Embedded System Design with ARM
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Lecture – 38
Accelerometer

Welcome to week-8. This is the final week for the course Embedded System Design with ARM. In this week, we will be discussing about Accelerometer and some of the experiments that we can do with this device. So, essentially in the first lecture which is this lecture, lecture-38, I will be discussing about accelerometer what it is and what is the principle operation of this accelerometer.

Then in the subsequent next two lectures, I will first discuss that how we can interface an accelerometer with STM board. And how we can receive the data, this is the first thing that I will show. And then I will show you some experiment where the orientation of the device we will find out, what is the orientation of the device, whether the device is lying flat or it is vertically up or it is vertically down etcetera, etcetera. So, these are the few things that we will be looking into with respect to accelerometer. And there is one more thing that we will look into in this week is with gas sensor an experiment with a gas sensor.

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So, let me talk about this accelerometer. In this particular lecture, I will be discussing the principle of operation of accelerometer. And the accelerometer that I will be discussing the features of the accelerometer that I will be discussing is ADXL 335 accelerometer.

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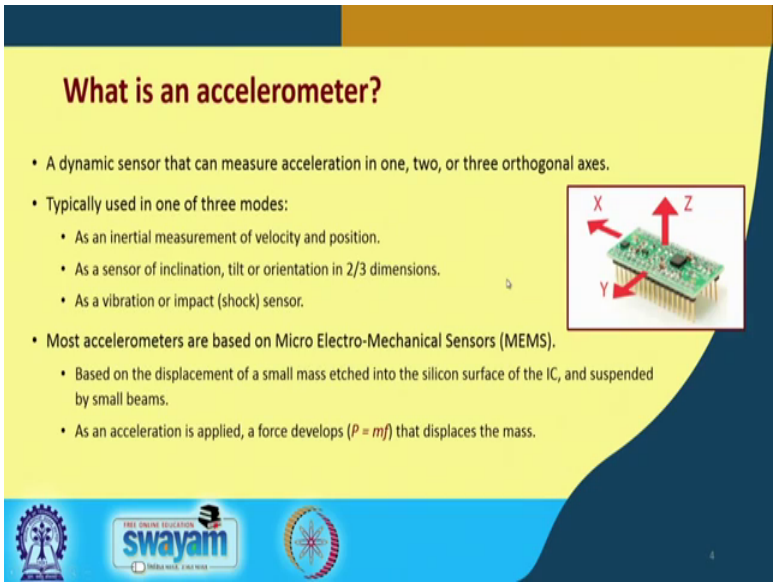

So, what is an accelerometer? It is defined as a dynamic sensor that can measure acceleration in one, two, or three orthogonal axes that is X, Y and Z. And typically it is used in one of the three modes. It can be used as an inertial measurement of velocity and position. It can be also used as a sensor of inclination, tilt, or orientation in 2 to 3 dimensions, or it can also used as a vibration or impact sensor, shock sensor that we see.

Most of these accelerometers that are developed the devices that are developed are based on Micro Electro Mechanical Sensors called MEMS. So, it is based on this technology. And this is based on displacement of a small mass that is etched into the silicon surface of the IC, and suspended by small beams. So, we will look into further when we display the working principle when we show the diagram, it will be more clear. So, as an acceleration is applied, a force is developed. We know that P equals to mass into acceleration that displaces the mass. So, this is the general concept of acceleration.

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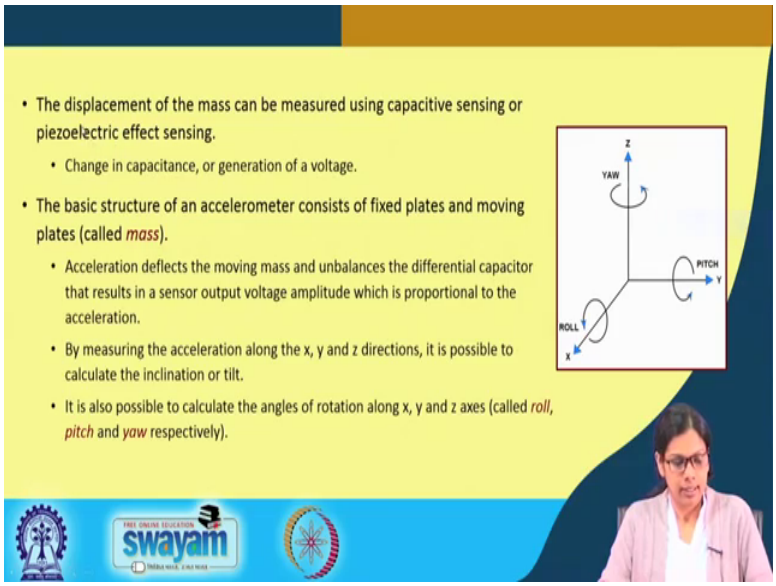

The displacement of the mass can be measured using capacitive sensing or piezoelectric effect sensing. So, these displacement of this mass when it is moved from one point to another, it can be measured using either capacitive sensing or through piezoelectric effect sensing. So, what it happens basically there is a change in capacitance or there is a generation of voltage through which it is measured. The basic structure of the accelerometer consist of a fixed plate and a moving plate. And the acceleration deflects the moving mass and unbalances the differential capacitor that results in a sensor output voltage amplitude which is proportional to the acceleration.

What does it mean basically there is a moving mass ok. So, this when acceleration we some acceleration is made then this deflects the moving mass and unbalances the differential capacitor ok. So, then the in the two parts we will see that the moving mass in one part, it will come to the other side and the other part it will come little more to the other side. So, there is an imbalance in the mass. So, by measuring the acceleration along the x, y and z direction, it is possible to calculate the inclination or the tilt.

So, how much it is tilted we can accurately find out using the accelerometer. So, this can be done by measuring the acceleration along the x, y and z direction. It is also possible to calculate the angles of rotation along x, y and z axes which is called if it is along x axis, it is called a roll; if it is along y axis, it is called the pitch; and if it is z axis, it is the yaw ok.

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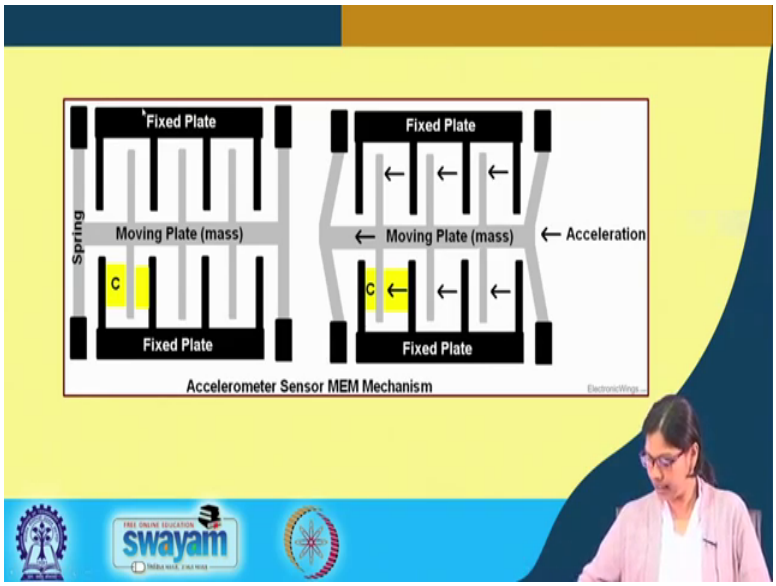

Now, this is like this. Here we have these fixed plates ok. So, here if you see we have fixed plate this one and this one, and this here we have the moving mass. And you see that whenever there is an acceleration this changes, so this particular yellow thing which is there it changes ok. So, based on which we can accurately find out whether it is tilted more towards x direction, or y, or z direction ok. So, this is the accelerometer sensor with MEMS mechanism.

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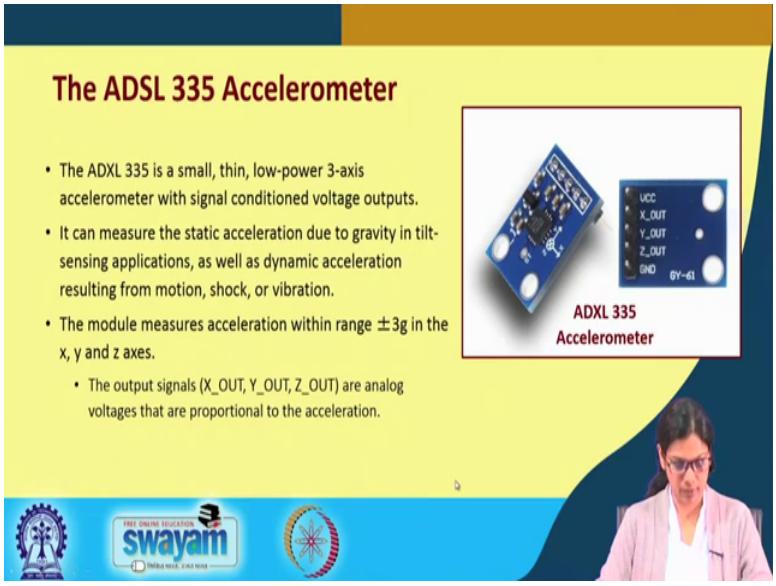

Now, the accelerometer that we will be using in this experiment is ADXL 335 accelerometer, where you can see that these are the pins of this accelerometer basically. You have this V CC; we have this ground; and we have x, y and z coordinate. So, this is from the other side and this is from the other one. So, this arrow shows the x axis, this arrow shows the y direction, and this one is the z one, z direction.

So, the ADXL 355 is a small, thin, and low-power 3-axis accelerometer with signal condition voltage output. What it can do basically it can measure the static acceleration due to gravity in tilt sensing applications as well as dynamic acceleration resulting from motion, shock or vibration ok, this we already discussed. So, this accelerometer can will be able to access I mean we can get the acceleration using this accelerometer due to gravity for applications as well as for dynamic acceleration resulting for motion shock and vibration. This module measures acceleration within the range of plus minus 3g in the x, y and z axes.

When we connect this with STM, we will be seeing that we are mostly concerned about this X OUT, Y OUT, and Z OUT. So, what essentially we have to do here when we will connect we will be connecting these X OUT, Y OUT, and Z OUT to the analog port. So, the output signals of these are nothing but some analog signals. So, this has some analog voltages that are proportional to the acceleration.

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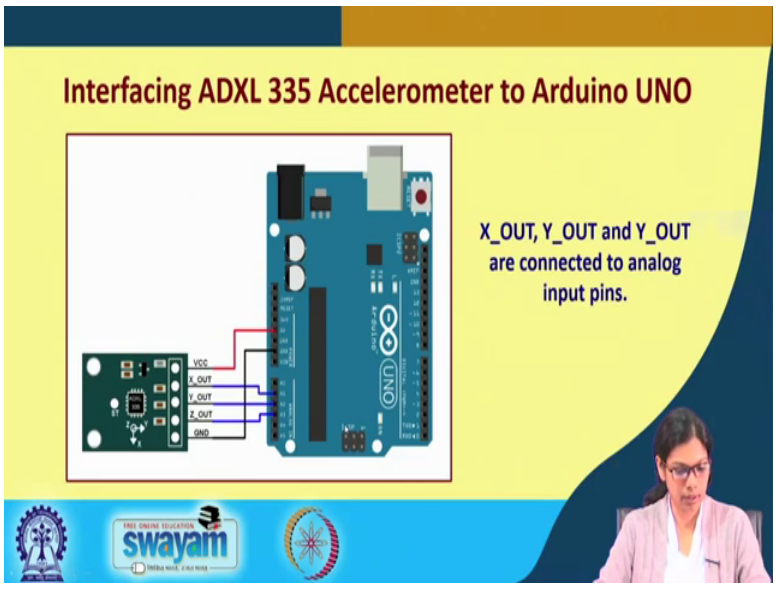

Now, the interfacing if you see which is fairly very straightforward. We have shown it using Arduino. We have done the experiment using STM when we show you next. So, this is where it is connected to V cc, this is connected to ground. And this x, y, and z is connected to pin a 1, a 2, a 3 depending on where you can it you can also connect to a 0, a 1, and a 2. So, this is a very straightforward connection diagram that we have.

So, X OUT, Y OUT and sorry this will be X OUT, Y OUT, and Z OUT are connected to the analog input pins ok. So, this is all about this device accelerometer. So, next we will look into how we can connect this accelerometer with STM board. We have already shown you the connection. So, how we can connect this and we will see that what value changes what we get, what kind of values we receive from this accelerometer from the x axis, y axis and z axis. So, we will look into that in the next lecture.

Thank you.