**Introduction to Industry 4.0 and Industrial Internet of Things**
Prof. Sudip Misra
Department of Computer Science and Engineering
Indian Institute of Technology, Kharagpur

Lecture - 50
IIOT Application: Food Industry

Another application of IIoT is in the food industry, agriculture and food industry. So, in the food industry let us first try to understand what actually happens. So, we have agricultural produce, those agricultural produce; they come from the field then those produces are basically taken through different processes and finally, the consumers basically consume the agricultural produce. So, let me elaborate this little bit further so, the process is well known as field to plate.

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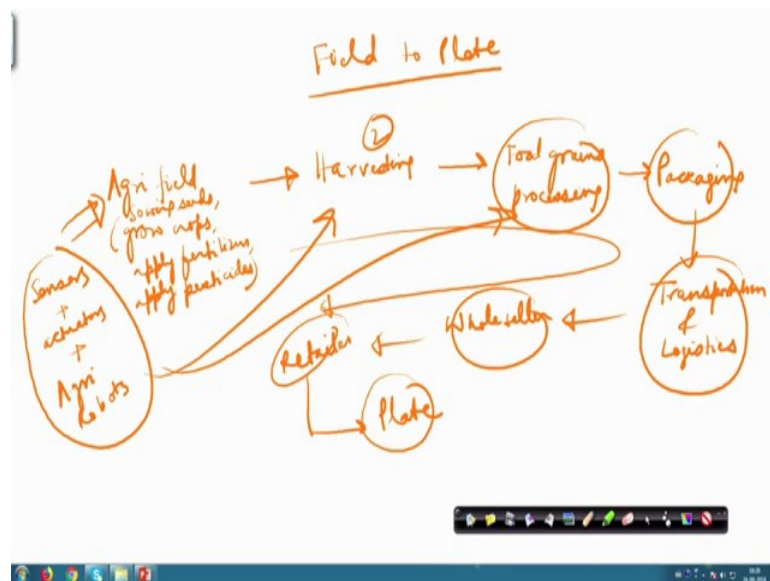
So, field to plate; what it means is that from the field, where the production is made to the plate, where the consumption is made, what is the supply chain? What is the chain of production?

So, let us say that it will start with the agricultural field. So, in the agricultural field you would be growing the crops. So, let us say that sowing of seeds, the farmers are going to sow seeds, grow crops, apply fertilizers, apply pesticides, etc. and then after the agricultural plans they become matured, then basically these crops are harvested right. So, these crops are harvested.

So, the next step is broadly is going to be harvesting. Following harvesting these food grains are going to be processed; food grain processing, after food grain processing we are going to have let us say the packaging, packaging of the food grains. After packaging of the food grains these packages are going to be transported; transportation and logistics. So, they are going to be transported typically to a wholesale market.

Then it goes to the retailer, the retail market and finally, the consumers are going to buy and cook the agricultural produce and they are going to consume. So, basically this is going to be the plate right. This is typically the chain from the agricultural field to the plate. So, this is typically the chain of activities that are followed; this is the supply chain let us say. So, supply chain comes because ultimately for each of these things the supply will have to be ensured through this entire cycle right. So, all these supply through these entire processes and the different steps will have to be ensured.

So, we are talking about this kind of scenario. So, in this kind of scenario sensors will have to be used; you have sensors, IIoT devices will have to be used in the agricultural field for monitoring the growth of the crops, the sowing of the seeds, for applying fertilizers precisely adequately and so on and also to precisely and adequately apply the pesticides.

So, sensors, actuators, plus different agricultural robots could be used over here. So, not only over here even in step 2 for harvesting also these could be used for food grain processing, again these could be used, for packaging likewise transportation, logistics, wholesaler, retailer, plate actually let us leave this aside. So, we still are not in a point of having a plate which is sensor enabled and robotic plate and so on. So, that is a far dream to be achieved so, but in retailer basically sensors, actuators, robots etc. these are all going to help the systems, or the machines that are helping in the processes and the different states etc. to be made much more efficient autonomous and so on.

So, let us now look further ahead and see what we have in terms of IoT implementation in the food industry.

So, these sensors, actuators is something that I have already mentioned right, but they will have to be networked. So, we need to have network sensors for food quality monitoring along the supply chain that I have just mentioned, sensors and their networked sensors for monitoring the environmental conditions. So, food grains going through different warehouses whether the temperature of the warehouses have been properly maintained, monitoring of those temperatures, the crux carrying those temperature monitoring etc., those will also have to be done. So, sensors are very crucial over here in this entire food supply chain.

Communication layer basically talks about stakeholder access supply chain data etc., the communication between the different stakeholders, access to the stakeholders, communication between the different components of the supply chain, connecting different data to the use of sensors, from the sensors through the communication network, all of these things are required. And finally, that the application layer to have applications for farmers, retailers, government, analysts, consumers, insurance companies which have not written over here but very important for insurance companies also it is very important.

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So, you need sensors for doing number of things, sensors for monitoring humidity, temperature, composition of food products and so on. So, sensors can do number of these different things, but the sensors will throwing lot of data in real time which will have to be analyzed in real time as well in order to make the most out of those data that that have been retrieved. So, you need easier process control, increased food safety, etc. and it is also very important to have adequate end to end traceability.

So, I told you about the field to plate concept at the outset. I explained it. So, field to plate and the corresponding supply chain. So, if you have this adequately implemented using suitable IoT solutions it would be possible for example, to trace a rice packet back to the paddy field; that will be possible. So, as you can understand that this is going to be this is going to be very attractive if you can implement it properly.

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So, the impact of IIoT in the food industry is like this; that we are going to have efficient production line, we are going to have adequate, suitable, efficient food safety measures, the food safety regulation implemented.

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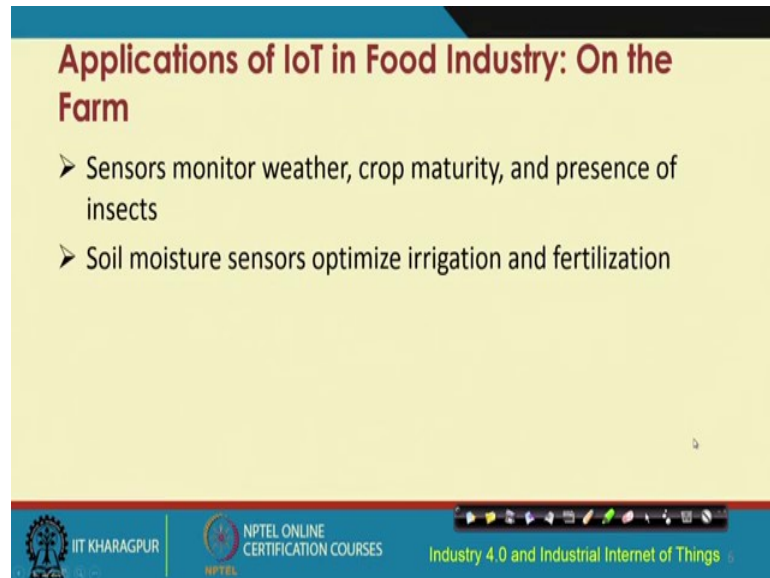
We are going to have transparency of the supply chain, we are going to minimize the wastage in the entire supply chain, we are going to have minimized wastage of food resources, and we can analyze in real time for example the information of food products

and reduce the food wastage. So, all of these things are possible if you have IIoT implementation in the food industry.

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So, on the firm we can have sensors to monitor weather, to monitor the crop maturity, to monitor the presence of insects, to monitor the conditions of the field with respect to the soil conditions for example, how much soil moisture is there in the field, how much is the water level, how much is the fertilizer content of the field, the soil nutrient condition of the field. So, all of these things are possible with the help IoT implementation in the food industry. So, these are some of the different applications like wise you have large number of different applications that are possible for IoT implementation.

So, I am now going to give you some examples; in the livestock barns sensors can help in monitoring the health parameters of different animals, different live stocks such as cows, buffaloes and different other live stocks including sheep and goats and so on. So, all of the life monitoring, continues real time monitoring using IoT enabled devices is possible in the form.

Automated feeding cycles can be set up with the help of IoT implementation, diet control of these different livestock, the different farm animals is possible with the help IoT implementation. Automated temperature control in the brooding barns and hatchery these are also possible with the help of suitable IoT implementation.

On the equipment, IoT enablement can be done in terms of you know GPS tracking whenever these animals are moving around their exact location their position etc. could be could be tracked. This is a just an example like this GPS could be used for tracking the movement mobility of different other components in the IoT in the food industry.

Drone-assisted field monitoring is quite common, drone assisted field monitoring applications in agriculture are quite common and are being implemented, we ourselves in the lab are working on different agricultural drone applications for doing number of different things.

So, in the food industry IoT implementations can be done for maintenance embedding sensors to these different machines such as farm machinery, tractors, etc. to monitor their condition, to monitor their performance, to detect whether any machine is going to go down in the future. Early detection of warning signs, smart maintenance etc. of these machines extending the lifetime of these equipments all of these things are possible with respect to maintenance in the food industry through IoT implementations.

IoT implementation in the food industry can improve the margins through predictive analytics, spotting early warning signs, making well informed decisions and maximizing profits.

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For the consumer, there are different initiatives, smart level is an initiative by the Grocery Manufacturers Association GMA, which uses QR code to provide product related information to the consumers. These consumers consequently can get information about the ingredient details of a particular food item, allergens exposure of that particular food item, nutrition, value and many different other Information.

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Consumers can scan the QR code to get details about the product; the product information includes nutrition, ingredients, allergens, third party certification, social compliance programs, usage instructions, advisories and also safe handling instruction.

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In the factory, IoT implementations can help the different machineries in the food processing industry, the different workers who are working in the food processing industry to remain connected autonomously. This connectivity can help in gaining insights to improve the quality of the food product, the quality of the food processes and so on and consequently they can also help in the reduction of the time to market TTM.

So, IoT implementations can also improve compliance and safety of the food product, compliance to regulatory standard, compliance to best practices and also safe handling of the food products, these are all possible with the help of IoT implementation in the food industry.

IoT implementation in the food industry can also help in empowering the workers through augmented reality safety glasses and other wearable, thereby increasing the

overall productivity and efficiency of their processes, efficiency of the workers, and efficiency of the machinery that they are using.

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City crop is an intelligent indoor garden that provides intelligent indoor garden to grow fruits, herbs, vegetables, greens and edible flowers, they have implementation of automated climate control, automated livestock monitoring, automated smart notifications which can be sent to the concerned stakeholders and also to the plant doctors' automated notifications would be sent.

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Diagenetix has this product, the bio ranger which can help in detecting the presence of microbial diseases in the food. Bio ranger is a small handheld device that connects with android app and instantly detect pathogens in the food.

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Eskesso is a company that has the cooking sorcery the product which is basically for smart cooking. So, they have this Wi- Fi connected smart cooking device that can help in easy monitoring of the cooking status via the smart phone app. Smart cooking basically helps by placing the food packet and Eskesso device in a pot of water, selecting the recipe and starting via smart phone app you can get your food cooked in a smarter way through minimal involvement.

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Culinary science industries has the flavor matrix which basically infuses foods and beverages with unique flavors, they collect data on the food ingredients, collect user data and uses different implementations of machine learning and data analysis to enhance the flavor of dishes and provide user specific food and beverage pairing.

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Intellicup has the smart cups solution which basically is a smart beverage vending machine which reduces the waiting time and increases the profit at the beverage shops. These are sort of like IoT enabled cups which have NFC integrated chips at the base of

the cup and they connect the cups to the mobile banking platform and IntelliHead which is a modular dispensing unit. So, this NFC chips basically helps in connecting each user to a cup. So, the cups are usable and made with biodegradable material.

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So, how the smart cup works? So, basically there are separate apps for the merchants and the customers, the customers create intellicup accounts using the app, they transfer the funds to the e-wallet us and linking there after the cups are linked to the e-wallet by scanning a QR code via the app and docking the cup on the dispensing unit using the intellihead. So, customers there after enjoy the beverage that is finally, produced through this smart cup.

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Likewise there are different other IoT solutions for the food industry by Spinn Inc for smart coffee brewing and farm shelf for smart indoor farming.

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So, these are a list of different references talking in more detail about the solutions that I have talked about briefly, IoT solutions that have been used in the food industry, food processing industry and so on. So, if you are interested about any of these solutions that I just mentioned you are encouraged to go through these differences.

Thank you.