Sensors and Actuators
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Lecture - 22

Hello, this is Lab number 8 and what we will be teaching you the demonstration of Peristaltic Pump using Arduino. What exactly is a peristaltic pump? When you look at a drug delivery module or you want to flow the media, there are several kinds of pumps; one pump is called a syringe pump where you use a syringe and whatever the media is there in the syringe, as soon as the media is over you need to refill that syringe. But in the case of a peristaltic pump you have a reservoir, you have an inlet and you have an outlet, so you can use it as a continuous closed-loop system.

What is that mean, that if you have the microfluidic chip, in the inlet of the microfluidic chip you can connect the outlet of the peristaltic pump, from the outlet of the microfluidic chip you can connect the inlet of the peristaltic pump. And be very careful what I am saying, you have a microfluidic chip, microfluidic chip has an inlet and an outlet. The inlet of the microfluidic chip should be connected with the outlet of the peristaltic pump and the outlet of the microfluidic chip should be connected to the inlet of the peristaltic pump.

If my reservoir which is within the peristaltic pump has a media, then I can flow the media through the outlet to the inlet of the microfluidic chip, it will flow through it and from the outlet, media will come back to the inlet of the peristaltic pump. How can we run this peristaltic pump? how can you control the peristaltic pump, because the peristaltic pump can be used to control from 0.1 microlitres per minute to several microlitres per minute or in fact, in some cases few ml plus per minute.

Now, this is an extremely important pump because we can mimic the in vivo situation whereas in some of the cases your drug will diffuse into your tumor tissue at a rate of 0.1 to 1 micrometer per second. How can you exactly replicate that kind of environment in the in vitro laboratory testing? For example, during drug screening, you want to flow the drug with 1 microlitre per

second, and for that, you can use a syringe pump or you can use the peristaltic pump. But as I said if you want to flow it for 48 hours, you might have to refill the media in the syringe.

You cannot have a closed-loop in that case while in the peristaltic pump, you can have a closed-loop system. That is the advantage of it and can be used for a lot of applications including immunotherapy. Just focus on that particular aspect and I will see you before the next lab class, bye.

Welcome to the Sensors and Actuators course, in today's session we will be discussing an actuator that is called a peristaltic pump. So what are pumps? Pumps are devices or actuators that are used to move a fluid from one point to another. The different types of pumps may be centrifugal pumps, peristaltic pumps etcetera. We will be showing a demo of one of them.

The pumps can be classified into different categories such as a positive displacement pump and centrifugal pumps. A peristaltic pump is a type of a positive displacement pump. You must have discussed the negative and positive displacement pumps as well as centrifugal pumps in the previous lectures by the professor. I will be showing the demonstration of peristaltic pump, which is a positive displacement pump.

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On the screen, you can see two pumps, one 12-volt peristaltic pump and another costly peristaltic pump for the microfluidic application. You must have seen this kind of peristaltic pump as a part of the lab videos. These peristaltic pumps are positive displacement pumps and they are used for very precise applications especially in micro fluidics, drug delivery and other things where the flow has to be controlled very accurately.

We have a bigger peristaltic pump which comes costly, but at the same time, they can regulate the flow in the rates of milliliter per hour and also; which is kind of where a minute volume of fluid that is being pushed and this is a higher volume displaced as well as 12 volt motor.

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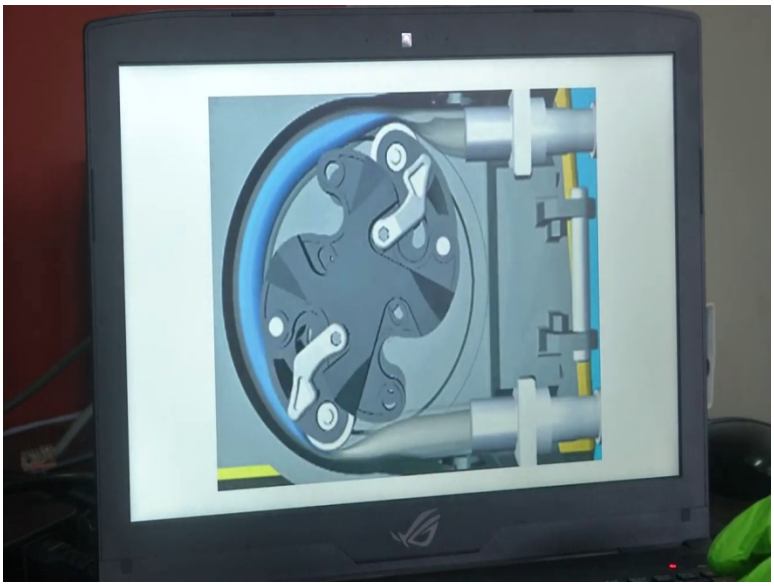

Now, I will show you how a peristaltic pump works. you can see here in a GIF image that the fluid will come through a port. What we have is a rotating a roller kind of thing and in that rotating a roller itself we have some small different wide rollers.

There is a casing of the motor or the peristaltic pump and there is a flexible tube. The water or any fluid that is to be pumped will be coming over there. And what happens is, when the roller rotates, it pushes the fluid within the tube between the wall and the roller and push it to the other end. This is a positive displacement pump; that means that the fluid will move only in one direction.

This flow process is called the peristalsis, it is present even in human bodies.

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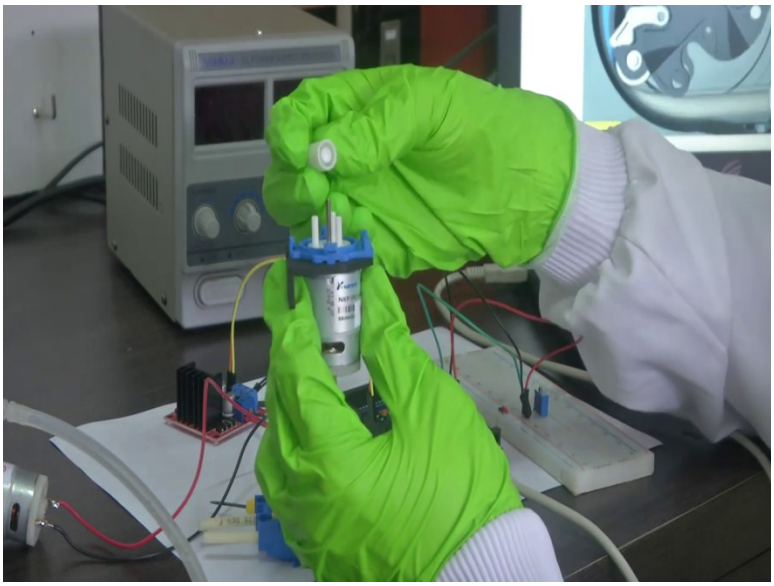

I have a peristaltic pump, like what you saw in the image previously. This is a small 12 volt peristaltic pump, I will open it up and show you how it looks like from inside. This is the flexible tube that we talked about. This will be compressed, if we give the input fluid it will be sucked and pushed in and the output will come through another tube using nothing but just a DC motor here.

The DC motor rotates that roller that I have shown here. You can see the rollers and the tube and there is a casing between which the tube will be pressed. This is a different model for the rollers. I am just putting the thing over the roller and if we give power supply to the motor, this roller unit will start to rotate.

Now, the tube that is going to come over here will be compressed, it has deformed, but it will still work. This is the internal construction of a peristaltic pump composed of a DC motor, but with a different construction, a flexible tube and outer casing to hold the flexible tube and the rollers attached to the DC motor.

Now I will demonstrate how you are going to use the peristaltic pump. As I already said, peristaltic pump is nothing, but a DC motor when it comes to it is working principle. We will be

using the same circuit and code that we used previously for the DC motor. I will be showing the demo with that code as well as circuit.

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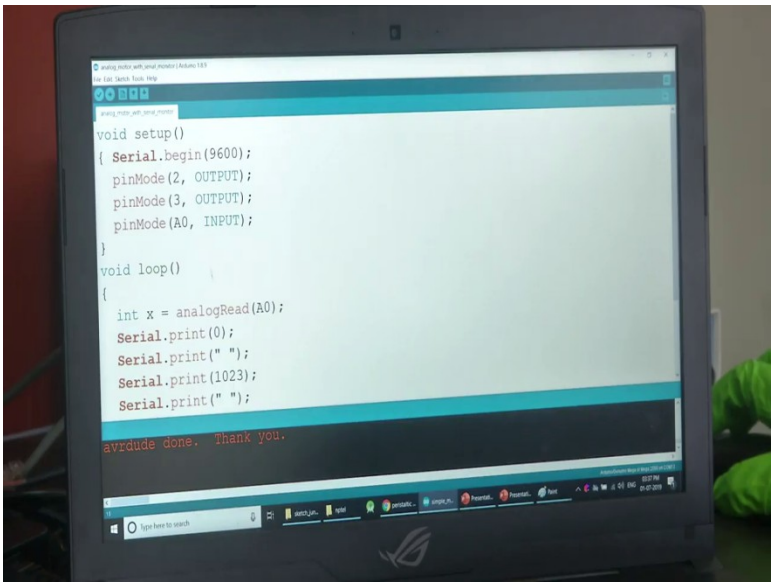

You may remember this Arduino code. It is the same code that we used for the motor. I have used the serial communication, then pin number 2 and 3 are connected to the motor driver, over here it is the pump that is being connected to the motor driver now and I have connected a potentiometer to the analog pin A0.

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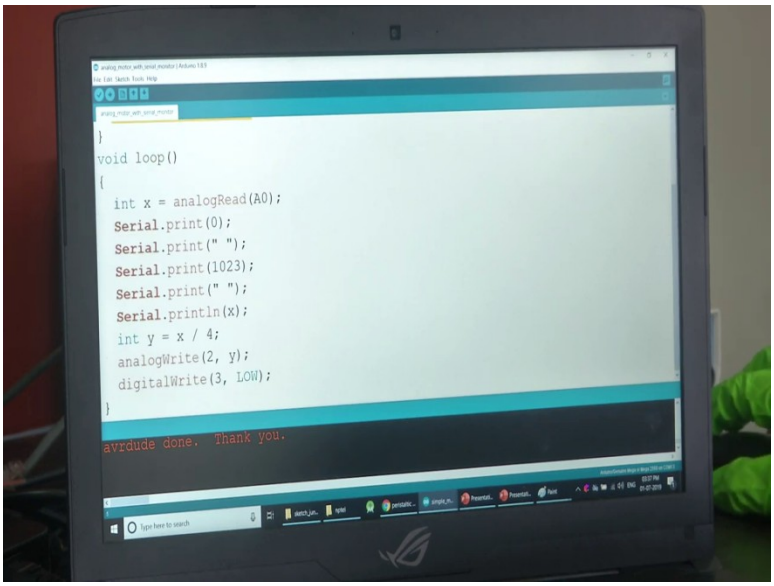

The same process in which we took the analog value from the potentiometer and printed it. On the serial plot plotter the value y will be stored with the value of x / 4. We can adjust the range from one 0 to 10232, 0 to 255 then using the analogWrite (2, y), I am controlling the speed of the pump and here it is ground, in other terminal of the pump.

By adjusting the potentiometer, we will be able to adjust the flow rate. Now we will see this circuit at once.

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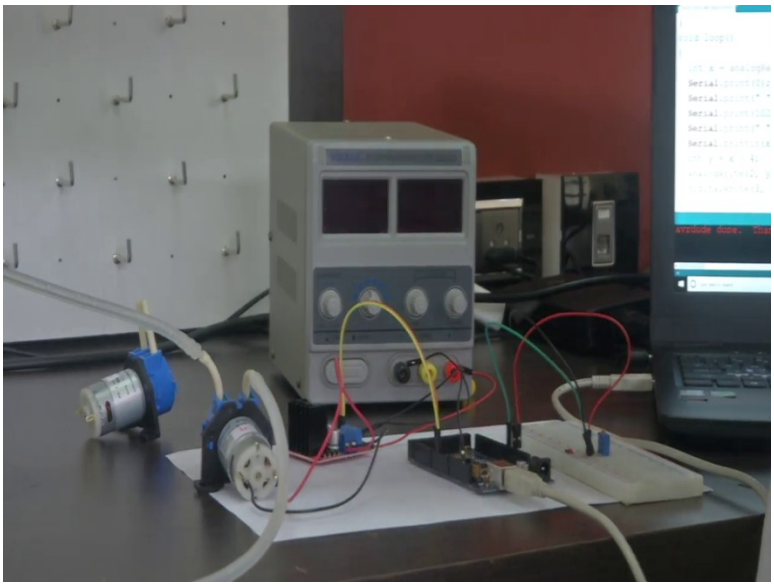

as we can see it is the same circuit that we used previously. I have the mega board, I have the potentiometer connected, I have the motor driver l 2 9 8 10 and the peristaltic pump I showed to you. And then here is a peristaltic pump that is connected to the circuit in the same way as the motor driver was, the motor was connected to it. There is a DC motor in the peristaltic pump, and the tubes.

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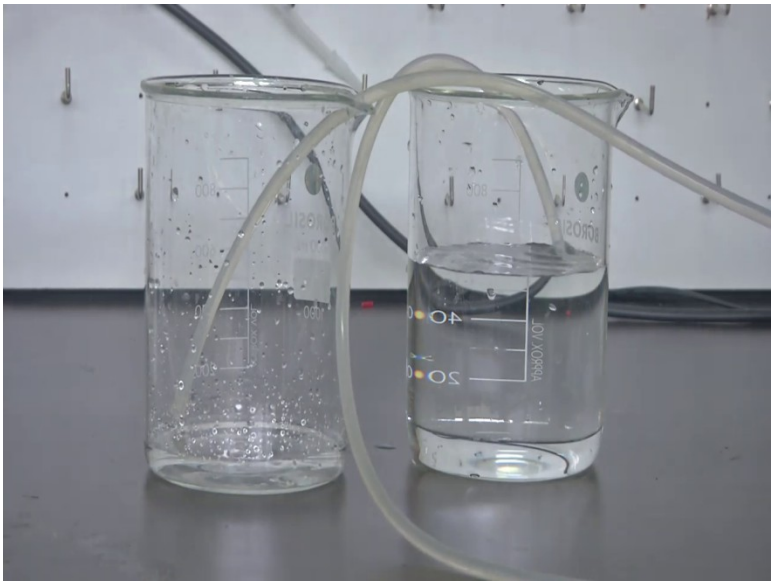

You can see that the tube here; one of the tubes is going to this empty vessel and the other one is going to a vessel with the water. I am going to switch on the DC power supply. Since I have already uploaded the code, you can see that the pump is starting to operate and pumping the water.

We can see that water is not falling continuously, it is falling in and not continuously, but at discrete intervals; this is because you must be remembering that the peristaltic pump is not continuously pushing water. It will push water in the tube for a while and then the roller will lose the contact and it is kind of pulsating and not continuous.

This is one of the pumps that we use very commonly, mainly because of the fact, that it is very accurate and consistent. You can see that the water level is increasing. and if I switch those cables now, you can see that no longer water is coming, because the motor or the pump is pumping water in the opposite direction, but you can see bubbles. The peristaltic pump can even pump air because it is just a positive displacement pump.

The peristaltic pump since it is a positive displacement, it is self-priming. But in case of a centrifugal pump, you have to prime it before use.

Thank you.