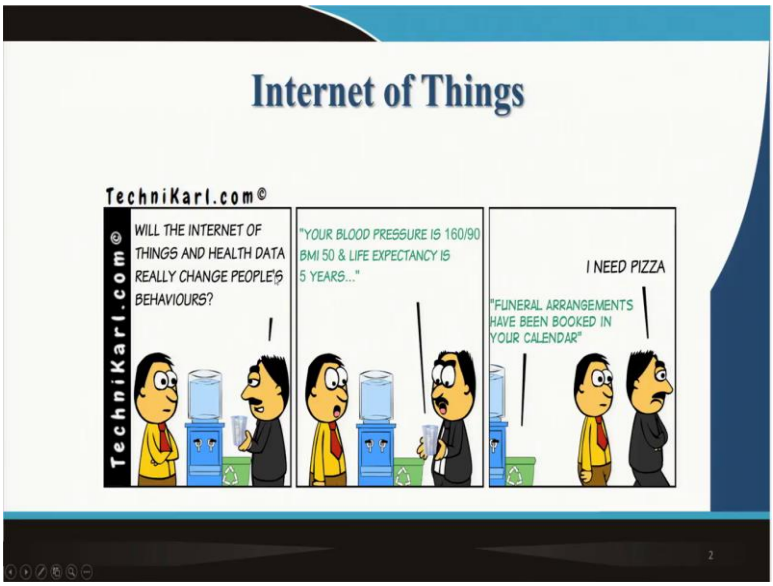
**Management Information System**
**Prof. Saini Das**
**Vinod Gupta School of Management**
**Indian Institute of Technology, Kharagpur**

**Module – 09**
**Emerging Technologies Internet of Things Part - I**
**Lecture – 42**
**Internet of Things Part – I**

Hello, and welcome back! Today we are going to discuss about 'Internet of Things'. So, in this session and the subsequent two sessions, we will be continuing with 'Internet of Things', which is a very important emerging technology and it is prevalent across organizations in multiple domains.

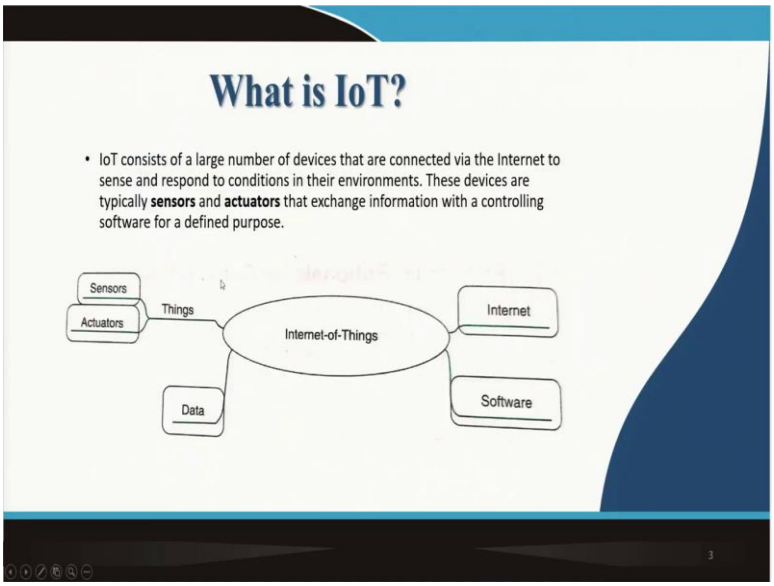
So, most sectors today avail the services of this particular technology in order to, you know, may be collecting data continuously, performing some real time data analysis and making some decisions based on real time data.

(Refer Slide Time: 00:50)




So, I think you can quickly go through this; it talks about, you know, IoT becoming very-very dominant in our lives. So, we would rather want IoT to give us a lot more insight than become so dominant and so overpowering in a negative sense we do not want it of course, we want it to be dominant and overpowering in the positive sense.

(Refer Slide Time: 01:22)

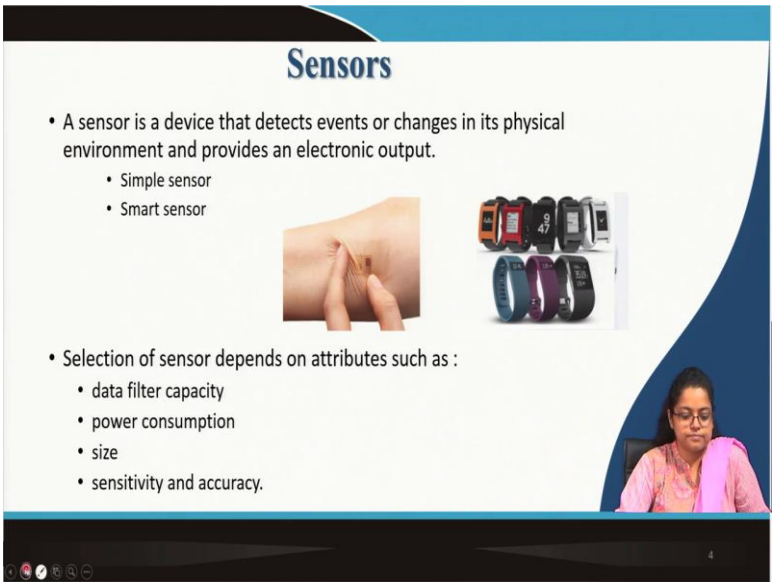



So, moving on: what is internet of things? You might have heard about this you know terminology of this phrase being spoken around you time and again in today's world. So, internet of things consists of large number of devices that are connected –via- the internet to sense and respond to conditions in their environment. These devices are typically sensors and actuators that exchange information with the controlling software for a defined purpose.

So, if you see this diagram over here, we have sensors that are built into different things or devices or objects that we have around us. These sensors collect data and the data flows through the internet to some software, which depending on certain conditions or depending on certain business logic would send information back through the internet to actuators, which would actually do some take some action based on the information provided by the or the direction given by the software.

So, this is how the entire system works; now we will take a lot of examples in these sessions to help you understand the concept in a much better manner.

(Refer Slide Time: 02:48)




So, we have just spoken about sensors. What are sensors? A sensor is a device that detects events or changes in its physical environment and provides an electronic output. So, here you see you know there are two categories of sensors simple sensors and smart sensors.

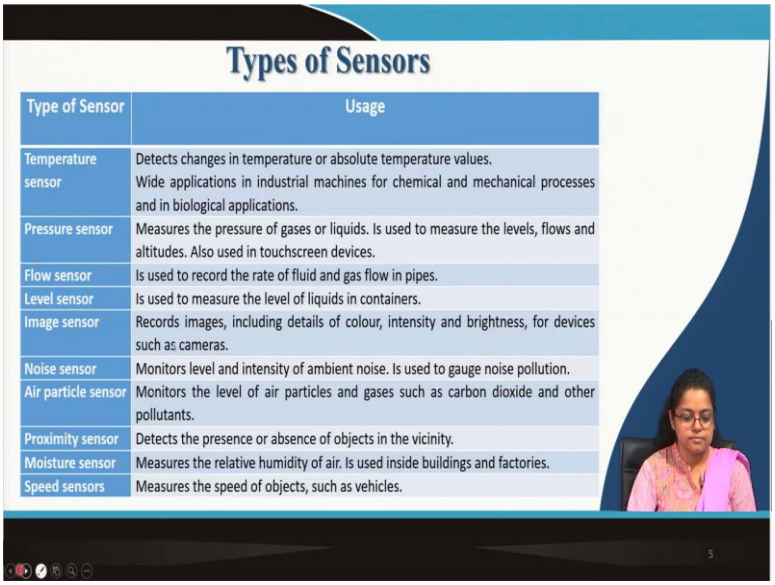
So, simple sensors are those which as the name suggests all the data that it collects it simply sends the data to the internet, but smart sensors are actually very smart or intelligent because, what they do is they do not send all the data that they collect, they send you know if there is data redundancy they would get rid of the redundant data and they would not send across the redundant data.

At the same time smart sensors could also you know send data based on certain conditions. If there are certain conditions that are programmed into the smart sensors, they would send data only when those conditions are met and not otherwise. So, here you see some examples sensors could be inbuilt into your body or there could be sensors in your wristbands and they you know you could have sensors in built into anywhere, right.

So, selection of sensor depends on attributes such as data filter capacity, so the amount of data that it is actually able to filter which actually dictates what a smart sensor does. Power consumption so, we require sensors that consume less power, sizes because today devices are becoming smaller and smaller we are gradually moving towards nano things right, very small things so the smaller the size of the sensor the better. And sensitivity

and accuracy so, of course, your sensor should be accurate and it should have very high sensitivity. So, that it is able to sense things much better.

(Refer Slide Time: 04:56)

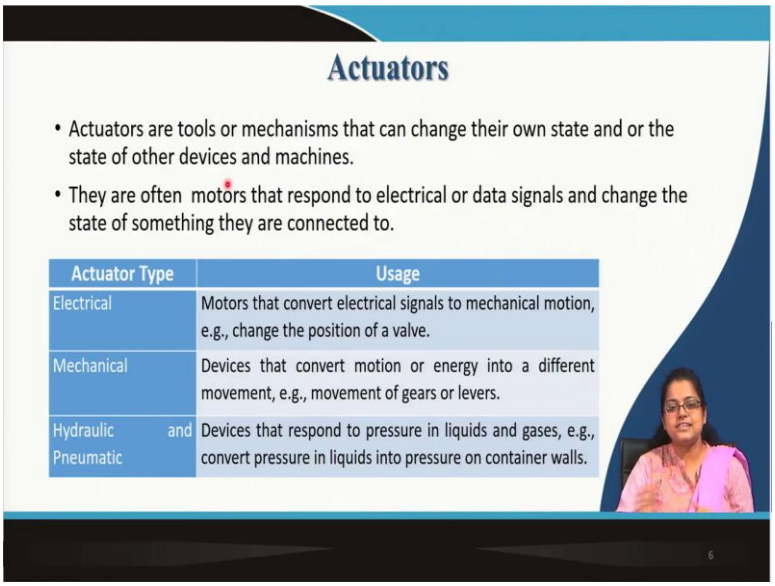



So, these are some of the different types of sensors that we have seen around us, or the different sensors that are inbuilt into various gadgets or devices. So, we have a temperature sensor, which detects changes in temperature or absolute temperature values it is used in a lot of chemical mechanical and biological processes to change to detect changes in temperature. Similarly, pressure sensor of course, would measure the pressure of gases and liquids; it is also used in touch screen devices to measure pressure for touch.

Flow sensor, is used to record the rate of fluid and gas flow in pipes. Level sensor is again used to measure the level of liquids and then take some actions based on that. Image sensor records images, including details such as the color, intensity and brightness, for devices such as cameras.

So, I think you can go through this particular slide and see what the different categories of sensors are and what their usages are. Here again we speak about some other sensors such as noise sensors, which are used to monitor the level of ambient noise as well as noise pollution, air particle sensor to monitor the amount of pollution in the air, proximity sensor, moisture sensor, speed sensor. So, these are again other different categories of sensors.

(Refer Slide Time: 06:37)



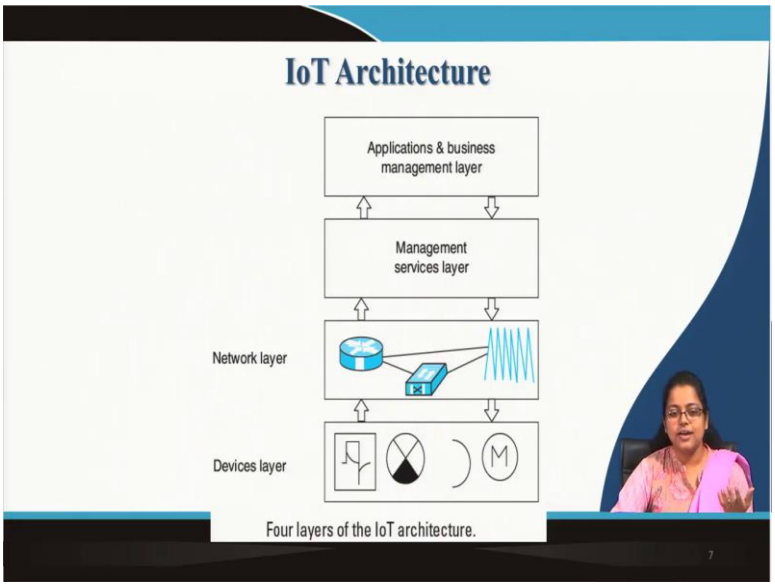

Moving on, actuators so along with sensors comes the term actuators. Actuators are tools or mechanisms, that can change their own state and or the state of other devices and machines. So, they are often motors that respond to electrical or data signals and change the state of something they are connected to.

So, actuators are the ones, which actually take some action where sensors collect the data and they send the data and based on the data and what the software dictates the actuators have motors, that respond to signals and they change the state of something that they are connected to.

So, again similar to sensors there are different types of actuators, we have electrical actuators motors that convert electrical signals to mechanical motion, change the position of a valve. So, electrical actuators are used in water supply they have a very important role to play in water supply.

Mechanical sensor actuators devices that, convert motion or energy into different into a different movement; example: movement of gears or levers. Similarly, hydraulic and pneumatic actuators, they have they are devices that respond to pressure in liquids and gases, example convert pressure in liquids to pressure on the container walls. So, these actuators are inbuilt on in all devices in, which they have to take some action based on the signals that they receive.

(Refer Slide Time: 08:27)




Now, coming to the IoT architecture, this is a very simple you know explanation of what the IoT architecture is without getting into the technical details. So, the IoT architecture comprises of 4 layers, the first layer is called the devices layer that you see here. The devices layer has sensors and actuators. So, the sensors of course, collect data we do have two categories of sensors we have already discussed simple sensors and smart sensors.

So, they send the data to the next layer called the network layer. Now, the network layer which is the second layer is made up of it has you know gateways, it has a lot of devices such as gateways, routers, it could have you know you know certain of course, gateways, routers and again certain devices which would transmit the data from the devices layer that is from the sensors to the next layer that is the management services layer.

So, the role of the network layer is to transmit data from the devices layer to the internet that is the management services layer. The third layer is called the management services layer, which is a very important layer because this particular layer controls the functionality of the entire IoT system.

Now this a particular layer actually determines, whether the entire IoT system is functioning properly or not. So, if they would check the health of the routers, they would check the health of the gateways as well as the health of the sensors and the actuators, they may also you know if they do not want certain sensors to send data they may mute

those sensors, they may prevent those prohibit those sensors from sending data and so on.

So, the entire functionality of the IoT system is managed by the management services layer. And then we have the fourth and the final layer, which is the application and business management layer. So, this layer controls the business logic of the entire IoT system.

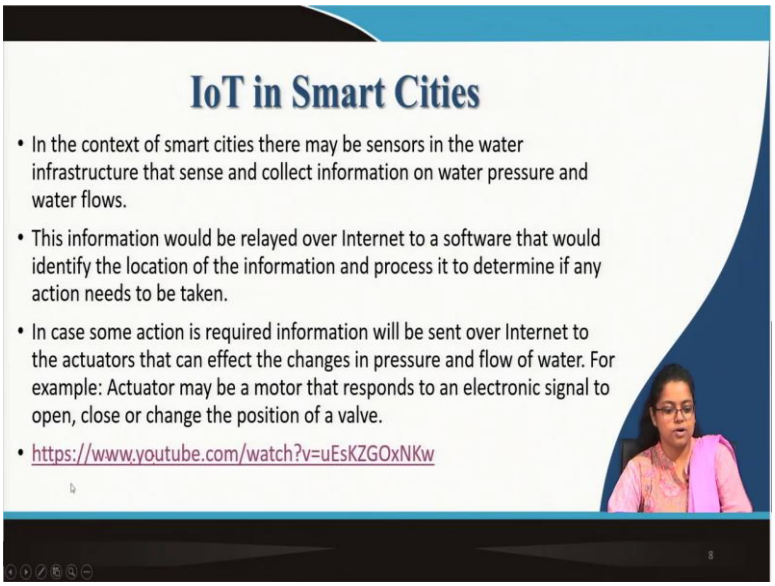
So, based on the business logic there are certain decisions that are taken and those decisions in the form of signals are sent back through the same path to the actuators and based on the signals, the actuators have motors that actually take the action.

So, if you take an example say there is a room in, which may be you know there is an air conditioner which is supposed to at 6'o clock in the evening it is supposed to maintain a temperature of 26 degree Celsius in a room. So, at 6'o clock data from the sensor would be collected sensor, which is inbuilt into the air conditioner would be collected and would be transmitted through this layer network layer, management services layer to the application and business management layer.

So, here the business logic is inbuilt. So, it would check that you know it is 6'o clock and the temperature of the room is say 28 degree Celsius. So, it would automatically send signals through the same path to the actuator, which would then have the motor that would reduce the temperature of the room temperature of the air conditioner of the room to 26 degree Celsius.

So, this is how the entire architecture works in order to according to the business logic. So, this is how in you know in very simple non-technical terms mostly non-technical of course, we have tried to explain what a what an IoT architecture is made up of.

(Refer Slide Time: 12:25)




Now, moving on we will talk about some IoT applications. So, IoT has a very important role in smart cities, in smart cities IoT has a role in in the traffic system, IoT has a role in the water supply, IoT has a role in maintaining the level of air pollution the quality of air. And, IoT has a role in smarts in multiple areas in a smart city, but in this slide we will talk a little bit about the role of IoT in the water infrastructure in smart cities.

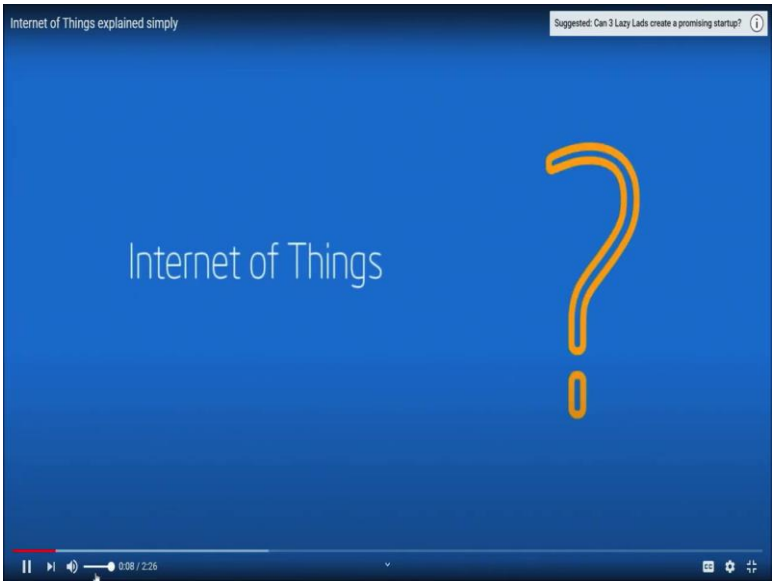
So, in the context of smart cities, there may be sensors in the water infrastructure that sense and collect information on water pressure and water flows. This information would be relayed over the internet to a software as you have seen, this is exactly you know whatever we have discussed in this slide is very similar to you know you would be able to relate to the architecture that we have discussed in the previous slide.

So, this information would be relayed over the internet to a software that would identify the location of the information and process it to determine if any action needs to be taken. If no action needs to be taken well and good, but if in case some action is required information will be sent over the internet to the actuators that can affect the changes in pressure and flow of water. For example, actuator here may be a motor that responds to an electronic signal to open close or change the position of a valve.

So, this is how based on the pressure and flow of water sensors actuators and the entire IoT architecture works to modify the pressure and the flow to a required level. So, this is

an example just an example there could be multiple other examples of the role of IoT in smart cities. So, we will see another example here of the role of IoT in smart cities.

(Refer Slide Time: 14:35)




By now you may have heard the term internet of things sounds interesting, but what does the internet of things.

(Refer Slide Time: 14:44)


Actually mean, IoT is an evolution of mobile home and embedded applications that are being connected to the internet integrating greater compute capabilities and using data analytics to extract meaningful information.

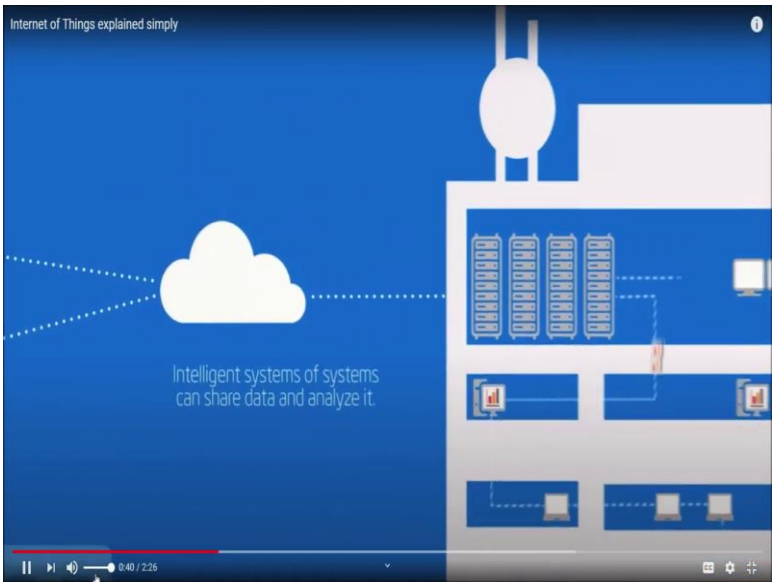
(Refer Slide Time: 14:56)


Billions of devices will be connected to the internet and soon hundreds of billions of devices as related devices connect with each other.

(Refer Slide Time: 15:02)

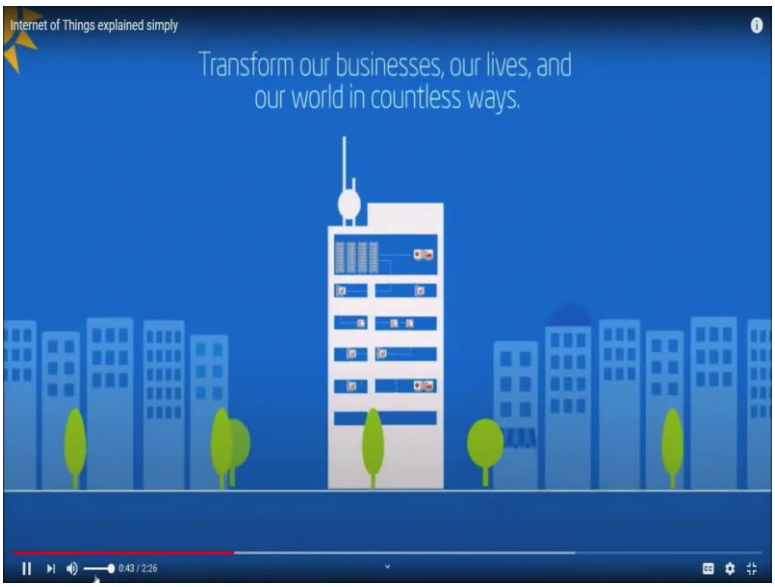

They can become an intelligent system of systems.

(Refer Slide Time: 15:10)




And when these intelligent devices and systems of systems share data over the cloud and analyze it.

(Refer Slide Time: 15:15)

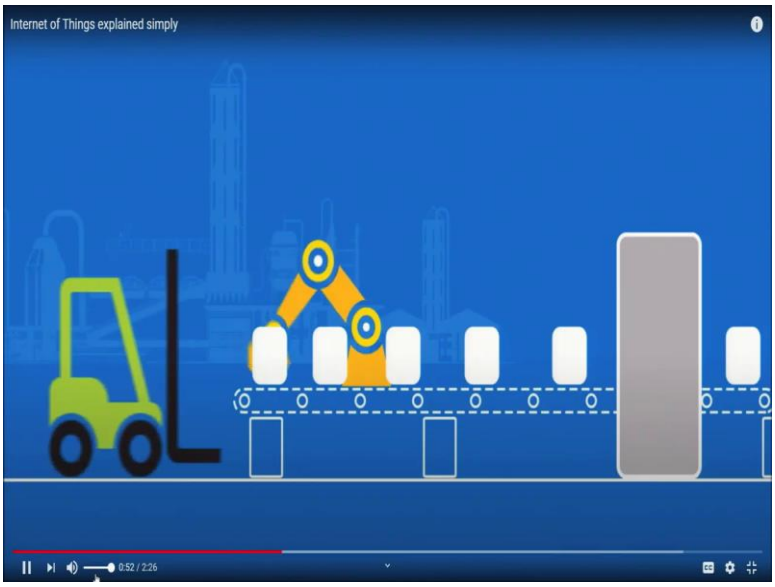



They can transform our businesses our lives and our world in countless ways.

(Refer Slide Time: 15:21)


Whether it is improving medical outcomes.

(Refer Slide Time: 15:23)

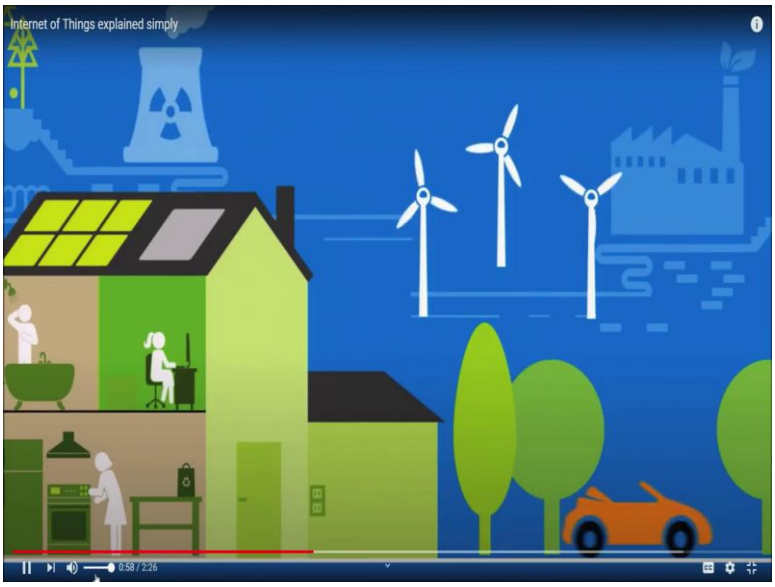



Creating better products faster with lower developing costs, making shopping more enjoyable.

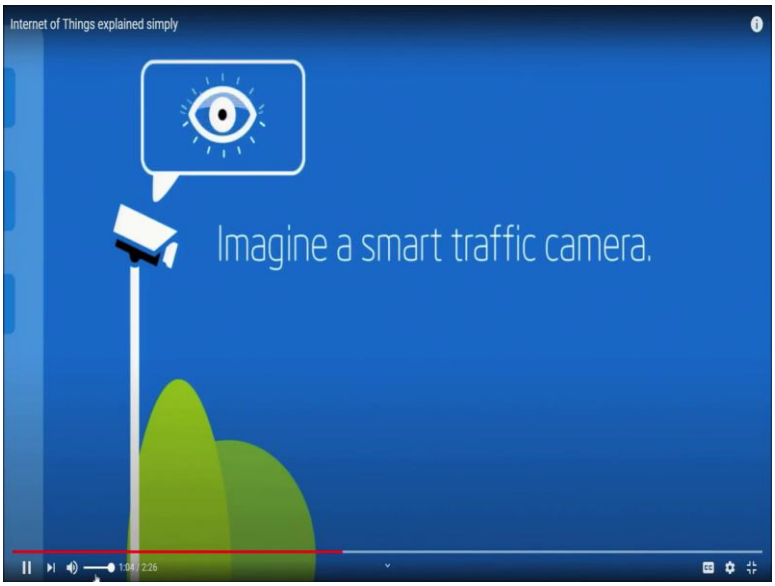
(Refer Slide Time: 15:28)


Or optimizing energy generation and consumption.

(Refer Slide Time: 15:30)

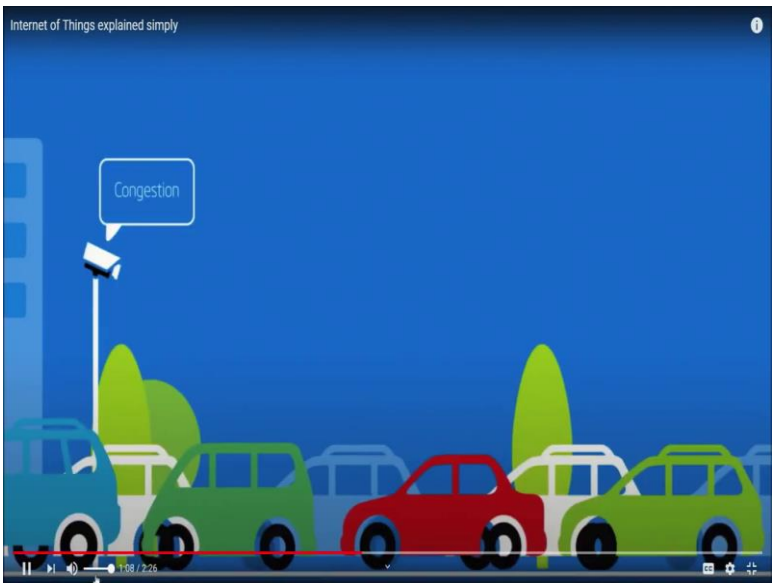


(Refer Slide Time: 15:36)



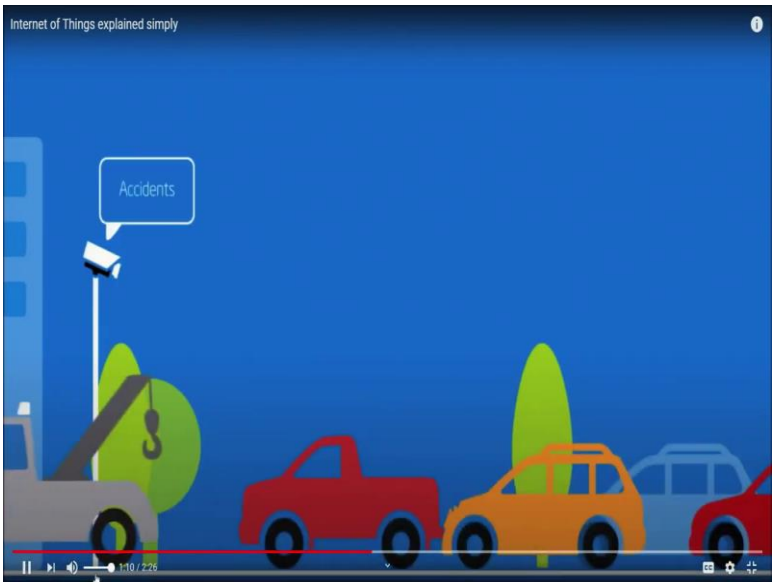

Here is an example of the big picture imagine an intelligent device such as a smart traffic camera.

(Refer Slide Time: 15:42)




The camera can monitor the road for congestion.

(Refer Slide Time: 15:43)




Accidents.

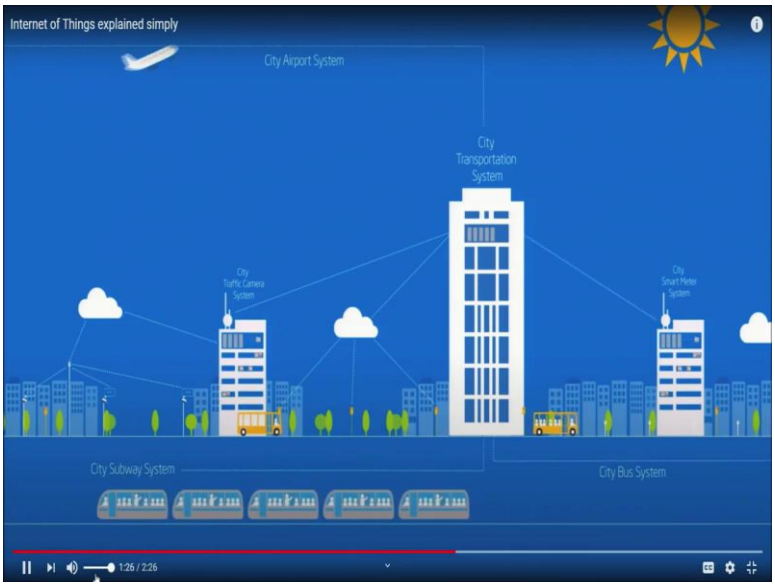
(Refer Slide Time: 15:44)

(Refer Slide Time: 15:47)


(Refer Slide Time: 15:48)

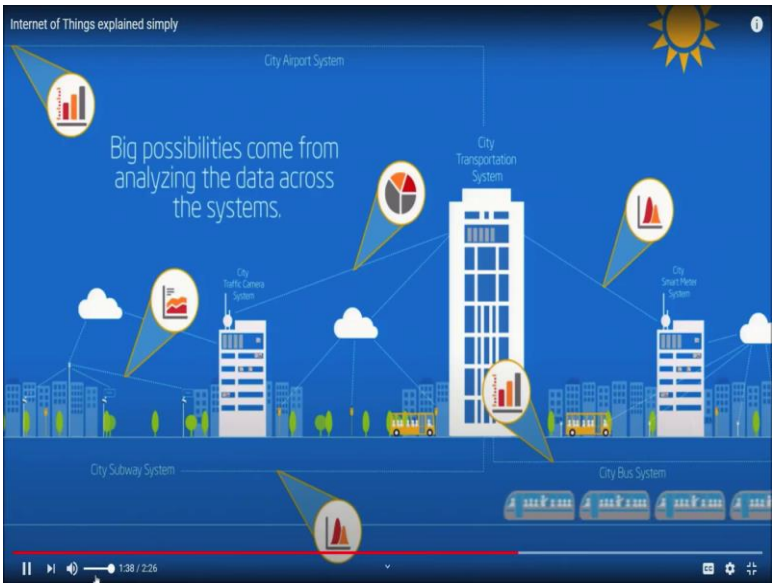

And weather conditions and communicate that status to a gateway they combines it with data from other cameras creating an intelligent city wide traffic system.

(Refer Slide Time: 15:55)



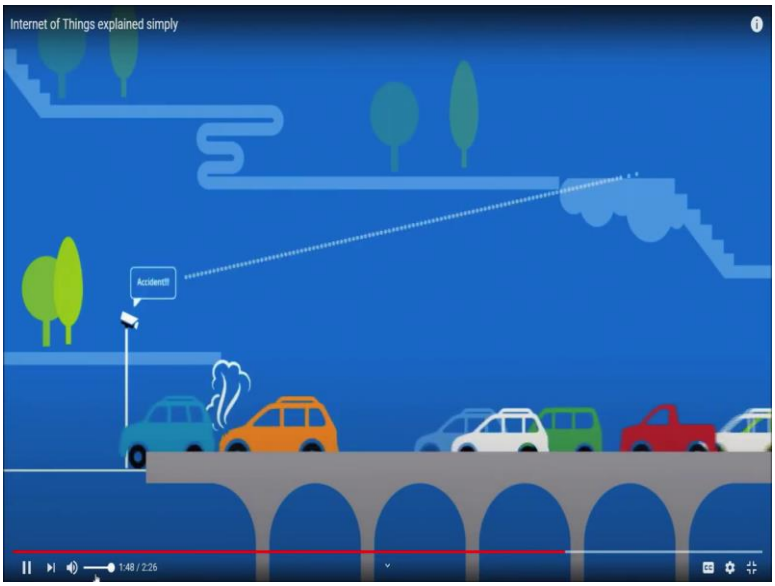

Now, imagine that intelligent traffic system connected to other city wide transportation systems, which get data from their own intelligent devices creating an ever larger intelligent system of systems.

(Refer Slide Time: 16:07)



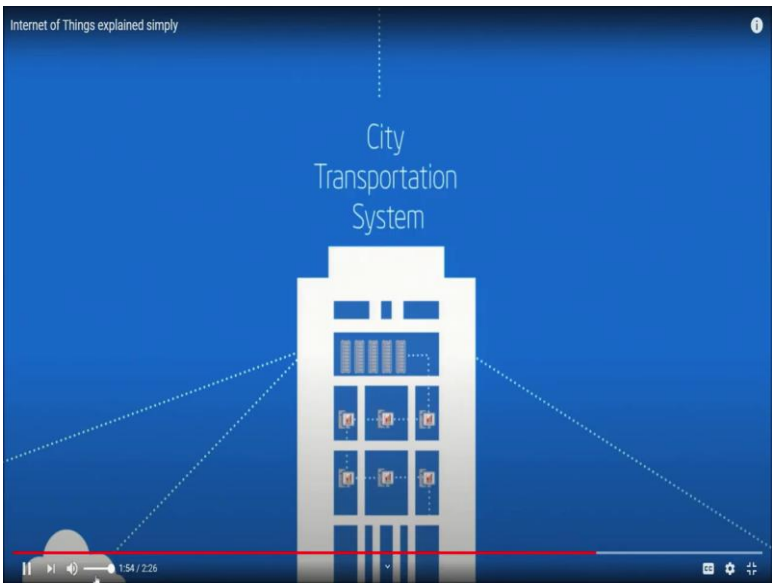

The really big possibilities come from analyzing the end to end data across that system of systems.

(Refer Slide Time: 16:15)




For example, let us say the cities intelligent traffic system detects massive congestion due to an accident that insight can be sent to the city wide transportation system.

(Refer Slide Time: 16:25)

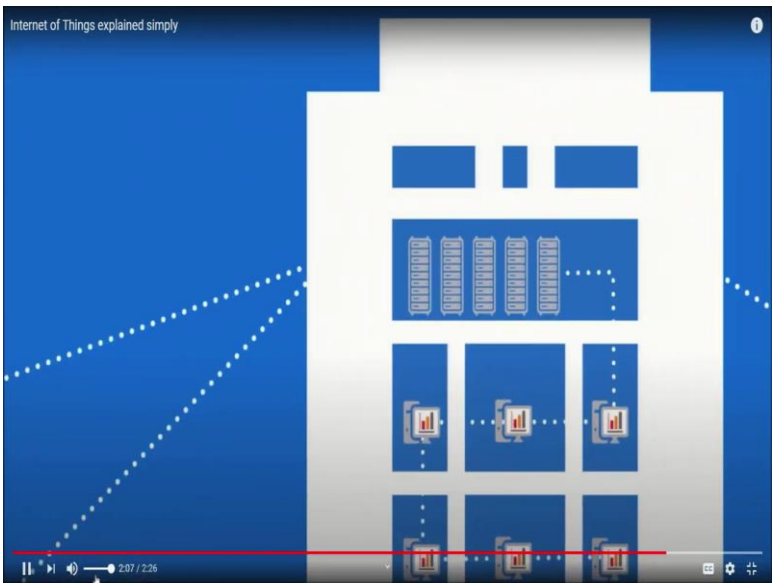



Which can analyze the accidents impact on other city systems.

(Refer Slide Time: 16:31)

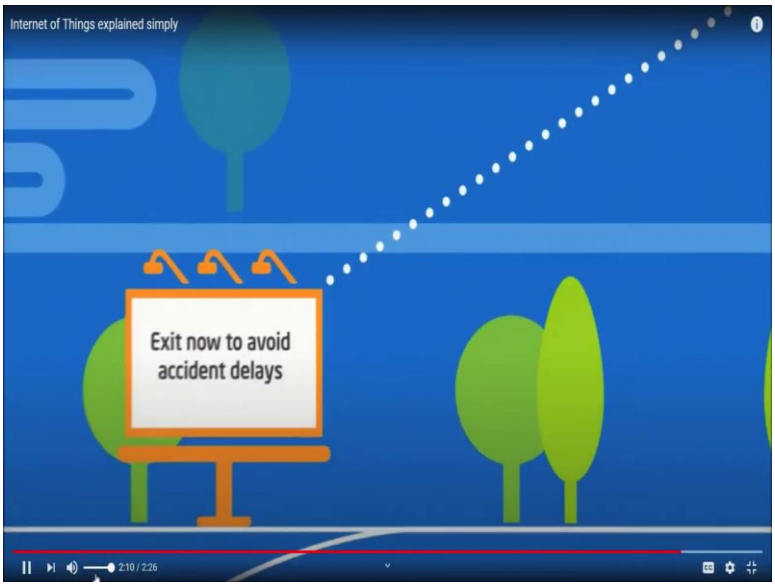

Recognizing the accident is near the airport and to city schools it could notify those systems. So, they can adjust flight and school schedules.

(Refer Slide Time: 16:39)



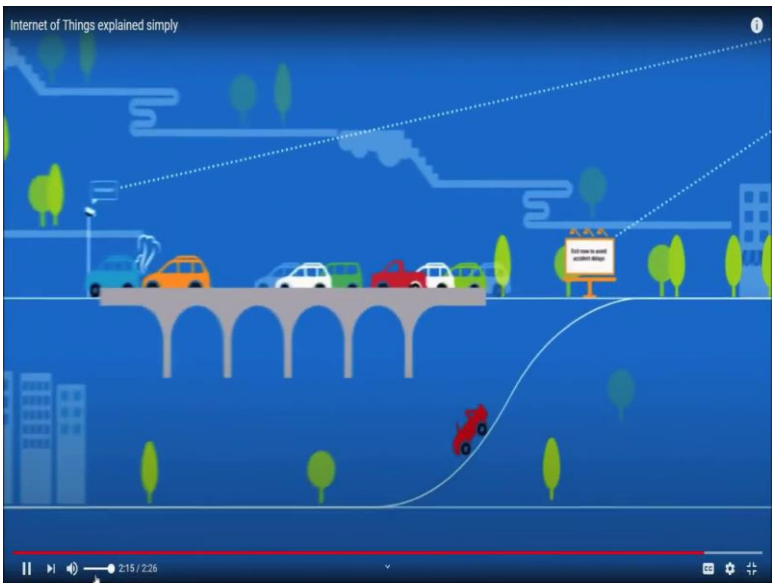

You can also analyze and derive optimal routes around the accident.

(Refer Slide Time: 16:44)




And send those instructions to the cities, digital signage system to guide drivers around the accident.

(Refer Slide Time: 16:46)

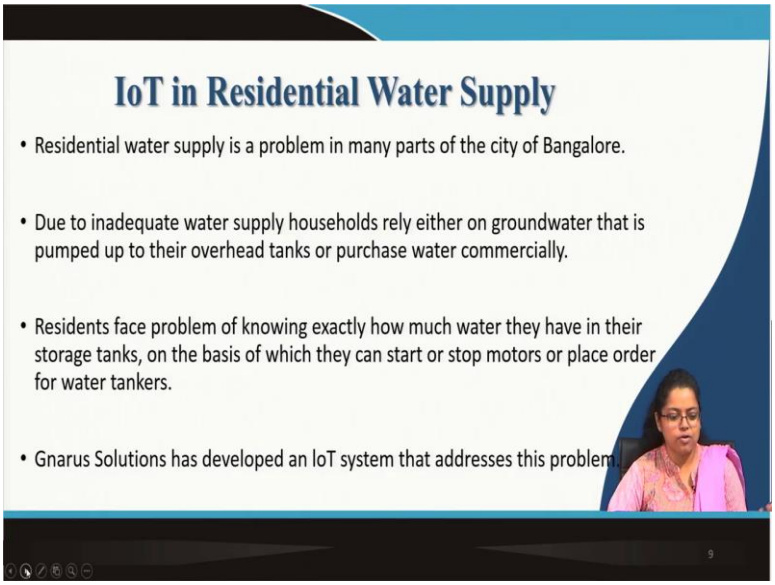



And that is just one example of the potential benefits that can happen when intelligent devices share insight with other systems forming ever expanding systems of systems.

(Refer Slide Time: 16:57)


So, in this particular video you saw how internet of things plays a very important role in the entire traffic system of smart cities.

(Refer Slide Time: 17:13)

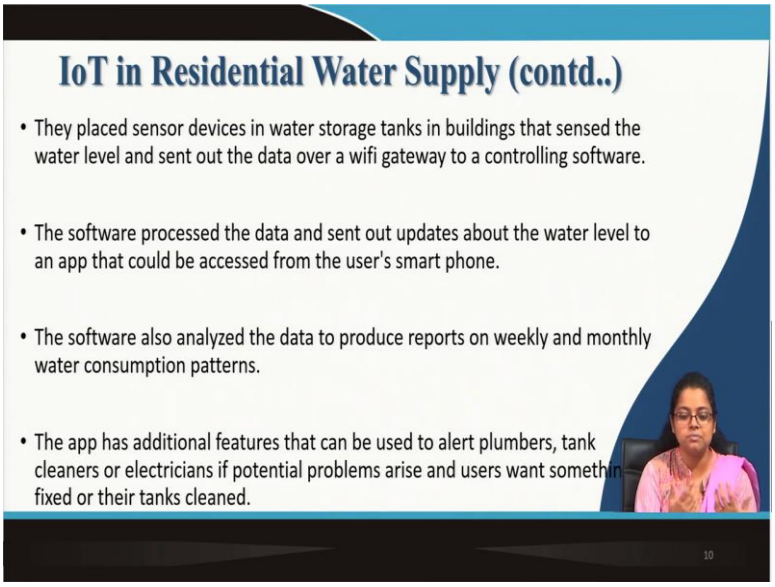



Now, moving on to a different example, IoT in residential water supply. So, this particular example talks about the role of IoT in residential water supply in the city of Bangalore. Bangalore is a city, where there is a lot of in India where there is a lot of water crisis. So, there is a river, but from there it is very difficult to obtain water.

So, residential water supply is a problem in many parts of the city of Bangalore. Due to inadequate water supply households either have to rely on groundwater that is pumped up to their overhead tanks or purchase water commercially. Residents face a problem of knowing exactly how much water, they have in their storage tanks, on the basis of which they can start or stop motors or place order for water tankers.

So, here there is a particular you know company name as Gnarus Solutions that has developed an IoT system to address this entire problem.

(Refer Slide Time: 18:19)




So, let us see what the company has done, they placed sensor devices in water storage tanks in buildings, that sensed the water level and sent out data over a Wi-Fi gateway to a controlling software. Again you will be able to relate to the architecture, that we have discussed in the previous slide.

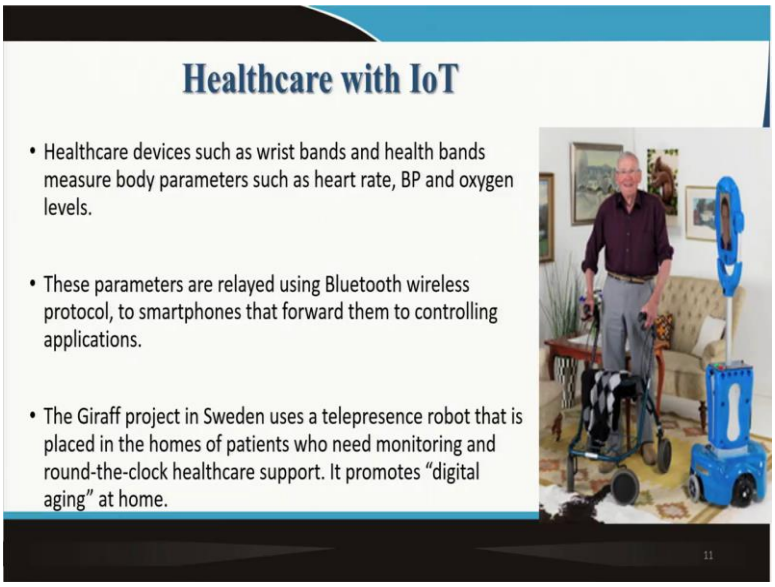
The software processed the data and sent out updates about the water level to an app that could be accessed from the user's smartphone. The software also analyzed the data to produce reports on weekly and monthly water consumption patterns.

So, this could also you know along with its core usage of you know taking information about, the water level through sensors and automatically sending alerts to the user's smartphone, that you know the water level has reached a certain minimum and automatically the pumps have to be switched on immediately.

Other than that other than its core usage it also gives reports. So, that on water consumption patterns of consumers or residents of buildings so, that they can be very cautious and this could overall help in reducing the problem of water crunch in the city. The app has additional features that can be used to alert plumbers, tank cleaners or electricians, if potential problems arise and users want something fixed or their tanks cleaned.

So, overall we see you know this has Gnarus Solution has been able to implement it in residential households in Bangalore, but this particular IoT system or application has a very important role in hotels, hospitals and other areas where there is a high level of water consumption, and the entire world is focused on water conservation. So, this could be a very important innovation of IoT.

(Refer Slide Time: 20:21)




Now, moving on to another example; so, healthcare; IoT has a very important role to play in healthcare. Healthcare devices such as wrist bands, health bands are very popular today; they measure body parameters such as heart rate, blood pressure and oxygen levels.

So, they could actually alert you know alert a lot of continuous gathering of data could actually alert maybe consumers or users of their body related issues and they could take measures to fix them before they get out of hand.

These parameters are; these parameters are relayed using so, the parameters such as heart rate, BP, oxygen levels that are collected are relayed using Bluetooth wireless protocol to smartphones that forward them to controlling applications. These controlling applications could be maintained by hospitals or healthcare providers and they could use it to monitor the health and livelihood of patients with chronic conditions. So, here IoT has a very important role to play in health care.

Another very important example that I would want to focus on is the Giraff project in Sweden; it uses a telepresence robot that is placed in the homes of patients who need monitoring and round-the-clock healthcare support.

It promotes something called "digital aging" at home. So, here you see a small you know this particular graphic, which shows the robot. So, here there is an elderly patient and he is you know his statistics or his movement around the house his say you know devices or objects that are there in his proximity, his position all of these are monitored by the robot here.

So, this is the telepresence robot that we have here and you would observe that this robot is mounted on wheels. So, this robot can it has two things ah. Firstly, it has a display a digit; a display and it also has cameras. So, with the cameras which have inbuilt sensors the cameras would collect pictures of the patient surroundings and would transmit the information to nurses or health care providers.

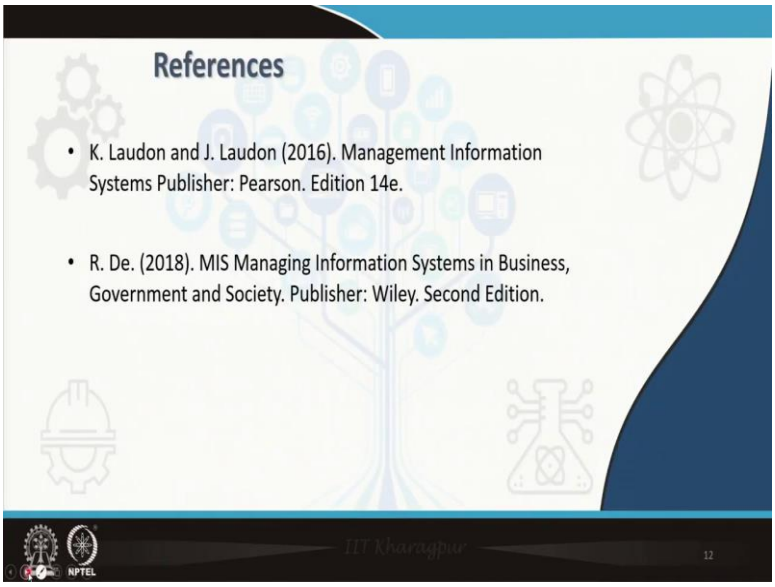
It also has wheels so, it can move around the house and collect pictures from different angles. So, the other facility that this robot has is it has a communication facility with a microphone and the elderly patient could actually use it to communicate with his healthcare provider or nurse.

So, this particular project actually promotes digital aging at home wherein you know in the comfort of your home you can obtain health care services using this telepresence robot and you could be constantly monitored by your healthcare provider.

So, all of these are in terms of you know in terms of a IoT devices we have sensors and we have sensors that are inbuilt in the cameras and the microphones. So, here we see how health care has been enhanced with the role of IoT with the involvement of IoT.

So, these are certain examples that we have discussed in this session.

(Refer Slide Time: 24:02)




These are my references. In the next session, I will be focusing on more examples with respect to IoT. And, we will also discuss about, you know, the advantages of IoT and the IoT technology, so, the technology that is involved behind IoT systems.

Thank you; see you in the next session!