D&LLTechnologies



Emerging Technolgogies

Internet of Things

Project 2

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Project 2: Industrial Machine Monitoring system

In this project you will build a circuit that monitors the temperature of a machine, the values of the temperature will be visible on the serial monitor and any abnormal values recorded can be monitored. This data can also be viewed in the form of a graph which will allow the user to analyse the performance of the machine. Exciting? Let's get started!

Software:

1. cloud.arduino.cc

This website helps in building the IoT applications and programming the Node MCU.

2. Arduino Create Agent

This application helps in communicating with the Node MCU and the computer. It helps in dumping the code in the controller.

Components Used:

STEP by STEP Instructions

To build this project we will need the following hardware. Let's quickly look at the hardware and recall the purpose and function of the hardware in our circuit.

1. ESP8266 Node MCU

Node MCU is an open-source platform based on ESP8266 which can connect objects and let data transfer using the ESP8266 Wi-Fi module integrated in it. This board had two buttons "reset" and "flash". We can power up the board using the 3.3V DC through the "Vin" pin or 5V through a micro USB port. It has one "A0" Analog pin and 16 GPI/O pins. It has a flash memory of 4MB.



You will need 1 ESP8266 Node MCU for this project.

2. LED

LED stands for "Light Emitting Diode". It is a two terminal device. The shorter terminal is called the cathode and the longer terminal is the Anode.

You will need 1 red coloured LED for this project.



1 4-20V

2 OUT 3 GND

3. LM35 Temperature Sensor

LM-35 is a Temperature Sensor with 3 terminals Vcc, OUT and GND. This device gives the analog (Voltage) data from the OUT Terminal. The analog data is the temperature readings in Celsius. Hence, no other calibration is required.

4. Male to Female jumper wires

Male to Female Jumper Wires are used to connect the LM35 Temperature Sensor to the Breadboard where Node MCU is mounted. These jumper wires have a male pin at one end and female pin at the other end. A male pin is commonly referred to a solid pin that stands up. A female connector is commonly referred to as a jack with a hole in it to accept the male pin.

You will need 10 Male to Female Jumpers for this project.

5. Breadboard

Breadboards are used for building circuits easily. We can easily make and break the circuit. No soldering or PCB is required.

You will need 1 Breadboard for this project.

6. Micro USB Cable.

Micro USB is used to dump the program in the Node MCU board. It is also used to power-up the board.

You will need 1 Micro USB Cable for this project.

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LM35



PART 1: Building the Circuit

Step 1

Take a Node MCU board and mount it on the breadboard as shown in the figure.

The Node MCU has all the Male pins. These male pins are not user friendly to build a circuit with different connections hence we are placing the Node MCU on a breadboard.



Step 2

Take LM35 Sensor and connect the terminals of the sensor to the jumper wires as shown in the image given below.

Connect the orange wire to Vcc, red wire to OUT and black wire to GND.





Step 3

Now let's connect the temperature sensor to the Node MCU board.

a. Connect the black wire from the sensor to the "GND" terminal of the Node MCU as shown in the image given below.



b. Connect the Red wire from the sensor to the "A0" pin of the Node MCU as shown in the image.



c. Now let's connect the VCC of the sensor.

Take the orange wire of the sensor and connect it to the "3V" pin of the Node MCU as shown in the image given below.



d. We have successfully built our circuit.



PART 2: Setting up the device

Step 4

Open any browser and then search for "Arduino IoT Cloud" in the google search bar.

		Gmail Images 🏭
(Q arduino iot cloud X	
	Google Search I'm Feeling Lucky	
	Google offered in: हिन्दी वाश्मा తెలుగు मराठी தமிழ் ગુજરાતી ಕನ್ನಡ മലയാളം	र्थताची
India		
About Advertising Business How Search works		Privacy Terms Settings



Click on the search result https://cloud.arduino.cc/.



Step 5

To sign-in, click on "Google" and sign in using "Google Account"

÷		
	Sign in to Arduino	
	Username or Email *	
	Password *	
	Forgot your password?	130-
	Don't have an account yet? Create one.	
G Google	e O GitHub O Facebook é Apple	



Step 6

After signing in, you will find, "Create Thing". Click on the "Create Thing" button.

O IOT CLOUD	Things	Dashboards	Devices	Integrations	Templates	UPGRADE PLAN	 S
		Creat	e your	first Thi	ng		
		A Thing is a con with the cloud with other Th	nnected devi d. You can m nings or anyt wor	ice that can comr nake your Things hing else in the p Id.	municate interact vhysical		
			CREATE	THING			

After clicking you are redirected to "creating a thing" page.

Let's first rename the thing. Click on the untitled and enter the name as "Temperature Monitoring"





Click on the "Add Variable" button.

A popup will appear asking for the details of the variable.

- a. Name the variable as "temperature".
- **b.** Type of the variable is "Integer number" because we would like to check the temperature.
- **c.** Change the variable permission to "read only" as we only want to read data from sensors and variable update policy to "periodically" to give continuous data.
- d. Update the Threshold to 1 s. Then click on "Add variable"

Th	ings Dashboards Devices Integrations Ten	nplates	mings	Dastibuards Devices	Integrations	Templates	
	Add variable	×		Add va	riable		×
	Name temperature			Name temperature			
iat you a smart	C Sync with other Things (/ou ne.	hou hart	Sync with other Thing	gs 🕧		,ou ne.
IABLE	Select variable type		LE	Integer Number eg. 1		•	
	Declaration	0		Declaration int temperature;		8	
	Variable Permission 🚯	k c ce.	l	Variable Permission 🚯			·k cr ce.
	Read & Write Read Only			O Read & Write	Read Only		
	Variable Update Policy 🛞			Variable Update Policy 📧			- 1
	On change Or change Periodically			🔘 On change 🛛 Pe	eriodically		
	Threshold O			Every 1		s	
	ADD VARIABLE CANCEL			ADD V	VARIABLE CA	NCEL	



Step 7

Now let's link the circuit as a device.

Click on the "Select device" button then a popup will open.

⊖ IOT CLOUD	1	Things	Dashboards	Devices	Integrations	Templates	UPGRADE	PLAN	::: S
	Home Automation				Setup	Sketch	Metadata		
	Variables		Last Value	Last Up	ADD	Associat Select the de	ted Device		
	Fan bool fan;			Lust of	:	configure a r	new one.		ð
	Light bool light;				:	Select Device			Fee dba
						Networl Enter your n connect you	k letwork credentials to r device.		U
	Set webhook								

Step 8

Now in the popup, we have to select the type of board. Here we are using "Node MCU" which is a 3^{rd} party device.

So click on "Set up a 3rd Party device"

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	Setu	p device	×
Variables			Device
Name ψ			/ou want to use or ne.
Fan bool fan;		•	
Light bool light;	ARDUINO		
	Set up an Arduino device	Set up a 3rd Party device	
	Compatible devices 🧃	Compatible devices 🧯	rk credentials to
		۳ ۳	-
Set webhook			

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In the dropdown search for Node MCU 1.0 board and click on continue.

tomation		Setup		Sketch	Metad
÷		Setup device		:	×
	Select device t	type			Device
\mathbf{v}		type			you want to
an;	Please select the de configure	vice type and model y	ou want to		ne.
ight;	ESP8266	O ESP32	🔵 LoRaWA	Ν	
	NodeMCU 1.0 (ES	P-12E Module)	*		
			CONTINUE		
					rk credentia ce.
				G	

Step 9

Now let's name the device.

a. A random name is assigned to the device. Delete the name and enter the name as "Temperature_Monitoring" and then click on the "Next" button.





b. After clicking on "Next" a new page will open with "Device ID" and "Security Key". These two details are very important, so click on the "download pdf" and save the file.

OO IOT CLOUD	Thisse Deside on Desident Internations Translater	UPGRADE PLAN S
	Setup device	×
Home Automati	Secret Key, please copy and save them or download the PDF.	Metadata
Variables	Also, keep in mind that this device authentication has a lower security level compared to other Arduino devices.	Device
Name Ψ	Device ID	ou want to use or
— Fan	8aa2d423-6739-4470-aa1b-fdcb4b78d053	ne.
bool fan;	Secret Key	sc.
Light bool light;	VJMHOQQ8CH2UAWIVUTSU	
	Secret key cannot be recovered Please keep it safe, if you lose it you will have to	
	delete and setup your device again.	
		rk credentials to
	Secret Key	ce.
Set webhook		•
Arduino Device Sepdf		Show all

c. Then check the "I saved my device ID and Secret key" check box and then click on "Continue".

SO IOT CLOUD	Setup device	X UPGRADE PLAN III S
Home Automati	Also, keep in mind that this device authentication has a lower security level compared to other Arduino devices.	^ Metadata
Variables Name ↓ □ Fan bool fan; □ Light bool light;	Device ID 8aa2d423-6739-4470-aa1b-fdcb4b78d053 Secret Key VJMHOQQ8CH2UAWIVUTSU Secret key cannot be recovered Please keep it safe, if you lose it you will have to delete and setup your device again.	Device for want to use or ne.
Set webhook	I saved my device ID and CONTINUE Secret Key	rk credentials to ce.
Arduino Device Sepdf		Show all



Congratulations! your device setup is successful.



PART 3: Setting up the Network & Building the Dashboard

Step 10

Click on the "Configure" button then a popup will appear.

TOT CLOUD	Things Dashboards	Devices Integrations	Templates	UPGRADE PLAN III S
Home Automatio	on	Setup	Sketch 2 Metadata	
Variables		ADD	دت خ`ت Change Detach	1
Name V	Last Value	Last Update	-	
bool fan;	-	:		aack
Light bool light;		:	Network	L Contraction of the second seco
			Enter your network credentials to connect your device.	
			Configure	
			compare	*
Set webhook				
Arduino Device Sepdf				Show all X
1. 11/		Ð		
	₽ <u>₽</u>			
			1 martill	
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Enter the details of the network.

Wifi Name-

Password-

Secret Key- (Available in the pdf downloaded)

	Things	Dashboards	Devices	Integrations	Templates		(
			Configure	network		×	
utomati		connect to the n uploaded.	etwork once t	he sketch will be			Metada
s		Wi-Fi Name	*				دی
e ↓							etacn
fan;		Password *	•		0	- 11	
light;						-ti	credentials
		Secret Key	*		0	C	e.
				s	AVE		
ook							

After entering all the details click on the "Save" button.

	THINGS	Dastibuarus	Devices	Integrations	iempiates	_	
			Configure	network		×	
nati							N
		Your will find the	ese network pa	arameters in the	secret	^	
		tab in your sketo	h, and your de	evice will be able	e to		
		connect to the n	etwork once t	he sketch will be	1	- 18 M	
		uploaded.				1.0 (E?
						ne	
		Wi-Fi Name *				-15	
		SRK					
						Deta	ch
		Password *					
					0		
						к	
		Secret Key *			-		
			•••••		0	·····,	
					SAVE		
					SAVE		



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Step 11

Now let's build the dashboard. Click on the "Dashboards" button beside the "Things" button.



a. Click on the "Build Dashboard" button. Then a new page will appear. Click on the untitled Dashboard name and enter the name as "Temperature Monitoring System"





Step 12

Now let's add the User Interface. Click on the "Add" button and click on the value in the dropdown.

•

OO IOT CLOUD	Things Dashboards	Devices Integrations	Templates	UPGRADE PLAN		S
	Tempe	erature Monitoring Syste	m		< ⊥	i
WIDGETS THING	s					1
Q Search widgets						
						edback
Colored light						Ľ ₩
Time Picker						Т
Scheduler						
z.s Value						
Status						
Gauge	-					

a. Then in the popup select the variable "temperature" and then click on "Link variable" button.

÷		Link Variable	e to Temperature			
Things		Variables		temper	rature	
Untitled	>	temperature	>	Thing Type Last value Permission Update policy Last update	Untitled Int - Read-Only Timed null	E Feedback



b. Then rename the label as "Temperature" and then click on the "done" button.

F	Value	Widget Settings
		Name Temperature Hide widget frame
	Temperature N/A	Linked Variable temperature from Untitled
		Change Detach
	4	DONE

Step 13

Now let's add a Chart. Click on the "Add" button and click on the "Chart" and then a popup will appear.





a. In the popup select the "temperature" and then click on the "link variable" option.

Enter the name of the chart as Temperature and then click on "Done".

Temperature 15 D 7 D 1 D 1 H LI	Name Temperature
	Hide widget frame
	Linked Variable
	temperature from Untitled
	ඟ දර් Change Detach
	Show Thing name on widget

b. To adjust the position of the object click on the button beside the "add" button and move the objects to the required position then click on "done".

DO IOT CLOUD	Things Dashboards	Devices Ir	ntegrations	Templates	UPGRADE PLAN		S
DONE	Tempe	erature Monito	oring Syster	n		< ⊻	i
Temperature 15 D 7 D	Jre J/A J 1D 1H LIVE						Eeedback



If you want to adjust for mobile mode also, click on the mobile icon and then adjust the objects.



Now we are done with the interface

PART 4: Writing the Code

Step 14

Now let's start writing the code. Click on the "Sketch" button beside the setup button.

OO IOT CLOUD	Things Dashboards	Devices Integrations	Templates UPGRADE PLAN	s
Temperature Monit	toring System	Setup	Sketch 2 Metadata	
Variables	Last Value	ADD Last Update	Device	
<pre>temperature int temperature;</pre>		:	Temperature_Moni	E Feedback
			Network Wi-Fi Name: SRK Pasceword:	
Set webhook				



We have connected the OUT pin of the LM35 sensor to the AO pin of the Node MCU. So let's setup the pin mode. In the "void setup" function write the code as

pinMode(A0,INPUT);

○ IOT CLOUD	Things Dashboards	Devices Integrations	Templates	UPGRADE PLAN	 S
Temp	perature Monitoring System	Setup	Sketch	Metadata	
e	Temperature_Monitoring - NodeMCU 1.0 (ES	SP-12E Module)	Open full editor	Q 🗵 🥼	
11 12 13 14	Variables which are marked as READ/WRITE which are called when their values are c These functions are generated with the T */	in the Cloud Thing w hanged from the Dashb hing and added at the	ill also have functio oard. end of this sketch.	ins	*
15 16 17 18	<pre>#include "thingProperties.h" void setup() {</pre>				Feedback
19 20 21 22 23	<pre>// Initialize Serial and wait for port t Serial.begin(9600); // This delay gives the chance to wait for delay(1500); pinMode(A0.INPUT):</pre>	o open: or a Serial Monitor w	ithout blocking if no	ne is found	
24 25 26 27	<pre>// Defined in thingProperties.h initProperties();</pre>				
28 29 30	<pre>// Connect to Arduino IoT Cloud ArduinoCloud.begin(ArduinoIoTPreferredCo</pre>	nnection);			Ŧ

Since it's a monitoring system and the data has to be updated periodically, let's write the following command in "void loop" function.

Serial.println(temperature = analogRead(A0));

OO IOT CLOUD	l _	Things Dashboards	Devices Integrations	s Templates	UPGRADE PLAN) 🏼 🔇
Т	emperature Monito	oring System	Setup	Sketch	Metadata	
	✓ → temp - Node ♦ Port: CON	MCU 1.0 (ESP-12E Module)		Open full editor	Q 🗵 🗳	
	29 30 * /* 31 The following 32 related to th 33 the higher nu 34 The default : 35 Maximum is 4 36 */ 37 setDebugMessagel 38 ArduinoCloud.upd 40 41 * void loop() { 42 ArduinoCloud.upd 43 // Your code her 44 45 Serial.println(f	<pre>g function allows you he state of network an umber the more granula is 0 (only errors). Level(2); intDebugInfo(); date(); re temperature=analogRead</pre>	to obtain more informat d IoT Cloud connection or r information you'll ge (A0));	ion and errors t.		Feedback



Step 15

Downloading the Arduino Create Agent.

Click on the link to download the Arduino Create Agent

Install the application once your download is complete.

00		s
DOWNLO	AD THE CREATE AGENT FOR WINDOWS	
SETUP STEPS 1. DOWNLOAD AGENT 2. INSTALL AGENT 3. CONGRATULATIONS!	You need to download and install the Create Agent to be able to upload sketches from Arduino Cloud to your board. Please note that you have to be Administrator of your system to install the Agent. Administrative privileges aren't required for MacOS El Capitan or an earlier version.	
	DOWNLOAD FOR WIN32 DOWNLOAD FOR WIN64	

Step 16

Uploading the Code

a. Click on the "open full editor" button. Then you are redirected to a new page where all the libraries and other options are shown.

OO IOT CLOU	D Things	Dashboards De	evices Integrations	Templates	UPGRADE PLAN) ::: 6
	Temperature Monitoring Sy	stem	Setup	Sketch	Metadata	
	No associated device	e found		Open full editor	Q ፷ Å	
	<pre>1* /* 2 Sketch generated by the 3 https://create.arduino 4 5 Arduino IoT Cloud Varial 6 7 The following variables 9 int temperature; 10 11 Variables which are mari 12 which are called when ti 13 These functions are gen 14 */ 15 16 #include "thingProperties 17 18 void setup() { 19 // Initialize serial and 10 // Initialize serial and 10 // Initialize serial and 11 // Initialize serial and 12 // Initialize serial and 13 // Initialize serial and 14 // Initialize serial and 15 // Initialize serial and 16 // Initialize serial and 17 // Initialize serial and 17 // Initialize serial and 18 // Initialize serial and 19 // Initialize serial and 10 // Initialize serialize serial and 10 // Initialize serial and 10 // Initializ</pre>	Arduino IoT Cloud cc/cloud/things/cbf oles description are automatically ced as READ/WRITE i reir values are cha arrated with the Thi .h" d wait for port to	Thing "Untitled" 38c0a-1b55-44c4-aad8 generated and update In the Cloud Thing wi Inged from the Dashbo Ing and added at the open:	-3122eafafb5a nd when changes are m ll also have functio ard. end of this sketch.	nade to the Thing	Everback



b. Click on "Select other boards and ports" option and search for Node MCU 1.0 and select the port.

Note: Before selecting the port connect the Node MCU to the computer using the micro USB cable.



c. After selecting the port click on the board and COM4 port as shown in the list. Then click on the "arrow → " button to upload the code to the board.







While uploading the code percentage will be displayed at the bottom of the screen.

Note: if there is an error in uploading the code press hold the flash button on the NodeMCU and try uploading the code again.

Step 17

Now let's check the serial monitor for the Wi-Fi connection and temperature reading.

Click on the "Monitor" option from the editor section on the right side of the screen.

Check if the status is "Connected to Arduino IoT Cloud" this means that your connection is successful.

temp - NodeMCU 1.0 (ESP-12E Module) Port: COM4	Autoscroll 💽	Integrations	Templates	UPGRADE PLAN	 S
The serial port has been closed; please reload the page to establish the communication again.	×	etup	Sketch	Metadata	
133 132 132 133 133 133 133 133 133 Connected to Arduino IoT Cloud Thina ID: e50ab451-734e-4865-a7f8-5ce15bb79371		š re informatio	Open full editor	Q 🧮 🧔	•
133 133 133 132 133 133 133 133 133		you'll get.	u errors		🖬 Feedback
133 134 135 135 136 137 138 139 131 132 133 134 135 136 137 138 139 131 132 133 135 136 137 138 139 1310 132 133 133 134 135 136					
133 Newline ♥ 9600 baud	SEND				Ŧ

Step 18

Now let's check the data in the dashboard.

Click on the "Dashboard" and see the data there. If possible try adding different heat sources near the LM 35 sensor to check and record different temperatures.

You may place a glass of warm water and let it cool and monitor the drop in temperature.



	•						
OO IOT CLOUD	Things	Dashboards	Devices Integrations	Templates	UPGRADE PLAN		S
• • • •			Temperature		<	\checkmark	i
	135						•
Temperature	D 10 11	H LIVE					dback
		136.5					Fee
		136					
		135					
	22:23:34						

PART 5: IoT Application (Optional)

Step 19

Now let's try controlling the devices using an android application.

Open "Playstore" on your mobile and search for "Arduino IoT" click on the Install button.

10:26	80-111 8-111
\leftarrow	Q :
Arduino loT Cloud Re Arduino	emote
What's new • Last updated 01-Apr-2022 Added the support for the Time Picker widget	<i>→</i>
Rate this app Tell others what you think	☆
Write a review	
Developer contact	~
About this app The Arduino app to control your Internet of Things pro anywhere.	→ ojects from
Tools	507.
181 reviews © Rated for 3+ O	Downloads

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After installation open the application and sign in.



Note: Login with the same Email ID which you have used for creating the IoT project.

Step 20

You will find the dashboard once you log in. Click on the Temperature and you will find the values.



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Step 21

Congratulations you have successfully completed the Industrial Machine Monitoring System project.

Reflection:

- 1. Research and find out the differences between LM 35 Temperature sensor and Thermistor.
- 2. What is the purpose of "void loop" function?
- **3.** What improvements do you recommend to this circuit? What other sensors you would like to incorporate
- 4. What were your observations when the LM35 was exposed to different temperatures?
- 5. How do you think machine monitoring systems can save lives in industries?



