say I am checking right at this moment, but what happened to one year one hour before what was the temperature etcetera that also we can see, because we have stored everything in the database right.

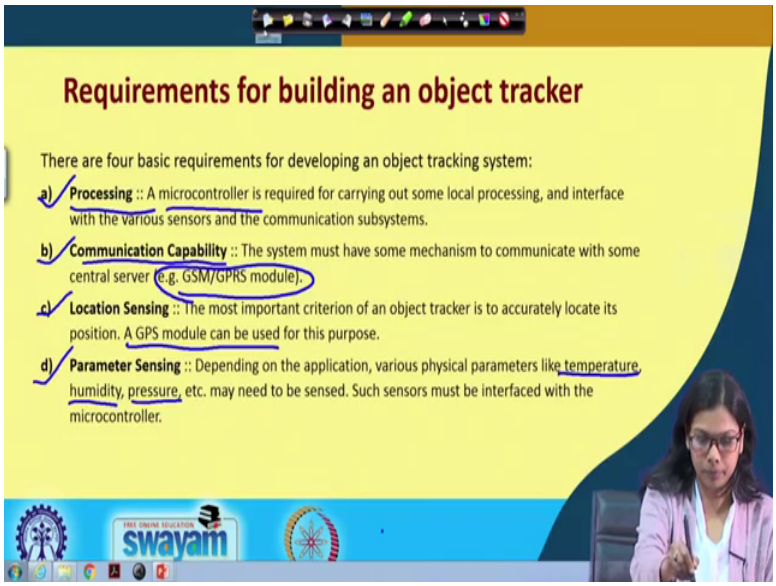
(Refer Slide Time: 18:19)



Let us say example-2 tracking of living beings ok. So, the mechanism is very similar as I have discussed for medicine, it will be same here only the sensors that are required shall vary from one situation to the next. So, here tracking children, when they are playing outside I have told you.

Tracking wildlife to gain information about their lifestyle, we can also get some information about the lifestyle I mean, there could be many other information like some more devices could be attached how much time they are moving a particular animal, whether he is moving in a day for how long. So, you should have some kind of device let us say an accelerometer, we look into that in course of time. So, what is an accelerometer we will see that, so that kind of device you can put in to find out the activities that a particular animal is performing in a day let us say. We can always track our pets and any cattle or any pets in that way.

(Refer Slide Time: 19:13)



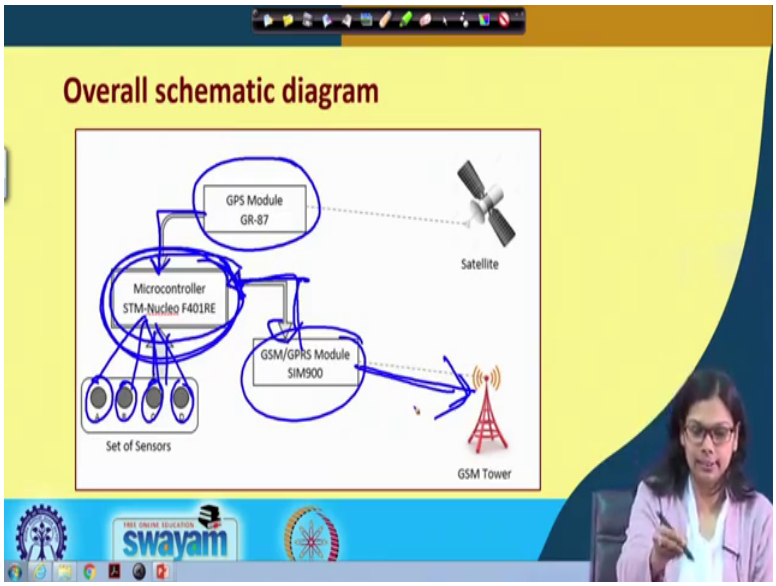
So, what is the requirement for building an object tracker? So, I have given you the motivation that this is an example object tracking system ok, but how should we build it. You can build it very easily, but there are certain requirements. So, you need to have some devices that will track the location that will also receive some data, if it is required like some sensor data, and we can upload it.

So, let us see what all devices are required for the processing microcontroller is required for carrying out some local processing, and interface with the various sensors and the communication subsystem right. So, the location has to be received, so there must be a code written in that microcontroller that will receive the location.

Let us say I want to track it every 5 minutes, I do not want to track for the full time, so 5 minutes. So, you can write the code accordingly. So, every 5 minute, it will read from the sensor the data, and it will upload to the server. So, we need a microcontroller on a first step. So, you see this is we for processing, we need a microcontroller in a first goal.

Then for the communication capability, you will need a GSM module ok. We will discuss about this in course of time. And for location sensing, we need a GPS module global positioning system ok. And for parameter sensing, you need various sensors like let us say temperature sensor or humidity sensor or pressure sensor. So, these are the four things that are required basically for this object tracking to build the object tracking ok.

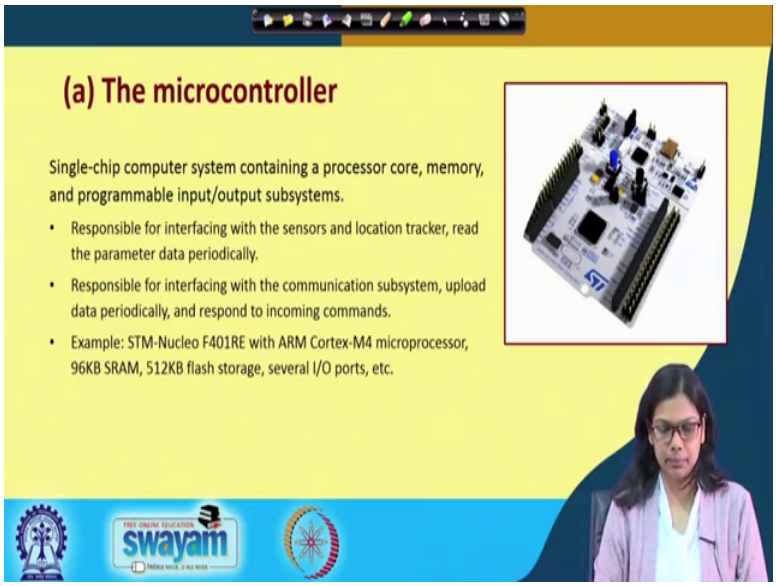
(Refer Slide Time: 21:53)



So, this is the overall diagram, if you see so this is my microcontroller, this is my microcontroller, this is the GPS module, which will be connected with the microcontroller which will sense the coordinate. There might be some sensors that are also attached, which will be read by this microcontroller.

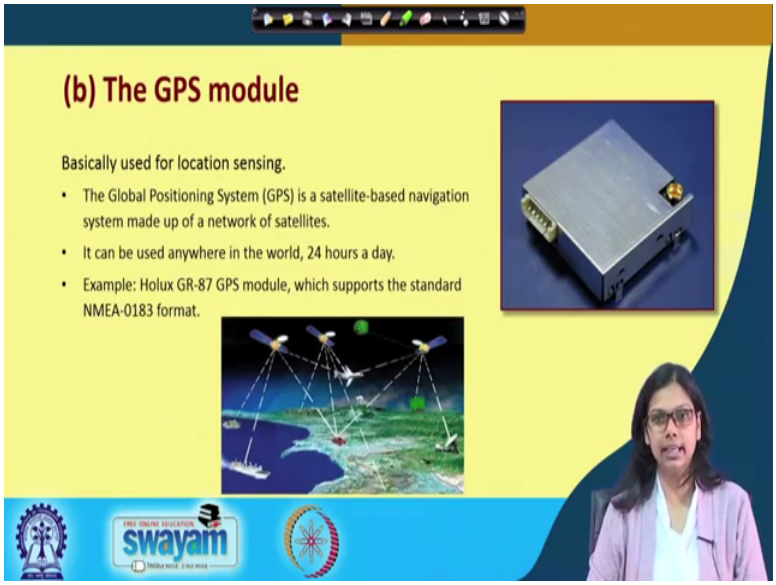
And as I said every 5 minutes, these data will be sent through this microcontroller to using a GSM module to some server ok. So, this is basically the overall system, where along with processing capability we already did, we have different sensors to read the data, and it will get stored here. But, here we also have some communication capability through this GSM module that is what we are sending the data to some server ok. So, whatever data is there in the server at this point of time, that will give us the location the current location. And if you want to see the past location as well, you always can see that.

(Refer Slide Time: 23:19)



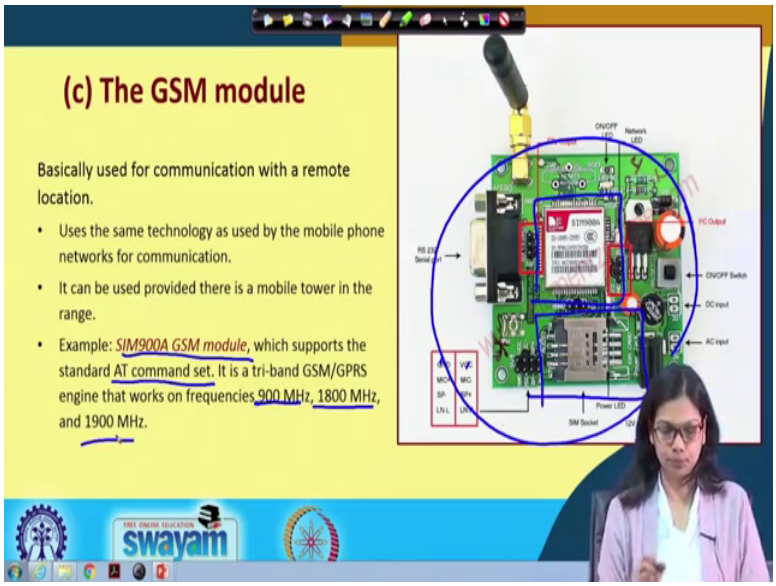
So, this is the microcontroller I have already discussed, so I am not discussing in detail about this.

(Refer Slide Time: 23:27)



The GPS module, there are various GPS modules that are available. This is one example GPS module that is HOLUX GR-87 GPS module, you can use any other GPS module that is available.

(Refer Slide Time: 23:39)

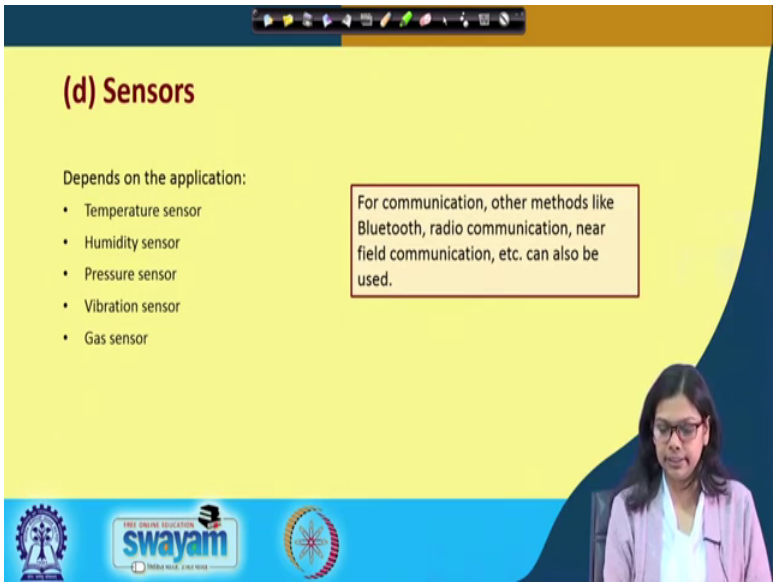


And the GSM module; so, in this course, we have used the SIM900A GSM model ok, which I will be discussing in detail. So, very briefly if I talk about it is basically used for communication with the remote location, and it uses the same technology as used by the mobile phone.

So, whatever we use in a mobile phone, you can see there is a SIM slot here you see there is a SIM slot here, you can put a SIM in this place, and this is the chip of the SIM900A ok. So, this is one development board, you can see this particular chip in any development board. Here is the SIM slot, where you will put the SIM. And of course, you have this VCC ground, and other pins to be connected along with your transmission and receiver. So, you also have these two pin that is transmission and receiver. So, these are the things that are there.

So, example this is SIM900A, the same module we have also used for our experimentation which supports standard AT command ok. So, we have to use standard AT command for communication with this GSM module. It is a tri-band GSM, GPRS engine that works on these four these three frequencies that is 900 megahertz, 1800 megahertz, and 1900 megahertz.

(Refer Slide Time: 25:29)



And you can have variety of sensors for integrating along with it. So, for communication other methods like we can use Bluetooth, radio communication or near field communication etcetera. So, we have come to the end of this lecture, where I have given you like what is an IoT, I have also given you an idea of how an simple IoT system could be built along with its processing capability, along with other sensor data, and I have discussed in detail about one of the application that is object tracking. We have seen that the building the whole system is fairly very straightforward, but it has got such a variety of application, it could be used in so many places ok.

Thank you.