Embedded System Design with ARM

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Lecture – 36
Design of Home Automation System

Welcome to lecture-36. In this lecture, I will be discussing about Design of a Home Automation System ok. So, the example that I will be taking here is I will consider a bulb, and that bulb I will switch on by sending an SMS. If I send on to the SIM associated with the bulb, and of course you have the entire system with bulb, micro controller, relay and other things, then the bulb will be on. And if I sent off to the system, then the bulb will be off ok.

Of course, we can do this using program control, but here we have done through SMS control such that we can give you a flavor of this IoT from anywhere in the world. If you can send an SMS on to this particular device, then the device will be the bulb will be on. And if you are able to send from anywhere off, it will be switched off.

First of all, I will be discussing two sets of code. One set where I can send SMS from any mobile, and it will work. And the other one is I will restrict sending SMS from some particular mobile, because of course you will not want anyone to switch on of your home bulb right. So, you want it to be done by your family members. So, you can actually integrate those numbers of your family member in a secure code, where only it will be on or off if the SMS is received from a particular mobile number. So, I will be discussing these two things in this lecture.

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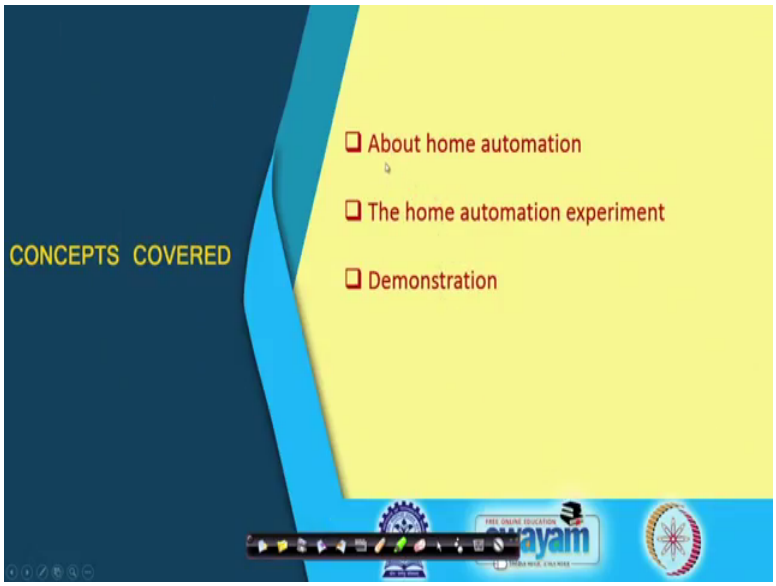

I will talk about the home automation, the experiment, and then I will demonstrate.

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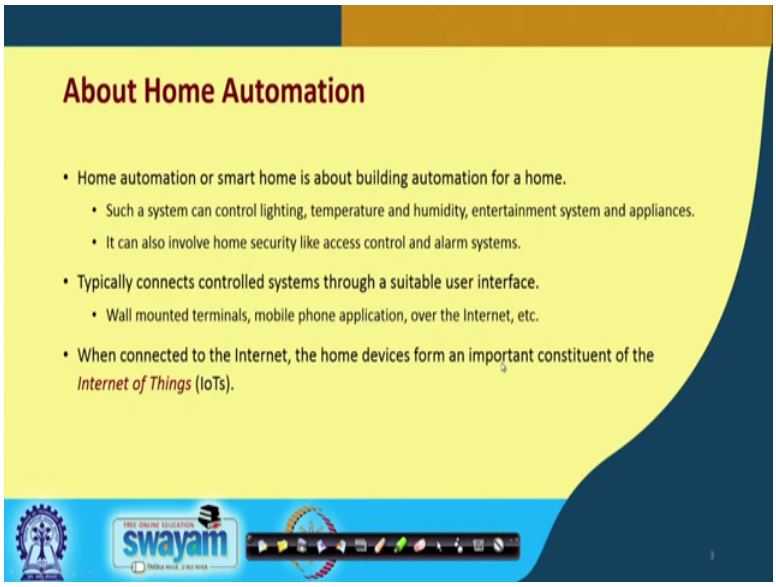

So, home automation or smart home is about building automation for a home. Of course, this is not only switching on and off bulb, there could be many more things that could be done. But, such a system can control lighting, temperature, humidity, the environment system and appliances. So, they could be many appliances in your home, which you can actually control. It can also involve home security like access control and alarm system as well.

Typically, it connects a controlled system through a suitable user interface. You can use a wall mounted terminal or a mobile phone application, over the internet. So, when connected to internet, the home devices form an important constituent of the so called internet of things ok. So, I have told you, the home automation that I will be discussing here is that I will be switching on and off a bulb through SMS control.

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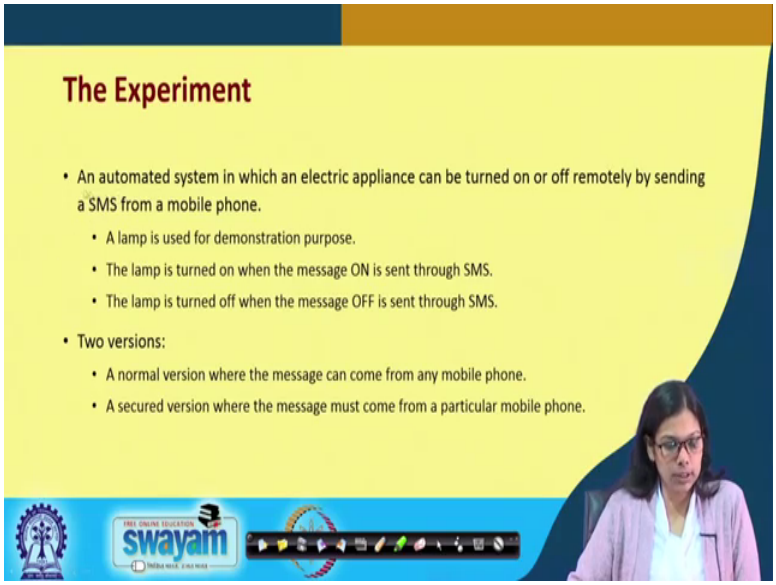

So, the experiment goes like this. An automated system in which an electric appliance can be turned on or off remotely by sending a SMS from a mobile phone. A lamp is used in this case a bulb basically for the demonstration purpose. So, the lamp is turned on, when message ON is send though SMS. And the lamp is turned off, when the message OFF is sent through SMS. And as I told you, there are two versions. One is a normal version, where the message can come from any mobile phone. And a secured version of course, where the message must come from a particular mobile phone.

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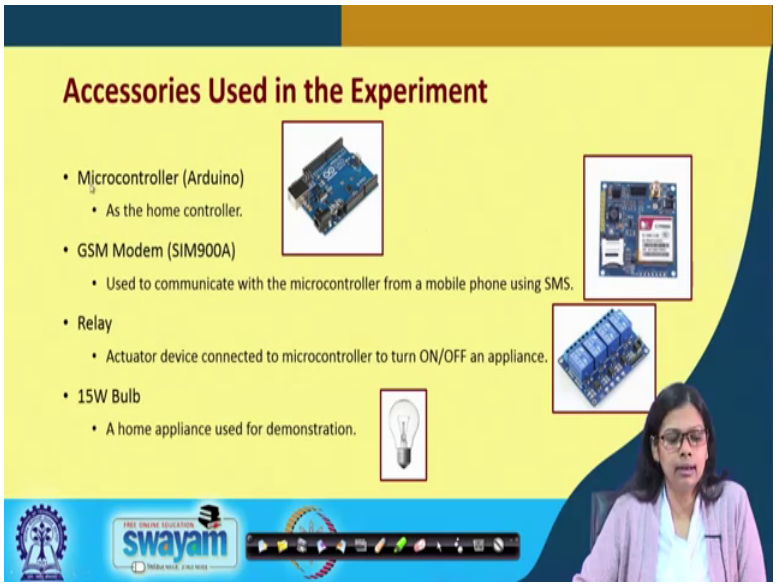

So, what are the hardware components that we require for this experiment. We of course require a microcontroller; in this case we have used an Arduino microcontroller. A GSM modem is required; we have used SIM900A GSM modem, which is used to communicate with the microcontroller from a mobile phone using SMS.

We need an electromechanical device here that is relay the description about relay is already discussed in prior week's. So, in this experiment it is acting as a actuated device, which is connected to microcontroller to turn ON and OFF the appliance. And we have used a 15 watt bulb a home appliance is used for demonstration, this is just for you used for demonstration, you can use any other device.

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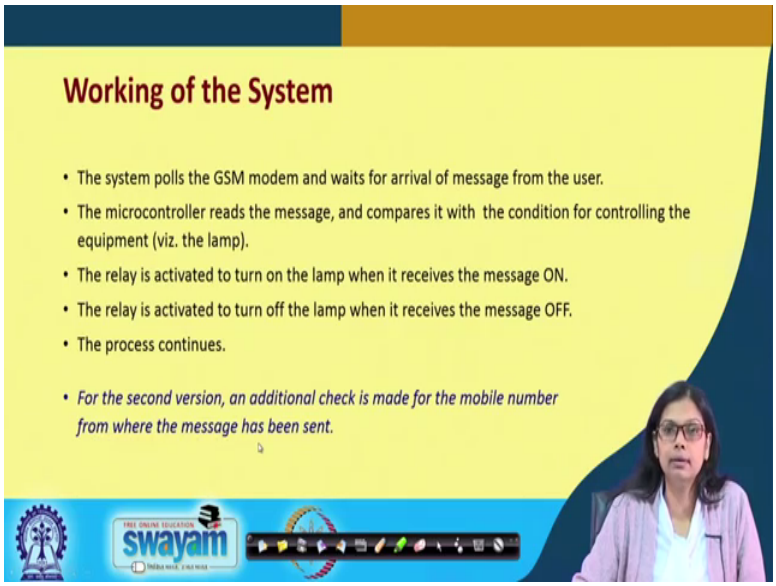

So, the working of the system goes like this. The system reads the GSM modem and waits for arrival of a message from the user. Then the microcontroller reads the message, compares it with the condition for controlling the equipment.

Accordingly, what it receives either ON or OFF. The relay is activated to turn on the lamp, when it receives the ON message. And the relay is activated to turn off the lamp, when it receives the OFF message and the whole process continues ok. So, this is all about working out the system. And as I said for the second version, an additional check is made for the mobile number from where the message has been set.

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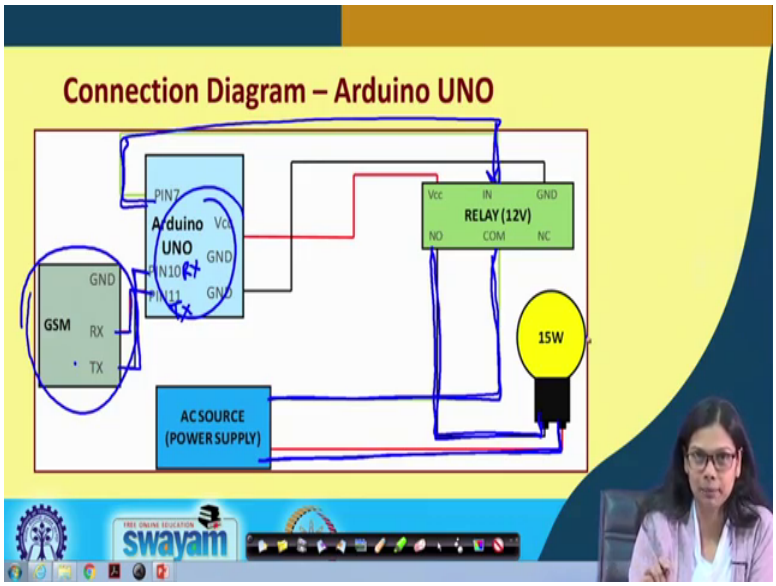

So, this is the connection, let us look into the connection. This is the relay and we know that the relay you have a VCC, you have a ground, you have a VCC pin connected with the VCC. You have ground, which is connected to ground. And you have an input; this input is connected to one of the pin of Arduino that is PIN 7 in this case ok.

And this is my bulb, and this is my AC source. AC source I will be when I show you the demonstration, I will show you exactly what is that. And this is the bulb. There are two ends of the bulb, please see what exactly we are doing. One end of the bulb is directly connected to normal open board of this relay.

And another end of the bulb is connected to the AC source. And another end of the AC source is coming and directly getting connected with the common port of this relay ok. So, pin 7 is connected to the input. One end of the bulb is directly connected to normally open. Another end of the bulb is connected to the AC source. And another end of the AC source is connected to the common point; this is how the connection is.

And with the GSM board, which will receive the SMS that is either on or off will be connected this RX pin of this is connected to pin number 11, which is the TX. And TX pin of this is connected to pin number 10, which is the RX here ok. So, this is all about the connection, and of course ground and VCC will be connected accordingly. So, what happens GSM will receive an SMS depending on that it will do some processing, and

send a value through this PIN 7 to this relay. And according the relay will make this bulb glow or it will make this bulb off depending on the condition that we have given.

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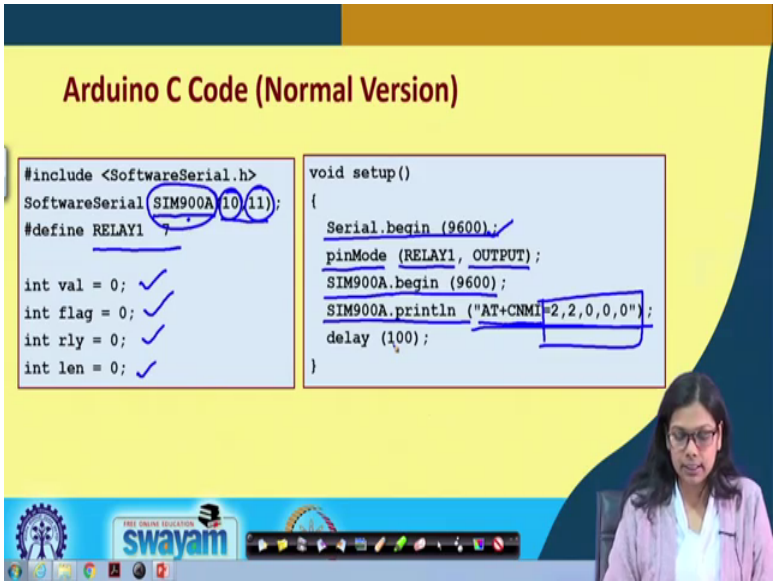

Let us now see, how the code goes here ok. So, you have to include this software serial that is always there. And for the software serial, you have to make this SIM900A this RX, TX pin which is 10 and 11. And we define this relay one as 7. Then we define some variables one is val, one is flag, one is relay, and one is len, we have initialized all these to 0. We will see one by one why we require these following variables ok.

Now, in the setup phase. In the setup phase please recall that I have already told you that for serial communication, we do not require explicitly any hyper terminal for Arduino, but for STM we require that. For Arduino it is it can be directly printed in the serial monitor.

So, in the setup phase we first define this baud rate for that serial printing that is serial dot begin 9600. PinMode the name relay one we have given, we have made it as an output port and SIM 900A the object that we have made along with this pin 10 and 11. We are setting up the board rate as 9600 again and one of the important thing that we are doing, now once we have made this particular object dot begin 9600. We have to also specify that the module the GSM module that we are using that is SIM 900A, we will be using it for messaging purpose ok, so that particular thing we have to define it.

So, for that particular reason, we need to use an 80 command, which goes like this. So, for different purpose it will be different, like I have told you for fax it will be different for SMS, it will be different for GPRS sending, packets sending, it will be different. So, you have to look into it and find it out. For the SMS we are showing it, which must be this 80 plus CNMI equals to 2 comma 2 comma 0 comma 0 comma 0.

Now, this CNMI stand for Command Name Message Indication ok. So, command name message indication is this meaning, we will be able to receive message here ok. So, this is the thing we need to specify of using this SIM900A print ln command that is using this at command. And then we give a delay of 100 millisecond, let us move on.

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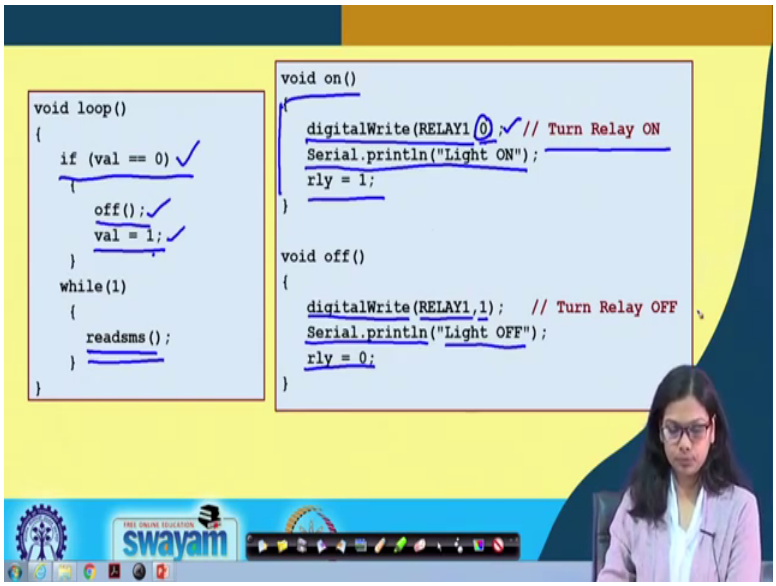

This is the set up phase. Now, in the loop phase, what we are doing. Initially, we are checking for a variable, you remember that we have defined certain variables in the first code one of the variable is val, we can see that right val equals to 0. So, now we are checking on the first go, if val equals to equals to 0 or not it will be 0 initially, because we in the set of phase we have already made it 0. Then we are calling a function called off, we will see off does. And I am initializing val to 1 ok.

So, what I have done, I have in the loop phase which will which will go continuously. I am checking for val what is the value for val, and it is 0 now. I make it off, and then I make val equals to 1. So, it will not go to this loop again, because val has now become 1.

Then what we are doing in while in one phase, this will go for once. And then in the while one phase, I am reading SMS read SMS ok.

So, I will see what this read SMS function does prior to that. Let me tell you what this ON and OFF function will do basically the ON and OFF function will make the relay ON or relay OFF. If you make relay ON or OFF accordingly, the bulb will be made ON and OFF, you see what we are doing? In the ON function, we do a digitalWrite RELAY 1 to 0 to turn the relay ON. And this serial dot println, we see that such that we have already executed this or not it will print light on in the serial monitor ok.

And then we are making rly has 1 now rly has become 1. And in the off function, we are doing a digitalWrite RELAY1, 1 which will turn of the really ok. And it will print in the serial monitor light OFF. And this will also make rly equals to 0. So, on will make the relay OFF that we are sending 0, basically which will turn relay on basically and this OFF will make this relay OFF to make it OFF. So, this is how it has to be done.

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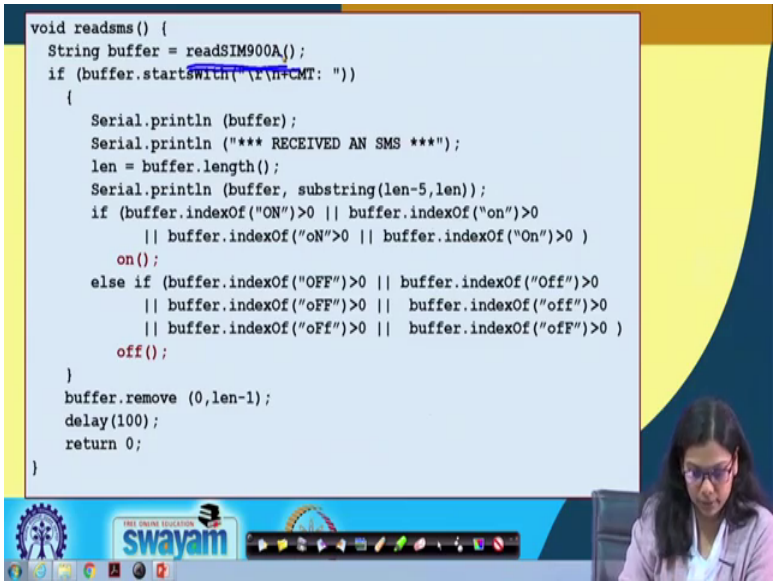

Next readsms. So, under readsms, there is one more function that we have written that is readSIM900A, let us understand this carefully. What we are doing in readsms, readsms I am continuously running this in that loop. First of all string buffer, it is returning, it is calling readSIM900A readSIM900A. Let me go to that function and tell me, I will tell you that what this readSIM900A is doing ok.

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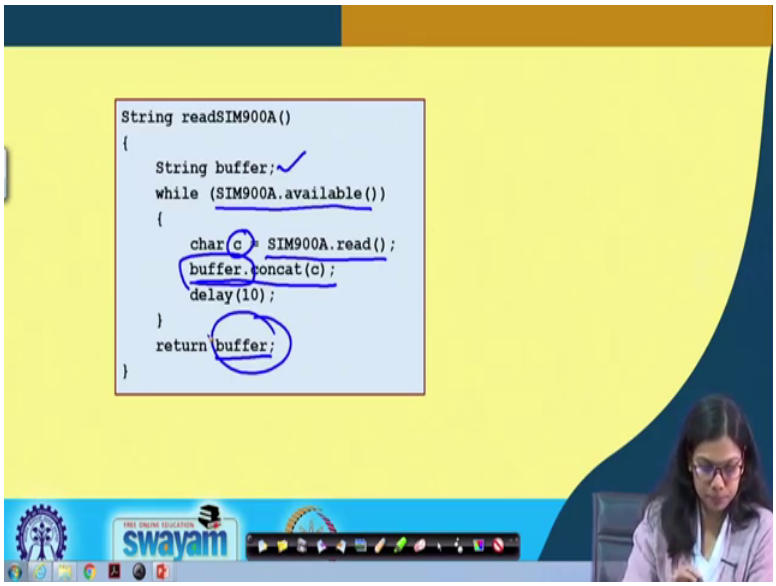

Let us go there first readsim900A, what it is doing it is defining a string called buffer. And then it is checking in this while condition, whether the connection is available or not ok. By this function SIM900A dot dot available.

If it is available, it is readingSIM900A dot read using this function and it is storing it in c. And this buffer dot concatenate, we are taking each of this character one by one by one reading it, and we are concatenating in this buffer dot concat c. And we have given a small delay that is 10 millisecond ok. And finally, what we are returning we are returning this buffer ok. So, the code seems to be straightforward we have defined this, we are checking for the connection, then we are reading each of the character, and then we are concatenating, and we are storing it if this in buffer and we are returning this buffer fine.

Now, we will go to this now well go to this previous slide that is readsms. So, on the first go of the readsms, we are calling that function which I have shown you just now, and we are storing it in buffer ok. And then we are checking if this buffer string starts with this or not backslash r backslash n plus CMT colon space. So, you will see that it starts with this, but we do not need this. So, later we will see that we will cut out this part. So, how many characters 1, 2, 3 colon 4, and this one space 5 ok.

Now, again we are printing, whatever we have received after if it starts with this, serial dot println the buffer. And we see that once this is printed SMS is received an SMS, we display this in the serial. And these things are only written for our checks ok, you can

remove it in the final program if you want to ok, this we do. Then we calculate the length of this buffer ok, we calculate the length of this buffer ok. After calculating the length of this buffer, serial dot println this buffer we take the substring, where we cut out that length minus 5, and we take that particular string. So, this part will get cut down ok.

And now what we do, once now I have just the SMS with me. So, when SMS is sent or received, there are certain other characters also, that comes in ok. So, we are removing that part, and we are now concerned about the exact SMS ok. Now, if buffer dot index OF is ON index OF will search for this string from this buffer, and it will return that particular location where it has found out ok. So, in that case, it will always return a value greater than 0. And if it will not find that, it will return something less than 0 that is minus 1 ok.

So, in our case will receive something greater than 0 of course, so that is why what we are checking here buffer dot index OF is it ON capital ON. Buffer dot index OF small on ok, it could be combination small and then big, and then big and small ok. So, all the possible ways we have taken into consideration.

If the message contains any of these things, then it will call the on function, and it will switch on the bulb ok. Similarly, we check for OF buffer dot index OF if it is OFF OFF, there are various possibilities, then we make it off that is what needs to be done. So, we receive an SMS, and then we cut out some portion, and then we see the exact SMS with us.

And that particular SMS now, I am checking for whether it has gotten on in that message or not if it has got will on it, if it has got off will off it. And finally, from this buffer we are removing the entire that string, we are giving a 100 millisecond delay, and we return 0. So, this goes on repeatedly ok, this is all about the code. This is a simple code from any mobile number the SMS comes, then it will do it like this.

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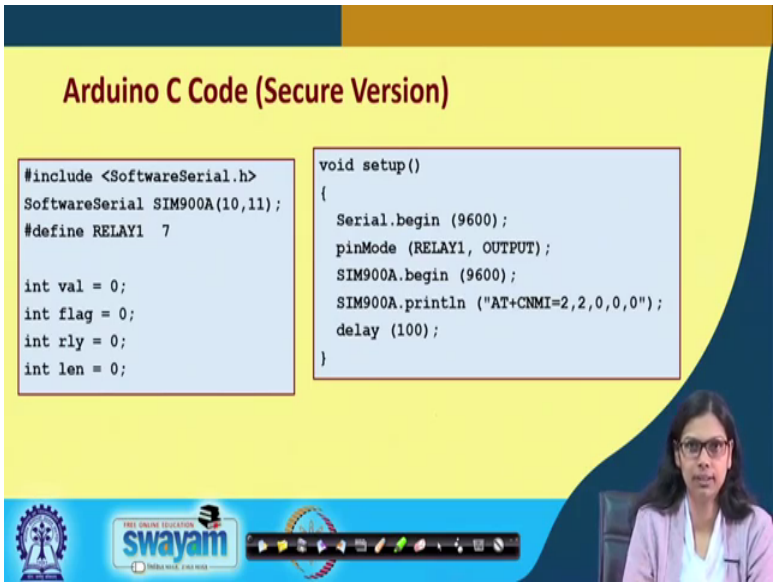

Now, we will see the next code, where this I have already discussed secure version. Secure version meaning, I have already told you, it must receive from some particular number. And then only I will go for it, I will make it on or off. If I get it from any mobile number, I will not make it on or off ok. So, this part of the code will be fairly the straight forward, and this part as well will be the same one, where the different starts is here.

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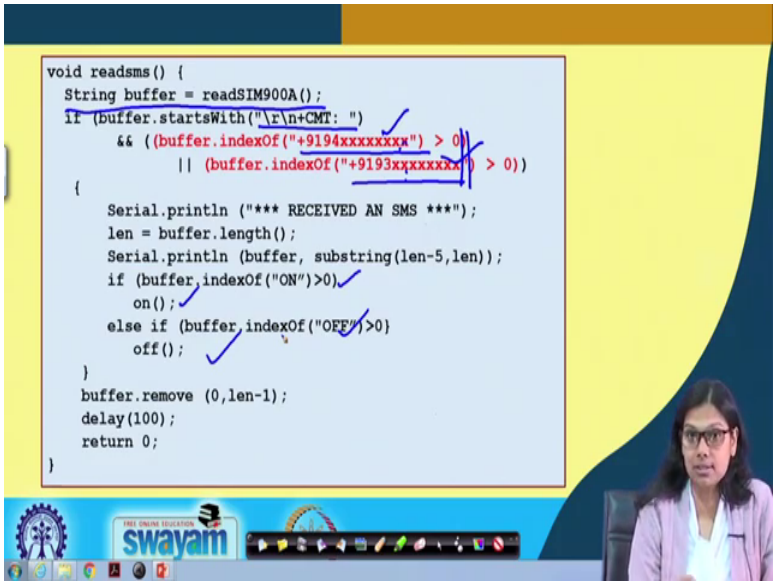

Along with so we read the SIM900A really readssim with this function we read, and in the buffer I have the value with me the entire message. Now, what we are doing, we are

checking starts with this. And we are also checking buffer dot index Of with some mobile of course you have to put the entire mobile number is greater than 0 or not or buffer dot index Of with this mobile number is greater than 0 or not, so whichever mobile number through which you are sending that two numbers I am checking here, here I have checked with these two numbers ok, you can happen many numbers ok.

If it sends either from this number or from this number or from 10 more numbers, then it should work. But, it should not work with any other numbers other than which is specified here that is the only check you have to do, and this fairly goes straightforward if it is ON, you make it on; you it is OFF, make it off. And then finally, you remove from the buffer ok. So, this is all about the two versions of the code for this making a bulb ON and OFF using SMS control. So, this is the readsim which I have already discussed. So, I have come to the end of this lecture. Now, following this we will be demonstrating you the experiment that I have just now discussed with you.

So, now I will be showing you two experiments, where I will be switching ON and OFF a bulb using SMS control ok. I have already discussed the codes with you. I have already discussed how you will be making the circuit. But, two experiment that I will be doing. One will be which is not secure in the sense that if the SMS is received from any mobile number, the bulb will glow. But, it is not the case always, we would like to have it should only work when the SMS is getting received from a particular mobile number.

So, there are two variation of the code that we have done. One anybody can send, another you can put series of phone numbers from whom you want this particular switch ON and OFF to happen ok. So, these are the two things that I will be showing you. You already have come across, how you will switch ON a bulb using relay just using program control. There we are not sending any SMS rather, we are just switching ON and OFF a bulb using relay controls. So, you already know that how it works. I will just integrate it along with the GSM module ok, let us see the experiment ok.

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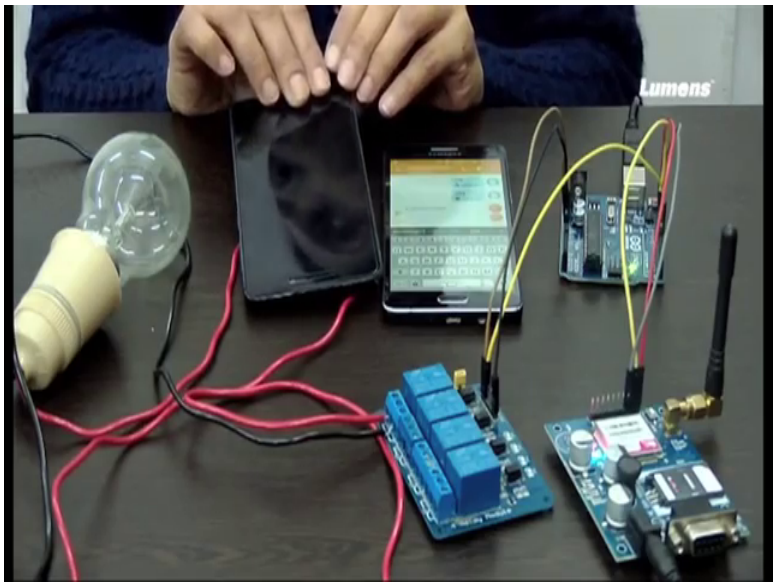

So, this is the bulb. So, what all things you will be requiring, when you start this experiment of course a bulb ok. This bulb should be connected to this plug like this AC source, you must have a relay module with you this is a four module really, you can have a single module relay with you. You should have a GSM module with you, this is the GSM module. This is SIM900 module, I will have already discussed in detail regarding this module. So, this is the SIM900A module that we have used the GSM module. You need a SIM card for it ok, you can see the SIM card that is put in here ok. And you need a micro controller board, which is Arduino in this case the same Arduino Uno.

Now, see how this connection goes, this connection goes like this. This is the AC source what I said one point of the AC source will be directly connected to this bulb, it is getting connected we can see that. This part is directly connected to the bulb. And another point of the AC source, which is this one is going to as an input to the common point of this relay ok, you can see that it is going to the common point of this relay here is that point here it is going. So, this is the connection. And another end of the bulb is going to this normally open point of the relay ok.

So, I just repeat once more. This is the AC source. One end is directly connected to the bulb one end is directly connected to the bulb; another end is connected to this common port of this relay. And another point of the bulb is connected to normally open point of

the relay ok. This is this part how we will be connecting the bulb AC source with the relay.

Now, I will be showing you what connection you have to make with this GSM board, and with your microcontroller board that is the Arduino board ok. GSM board has got a ground. This ground is connected to the ground of your Arduino Uno. And this GSM board has got an RX and TX pin ok. So, you have TX this one is the TX, this one is the RX ok. So, this one is the TX, and this one is the RX.

Now, the TX pin of the GSM must be connected with the RX pin of the Arduino. So, we have made two pins as RX and TX for Arduino, which is pin 10 and pin 11. So, the TX pin must be connected with the RX pin, here it is pin number 10. And the RX pin is connected with pin number 11 that is the TX pin of Arduino. This connection you have to make for GSM to Arduino connection. And one is connected to the ground fine.

Now, this connection we have made. Now, finally I have to make a connection with the relay. Now, what is basically happening if you see, I said this bulb will glow, when you send an SMS. So, SMS for SMS sending you must have a connection between this GSM module and the Arduino board. The Arduino board must receive the SMS depending on the SMS, it should control this relay such to make it ON or OFF.

And accordingly, I have already told you how this connection is with the AC source and with the bulb. Similarly, you have to connect now, this Arduino board and the relay module, let us see how we have made this. We have used this PIN7 of Arduino for connecting with the input of this relay through which will be sending. And there is one ground, and one VCC. So, we are using this fourth input of this relay. So, this is connected to PIN7 of Arduino Uno, and this is connected to ground, and this is connected to VCC of Arduino.

So, let us once again recapitulate, what I just now discussed. I have already told you how you have to make the connection with the AC source bulb, and the relay. Then I have told you how you have to make the connection with GSM, and Arduino board. These are the two boards, GSM board and Arduino board ok. And then I have told you, how you will be making the connection with the Arduino board and this relay ok.

So, finally an SMS will be received through this GSM will be sent this SMS will be somewhere received through this microcontroller. And is this microcontroller will instruct to do certain things either ON or OFF. Now, I will be dumping the code one by one to show both the things ok. So, how do I show you the secure one. So, I have I will be using these two mobile phones. First I will send SMS from this particular mobile phone, and you see that it will work.

Secondly, I will show a secure connection where I will only send I will send first SMS from this mobile phone, and you will see that it will not work. But, when I sent from this mobile phone, it will work. Let me show you one by one the things. So, let me dump the cord ok, so I have already dumped the code.

Now, see I will be sending an ON message ok, it seems to have some issue ok. So, I will just ON it oh and I will just send ok. So, you can see that I have send it from this mobile, so this is not the secure code basically. I will again send it OFF from my other mobile, which is this one let me do that ok. So, I will make it OFF ok. So, the bulb is switched off.

I will show once more ok. I am sending ON ok, it is working. And I will send again OFF, you see it is working ok, but this code is not the secure one. As you said from both the mobiles, it was working. Now, I will make sure that I will when I send it from this mobile, this will not run. And when I send with this particular mobile, it will only work ok. So, I will do that ok.

So, now I will try out in this mobile, I have already dumped the cord ok. So, now I am sending up ON message, let us wait for some time nothing happened right ok. Now, I will try with this mobile, and it worked ok. So, this is a secure communication, where you can restrict doing this kind of automatic ON, OFF switch through SMS control for certain phone numbers, and not for any phone numbers have a login off it ok. So, it is just working with this mobile phone, but it is not working with this particular mobile phone ok.

So, today we discussed about a simple automation that we can do using relay, a GSM board, a microcontroller, and of course a bulb, it could be any electrical appliances, but here we have used a simple bulb to make it ON and OFF. So, what is the takeaway from this experiment? So, you can say that we have been working and this is almost last but

one week, where we are discussing about some kind of advanced aspects. But, how will you integrate it in the form, and make it a little more advanced, you can think of some more things where you can not only use a single bulb, but couple of more devices you can connect and try out that how that automation you can do.

Thank you.