Introduction to Industry 4.0 and Industrial Internet of Things

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Lecture - 65
Steel Technology Lab

So, right now we are in the friction stir welding facility of the department of mechanical engineering at IIT Kharagpur. So, I have with me over here the lead of this particular lab Professor S.K. Pal. So, here actually what we intend to do is to show you the use of cyber physical systems, the concept of cyber physical systems and IIOT over here. So, these are as we have seen in the previous lectures that these are prime contributors to the development of industry 4.0 concepts. So, I have with me Professor S.K. Pal who is going to explain how this kind of friction stir welding is cyber physical system whats impacted?.

So, just you give you a recap of how a cyber physical system works. So, we have the physical system; that means, the machine which is actually performing the work and the cyber component so, working hand in hand. So, we have different sensors that are equipped with this particular machine that we are going to show you now and then these sensors they collect lot of data and based on that there is some actuation that is performed and also consequently some kind of control.

So, we have the sensing component, the computing component and the contour component all working hand in hand. So, this is what the cyber physical system is and this friction stir welding machine is a good example of this particular system the cyber physical system. So, these are actually prime contributors to the industry 4.0 development.

So, Professor Pal would you please explain over here how this friction stir welding process works.

Yeah, thank you. Thank you Professor Mishra. So, friction stir welding is a solid state joining process. So, it means it is the most advanced you know the joining technique and you know it is quite different from this the fusion welding process because in case of fusion welding we melt

the material and then after that it gets you know the after solidification you gets the joint and all. So, I quickly explain, what I mean what is the process about (Refer Time: 02:23).

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So, if you would like to ah; let us take an example if these two plates have to be joined. So, they are placed side by side in an arc welding configuration and we make use of this the tool, tool has got a projected part which is called the pin and the flat part which is called the shoulder ok.

So, that the tool rotates and plunges into this the joining line until and unless this flat part touches on the top surface of the tool ok. So, this; there is a friction between the platform of the tool and the job surface that is why the term is the friction is there, friction is (Refer Time: 3:00) generation of the heat and there is a plastic deformation because of the movement of the pin so that material from one side gets moved to the other one so, that is the starting operation so, that is why the second name is there.

And since there is a relative movement so, that the joining is taken place. So, when the tool comes up it leaves a hole over there. So, the advantage of this process as I mentioned that there is no melting so, it is a solid joining process. So, a lot of industries have you know they come forward and they have already started using it you know for different applications if you could look at this board.

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So, there are applications like this apple, you know the computer they have (Refer Time: 03:41) the front part as well as the you know the back part by the friction welding process. We have got the example of these high speed railway carriages, we have got also the example of the space shuttle ah, but all these you know the examples what we see is that from the you know the industries which are Abroad which are outside. There is no Indian industry so far you know that use this process, but there there is a recent announcement by the chairman of the ISRO Dr. Sivan told in the last you know satellite launching, that they are going to use this process to a large extent so that there is increase in the payload.

What (Refer Time: 04:21).

Yeah. So, the most you know the beautiful example of this process is that you know this automobile industry, because there we need to always think for this light weighting. So, light weighting means that you know the situation comes for the different (Refer Time: 04:38) material welding

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We have got several examples like aluminium and then steel we have got the material you know the one different composites in LAP and (Refer Time: 04:47), you have got the magnesium and then steel, we have also used this HDPE that high density polyethylene, copper and aluminium, and also different configurations including this you know the pipe holding.

So, we have exposed you know all this process, but you know each and every industry these days is looking for these you know the compliance of the missing towards the industry 4.0. So, for this compliance the main thing is that as you mentioned that the sensor, sensor we can engage different types of the sensor which collects the data and then we can work on that. But essentially based on these you know the sensors information and your analysis analytics you have to control the process and so, the feedback loop is very much important over here.

So, we have you know the come up with a the module for this you know this online control, online monitoring and then analysis and then control everything is done on the cloud based. So, in this particular machine we have engaged you know the two types of the sensor; one is inbuilt that is the node sensor so, node sensor senses the you know the course information. Because if during welding if any defect comes up, so that will be reflection on the signature of this you know the force.

And this (Refer Time: 6:12)force data is sent to the cloud similarly, we have also acquired the power sensor, power is a direct and the power it has got the direct indication about the defects. And also not only that the defects you know we basically mean the type of the defects and also the severity of the defects. So, depending on the that you know the different varieties of the defect the signature gets changed and also the severity of the defect the signature gets changed.

So, we collected you know the you know the more of all these informations and then we have send it to the cloud, in the cloud we have got the decision you know the box is an engine. So,

So, basically the analytics is performed at the cloud.

Analytics is performed at the cloud, you are absolutely right and then based on the decision and then you know which is taken in the cloud out of the knowledge box is there. So, data is that information is information comes from the cloud to the machine, you change the parameter; parameter means the welding parameter, the rotational speed and also the linear speed so that (Refer Time: 07:14).

Basically, the accuracy of the job can be controlled with a help of this entire play back cycle.

Yeah, exactly because you know for any manufacturing the process or any if you like to study the performance of the product and the quality of the product, you always need to study the performance of the machine ok. Even though you are setting the optimum parameter, you know that you are not you are bound to get the true quality, but essentially you know you wont get it. So, you always need to look at the weld quality or the you know the product of the of any process and accordingly you have to change the parameter so, that in terms of essentially in the product.

So, that is the that is the essence of this industry 4.0. So, we have implemented that one to friction stir welding process which you have you know the we are also working on that in a large extent. So, that different machines can be connected to the cloud so, the knowledge of one machines can also be thus shared with the other machine; just like the human being you know interacting with social media and in the society.

And that physically solves also the purpose of industry 4.0.

Yeah.

We need to have connectivity between the different processes

Yeah, because when you say the industry 4.0 you essentially means that you know the performance of the different types of these you know that the machines and also how do we interact with the other machine, and also the supply chain line; that means, how the you know in this sequence the materialis coming up and going out so with the entire change starting from the include the raw material supply to the finished product. You have to think when it is connect connected with you know the cyber system then that would connect me to cyber systems and the physical system, and that essentially is very good for industry 4.0 compact to the process.

So, thank you so much can we have a look at the.

Yes I will request one of my doctors, scholars Mister Devashish Mishra. So, Devashish Mishra works on this you know industry 4.0 process analysis.

Yeah.

So, he is Mister Devashish Mishra, he will quickly run you know this the machine and we demonstrate that the welding process, all the in you know it will it will show the defects and then essentially over the period of the time how the defects get (Refer Time: 9:36). Because when you see the joining process, it means the assembly of the different components and which might be a process to the other you know the manufacturing technique. So, the quality you know the check on a on online basis is very very important otherwise can be the rejection of that entire thing.

So, I will Devashish coulkd you please quickly switch on the machine and then demonstrate the process.

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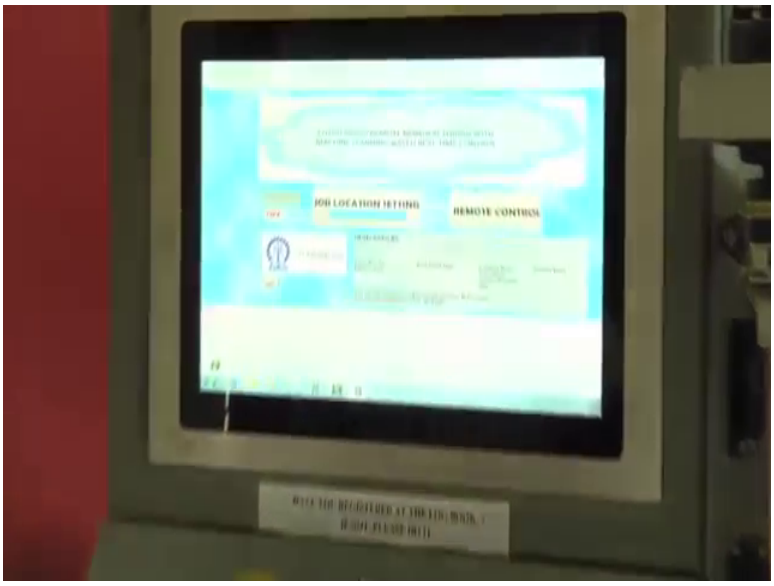

And would like to show it; please show the how bad qualities will getting changed and coming up with a good one.

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So, behind me what you see over here is a is an indigenous friction stir welding machine which can do friction stir welding on two different materials. So, this particular machine is able to do linear jobs; that means, that two different materials it can weld together in a linear fashion. So, I

have with me Mister Devashish Mishra, who have been the scholar in this particular department and he is going to explain to you how this particular machine works. But before that let me just tell you that what is the whole purpose of showing this particular machine here.

So, we have studied about cyber physical systems and industrial IOT. So, this is a this is a good example of how cyber physical systems work. So, as I told you before that there is a cyber component and the physical component of these systems which work hand in hand . So, we have different sensors which basically sends different parameters as Mister Mishra will be explaining shortly.

So, the sensor parameters will be taken and then some computation that is that is done and based on the computation getting some control that is also implemented on this particular system. So, the sensing component the computing and the control working together hand in hand, this is how this particular system works so, this is a good example of a cyber physical system in action. And these types of systems are very much important for industrial environments in the industry 4.0 scenarios. So, Mister Mishra /could you please explain the functionality of this particular machine.

Yes sir. So, this is manufactured by (Refer Time: 11:46) private limited and it is a three axis friction stir welder. So, as you told it has the capability to join dissimilar materials with similar materials. It has got a maximum rotational speed of 200 rpm and the maximum (Refer Time: 11:59) 1000 (Refer Time: 12:03) per minute. And with this machine we have inbuilt load cells of 10 kilo newton 10 kilo newton capacity inch.

So, this gives us the force section to direction as well as (Refer Time: 12:12) utilization. And apart from that, we have the speed sensors which senses the rotational speed of the machine doing the welding (Refer Time: 12:18) and the covers (Refer Time: 12:19).

So, apart from this rotational speed and travel speed we have two different parameters as well. We till (Refer Time: 12:26)concept, however in this machine we cannot controlled the real time. Now, what .

So, where are these sensors?

Real time monitoring (Refer Time: 12:35) and controlled video of this path, so we have here two aluminum plates which are being placed very close to each other without maintaining any gap between them. And this is the tool which is going to weld these two materials.

So, we have two materials which are aluminium and this particular tool is a steel tool.

Yeah, this a H 1 tool.

Ok.

Which has a (Refer Time: 12:55).

Ok.

Which has been fabricated as per of the dimension of the workpiece

Ok.

So, the thickness of this material is 2.5 mm. So, we have a pin which is of length 2.2 mm and this is the pin diameter is 5 mm and we have this shoulder of 30 mm diameter

Ok. Can we see how it works? .

Yes. Actually this is the GY (Refer Time: 13:27) ; so I am going to switch on the machine (Refer Time: 13:32).

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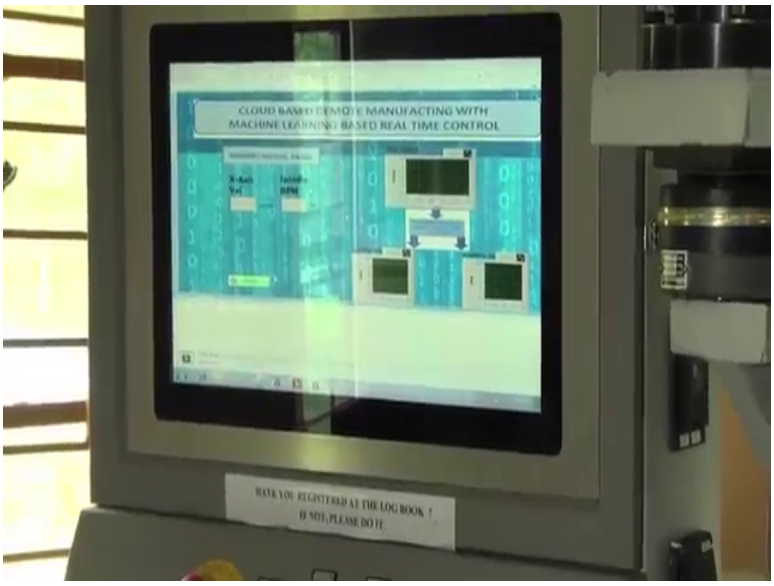

And this is the remote controlled panel I am going to turn up the security. Then (Refer Time: 13:52) this is a remote control

This is the (Refer Time: 13:57) you can remotely.

Access the machine (Refer Time: 13:59).

You can control the machine also remotely.

Yes sir. So, here initially we have set the rotational speed and power speed in such a way, that they are bound to get some (Refer Time: 14:57).

Here, what you see is a vertical milling machine the conventional, traditional, vertical, milling machine. Milling machine as you know are used for smoothing of some metal sheets. And this particular milling machine is something that has been transformed to a friction stir welding machine with the help of different technologies, which will be explained by Mister Mahathva who is a PhD scholar in this particular lab. So, Mister Mahathva could you please explain, how this particular machine works.

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This is the vertical manual milling machine and this machine has got wide range of this spindle speed and this machine has got wide machine or t able as well. And this table can carry the weight up to the 600 kg and the spindle rpm can be up to 31.5 rpm to 6 1800 rpm. And on the same time this table can move along x axis, y axis, z axis (Refer Time: 16:17) 16 (Refer Time: 16:19) per minute (Refer Time: 16:20) to 1600 minute (Refer Time: 16:22).

So, with the help of this (Refer Time: 16:26) spindle speed and the rate at which speed and its high weight carrying capacity. This machine can be used for the of friction stir welding of similar and dissimilar material and so far we have converted this machine as a manual FSW machine and we have performed FSW on aluminium sheet and also on aluminium sheet dissimilar (Refer Time: 16:55) aluminium sheet and for monitoring the welding process we have inter related thid machine with the same sensor.

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Such as the piezoelectric dynamometer has been installed with this spindles by using this piezoelectric dynamometer during the welding the forces acting on the (Refer Time: 17:14) movement. We can one monitor and on the same time we have also integrated other sensors such as or thermo buffersto (Refer Time: 17.26) the wielding and the heat input. And by using the power sensor we can a measure the power the electric power consumed by this machine.

So, with the help of these data such as the single flow stir welding heat input and electric path and electric path (Refer Time: 17:48) this machine can monitor given a quality. However, since this is not a CNC controlled machine control machine. So, this whole data can be used after welding piezoelectric dynamometer has been connected with a charge amplifier and this inside the piezoelectric dynamometer few piezoelectric crystals are there.

So whenever the spindle is experiencing some sort of the force; electric volt is getting generated on those piezoelectric crystal and by using sensors we are that voltage we are recorded by using our computer.

Thank you.