Embedded System Design with ARM
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Lecture – 26
Experiment with LDR Light Sensor (Part I)

Welcome to lecture 26. In this lecture we will be interfacing LDR with the STM board. LDR is Light Dependent Resistor ok. So, we will be first looking into what is LDR. When you connect an LDR what all things you should take into consideration? And of course, the circuit diagram to perform the experiment with LDR, the first experiment we will be doing two experiment first experiment with LDR I will show the circuit diagram and I will discuss the code, and finally I will demonstrate it ok.

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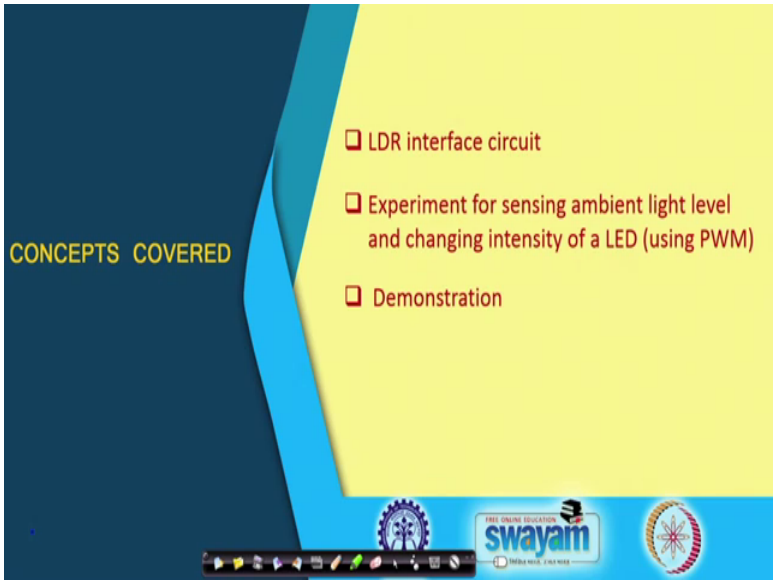

So as I said, we will discuss the LDR interfacing circuit. In this experiment we will be sensing the ambient light level. And, we will change the intensity through PWM port of an LED and we will show the demonstration.

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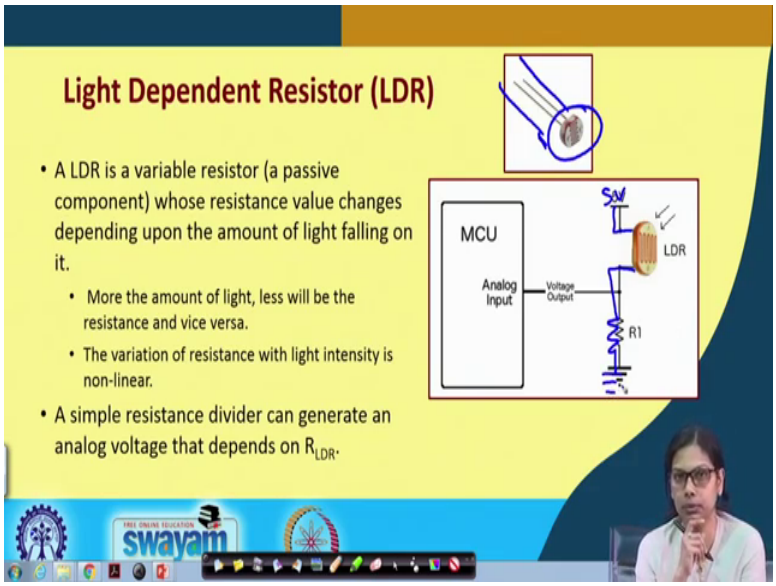

Firstly, coming to what is light dependent resistor. It is a variable resistor which is a passive component, whose resistant value changes depending upon the amount of light falling on it. So, whenever light falls on it, its resistant value changes how it changes? More the amount of light less will be the resistance and vice versa. So, if the light is more light falls into the device, then its resistance decreases, and if less light falls on it; that means, if it is dark, then the resistance value will be high.

The variation of this resistance with light intensity is non-linear like for LM 35 we have seen that with 10 milli volt chains there is a degree centigrade increase in temperature. So, there was a linear change here that is not there ok. So, the variation of the resistance with light intensity is not linear. A simple resistance divider can generate an analog voltage that depends on the resistance of this LDR. So, this is a typical diagram this is an LDR how it looks like when we do the experiment we will show you in more detail. This is an LDR and you see that one port is connected with 5 volt another port through a resistance is connected to ground ok.

So, I repeat one; one point of the LDR is connected to 5 volt, another point is connected through a resistance to ground and the voltage output from where we are taking is from here. Here, we are connecting to the analog input this is how the connection goes.

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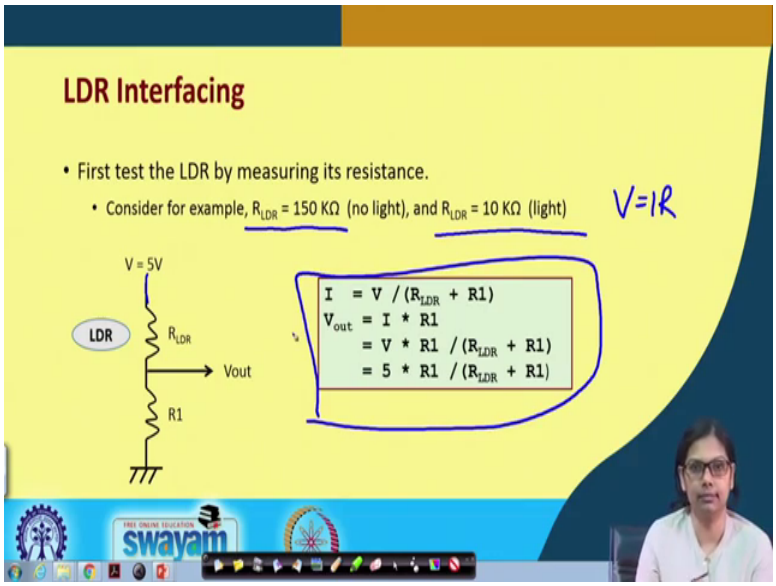

Now, let us see this LDR interfacing. We need to first test the LDR by measuring its resistance. See in this room there is an ambient light maybe in other room the intensity of this light might be different right. So, depending on that at what value this earlier will change its state or LDR will work upon depending on the application we are thinking of, it is dependent on all these parameters.

So, you see this. So, we consider this, the resistance of LDR when there is no light is 150 kilo ohm and when there is light it is 10 kilo ohm let us say this is what we are getting. But you have to take this and take the reading using a multimeter, and then only you can do this experiment. Let us say we have taken and we got a value in this range.

Now, from 5 volt this is the LDR which is connected one end of it, and then resistance R 1 it is connected through ground and from here we are getting the out. So, what will be the current flowing through it current will be V equals to I R, I will be V divided by R. So, V divided by resistance of this LDR plus R 1 what will be V out here? V out here will be I into this particular resistance what is I? I we have already calculated V divided by R LDR plus R 1 and this is multiplied with R 1 ok. So, if V is 5 volt then it is 5 multiplied by R 1 divided by R LDR plus R 1 ok.

Now, based on this particular condition we will be looking into what kind of values will be how do we choose this particular R 1 depending on the previous calculation that we have already made.

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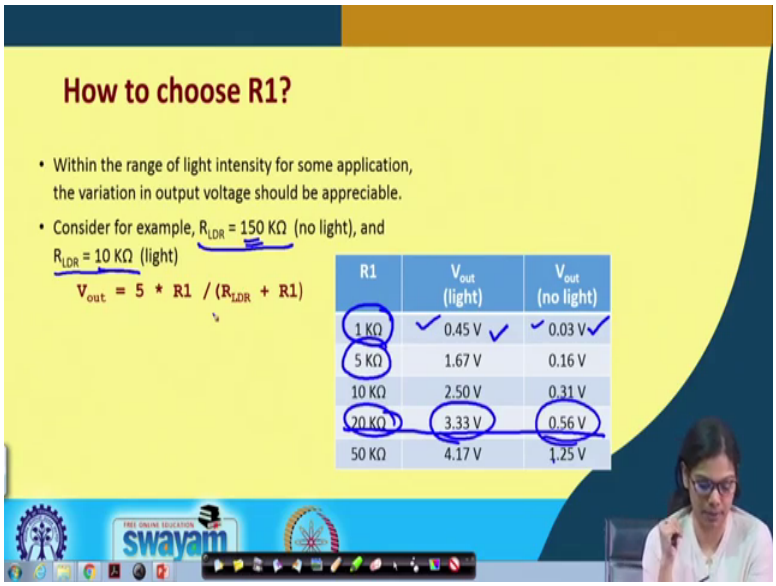

So, within the range of light intensity for some application the variation in output voltage should be appreciable, because I want that variation should be more ok. When there is light and when there is no light we need to choose that R 1 in such a fashion that that is quite visible ok.

So, consider for example, this r consider for this example let us say R LDR resistance of this LDR is 150 kilo ohm and R LDR 10 kilo ohm when there is light and when there is no light 150 kilo ohm. And we put it in this particular formula to calculate V out for light and V out for no light when R 1 is 1 kilo ohm. So, R 1 we already know then R 1 for light. So, with 10 kilo ohm we got this value and V out with no light with this particular kilo ohm as R LDR we get this value ok.

So, depending on that you can actually calculate for 5 kilo ohm as well which is coming down to 1.67 volt and for no light it is coming to 0.16 volt. So, you can actually work out for all the values. By putting the value of R 1 as 1 kilo ohm here and R LDR when there is light 10 kilo ohm, and when there is no light 150 kilo ohm, and you find out what value you are getting for this V out. You see that for twenty kilo ohm the range is it is 3.33 and this is 0.56 which is considerable. Because when it is 50 kilo ohm it is 4, but it is also becoming 1.25 ok.

So, how do you choose this value of R 1 is somewhat important? Please take this into consideration and you can do this calculation by using a multimeter to read the value of

this R 1 and LDR value depending on light and no light and then you can work out this example.

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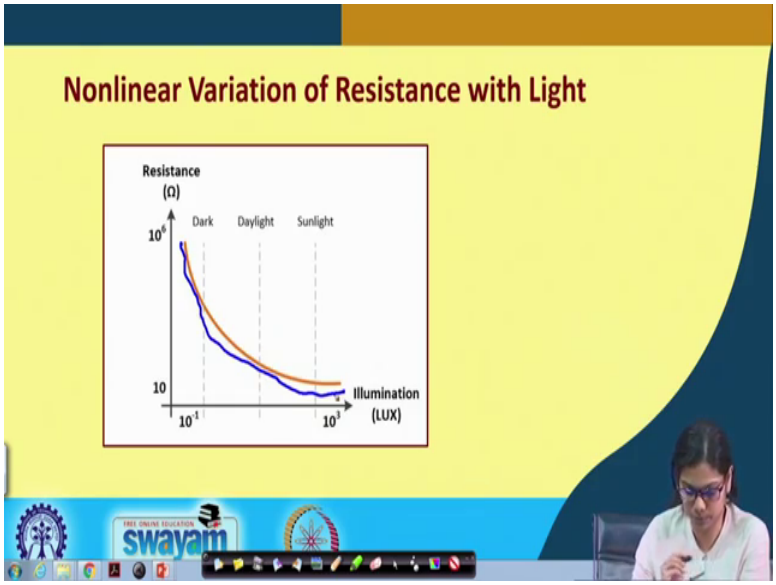

So, if you see the non-linear variation of the resistance with light. So, when it is dark its resistance is high, and when it is dark its resistance is high, and slowly its resistance decreases when there is light the resistance is low.

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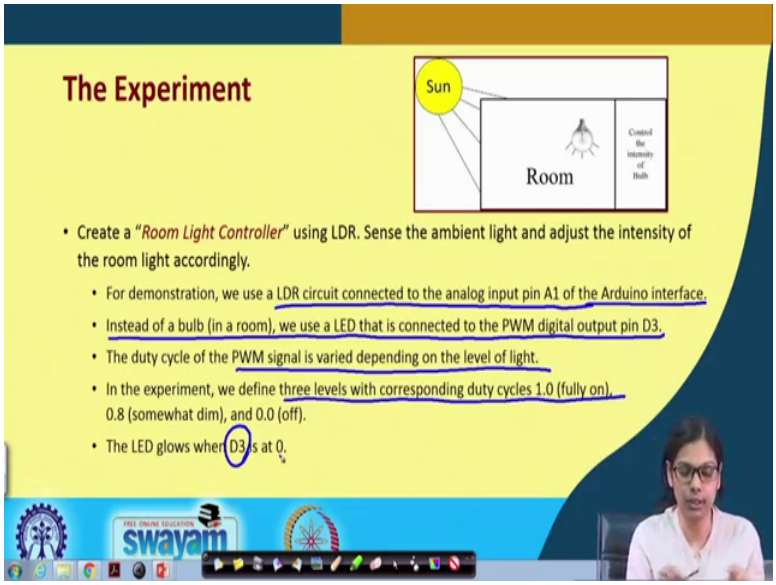

So, the experiment that we will be doing today is we will create a room light controller using LDR. And will sense the ambient light and adjust the intensity of the room light

accordingly. So, how do you simulate here? For simulation purpose we have just use an LDR. We have used an external LDR that will be connecting with this STM board and depending on the ambient light the LED will glow fully or if the light is little bit if the light is very bright, then the LED will not glow and if the light is little bright the LED will glow, but very lightly and there is no light then the LED will glow ok.

So, let us see for demonstration what we have done basically? We use an LDR circuit connected to the analog input pin A 1. So, instead of a bulb as I said we are using an LED that is connected to the PWM digital output pin D 2. We have already discussed specifically what is PWM pin, what are the functions that are attached to the PWM pin what we can do through that PWM pin? So, in this case we will be using one of the PWM pin to glow the LED to full intensity with little less intensity and we will off it ok. The duty cycle of the PWM signal is varied depending on the level of the right depending on what level of the light we are having we will change the duty cycle.

In the experiment we defined three levels with corresponding duty cycle of 1 0.8 and off these are the three things that we have used. And the LED will glow when which is connected to D 3 port when this is 0 ok. So, we will take the experiment that we will be doing we need to take the following things into consideration.

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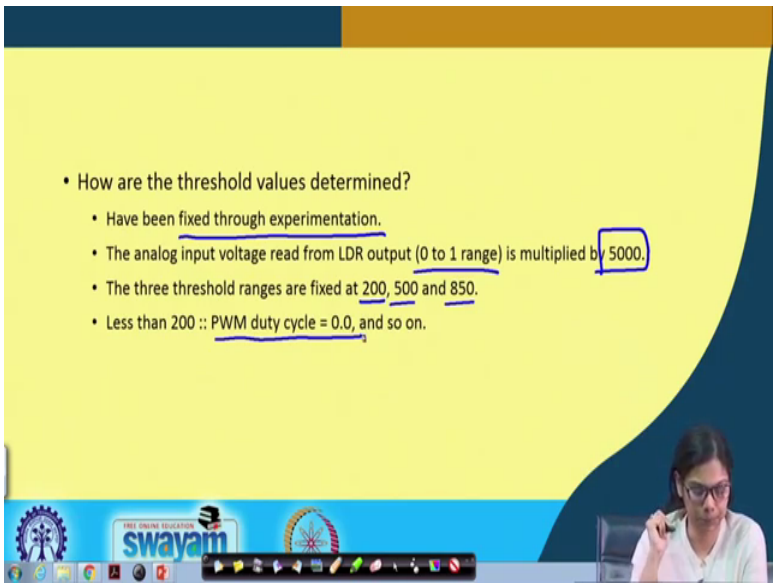

Next, how are the threshold values determined? So, the threshold values that we have determined here have been fixed through experimentation. We did quite an experiment

and we find out that, what is the best value that will help that LED to take the following things into consideration that we want it in this ambient light thing. The analog input voltage read from LDR outputs in the range of 0 to 1 which is multiplied by 5000 to make it to some point such that we can find out what is light and what is no light. The three threshold ranges are fixed at 200 500 and 850. These are the three ranges that we have kept and this less than 200 PWM duty cycle will be 0 and if it is 500 and 850 we change it accordingly ok.

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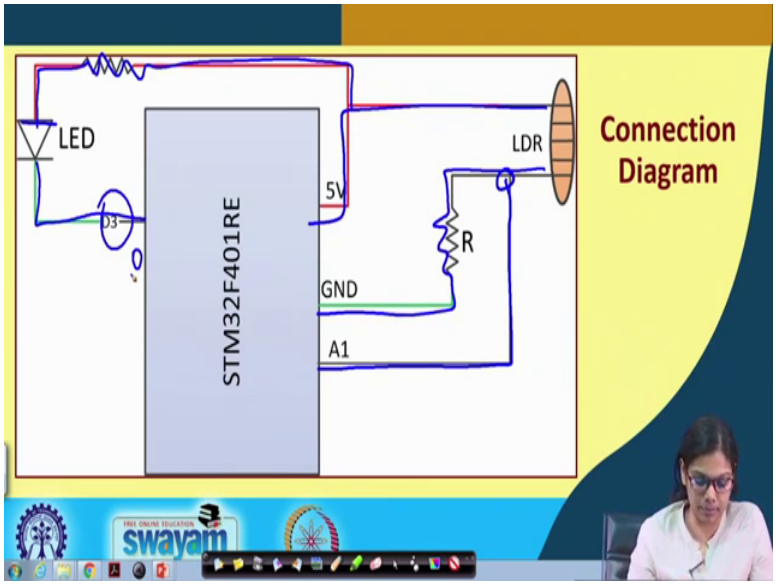

Now, this is the circuit diagram. Circuit diagram is fairly straightforward here. This is a single LDR one end of the LDR is connected to 5 volt. Another end of the LDR through a resistance is connected to ground. So, this is one end of the LDR which is connected to this 5 volt another end of the LDR through this resistance is connected to ground. And the analog value that we are taking input is from this point to put A 1 and as I said the LED that to simulate a bulb basically we are here we are using LED. So, the LED this is the anode which is connected through a resistance to 5 volt and the cathode is connected to port D 3 it is connected to D 3.

So, if this value is 0 then the LED will glow, but now, we have to see it is D 3 is the PWM pin. So, we have to make sure that it glows with full intensity or with little less intensity and it will be off ok. So, this is the circuit diagram now let us move to the code.

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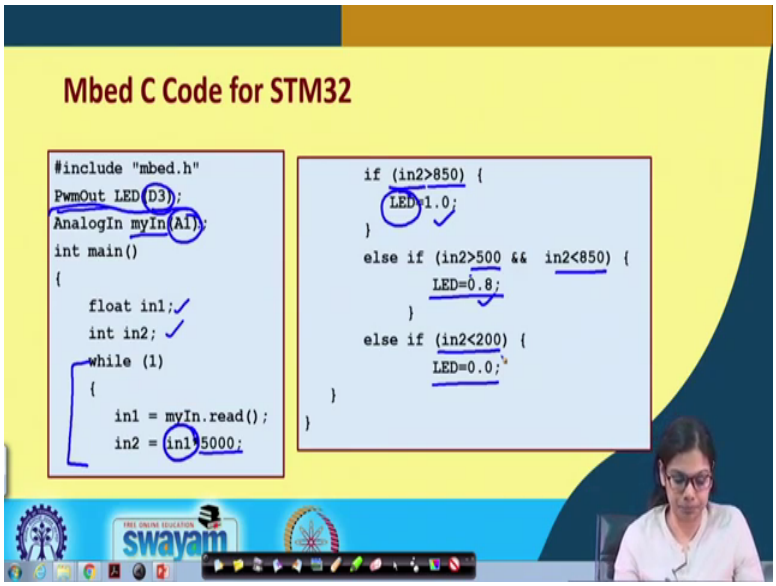

This is the code now PWM out LED D 3. So, this is connected to this LED which is not only a digital output pin we are using this pin as PWM out pin, that is why instead of just digital out we have specified PWM out LED which is this D 3 pin of the board analog in my in I have given the name which is connected to a one input of the analog port float we have taken value then an integer value.

In the while loop what we are doing? We are reading with the same function that we have read for temperature my in dot read, then I am multiplying this into 5000 and then if this value is greater than 850, then I am making that LED on if it is greater than 5000 and less than 850 then I am glowing it, but not with full intensity with zero 0.8 and if it is less than 200 I am making it off. So, these are the three levels that we have made for this LED.

What we are outputting? We are outputting to this LED which is the PWM put we are putting one fully it will glow 0.8 it will glow for 0.8 and off for two second and this will be totally off ok. So, these are the three levels that we have shown ok. So, what we will do now is that whatever I have told you I will be showing you the interfacing path. And in the interfacing path firstly, I will tell you how this LDR value changes depending on the light that we have in the ambient light depending on the ambient light ok. And depending on that, we have to make our code accordingly. So, that is the calibration you

have to do at the first step let us now look into the interfacing that is the demonstration of this experiment.

Now, I will be showing you the experiment with LDR. LDR is light dependent resistor. So, the experiment that I will be showing you today is that, depending on ambient light we will see that how we can change the intensity I mean of the light glow. Let us say when the ambient light is full the light will not glow when the ambient light is little less the light will glow, but not glow with full intensity. And when the ambient light is really very down; that means, it is dark then the light will glow to its full intensity.

So, I mean to do the experiment, we have taken an LDR and an LED. So, the LED will glow in three levels at one time it will not glow when the ambient light is high when the ambient light is little less it will glow, but it will not glow with its full intensity and when the ambient light is very less it will glow with full intensity. So, we will do that experiment. Prior to that I will be telling you about the property of this LDR; LDR is light dependent resistor. So, its resistor changes dependent on the light that I have already discussed, but I will see that with this particular ambient light that we have it in this room, what value I will be receiving it in the multimeter for this LDR and then I will make this ambient light little little dark and then what value I will receive.

So, you will understand that when you do this experiment you have to take this particular scenario into consideration ok. So, first of all I will now show you.

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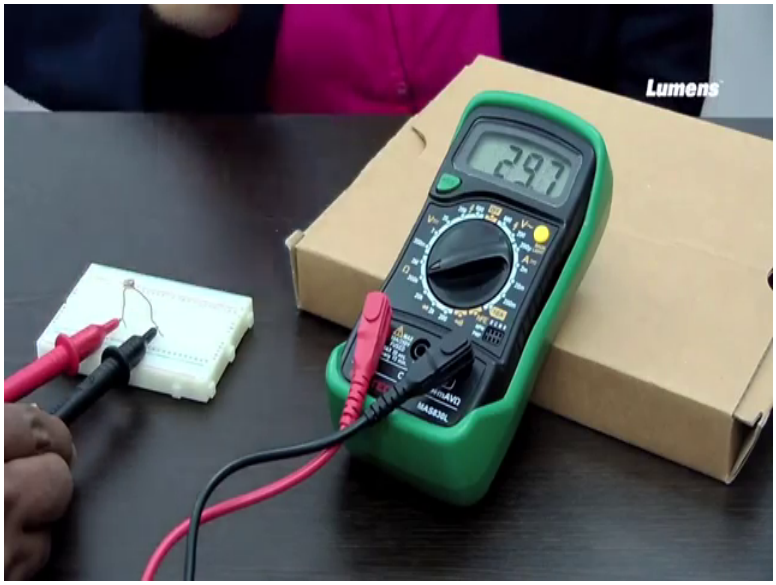

So, this is an LDR ok. So, and this is the multimeter. Now we will see that what value this will give when we connect using this particular ambient light that we have. So, let us see. So, what value it is giving? It is giving around 29 let us see and now see I will put my hand. So, I will put my hand you see that that the resistor value changes it is going up till say 130 or so, again I take out it will settle down to let us say 29 ok. So, this is dependent depending this value that we are receiving here is dependent on the ambient light ok.

Now, I will make this ambient light of this room little bit dimmer ok and now let us see what value I will be getting. Now you see that the value initially I was getting 29 when there was full light and now we are getting a value about 41 or 42 let us say 41.7 now when I put my hand there ok. So, when I put my hand the value goes up till let us say 77 100 and its a 100, it is going 115 sometime. So, this particular thing you have to incorporate in your code. So, this is how basically you have to look into it ok.

Now, again you see with the fulbright light it is coming 29.5 ok. So, this is a property of this LDR. So now, I will be showing you the experiment as I said with LDR, but one thing you have to remember that one thing you have to remember that. So, the value of this particular LDR changes dependent on the ambient light. When you incorporate your code when you try to design something with LDR, you have to take into consideration these few things ok. So, what is the ambient light and dependent on that you have to change your code or anything.

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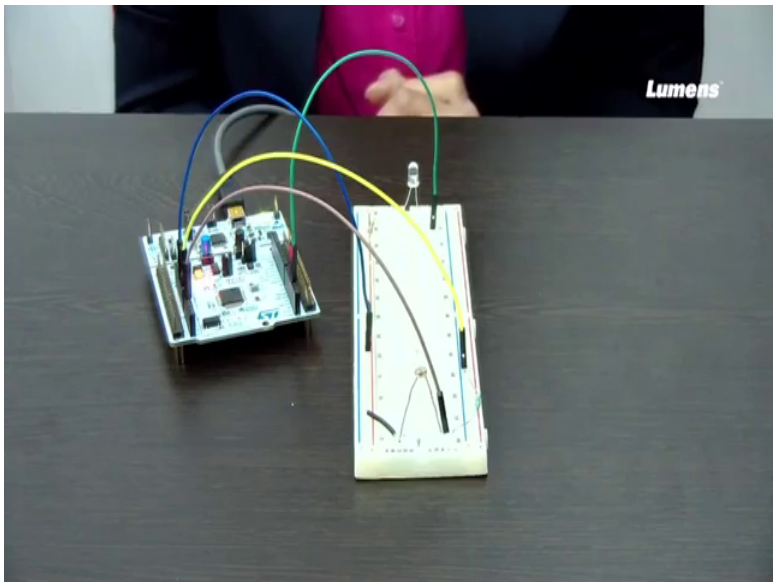

So, now I will the experiment that I will be doing is this LDR, we will be sensing saw the ambient light and depending on that if the ambient light is little dim, then the LED will glow to certain extent, but it will not glow fully. But if the ambient light is very light there is no light then the LED will glow to its fullest ok. So, I will do the connection see let us see how I make the connection this is LDR. One end of the LDR I will be connecting to bcc another end of the LDR through a resistance I will be connecting it to ground and you see from this point.

So, please understand from which point from this point, from the point where I am connecting this LDR through this resistance to ground, I will be taking from this point to the analog input ok. So, please make this connection clear two ends of the LDR one end I will be connecting it to bcc another end through a resistor I will be connecting it to ground and from this end I will be taking the input to the analog port. And this LED will is straight forward, LED we are connecting this (Refer Time: 24:02) using this resistant to bcc. So, this is connected this way and this cathode will be connected to the PWM port D 3 ok.

So, the PWM port as we already know already been discussed that what we are doing with PWM. So, we are connecting there, because we need this LED to be glow with different intensity. So, let me do the connection with STM board first. So, this as I said will be connected to A 1, this point is connected to bcc and this point will be connected

to your ground and from this point that is the cathode of this LED, we will be connecting it to the PWM D 3 port ok. So, this is all about the connection we need to do, when we do this experiment using LDR intensity; so changing the intensity changing the intensity of the light, depending on the ambient light.

So, now I will dump the code that I have already discussed with you once the connection is all right ok. So, let me dump the code now the code has been dump ok. Now see the LED LDR here is receiving full intensity. Now I will decrease the intensity little bit now see I have decreased the intensity. So, it is glowing, but it is not glowing with full intensity. When I put entirely dark when the ambient light goes down to I mean the light inside this room becomes really dark then the LED is growing in its full fledge let us see again.

Now, the LED is glowing not glowing at all now see when it glows. It glows when there is less ambient light. Now it is glowing in full fledged when the ambient light is completely very very less ok. So, this is the experiment with LDR by getting the ambient light, how do we actually switch on the light with different intensity. So, this we have simulated using this LDR. So, I just will show you once more. So, this is glowing, but not with full intensity, but you see this is glowing with intensity ok.

So, in this experiment we basically have shown you how you will connect LDR with STM board and depending on the ambient light, how you can actually do some kind of operation. I mean here we have done using this LED; we have made the LED glow with three different levels when one time when there the ambient light is full it will not glow, when the ambient light is little less it will glow, but not with full intensity and at one level when the ambient light is very less, then it will glow with full intensity.

Thank you.