Introduction to Internet of Things

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Lecture – 59
Activity Monitoring (Case Study) – I

Hello, in this lecture this again will be a two part lecture on activity monitoring, the first part will focus on the basics of activity monitoring like what we are going to do, why is it required and what is the necessity for activity monitoring in day to day life or maybe in special scenarios and finally, in the second part of this lecture which is mainly a case study, will give a demonstration has small demonstration of a simple network based data aggregator which can be used for monitoring various activities. So, the data is being generated from a smartphone and being sent to a remote server over the network. So, we have developed a small app which generates or captures the various human activities not actually activities, it captures the various sensor behaviour during human activities.

Suppose a person is walking running lying down is talking maybe person is fighting or had an accident and so on and the sensor values keep on changing the specially the smartphone sensors since we are talking about or the case study we are talking about smartphone sensors. So, we have taken the inbuilt sensors in the smartphone. So, those sensorial values are transmitted over the network to remote server, where they can be used for multitude of applications ranging from normal activity monitoring fall detection you can even use a offline non smartphone sensor like a standard accelerometer or Imo based sensors integrated to a small processer board, and the same operation can be performed for those sensors also.

So, these things this non-smartphone based activity monitors, they have been given the common name wearables. So, you must have heard about wearables, you have fitbits activity trackers it is in the form of a small watch inside it is thinner and tinier then a watch, you just charge it wear it and go about your daily activities.

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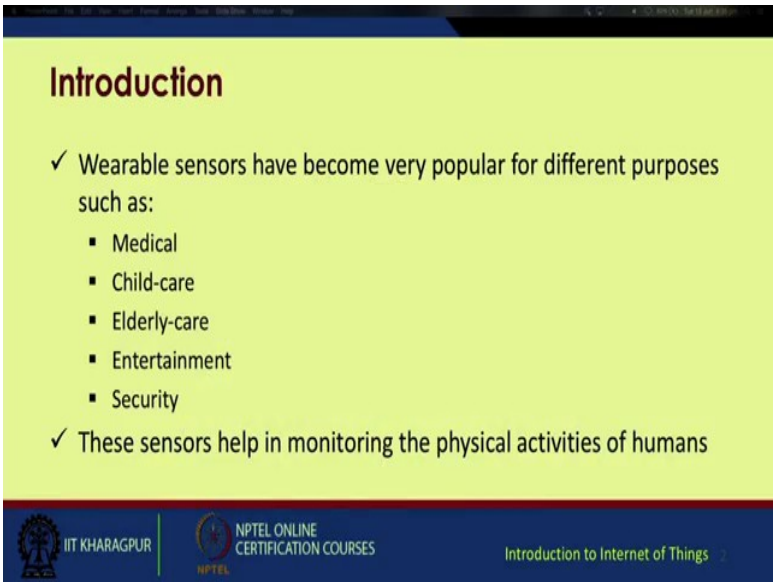

So, these are a few basic ideas will be discussing in this case study. So, these wearable sensors have nowadays become very popular. This has been due to multiple reasons first and foremost they are very efficient, second they are low power consuming, third they generate reliable data so, that your activities can be accurately tracked. So, they have found many applications in various fields such as medical field childcare elderly care entertainment industry security and so on. So, these sensors help in monitoring the physical activities of human; and your physical activities not only restricts to daily activities. So, people can say if your monitoring my activities you can track what I am doing. So, I am not comfortable with sharing those kind of data over the network.

So, yes there are various issues regarding privacy regarding security of data, but we would not be dealing with those issues here. So, one by one let us just go through the basics like in medical, childcare, elderly care, entertainment security even military what are the applications what are the implications of using activity recognition. So, generally in medical field imagine a patient is hospitalized and his or her activities need to be monitored, suppose you have a very fragile patient he needs to go to the washroom to relieve himself or herself, and while doing so, the patient falls down. So, normally it may be a while before someone finds that patient in a foreign state. So, to avoid this kind of injury or this duration after falling down. So this recovery duration can be massively reduced by using activity trackers. Suppose the patients are made to wear bracelets embedded with small activity trackers, which are train to detect fall in patients or maybe they detect the changes in biomedical parameters

like your pulse rate heartbeat and so on. So, these are now available in the market and collectively their called wearables, you have smart watches with activity trackers you have standalone activity trackers and so on.

So, in the medical field this can be very important for monitoring patients in child care if your child is playing on the streets if your child is going to school, you can monitor your childs activities if your child falls down or there has been accident, automatically the system will alert the parent that child has met with an injury or an accident. Then as we have covered earlier it for elderly care it is almost the same as the medical usage of wearables. So, imagine elderly people in your home wearing small activity trackers the best part is these are very small.

So, people hardly notice there even there. So, an additionally they are not very power hungry. So, once in a while you charge it may be in three days four days you charge it and it will keep on going. So, in elderly care you are you can use these activity monitoring applications. In the entertainment industry, you must have seen various documentary documentaries or you must have seen those action movies where the protagonist performs multiple and dangerous stunts. So, you must have realized most of these are something which is known as CGI. So, in CGI actually you stand in front of a green screen wearing various activity monitors in front of cameras, which are used to track your activities and you have certain highlighted points or markers on your body and these will be used for generating what activity you are performaning and so, that this can be reliably translated in terms of a movie scene with changing backgrounds maybe you see some dinosaurs running around, you after your CGI scripting and editing has been done maybe you are jumping of a bridge you are jumping of a plane and so on.

So, this is from the entertainment industry in security also you can have activity monitors monitoring where you are going what exactly you are doing maybe you have no person zone, and if someone is entering that zone or maybe have activity sensors installed which you do not want in our area you do not want anyone to access, and suddenly in the middle of the night some of the sensors go off. So, you hit upon this idea that since no one is supposed to be in that area and suddenly many activity sensors are turning on. So, there may be a case of breach of that security. So, this is maybe one of the potential applications of activity monitors in the domain of security.

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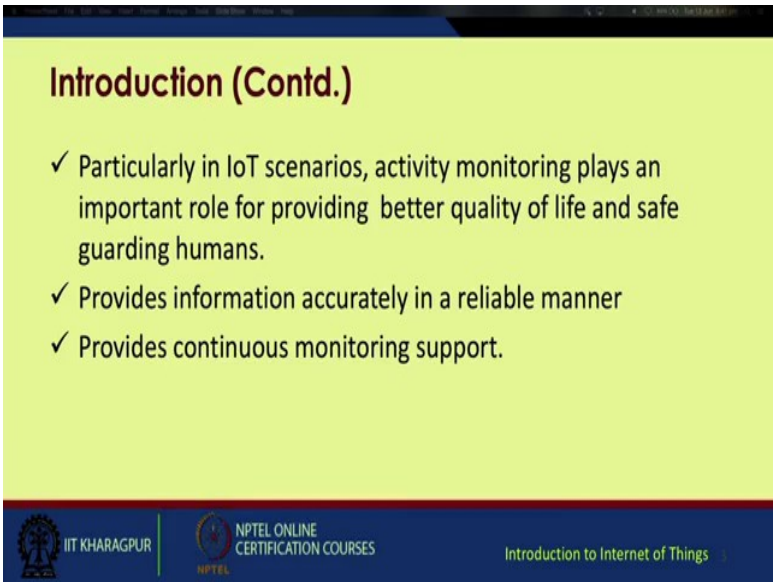

So, now coming back to the IoT based scenarios, this activity monitor monitoring plays a very important role and since mainly if you keep the security aspects the entertainment aspects aside normal medical and human implications in day to day life they provide for a better quality of life, they provide and they promise for a better quality of life and they safeguard the humans against various accidents. By promising and providing quicker response quicker emergency action and other system.

Now suppose while driving a person is wearing an activity monitor which normally under emergency normally alerts some emergency numbers as well as his family members. So, the person meets with an accident on the road, and there is a sudden change in the persons activity since let us suppose the person is only wearing an accelerometer on his wrist, and within normal limits the accelerometer is giving two units of reading and the impact of with the impact of the accident these two units will be translated to 100 units.

So, that would be a massive jump in the persons daily activities so; that means, the person has received a big physical shock. So, that the sensor is giving such an abnormal reading. So, in this way you can train your system both on the device as well as offline or online on the network, to generate abnormal activities sometimes it may be due to sensor malfunction sometimes it may be due to electrical disturbance, but sometimes it maybe even due to some serious life threatening situations. So, once this abnormal activity has been registered maybe some emergency numbers are alerted, family members are alerted and they are notified of the

persons location the present location or the last location from which the alert was generated, and immediately rescue teams reach that person and eventually the person will survive.

May there are high chances that the person may survive. So, another thing is to provide information accurately and in a very reliable manner, and you need to provide a continuous monitoring support while considering activity monitor.

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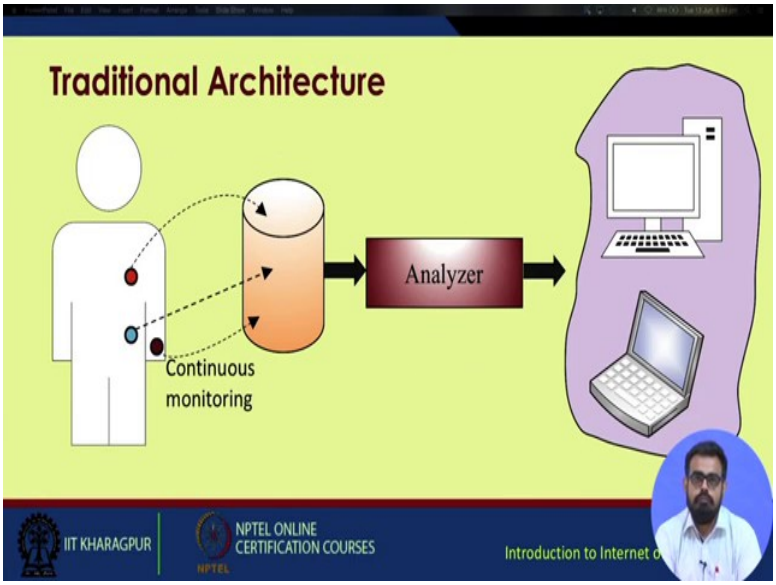

So, typical architectures deal with suppose you have this person and he is equipped with multiple wearables, one is tracking the heartbeat, one is tracking the body temperature, one is tracking the activity on the wrist and all this data is being forwarded maybe to a remote router or a network server, and then an analyzer analyses the activities and instead of transmitting the raw data, the analyzer transmits the analyzed activities to various connected stations that may be a home computer to which the family members are keeping track of view, that maybe a laptop or a mobile computer or even a cloud or maybe your medical doctors or consultants are keeping track of your activities.

So, this is a online base model, maybe for offline based models you can have all these things on a single wrist band in a small minute size, and it is doing all the processing offline that is within the device itself. So, there may be certain disadvantages of these and the applications may be restricted, but yes suppose you are going for jogging and you can using these offline models like every calculation and everything is being done on the device itself, you can keep track of your heart rate and it will give you an analysis whether you need to slow down or

need to speeded up during your jogging and there are multiple such applications of activity monitoring.

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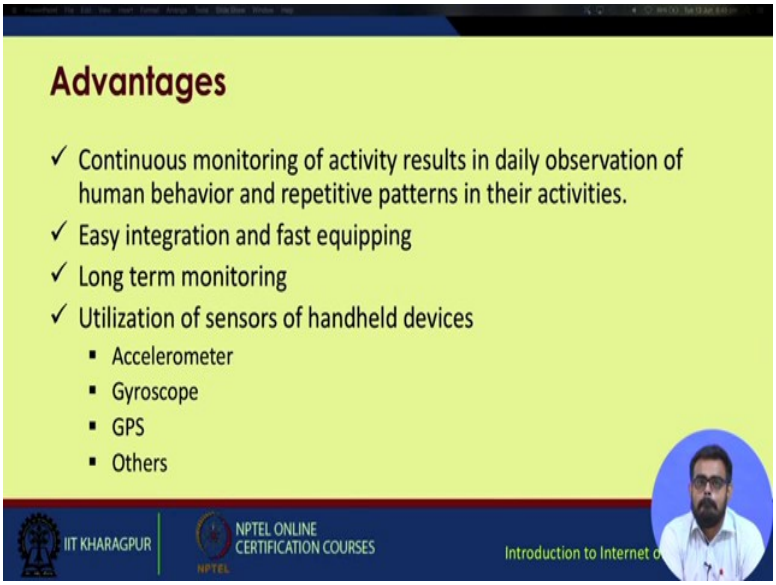

So, they inherently have certain advantages first is your continuous monitoring of activity will result in daily observation of human behavior, and repetitive patterns in the activities.

So, prior to generalizing some activities, your walking pattern, your running pattern the way you sit way you stand the your basic body language, varies for every person. So, that may vary due to height that may vary due to weight that may vary due to some previous injury some present injury and there are multiple reasons, while there may be variations. So, you need continuous monitoring and continuous training of the system to generate reliable results and this will also generate repetitive pattern. Suppose if you are going for normal activities like running, walking, jogging maybe driving sitting lying. So, they have clear cut markers they can be easily applied to, but what if you have some special activities you need to take care of like when you are lifting your left leg when you are lifting your right leg, you need to distinguish between these kind of minute activities you need to find in your system, in this can be only done through collection of data over a long period of time from individual subjects.

Now, another advantage is the easy integration of these sensors and the fast equip equipping time of persons with these sensors. Then you have long term monitoring available since these are very low power consuming you can keep on monitoring the activities for days at an end,

then using normal sensors and basic handle devices you can build up the system which can monitor activities, you can opt for either smartphones or you can go for accelerometers attached to a basic processor and maybe a Wi-Fi radio or you can go for gyroscopes, which gives the orientation readings you have GPS and you can have multiple sensors, you can keep on increasing the sensors, but at the end the more the sensors you are increasing the more power hungry your device becomes, the more costly your device becomes and more volume of data it will generate.

So, these are some of the plus and minus points of using activity monitoring, using sensors. So, mainly you need to restrict the number of sensors you go on including on a variable so, that it is lightweight, it is portable and it is less power hungry.

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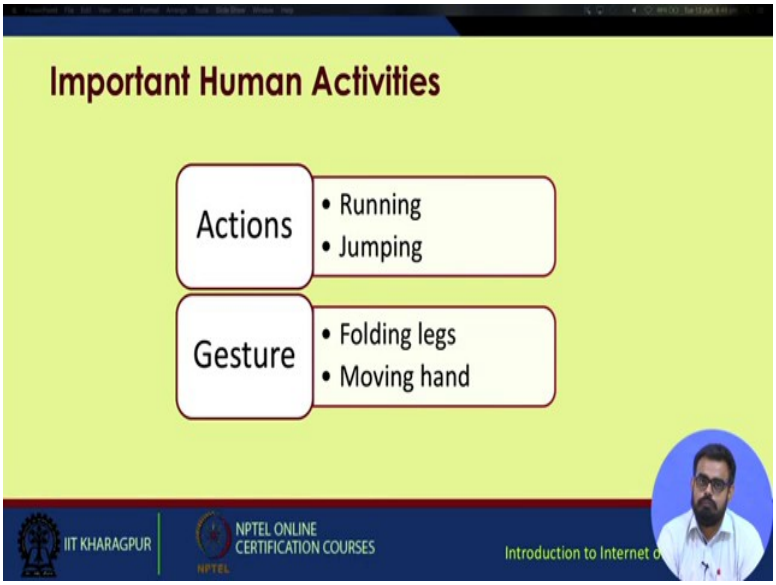

So, some of the basic human activities which these market available devices do are they can distinguish, actions they can distinguish gestures like for actions they can distinguish between running jumping or whether a person is lying down or sitting, and what gestures you can have if a person is holding his or her legs, if a person is moving his or her hands and suppose if a person is dancing right. So, that would be considered as an action, but there will be gestures involved also. So, maybe a person is dancing peacefully or a person is dancing aggressively, you can detect that using various gestures you can detect you can maybe predict the intent of a person using the gestures the person is providing maybe a person is threatening, someone maybe a person is trying to please someone and so on.

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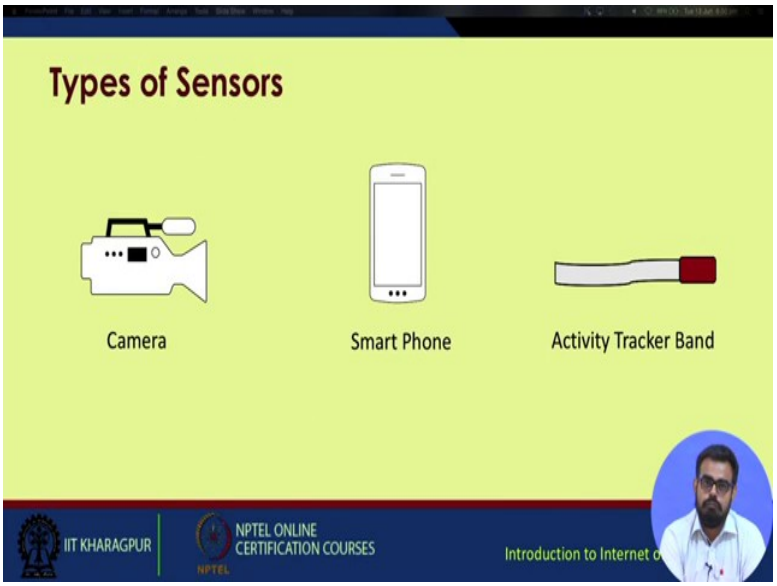

So, some basic sensors you have you can either go for video or image based monitoring of activities, which is very processing intensive then you can go for smartphone based activity monitors, you can involve a lot of sensors inbuilt sensors, but your phone has to generate a lot of data and then again you have this normal activity tracker band where the sensors unlimited and power is quite restricted.

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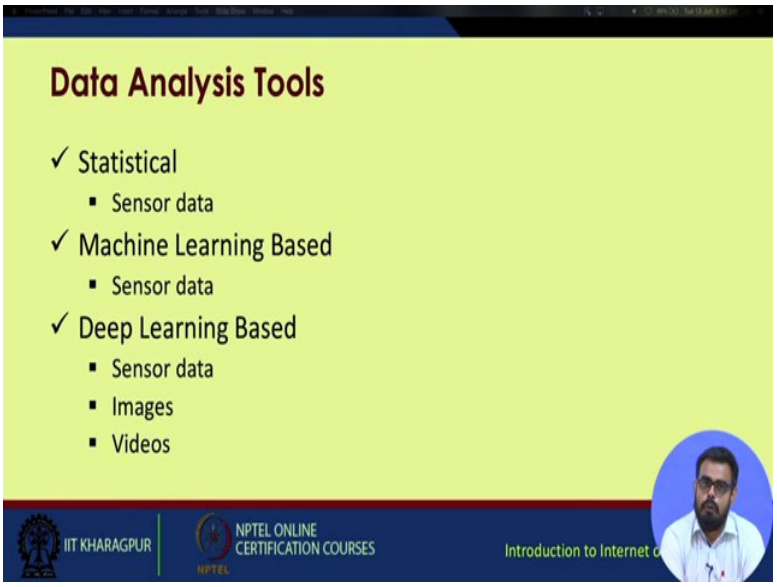

So, once your data is collected from the sensors be at the camera, be at the smartphone sensors, be at normal standalone sensors, what next? You have to find some means or

methods to analyze these data. Generally these data are going to be very long there will be errors or let us say in statistical terms there will be outlets, that may be due to errors in the sensor reading that may be due to fluctuation in the sensor itself that may be due to some accidental minor accidental bumping of the sensor, suppose you are about to wear your activity tracker band and suddenly it falls off on the ground.

The person is standing still the person is fine, but the sensor falls off. So, that will record a major shock other alert in the activity monitoring system. So, these kinds of falls predictions can be avoided and we will name them as out layers, that is beyond the normal statistical behaviour of the data. So, you have statistical analysis of the data being generated, generally they work on sensor data then you have machine learning based analysis again they work on sensor data, maybe machine learning, with image processing you can use for analyzing video and image data then you have this deep learning based approaches you can use normal sensor data you can use image data you can also go for video based data.

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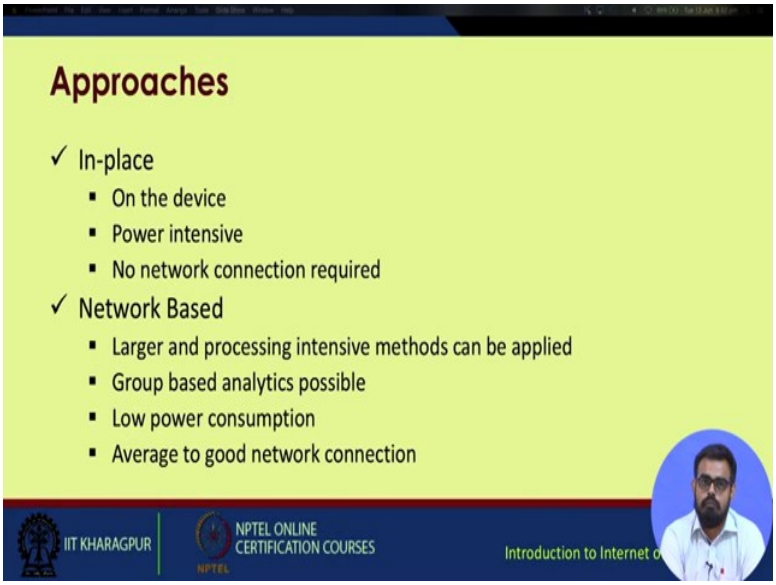

So, somewhere sometime in the previous slides I have already discussed it, but mainly your activity monitoring can be divided into two parts one is in place the other is network base. So, I am calling the activity monitoring or the processing of data on the device itself as an in place approach. So, your monitoring is done on the device, since you are monitoring your diagnosing the activities on the device itself will need a processor, the processor has to process the sensor data and has to generate some alert. So, it is definitely going to be power

hungry or power intensive, and generally no network connection is required, but yes you can obviously, opt for network connections. So, even if you go for network based in place devices, there will be an unnecessary wastage of additional power.

Next is your network based system. So, these are mainly aimed at processing larger and processing intensive methods such as deep learning tasks, computer vision based task, machine learning based task and so on. Group based analytics is possible suppose you and your group of 20 friends are out on a hike, maybe on the hillside or somewhere of terrain. So, suddenly one or two members start lagging behind. So, since you are not aware in that rough terrains since you are yourself very tired, but you are not aware about your friend's position. So, your activity tracker will tell your group that you are group is moving at this average velocity whereas, two units or two persons from this group are lagging behind. So, maybe they are facing some hardships or they are maybe facing some medical condition and need to be looked into.

So, we call this group based analytics. So, in this one network based approach you can go for group based analytics then; obviously, most of the processing and data is off loaded to a server and only you have a wireless radio and a sensor on your body. So, this will be low power consuming and additionally you will required an average to good network connection maintain with the server to which you are sending your data for activity monitoring. So, those are different approaches. So, I hope for this case study the basic importance of activity monitoring has been established, in the next part will give a demonstration of how we are using smartphone base sensors and connecting it to a network and visualizing it ok.

Thank you.