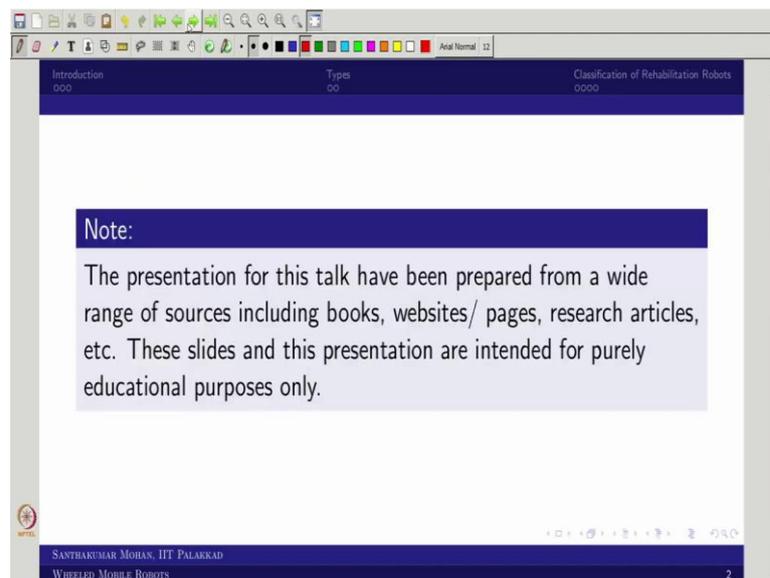


Wheeled Mobile Robots
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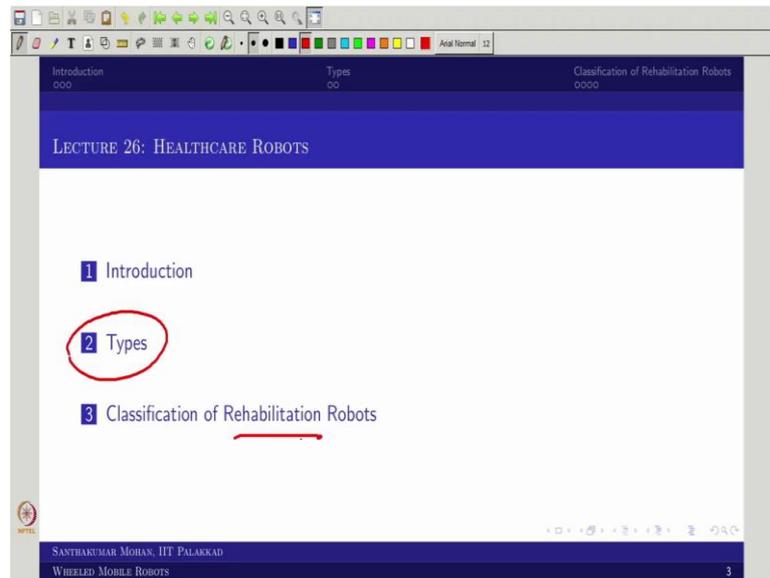
Lecture - 46
Healthcare Robots

Welcome back to the course on Wheeled Mobile Robot. So, far what we have seen? We are actually like seeing something like special you can say robots other than wheeled mobile robot. So, in that direction so, we are actually like trying to see one specific case called Healthcare Robots which is actually like covered both surgical and other you call health care robots that is why I put it is a very broad health care robots. Let us actually like see what are the things we are going to cover.

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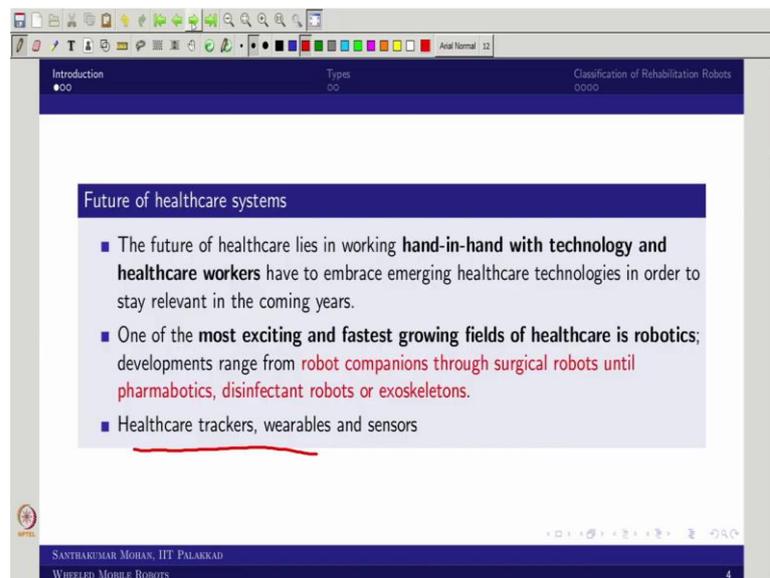


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So, in that case, we were actually trying to see two things. So, we are actually trying to see what is actually like healthcare robot. So, what are the types? In that one specific health care robot we are going to see in detail. So, what that mean? The you call rehabilitation robot we are going to see in detail. So, let us actually like move further.

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So, in the sense, what we can actually like see? What is actually like future of healthcare system? So, if you all look at it, so, the future what we can actually look at it so, the

technologies and the healthcare workers, so, definitely connecting one to one so, in the hand-in-hand.

So, for example, that technology what you wanted for a medical health care so, that can be actually like given to a technologist, that technologists will give a proper solution. So, earlier, you know like several of cases, people would be the doctor would be in a uncomfortable position doing some surgery, but now, the situation has change right that uncomfortable situation become a comfortable situation by making some additions.

So, in that sense, you can see like what happening, the hand in hand in you can say connection with a technologist and the health care workers are actually like growing. So, you know some kind of pandemic situations, so, where this is also like would keep going. So, you know like some cases where the disinfection robots have come or drug delivery robots have come or in the other way around.

For example, just checking the temperature in a mass level, some devices have come like that you can actually like see several advancements have come based on the need. So, in that sense, what one can see? This hand-in-hand with technology and health care workers are the future health care.

So, if you look at that, what would be the emerging or exciting? So, the most exciting would be what you call health care in robotics. So, or you can say the robotics in health care is actually like one of the fast growing field. So, then what you can see like from robot companion to what you call surgical robot until what you call forum pharmabotics or you can say drug delivery robot or just disinfectant or just assistive robot what you call exoskeleton.

So, these all actually like coming into a picture in the sense, what we are trying to address here? So, we are trying to address healthcare is robotics or you can say robotics in health care that is what we are trying to see in this particular lecture. So, in the sense, what you can see? We are not seeing all the things what you are actually like seeing as a tracker or wearable or sensor.

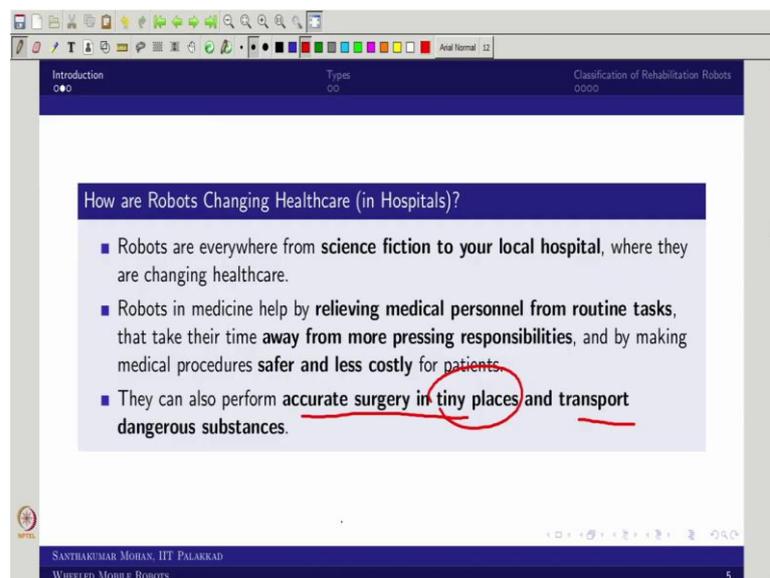
For example, in certain pandemic situation, you want to monitor some of the patients so, what you can do? You can make a wearable that too like a trackable wearable, then you

can actually like monitor where he is going and what he is doing. So, you know like some of them, they may not actually like obey the rule of you can say hospital.

So, somebody you actually trying to actually like go away, somebody actually like will go away from the home. For example, I say home quarantine so, the person is in the home or not I can easily see if I actually like put a wearable trackers right. So, in the other sense, what you can see like some kind of idea also coming now that wearable tracker can you actually like put it on the human being or not, there would be a legal issue right.

So, you know like in the most of the American soldiers, they have a chip on their hand or probably in the body. Can we do it that way? No. So, why? There is a legal issue. So, that is what we are actually like trying to see what would be the future in actually like healthcare along with the robotics.

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So, in that sense what you can see, how the robots can change the healthcare. So, definitely the science fiction become a real right. So, earlier days, you would have seen the robot would be actually like once in a while probably some of the academicians would be having it or probably some of the modern or you can say that industry who is having huge money, they would be having a robot, but not now right.

So, now, you even you go a small-scale industry, you can see a robot. In that sense, even you go to a small-scale, you can say multispecialty hospital, you can see laparoscopic instrument or surgical robots are available. So, in the sense, what you can see from the science fiction to the reality it is happening that is one thing.

So, where you can actually like bring the science fiction into a local hospital so, then that would be definitely changing the healthcare system in a dramatic way and drastic sense. So, what additional aspect? You can see it is actually like one of the key point it is relieving the medical personnel from the routine task. Very simple example I am saying that for your temperature measuring, you have a small device so, you no need to actually like go to the assistant right.

So, but you know like just example, you consider the you call a simple pediatrician. So, the pediatrician always actually like very demanding right. For example, you go to a pediatrician at 10 o' clock, you would have seen that there are there would be 10 or 50 even 50 if it is a popular, there would be 50 odd people who would be carrying where their kid and there would be sitting in front of the pediatrician right.

So, when you go to pediatrician, what would be the first thing? They will make a registration and they take a file and they check the baby weight, height, temperature, pulse everything right. So, now, imagine this you are trying to automate with some kind of you can say machine that too like a robots.

So, what you can see that the routine task what the medical practitioner or the assistant who is doing usually the you call the assistant doctor or some kind of assistance used to do it.

So, very simple example when I was taking my kid so, he was actually like probably so, that time he was 7.5 kg, but this lady was taking a phone who is supposed to enter she was in the phone and she was actually like writing as 17.5 but imagine so, this is I have corrected, but imagine the doctor is taking and looking the baby, hey how it is 17.5, it is a fault right, it is a fake data.

So, now you can see that that additional pressing, what it is giving it is actually like enduring with some kind of you can say a false details right or you can say some kind of you can say mistakes can happen, but if you are deploying a robot that too like with

some kind of recording base so, if the doctor even the robot also making something like 17.5, the doctor can just scroll the video and see no it is 17.5 it is actually like wrongly enter as a probably 17.5. So, this kind of thing can happen.

In that sense, what you can see? The routine task, you know that medical assistants so, they would be doing as a assistant for the doctor and attendant for the patient and as well as attender for the you can say receptionist. All those things this lady or the boy who is doing it. So, in the sense, he is actually like doing multitask right.

But now, imagine these all actually like centralized with something like a robot. So, it would actually like take away, further what happen? The doctors also like would be you can say taken away right in certain pressing task. So, in the sense, what you can see? It is actually like the responsibility also will go away.

So, now, imagine the robot is doing some kind of ultrasonic imaging just imagine ok, the doctor is watching from the remote station because you know the scanning center would be away from the regular nursery right. For example, the gynecologist is there so, there is a lady who is going for checking her ultrasonic image.

So, she is actually like giving a perception, these are the test you have to take and go and do it. So, she is going to the scanning center and the scanning center also there would be another doctor but based on the prescription, he is doing. Now, imagine this robot tele prompt it is there, imagine just IOT enable.

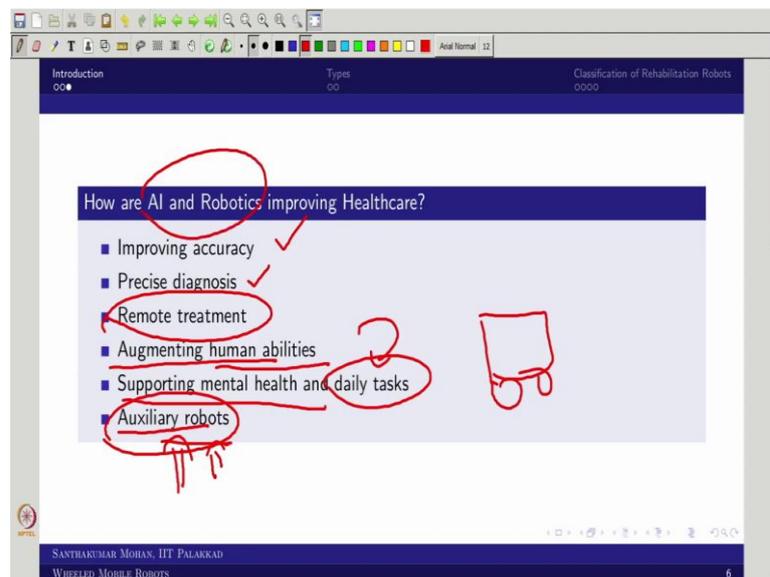
So, the doctor is actually like keep on watching that what is happening in this particular ultrasonic sensing for that particular patient, it was you can say intimated the doctor start seeing the camera, then what you can see like the video so, if something is actually like specific so, she can naturally give a command to the one who is doing that can you actually like do it little more or can you do another test because I am actually like suspicious.

Otherwise, what happens? This test result you have to take it and go and then, show it, you have to do another one more scanning, can you go? But now in this case what you can see this can actually like avoid. So, that is what one important thing you can actually like see it.

Further, what happened? You can actually like make a safer and less costly and as well as it is comfortable and available to all the patients.

So, these all can happen in the robot. So, that is what we are actually like trying to see. In that sense, what you can see even the accurate surgery like small eye retina, you can doing right, already you are start doing it which is very tiny place and what you can see? You can even transpose dangerous substance. So, that also you can transfer without having any difficulty.

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So, these all actually like what the robots can actually change the healthcare system in that sense, what the AI and robot can improve it in the existing healthcare? Definitely, it can improve the accuracy and the precise diagnosis can be given and the remote treatment is still possible and human ability can be augment, you can actually like put a virtual reality or augment reality where the patient will start recover faster.

For example, the patient is in something like small you can say problem and he is putting in ICU, but he is always seeing the ICU and he is seeing all the you can say other cases, but instead of that you can actually like put it a virtual reality on his eye and he is seeing something like a park or probably some kind of a beautiful scenery, his recovery would be faster right. So, that kind of thing all can be brought into the AI robotics in healthcare system.

And further, what I can? You can naturally like support the mental health and daily task. I adapt the you can say wheelchair system to a you can say disable person what you can see? You can actually like allow him to do his daily task and auxiliary robot for example, I am giving a small example. For example, you take a pharmacy.

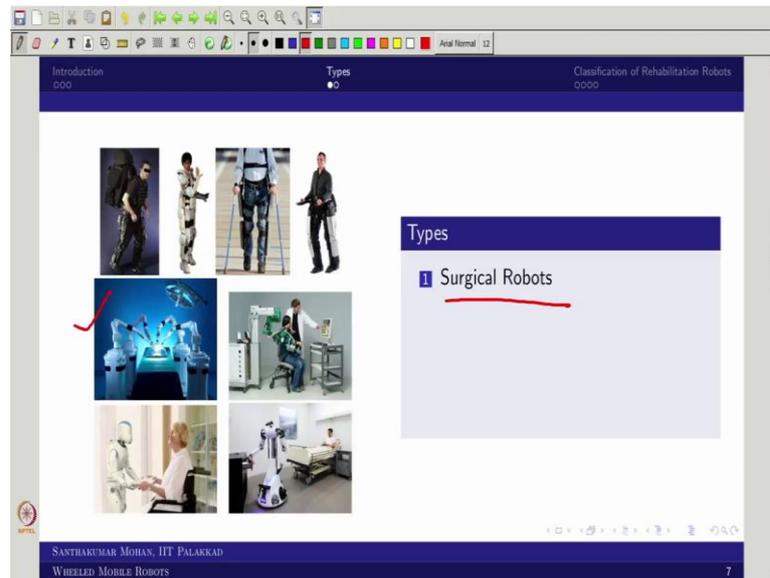
So, you go to a pharmacy so, you know like several time you would be standing in a queue even not in a queue so, some people coming here and there says that, you give this medicine and the pharmacist say that no, this is not available can you get the other one. Sometime you need to go to the doctor again.

So, now, imagine you are putting a robot as the drug delivery robot within the pharmacy itself that drug delivery robot is getting a command from the doctor prescription when the doctor is writing the prescription that is directly transmit to the that particular robot, this robot will actually like pick everything and put it in the case and keep it this tag says that this particular patient.

So, when the patient comes to that pharmacy, it is already actually like patched. So, you just pick and take it that is all, even that you call the payment also you can do it at this digital. So, in the sense, what you can do? You can actually like apply several auxiliary robot.

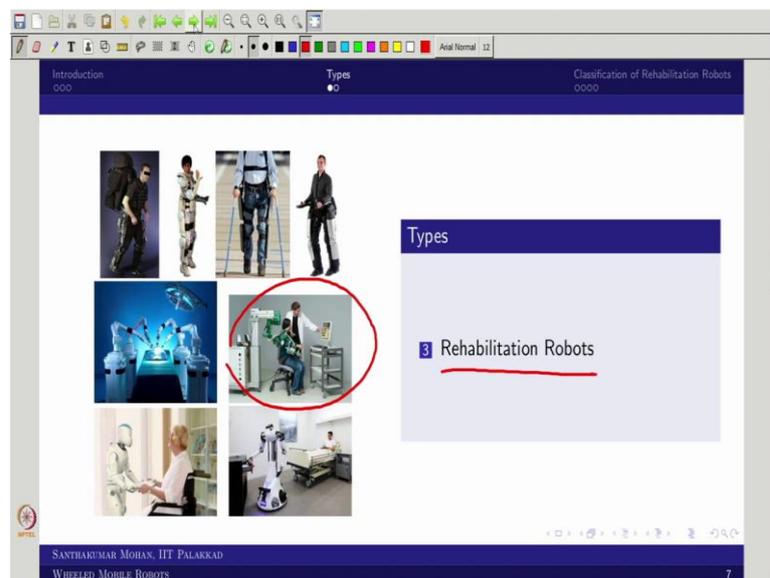
So, this auxiliary robot can be even disinfectant robot, or small assistant for the existing inpatient patients or it can be used for the doctor assistant or like a drug delivery robot and all. Even it can deliver even the food and all right. So, these all actually like come into a case if I apply AI and robotics right.

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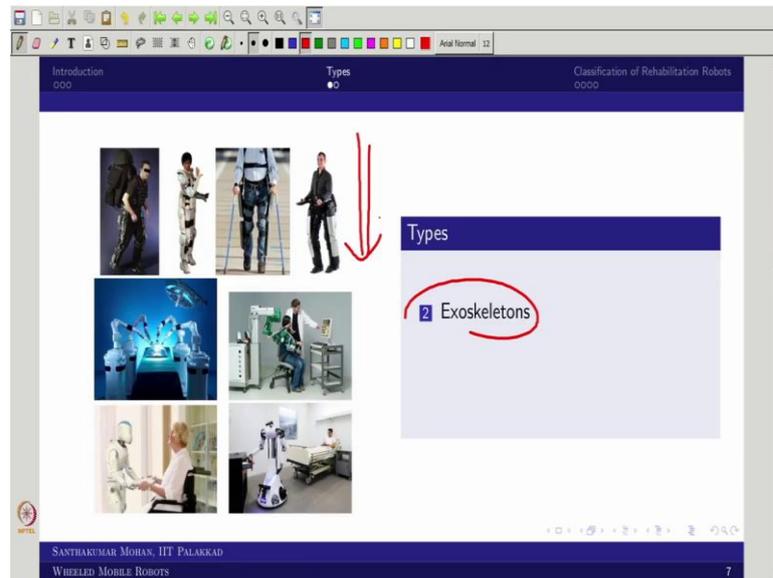


So, then what would be the types? So, that types you can actually like make it the surgical is the broad. So, whenever I call medical robot, immediately you think about this surgical robot, but the that is not the only type, there can be several other things.

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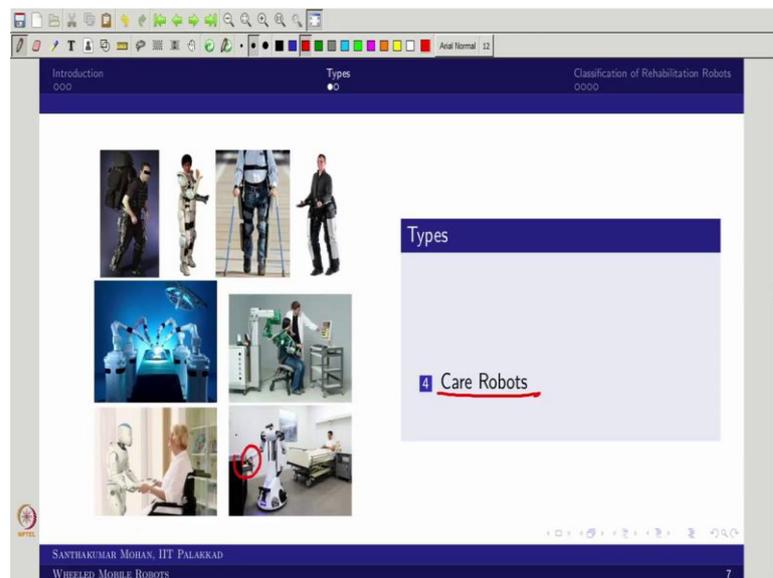


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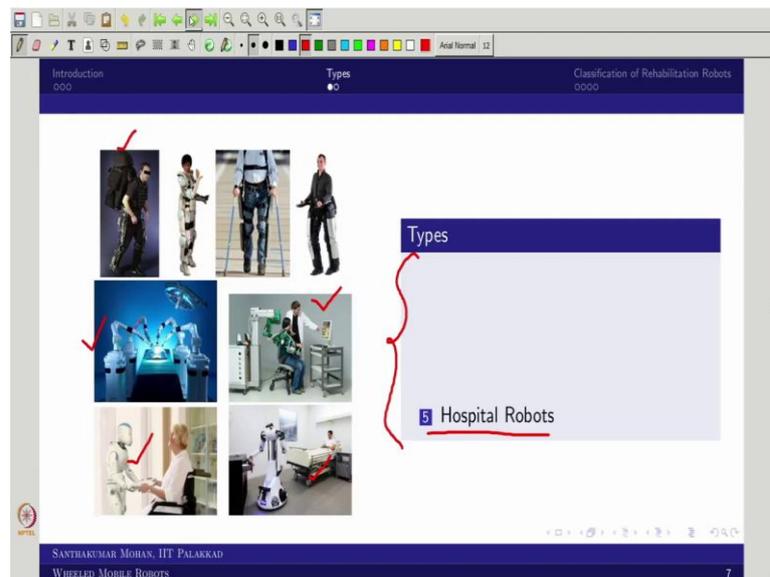
So, probably one another thing is actually like exoskeleton where you can use as a assistive or just for power for example, carrying more load, you can actually like use it or you can actually like use it for therapeutical for example, this is the you call physiotherapical robot or even that can be emotional therapy.

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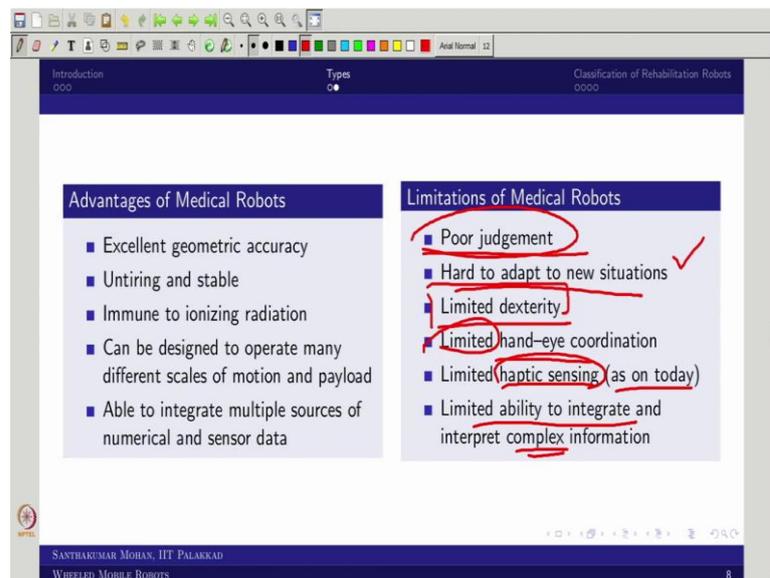
Or simple you call the care robots or what I call the hospital robot. Now, this hospital robot, this guy is asking something, it is taking from the case and it is trying to give.

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So, in the sense, what you can see the hospital robots have come. So, now, these are the five types we have actually like brought. So, one is surgical, the other one is exoskeleton, then you call you can say rehabilitation robot, then you can see care robot and finally, hospital robot. So, these are the major type.

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So, now, in that sense so, what would be the advantage by using this medical robots? So, one is actually like you can definitely increase the accuracy and precision right. Further, what you can expect so, these all be listed here. You can see that the doctor may be tired

for example, the lecturer can be tired, but if it is a recorded and the video keep on playing, you will see that there is untiring right so, that is what you can see that untiring and it is stable all the time.

When the doctor is tired, he even actually like he can be end up with something like or you can say make mistakes right, but if it is actually like robot, it is untired and it is all the time stable. Further, what happened? It is actually like immune to the what you call radiation. For example, I am doing ultrasonic imaging for several time so, I may be actually like tend to be something like. For example, ionizing. So, these all actually like can be happen right.

But if I am actually like using a medical robot, what I can see it is actually like immune to that. Further, what you can do? You can actually like design to operate many different scale of motion. So, for example, you even you can take a nano size robot and put it in your you can say blood or mouth and it can travel and do it or it can be actually like even take care of the entire patient to change one bed to another bed probably, ICU to probably in other case it can actually like carry right so, like a nurse robot.

So, like that you can actually like do it. So, further what you can do? You can actually integrate multiple source, so, that you can actually like give a proper you can say idea about the you can say the treatment. So, in the sense, your numerical and sensor data would be process in a common venue and then, it will throw it.

So, now, imagine you are actually like going to a hospital probably, two years before you have a same issue and you have actually like keep on visiting several clinic and you are actually like getting a pile of these many files just imagine and now, the final doctor says that no, I am not the right person, can you do it, he is referring to another doctor.

So, now, when you go to the new doctor so, this doctor has to read all the two years history right. So, now, imagine if it is actually like automated with a robot where the robot is actually like keep on feeding all your data and taking it so, when this guy says that the history of the diagnosis, it gives a smart you can say image or smart you can say table so, in that sense, you can see like the overall picture of the hurdle become actually like modern you can say tool right.

So, these all can happen by integrating multiple source of you can say data. So, but definitely, there is a pro, then there would be a con right. So, that what would be the cons? So, the judgement maybe poor. The doctor can actually take a judgement on the spot, but the robot cannot do it. So, in the sense what happen? It can be done a poor judgement and hard to adapt a new situation.

For example, the ultrasonic scans ultrasonic image for a week before it says something, even a day before it says something, but the day when we are operating, there would be something else. So, then it cannot easily adapt, but the doctor can easily adapt right. So, that is what actually like you can see.

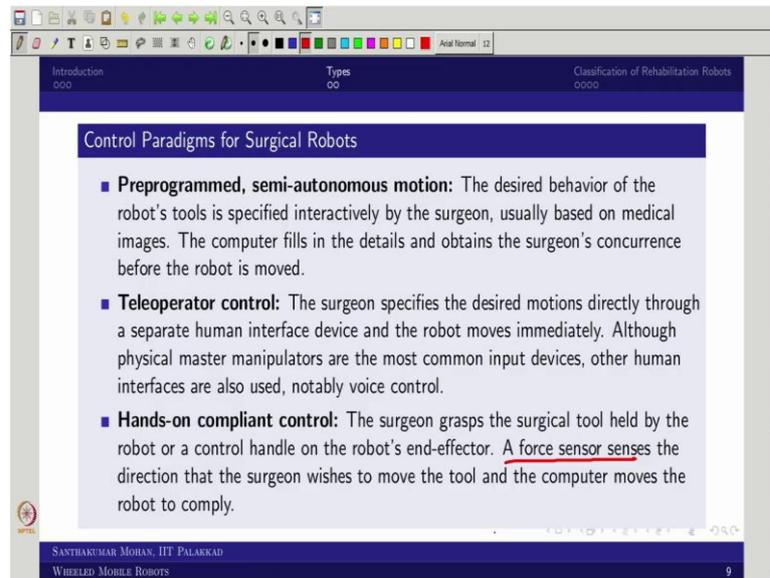
And final, you can see the flexibility. The limited flexibility is available in the you call medical robot where the doctor would be having further dexterity. In the sense, you can actually like manoeuvre, but you want to give that manoeuvrability to the robot, then you have to actually like play lots of investment.

So, final, you can see hand-eye coordination can be done. So, the doctor can do the treatment like this with the hand-eye coordination, but the robot means it has to supposed to be communicate properly. So, in the sense, I can see limited. So, finally, the haptic sensing in the sense, I can touch the skin and see what kind of nature of the skin, it is a rough or soft.

I can actually like play according to my you can say scissor or the scissel, but the you can say robot will not know, it is actually a soft skin or hard skin by measuring something only it can get. In the sense, limited haptic sensing as on today it is not there, but it can come up.

So, finally, you can see that limited ability to integrate and interpret the complex information. For example, I am actually like giving a CT scan and MRI scan so, immediately I cannot process. Even the doctor will not able to process immediately right. So, in the sense, this is all actually like complex. So, that is what we are seeing it. So, now, in that sense, we have seen what is medical robot. So, we will see further end.

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So, what that in the sense, what is the control paradigm for the surgical robot people usually uses? You have seen probably in this firm, you have seen some control strategy right, the same way here also you can see. So, one is actually like tele operation where actually like you would be used as a master slave, the master would be doctor and the slave would be the machine so, this is one option.

So, the other one is actually like you share and the final one you make it autonomous right, but autonomous we are not going to do. So, what we used to do? The preprogrammed and semi-autonomous and you can actually like use it actually second thing is teleoperator, the third one is actually like final which is autonomous.

But when you talk about semi-autonomous, what you can see? The doctor would be actually like interactively with the tool in the sense that doctor and the tool would be specifically interacted, but it is actually like preprogrammed motion, but you would be interact only certain manner.

For example, it is actually like cutting the skin that we will not interpret, but while cutting there is something, then I can stop ok. In the sense, what happen? The motion is preprogrammed, but I can stop, or I can actually like monitor. For example, if you take a laparoscopy so, the doctor would be actually like a give a preprogrammed motion and he will go back and see the image, or you can say the computer window and see that the machine is actually like doing proper or not.

If he feel, he can actually stop or he can actually like manoeuvre. So, that is what we call semi-autonomous. Whereas the teleoperator in the sense, you would be actually like interface all the time only thing it is a master slave kind of thing where you would be actually like moving something and that would be actually like move according to that the robot also will move.

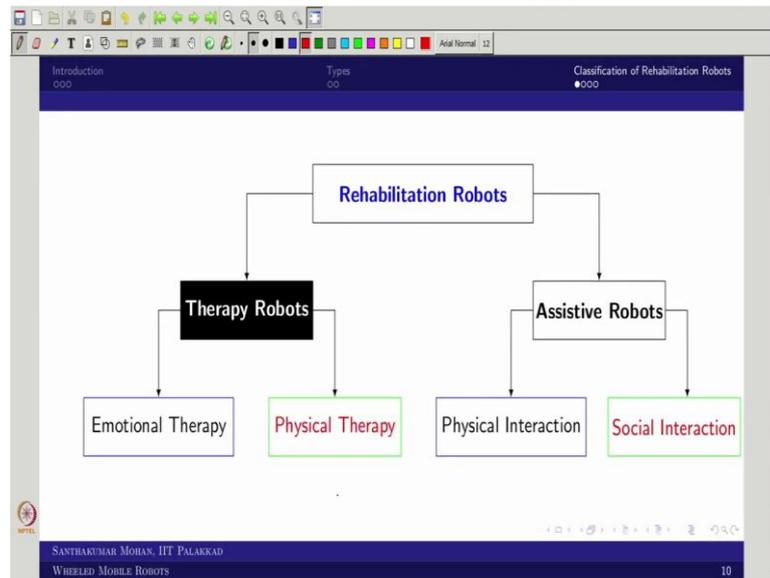
So, the last one what we are actually like seeing that hands on compliant control, which is actually like close to autonomous, but it is not. So, it is actually a compliant where the surgeon grasps the surgical tool, and it would be playing which is something like I wearable and then do it ok.

So, I just wear that total set up and do it in the sense, you see that device is actually like one part of me, but whereas, in the pre programmed in the sense that is actually like away where the teleoperate, it is a master slave, but the hands on compliant is actually like where you connected together.

Then, what we say? There is the semi-autonomous to autonomous, it is not yet achieved in what you call in the surgical robot ok. So, that is what we need to know. So, then you can see that the sensor will always sense and give the surgeon and the surgeon also wishes which tool to move or what way we can move it. So, when it is actually like moving, it will give a additional you can say flexibility because he is actually like having the compliant control.

For example, now I touch this pen, I can see that the feel of the pen right. So, now you can see this pen is actually like going in and out because there is a you can say suspension inside. So, that kind of actually like the sensing would provide by the wearable compliant control that is what the overall idea.

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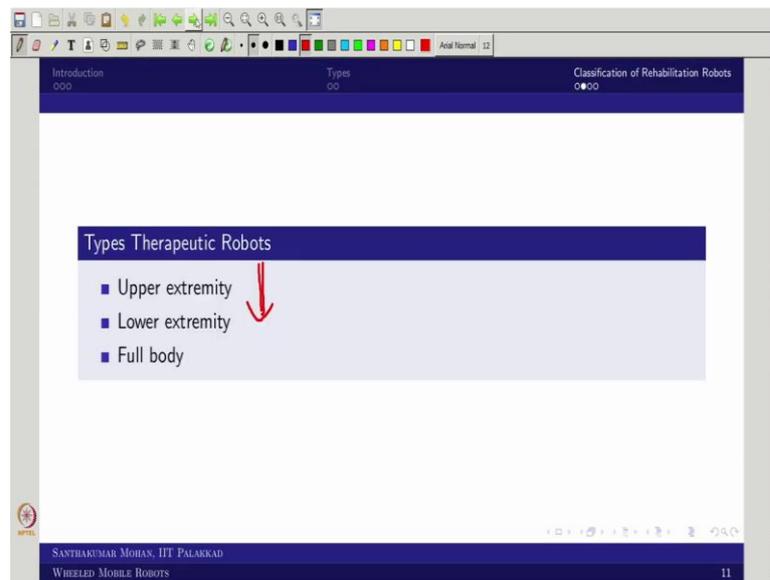


So, now we will actually like move further. We talk about the rehabilitation, the rehabilitation is neural or physical anything right. The neural is actually like one side we call emotional so, the other one is actually like physical, but apart from this rehabilitation robot classified into two things so, one is what you call therapeutical robot, the other one you call assistive robot. So, that is what we are actually like trying to see.

So, you can see like this is a therapeutical robot. So, the other side is actually like a assistive robot. This assistive robot further it can be classified into two so, where it is actually likely assisting the physical motion or just interacting the social. So, in the sense you can see the social interaction is one subclass and you call the other one is actually like physical infraction.

So, whereas, the therapeutical robot also classified one is emotional therapy so, the other one is physical therapy.

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The physical therapy further classify into what you call the lower extremity or upper extremity or full body treatment. So, what that mean? The therapeutical robot required to move you can say certain, you can say limbs. So, why this therapeutical robot is very important or why this rehabilitation robots is important in very general? So, you imagine, you just imagine so, after 40 or 50 year so, your limbs are actually like weak.

So, you need to actually like give some kind of you can say routine task in order to increase your you can say limb strength. So, for that what we used to do? We used to go to a rehabilitation clinic usually, the physiotherapist will do. So, now, when you are doing the physiotherapy, the physiotherapy will take for example, I am assuming at your leg so, you will lift the leg and do the therapeutical motion ok.

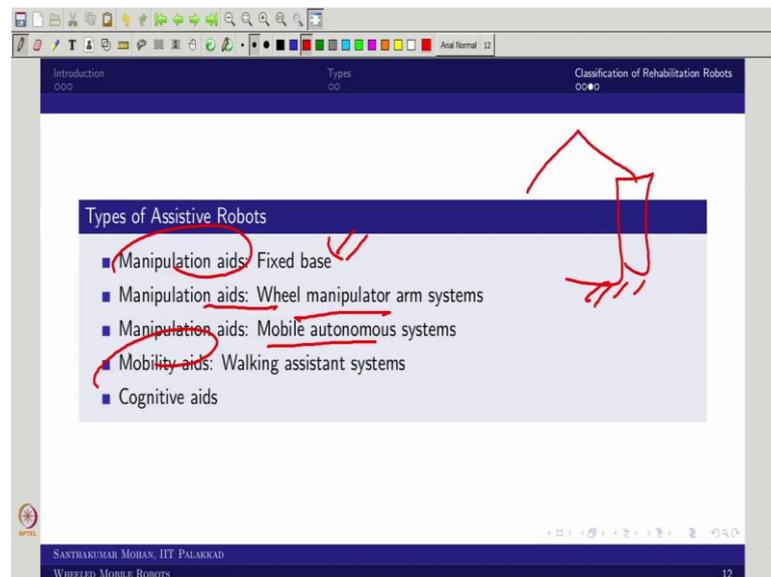
So, now, imagine the therapeutical treatment for example, it takes 20 minutes so, this therapist or you can say the physiotherapy is doing for 20 odd patients, how much time he is actually like taking? How much load he is end up? It is the really fatigue task right. Can we employ some machines to do this? This is one side.

So, the other side is somehow the gait of the patients is actually like missed, we need to regain so, we put it in a treadmill and that time you can see that there are three or four you can say physical physically the people involve and try to do the gait regaining. So, these all actually like a tremendous, you can say laborious work and huge task force is required.

So, instead of that, can we deploy some kind of robots? So, that is what the whole idea for bringing this rehabilitation for therapeutical side where the assistive side for example, the activity for daily life so, for example, I need to pick the bottle so, the patient is actually like probably you can say that he is actually like injured or he is having no leg so, he cannot actually like manoeuvre by himself.

So, then the wheelchair along with something like a manipulator arm can actually like move and do it on behalf of him. So, in that sense, you can see like the robot can actually like do it I just show it I just show.

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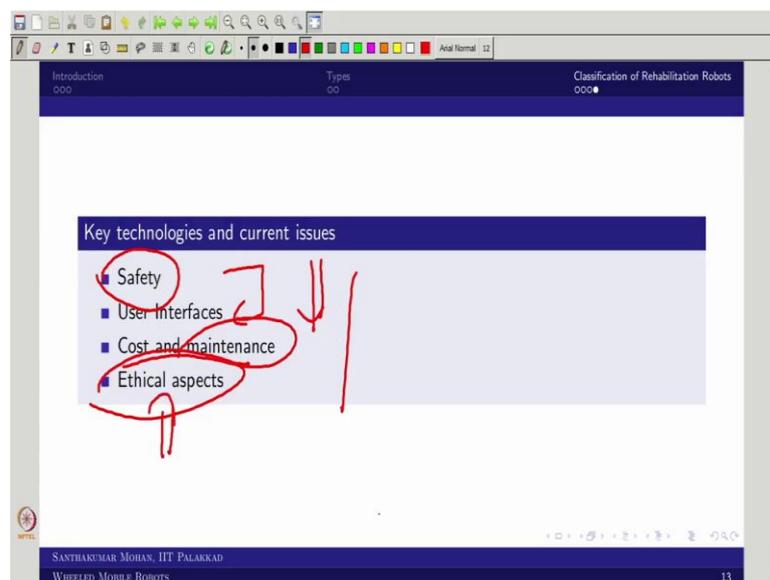
So, you would have seen in the beginning slide so, you can actually like see that the therapeutical robot or the assistive robot can do it. So, in that assistive robot, what would be the further classification? The manipulation aid can be with fixed base where there would be manipulator that would be doing it, but on the fixed base or the manipulation aid with something like mobility.

So, then that is actually like wheel manipulator arm system for example, wheel chair with manipulator arm or the otherwise, you can actually like make a mobile autonomous system for example, you are sitting on the sofa, the robot will actually like go to the kitchen and pick the bottle or pick the water can and bring it and give it to you. So, these all actually like will give some kind of manipulation aid.

Whereas the mobility aid for example, the wheelchair system or probably the exoskeleton all actually like can give the mobility aid. So, what would be the other aid? The cognitive aid. So, you can actually like get gain your cognitiveness, so, you can actually like make it.

For example, you can see that the hearing device that is actually like one kind of cognitive aid, but that is not robot, I am saying like for example, you want to actually like make your brain movement, can actually like bring it in that way? So, these all actually like you can see some kind of assistive robot side.

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So, what would be the overall picture here? So, there would be some technology which are actually like required and issues also associated. So, what the issue associated in the healthcare system? The safety is the prime most so, that supposed to be ensure and when we are talking about the safety, the user interface supposed to be easy.

For example, I am actually like taking into a case so, I am giving this particular system to a probably one of the you can say elderly patient, so, he is supposed to able to interface that, user interface supposed to be easy, and second thing is the maintenance also supposed to be very easy. So, in the sense, what you can see? The cost and maintenance is one additional factor which is actually like making the current scenario is not implementable to all.

For example, the surgical robot although I said the multi-speciality hospital is having it, but not all the individual hospital is having the surgical robot right. Why? Because the cost of the robot is very high so, the multi-speciality hospital can afford, but normal hospital cannot afford, but when you are thinking about this, you have to think about that ease of maintenance.

Very simple example, it is not connection with healthcare, but it is connected to something close to this when I was doing something related to agriculture robot so, I visited few of the farmer you can say field so, they were saying that sir; sir, definitely your robots will work, but how long? So, for example, you are giving a robot with electrical motor, suddenly if it get failed so, who will be the responsible to repair it.

So, if I am sending the robot to back to the service provider, it may actually like you can say make my system idle. So, then I understood so, if the system is actually like something like you can say tiller, the tiller is actually or probably tractor if it fail so, they can take it to any garage and they can; they can get it repaired.

But now, if I make a agriculture robot which is actually like probably failed in one of the communication model or something like a motor model so, I cannot make it. So, then we brought some solution so, we make it everything as a compartment wise. So, what that mean? So, the motor would be one compartment that would be plug and play.

So, the communication model is actual like similar compartment wise plug and play if we are actually like you can say delivering some agriculture robot to any of the you can say farm so, what we do we always give some kind of substitute for that. For example, if I have 2 motor, I would be giving 4 motors to that.

So, one communication model, 2 communication model. In that sense, if something goes so, this particular farmer itself he can actually like you can say pluck it out and plug in again. So, then he can see that which model is actually fail so, that particular model alone he will send it to the customer service center, but meantime his stuff will not actually like make it.

Further, what you can see the overall system is actually like ease of maintenance because it is plug and play right. So, if it is something goes wrong, he can actually like plug in

out and then, actually like plug in other system. So, in the sense, you can see like the maintenance side or the service side is taken care by the other side.

So, similar way if you are doing it you can say medical robot so, that also like you can take it into consideration where ease of maintenance or less maintenance so, that need to be care. Further, I already discuss in the modern, you can say robotics the robotic challenge the ethical aspect we have to bring. So, these all actually like one particular aspect.

So, now you know like what is medical robot or what is healthcare robot and what are the challenges, how they have actually like come from so on so to so on so, in the sense, from the simple assistive or auxiliary robot to surgical robot and you got all the idea what are the classifications and all.

So, with that, we are ending this particular lecture and see you some time in the life ok.

Thank you, bye.