RESEARCH ARTICLE

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## Modeling and simulation of the automatic opening of a door by recognition Facial with deep learning using a Raspberry Pi nanocomputer and cloud services

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### ABSTRACT

The objective of this work is to simulate in Packet Tracer a video supervision system using connected object technology. This device, based on facial recognition, uses a Raspberry Pi nano computer to which a camera is connected and uses cloud services to store the faces of people with authorization to enter the company. This system, thanks to the motion detector, makes it possible to detect the presence of a person around the door of the company. Indeed, the motion detector lights up to signal a human presence, which triggers the activation of the camera which films the scene in real time. If after 6 seconds the detector has turned off then the siren is triggered because this means that the face has not been recognized. From this moment, an email containing a message and the image of the scene is sent to the administrator to report the presence of an intruder. The latter, through his control interface in his telephone, has the possibility of activating the equipment (opening/closing of the door, activation/stopping of the siren, etc.). If, on the other hand, after 6 seconds, the detector has not turned off then this means that the face has manifested by the activation of the LED) then the door opens. The administrator receives an email containing the image of the scene in addition to the opening message.

**Key words:** Internet of Things (IoT), Raspberry Pi, Cloud Services, Deep Learning, Closed circuit television system (CCTV).

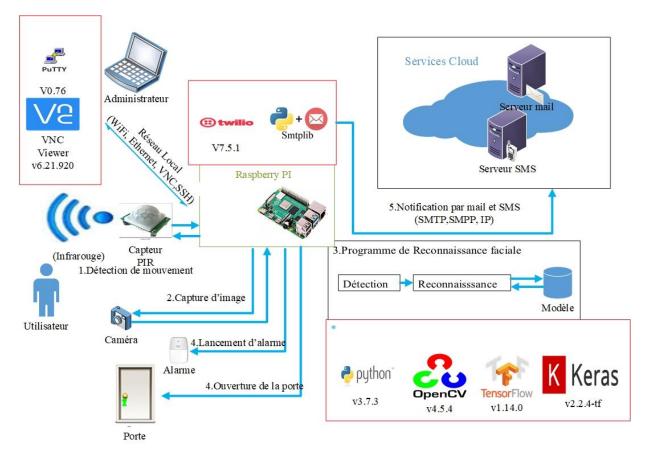
### I. INTRODUCTION

Facial recognition is a means of identification that is the subject of much research. Among these works, the use of the Internet of Things (IoT), which relies on connected objects [1], has shown its effectiveness. For example, in ultra-modern systems, we use biometric facial recognition technology for physical access control to a door (automatic opening or closing).

In our previous works, on a practical level, we realized a facial recognition device for the authorization of the opening of a door based on deep learning. The models (Deep Learning, convolutional neural networks: CNN) embedded in a raspberry pi nanocomputer make it possible to automate a chain of actions, from detecting a person's movement, taking their photo, recognizing this person to authorize the opening of a door and finally the sending of notifications (SMS and email) to authorized persons [2].

This work was published in October 2022 in a scientific article with the title "Facial Recognition in the Opening of a Door using Deep Learning and a Cloud Service" [3].

Figure 1 below shows the architecture of this device.



*Figure 1*: Architecture of the device [2] [3]

In this new work, we want to simulate with Packet Tracer, for educational purposes, the automatic access control system to a door by recognition using Deep Learning and a Cloud notification service (SMS and mail) [4]. We will put into perspective aspects such as the comparison of our educational tool with our practical device on the one hand, and with other devices on the other hand.

## II. METHODOLOGIE

## 2.1. CCTV system

Today, CCTV systems have become an essential part of our infrastructure. These systems play an essential role in our lives due to their enormous benefits, such as the security of public and private places. [5]

CCTV consists of placing cameras in an environment, keeping track of people observed and detecting suspicious behaviour by trained operators. CCTV systems are typically used to monitor high security areas. [5] As the number of cameras increases, this mission becomes very complex and sometimes impossible. It is for this reason that a particular aspect of artificial intelligence has emerged. This is the development of computer vision algorithms. These algorithms make it possible to process visual data and provide observations similar to those of a human being, making this system more intelligent. [5]

## 2.1.1. Technological Evolution

The technological evolution of video surveillance is correlated with the improvement of cameras. We have moved from 1GSS generation systems to 3GSS and 2GSS [6] [7]. Thus, three (03) types of innovation that punctuate the video surveillance revolution. It is:

- The first generation (1GSS 1960-1980) : all is analogue [8] [9] [10] ;
- The second generation (2GSS 1980-2000) : hybrid system [11] [12] ;
- The third generation (3GSS 2000-nowadays): all is digital [11].

2.1.2. New generation of video surveillance system: the Internet of Video Objects

Over the past decades, a large amount of data has been generated by multi-camera surveillance networks. [13]. this rapid evolution of camera-generated data poses many significant challenges to conventional video surveillance systems.

Faced with this evolution, a new generation of video surveillance systems called the Internet of Video Things (IoVT) is emerging to increase flexibility and address the challenges of conventional systems in terms of network, architecture, optimization, and real-time operation. [14].

**The Internet of Video Things IoVT -** (in French: L'Internet des objets vidéo IdOV -) network of distributed visual sensors or intelligent cameras, which are unambiguously uniquely identified, operating in an IoT (Internet of Things) environment. These cameras can interact and communicate with each other and/or with other IoT and human objects using information and communication technologies (ICT) for distributed processing, data exchange/sharing and increased system autonomy. [15]

The Internet of Video Things (IoVT) infrastructure is constituted of the following elements [5]:

- Smart cameras: These smart devices consist of cameras and microcontrollers to acquire, store, process information, and even communicate with each other and/or with other objects in the IoVT environment.
- The network: The communication networks that connect the smart cameras to each other or to others and transmit the data collected through various recent technologies (such as BLE, Wifi, ZigBee, etc.).

• Applications: The link between the IoVT interface and end users (people or systems), this is a layer for processing, storing and analysing the large volumes of data received from smart cameras.

• Computing paradigms: Modern IoT paradigms such as cloud computing, which allows large amounts of data to be stored and analysed thanks to their significant storage capacity and high computing power. Fog computing which effectively manages and controls a set of smart cameras located in its geographical area.

The Internet of Video Things (IoVT) infrastructure is illustrated in the figure below.

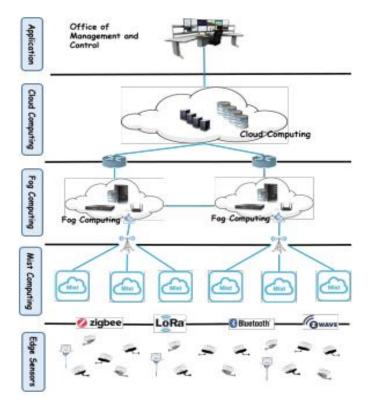


Figure 2: Infrastructure of the IoVT [15]

Model of Artificial Intelligence: The Deep Learning

Deep Learning is a set of machine learning methods attempting to model data with a high level of abstraction through articulated architectures of different nonlinear transformations. These techniques have fostered rapid advances in the fields of sound or visual signal analysis and in particular facial recognition, voice recognition, automated language processing, etc. [4]

Deep Learning techniques constitute a class of machine learning algorithm whose characteristics are as follows:

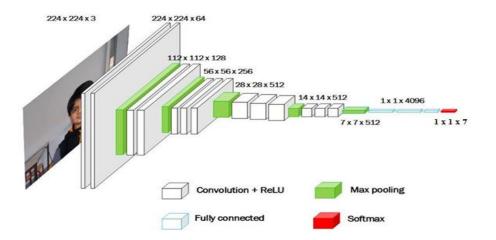
- They use different layers of nonlinear processing unit for feature extraction and transformation. Each layer takes as input the output of the previous one. Algorithms can be supervised or unsupervised and their applications include pattern recognition or statistical classification.
- They work with learning at several levels of detail or data representations. Through the different layers we pass from low level parameters to higher level parameters.
- These different levels correspond to different levels of data abstraction.

- This new field of study aims to advance further towards artificial intelligence capabilities. Its architectures now make it possible to give meaning to data in the form of an image, sound or text. [4]
- A Deep Learning system is based on artificial neural networks, which consists of a set of hidden layers, the word deep (deep learning) comes from the large number of layers and also neurons. This type of algorithm requires significant computing capacity, for this it is necessary to use GPUs in order to be able to perform complex operations in a short time.

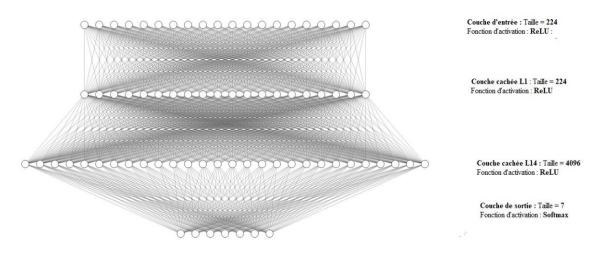
In the literature, Deep Learning models for face detection and recognition are a combination of different architectures that have been developed for other uses (most often for image classification and pattern recognition) but which are equally valid for faces. Thus, we distinguish for example some approaches such as:

- Facenet: a neural network made up of 22 deep layers [17].
- GoogleNet : a neural network made up of 22 deep layers.[18]
- DeepFace: a neural network made up of 9 deep layers. [19]
- Resnet50: a neural network made up of 50 deep layers: 49 convolution layers and 1 layer fully connected. [20]
- VGG-19: a neural network made up of 9 deep layers: 8 convolution layers and 3 layers fully connected.[21]
- VGG-16 (VGG Face-16): a neural network made up of 19 deep layers: 13 convolution layers and 3 fully connected layers, 5 pooling layers (sub-sampling), a classification layer that uses the SoftMax function (SoftMax layer). It takes as input an image ("feature map") of size 224 x 224 pixels and its output is a classifier of size 1000 (vector of facial features). [22]
- VGG-19 : is a neural network made up of 19 deep layers: 16 convolutional layers and 3 fully connected layers.[21]

In our previous work [3] [2], we used for face recognition a VGG-16 convolutional neural network pre-trained using the Transfer Learning technique. In this case, we have replaced the classification layer with a classifier of size 7. It consists of 7 classes (initially 1000) which represent the total number of individuals present in our dataset. [2] The three-dimensional representation of the architecture of VGG-16 used in our experimental device is given by figure 3. It presents the extraction of the characteristics of the photo (in colour: three channels) taken of the face of size 224×224 pixels.



*Figure 3*: 3D representation of the architecture of the neural network used [3] Figure 4 presents an overview of the two-dimensional architecture of the model used.



*Figure 4*: Overview of the 2D architecture of the neural network used [3]

Layer 1 is able to extract features of lower level of abstraction than Layer 2, while Layer 3 has higher quality. From these characteristics the system is able to recognize faces with a small error rate [23].

The source codes of the different algorithms used in our previous work [3]: facial recognition (model training, face detection and identification, real-time model testing), SMS and email notifications and door unlocking/closing are presented in appendix B.

- 2.2. Modeling of the system
- 2.2.1. Architecture of the system

The architecture of our tool is shown in the figure below.

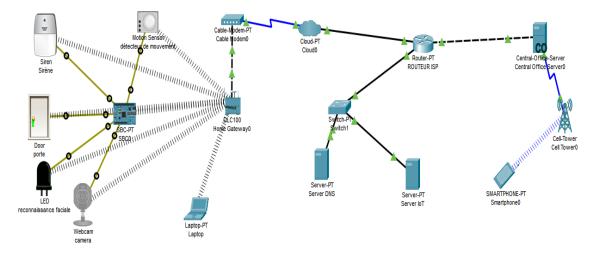


Figure 5: Architecture of the tool [4]

When a person arrives, there is:

- (1) Detection of the movement of the person using the motion detector;
- (2) Shooting of the face of the person who wishes the door to be opened using a connected camera. This image is transmitted to the Raspberry Pi nano computer; Automatic door opening upon face recognition;
- (3) Notification by Email through servers hosted in the Cloud.
- (4) Alert in case of non-recognition of the face.

A phone connected to the same local network (WiFi, Ethernet) as the Raspberry Pi, allows you to administer, monitor, control or maintain the tool remotely.

The scenario can be summarized as follows:

- **First case: face detected and recognized**. When the face is recognized by the Raspberry Pi (this materializes by the activation of the LED), the door opens. An email is sent to the local administrator, using Cloud services to notify of the presence of an individual. The email contains a message indicating either the opening of the door.

- Second case: face detected and not recognized. When the face is not recognized, the Raspberry PI sends an email to the owner (administrator) of the infrastructure to report the presence of an unknown person. The email only contains a message indicating the presence of an unknown person. The administrator of the device also has the possibility of authorizing the opening of the door to this one or even recording it.

2.2.2. Organizational chart of the methodological steps The scientific approach adopted for the realization of our tool is illustrated in Figure 5.

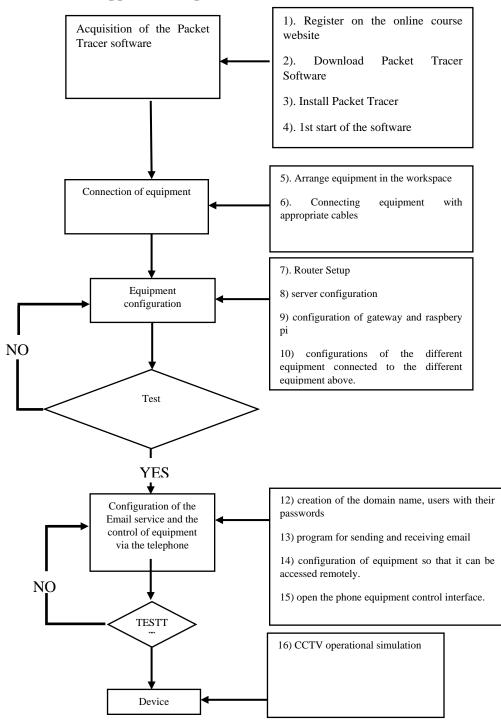


Figure 6: Organizational chart of the methodological steps [4]

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### III. RESULTS

### 4.2.1. The router

We did the configuration on the router as following:

The first configuration was the one for the port GigabiEthernet 0 /7

R	ROUTE	UR ISP					—		×
	Physical	Config	CLI	Attributes					
	G	LOBAL	~		Gigal	bitEthernet7/0			
	5	Settings						-	-
	Algorit	thm Settings	5	Port Status					On ?
	R	OUTING		Bandwidth		1000 Mbps 100 Mb			
		Static		Duplex		Half Duple:	x 🔘 Full Du	plex 🗹 A	Nuto
		RIP		MAC Address		00D0.D372.1EE0			
	IN	TERFACE		IP Configuration					
	FastE	thernet0/0		IPv4 Address		209.165.201.1			וו ר
	Gigabi	tEthernet6/0	C	Subnet Mask	(	255.255.255.0			- 11
1	Gigabi	itEthernet7/0							
Ч	Gigabi	tEthernet8/0	5	Tx Ring Limit		10			
	Gigabi	tEthernet9/0	D			10			
			~						
		t IOS Comman							
		configura		commands, one per line.	End with	CNTL/Z			^
	Router	c(config)#	inte	face GigabitEthernet7/0					
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				face GigabitEthernet7/0	)				
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Figure 7: configuration of the port GigabutEthernet 0/7

## Subsequently, port 0/8 configuration followed

GLOBAL	<u>^</u>	GigabitEthernet8/0
Settings		
Algorithm Settings	Port Status	(⊻
	Bandwidth	🔘 1000 Mbps 🔘 100 Mbps 🖲 10 Mbps 🟹
ROUTING	Duplex	O Half Duplex  Full Duplex
Static		
RIP	MAC Address	00E0.F7A5.B605
INTERFACE	IP Configuration	
FastEthernet0/0	IPv4 Address	209 165 200 1
GigabitEthernet6/0		
	Subnet Mask	255.255.255.252
GigabitEthernet7/0		
GigabitEthernet8/0	Tx Ring Limit	10
GigabitEthernet9/0	TX Ring Limit	10
	J	
outer(conrig-ir)	Ŧ	
Router(conrig-if)	# #exit	
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🗌 Тор

Figure 8: configuration du port gigabitEthernet 0/8

GLOBAL		GigabitEthernet9/0
Settings		
Algorithm Settings	Port Status	
ROUTING	Bandwidth	🔵 1000 Mbps 💿 100 Mbps 🔵 10 Mbps 🗹 Au
	Duplex	🔿 Half Duplex 🔍 Full Duplex 🔽 Au
Static	MAC Address	00D0.97DE.65DD
RIP	MAC Address	0000.9702.6500
INTERFACE	IP Configuration	
FastEthernet0/0	IPv4 Address	10.0.0.1
GigabitEthernet6/0	Subnet Mask	255 255 255 0
GigabitEthernet7/0	Sublict musik	200.200.200.0
GigabitEthernet8/0		
	Tx Ring Limit	10
GigabitEthernet9/0		
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quivalent IOS Commands	·	
Router(conrig-ir)#		
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Finally, the configuration of the third port is done as follows:

Figure 9: configuration of the port gigabitEthernet 0/9

This phase being finished, we moved on to the configuration of the routes:

💐 ROUTEUR ISP					—		$\times$
Physical Config CLI	Attributes						
GLOBAL Settings Algorithm Settings ROUTING Static RIP INTERFACE FastEthernet0/0 GigabitEthernet6/0 GigabitEthernet8/0 GigabitEthernet9/0	Network 192.168.	192.168.3.0 255.255.255.0 209.165.200.2 Address 3.0/24 via 209.165.201 0/24 via 209.165.201		Static Routes	bbA	Remove	2
Equivalent IOS Commands							_
Router> Router>enable Router# Router#configure te Enter configuration Router (config)# Router (config)#		one per line.	End wit	th CNIL/Z.			< >
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## Figure 10: configuration of routes

Finally we configured the DHCP service on the router via the CLI tab. To do this, we typed the following commands: enable

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configure terminal							
ip dhcp pool isp	ip dhcp pool isp						
network 10.0.0.0 255.25	5.255.0						
default-router 10.0.0.1	default-router 10.0.0.1						
dns-server 10.0.0.10							
exit							
exit							
ip dhcp centralofficeserver							
ip dhcp pool centralofficeserver							
network 209 255.255.255.0	0.165.201.0						
default-router 209.165.201.1							
dns-server 10.0.0.10							
exit							
exit							
copy run start							
sh run							

ROUTEUR ISP

	Physical Config CLI Attributes
	IOS Command Line Interface
	63488K bytes of ATA CompactFlash (Read/Write)
	Press RETURN to get started!
	<pre>%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet7/0, changed state to</pre>
	<pre>%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet8/0, changed state to</pre>
	<pre>%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet9/0, changed state to</pre>
l	Router>enable Router#configure terminal Enter configuration commands, one per line. End with CNTL/2. Router(config)#in dhcp pool isp Router(dhcp-config)#network 10.0.0.0 255.255.255.0 Router(dhcp-config)#dms-server 10.0.0.10 Router(dhcp-config)#exit Router(config)#exit Router# #SYS-5-CONFIG_I: Configured from console by console enable Router#configuration commands, one per line. End with CNTL/2. Router(config)#ip dhcp pool isp Router(dhcp-config)#dms-server 10.0.0.10 Router(dhcp-config)#dms-server 10.0.0.10 Router(dhcp-config)#dms-server 10.0.0.10 Router(dhcp-config)#dms-server 10.0.0.10 Router(dhcp-config)#exit Router# Router#configuretter# Router#configuretter# Router#configuretter# Router#configuretter# *SYS-5-CONFIG_I: Configured from console by console
	Copy

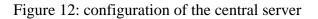
🗌 Тор

*Figure 11: configuration of the DHCP in the global configuration mode* 

This phase shows the end of the configuration of the router.

## 4.2.2. Configuration of the central server

Settings         Algorithm Settings         INTERFACE         Backbone         Cell Tower         Static         IPv4 Address         Subnet Mask         255.255.255.0         Default Gateway         209.165.201.1         DNS Server         Interface         IPv6 Address         Link Local Address         DNS Server         DNS Server	Settings         Algorithm Settings         INTERFACE         Backbone         Cell Tower         Subnet Mask         209.165.201.2         Subnet Mask         209.165.201.2         Subnet Mask         Default Gateway         DNS Server         Invo Automatic         Image: Setting Se	GLOBAL	$\sim$		Backbone Settings		1
· · · · · · · · · · · · · · · · · · ·	v	Settings Algorithm Settings INTERFACE Backbone		DHCP     Static     IPv4 Address     Subnet Mask     Default Gateway     DNS Server     IPv6 Configuration     Automatic     Static     IPv6 Address     Link Local Address: FE80::240:BFF:FE     Default Gateway	209.165.201.2 255.255.255.0 209.165.201.1 10.0.0.10	И	
			~				



## **4.2.3.** Configuration of the Cloud

Physical Config	Attributes			
Physical Config	Attributes			
GLOBAL		Ethernet6		
Settings				
TV Settings	Provider Network	Cable	O DSL	
CONNECTIONS				
Frame Relay				
DSL				
Cable				
INTERFACE				
Serial0				
Serial1				
Serial2				
Serial3				
Modem4				
Modem5				
Ethernet6				
Coaxial7				
~				

Figure 1: configuration of the Ethernet6 interface

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R Cloud0			- 🗆 ×
Physical Config A	ttributes		
Physical Config A GLOBAL Settings TV Settings CONNECTIONS Frame Relay DSL Cable INTERFACE Serial0 Serial1 Serial2 Serial3 Modem4 Modem5 Ethernet6 Coaxial7	Coaxial7 ~ Port Coaxial7 To Port Coaxial7 Ethernet6	Cable <-> Ethernet6 Port	~
	bbA	Remove	e

Figure 13: configuration of the type of connection <sup>®</sup> Home Gateway0

PHome Gateway0	0 01	v		-	×
Physical Config GUI	Attributes				
GLOBAL Settings Algorithm Settings INTERFACE Internet LAN Wireless	IP Configuration IPv4 Address Subnet Mask	LANS	Settings 192.168.3.1 255.255.255.0		

*Figure 14: gateway (a)* 

P Home Gateway0		×
Physical Config	GUI Attributes	
GLOBAL	Wireless Settings	\$
Settings Algorithm Settings	SSID HomeG 2.4 GHz Channel 6-2.43	ateway
INTERFACE Internet	Coverage Range (meters) 250,00	
LAN Wireless	Authentication O Disabled Q WEP WEP Key	
	O WPA-PSK OWPA2-PSK PSK Pass PP WPA WPA2 RADIUS Server Settings IP Address Shared Secret	trase temp1234
	Encryption Type AES	~

*Figure 15: configuration of the gateway (b)* 

4.2.4. Configuration of the camera

		)		Wire	less0	
GLOBAL				Will C	10330	
Settings	Port Status					🗹 On
Algorithm Settings Files	Bandwidth				300 Mbps	
INTEREACE	MAC Addre	SS			0040.0B40.B657	
Wireless0	SSID				HomeGateway	
Bluetooth	Authent					
Diddtootii			O WEP	WEE	Key	
		-PSK	TO WPA2-PSK		Pass Phrase temp1234	
				Use	· · ·	
		k -	O WPA2		sword	
	0 802	1X	Method:	MD		~
				Use	r Name	
				Pase	sword	
	Encrypt	on Type		AE	S	~
	PSonfig					
	O Stat					
	IPv4 Add				192,168.3.102	
	Subnet				255.255.255.0	

Figure 16: configuration of the connection of the camera to the gateway as well as the dynamic allocation of the IP address

Specifications Physica	Config Attributes	
GLOBAL Settings Algorithm Settings	Global Settings	^
Files	Display Name camera	]
INTERFACE	Serial Number PTT081099D4-	1
Wireless0	Interfaces Wireless0 ~	i 👘
Bluetooth		í
	Gateway/DNS IPv4	
	DHCP	
	◯ Static	
	Default Gateway 192.168.3.1	
	DNS Server 10.0.0.10	
		1

Figure 2: DHCP assignment of gateway and DNS server addresses

## **4.2.4.** Configuration of the door

# International Journal of Computer Science Trends and Technology (IJCST) – Volume 11 Issue 3, May-Jun 2023

GLOBAL	N		Wireless3	
Settings	Port Status			
lgorithm Settings	Bandwidth		300 Mbps	
Files				
INTERFACE	MAC Address		0002.176C.9352	
Wireless3	SSID		HomeGateway	
Bluetooth	Authentication			
	O Disabled	O WEP	WEP Key	
	O WPA-PSK	WPA2-PSK	PSK Pass Phrase temp1234	
	O WPA	O WPA2	User ID	
		U WHAZ	Password	
	O 802.1X	Method:	MD5	
			User Name	
			Password	
	Encryption Type		AES	$\sim$
	IP Configuration			
	DHCP			
	Static			
	IPv4 Address		192.168.3.103	
	Subnet Mask		255.255.255.0	

Figure 3: connecting the door of the door to the gateway and assigning the IP address

porte	- 0	
specifications Physical Config Attributes		
GLOBAL Global S	Settings	^
Algorithm Settings		_
Files Display Name porte		
INTERFACE Serial Number PTT0810A904-		
Wireless3 Interfaces Wireless3		
Bluetooth	-	-
Gateway/DNS IPv4		
DHCP		
⊖ Static		
Default Gateway 192.168.3.1		
DNS Server 10.0.0.10		

Figure 4 : dynamic address assignment to gateway and DNS server

## 4.2.5. Configuration of the alarm

~		Wireless3		_
Port Status				
		300 Mbps		5
				÷1
				-1
		TomeGateway		
Authentication	-			Ш
	-			Ш
WPA-PSK	WPA2-PSK			Ш
O WPA	O WPA2			Ш
	-			L
0 802.1X	Method:		$\sim$	L
				L
				L
Encryption Type		AES	$\sim$	L
IP Configuration				11
DHCP				L
◯ Static				L
IPv4 Address				L
Subnet Mask		255.255.255.0		L
IPv6 Configuration				11
<ul> <li>Automatic</li> </ul>				Ш
<ul> <li>Static</li> </ul>				Ш
IPv6 Address		N		Ľ
Link Local Address:	FE80::2E0:F7FF:FE3	3B:D3B6		11
	Disabled     WPA_PSK     WPA     802.1X     Encryption Type     IP Configuration     DHCP     Static     IPv4 Address     Subnet Mask     IPv6 Configuration     Automatic     Static     IPv6 Address	Bandwidth MAC Address SSD Authentication Disabled WPA_PSK  WPA2-PSK WPA 0 WPA 0 WPA2 0 802.1X Method: Encryption Type IP Configuration 0 DHCP 0 Static IPv4 Address Subnet Mask IPv6 Configuration 0 Automatic 0 Static IPv6 Address	Bandwidth     300 Mbps       MAC Address     00E0.F738.D386       SSD     HomeGateway       Authentication     WEP       O Basbied     WVPA       WPA-PSK     Image: WVPA2-PSK       O WPA     WVPA2       Password     User ID       Dassbied     User ID       O 802.1X     Method:       Image: Point Static     Image: Point Static       Image: Pv4 Address     192.168.3.101       Static     Ps6 Configuration       O Automatic     Static       Image: Pv6 Address     Image: Pv6 Address	Bandwidth     300 Mbps       MAC Address     00E0.F738.D386       SSD     HomeGateway       Authentication     WEP       O Bisabled     WVPA       WPA-PSK     Image: WVPA2-PSK       O WPA     WVPA2       O 802.1X     Method:       Image: Disabled     WPA2       O WPA     User ID       Password     Password       Image: Disabled     Image: Disabled       Image: Disabled     WPA2       Image: Disabled     Image: Disabled       Image: Disabled     Image: Disabled <t< td=""></t<>

ecifications Physical	Config Attributes		
GLOBAL Settings	Global Settings		1
Files	Display Name Sirène		
INTERFACE	Serial Number PTT0810JYRR-		
Wireless3	Interfaces Wireless3	$\sim$	
Bluetooth	Gateway/DNS IPv4		
	DHCP		
	O Static		
	Default Gateway 192,168.3.1		
	DNS Server 10.0.0.10		
	DNS Server 10.0.0.10		
	Gateway/DNS IPv6		
	O Automatic		
	Static		
	Default Gateway		
	DNS Server	 -1	
	IoT Server		
	O None		
	O Home Gateway		
	Remote Server		

*Figure 5: connection of the alarm to the gateway and assignment of the IP address* 

Figure 6: dynamic IP address assignment to gateway and DNS server

## 4.2.6. Configuration of the motion sensor

GLOBAL			Wireless0		
Settings					1
Algorithm Settings	1	Port Status		🗹 On	
Files	1	Bandwidth	300 Mbps		
INTERFACE	i	MAC Address	0030.F27A.84EE		1
(Wireless0)	1	SSID	HomeGateway		1
	1	Authentication			
		O Disabled O WEP	WEP Key		
		O WPA-PSK O WPA2-PSK	PSK Pass Phrase temp1234	——————————————————————————————————————	
			User ID		
		O WPA O WPA2	Password		
		O 802.1X Method:	MD5	$\sim$	
			User Name		
			Password		
		Encryption Type	AES	~	
		IP Configuration			
		DHCP			
		◯ Static			
		IPv4 Address	192.168.3.105		
		Subnet Mask	255.255.255.0		
		IPv6 Configuration			
		<ul> <li>Automatic</li> </ul>			
		Static			
		IPv6 Address	N		t,
		Link Local Address: FE80::230:F2FF:FE7	7A:84EE		
	$\sim$				_

Figure 7: gateway connection and dynamic IP address assignment

	<u>ц</u>	$\sim$
ecifications Physical Config Attributes		
GLOBAL    Global Settings		^
Algohithm Settings Files Display Name détecteur de mouvement INTERFACE Serial Number PTT08106570-		
Wireless0 Gateway/DNS IPv4 DHCP Static		
Default Gateway 192.168.3.1 DNS Server 10.0.0.10		
Gateway/DNS IPv6 Automatic Static		
Default Gateway DNS Server		
IoT Server None Home Gateway		
Remote Server     Server Address cisco.com		~
op	Adva	nced

Figure 8: assignment of IP address to the gateway and the motion detector

2.1. Configuration of the DNS server

Figure 9: definition of static server addresses

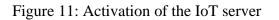
Server D	NS								-		>
Physical	Config	Sen	vices	Desktop	Programming	Attributes					
1	VICED	^					ONS				
	TTP HCP		DNS Se	ervice	(	On		⊖ Off			-
-	CPv6 FTP		Resour	ce Records							-
	ONS		Name		cisco.co	>		Туре	A Record	~	
1	SLOG		Addres	s 10.0.0.1							
N	ITP			Add	<b>,</b>	S	ave		Remove		
EN	1AIL										÷.,
F	тр		No		Name		Туре		Detail	_	
I	оТ		0	cisco.c	om	A Recor	d	10.0.0.			
VM Man	agement										-
		_	DNS	Cache							_

Figure 10: domain name definition

## 2.2. Configuration of the IoT server

' Server lo	т							_	
Physical	Config	Serv	vices	Desktop	Programming At	tributes			
	VICES TTP HCP CPv6 FTP INS SLOG AA AA ITP IAIL TP IOT ID ID ID ID ID ID ID ID ID ID	<	This se Servic	Username	top of the HTTP or HT Password admin	Registration S TPS service.			O off
									Delete
		~							
1									

] Тор



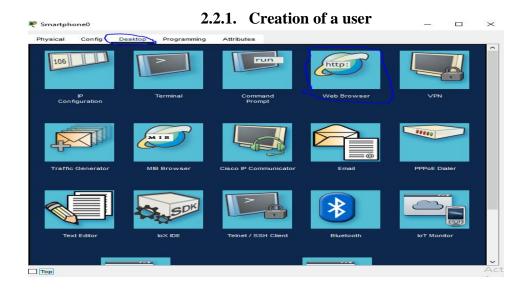


Figure 12: Opening of the web browser interface

Physical	Config	Desktop	Programming	Attributes				
Web Brow								x
<	> URL	cisco.com				Go	Stop	

Figure 13: address of the target server

🖉 Smartphone0	_	
Physical Config Desktop Programming Attributes		
Web Browser		×
< > URL http://cisco.com	Go	Stop
Registration Server Login		
Username: Password:		
Sign In		
Don't have an IoT account? Sign up now		

Figure 14: create a new user

hysical	Config	Desktop	Programming	Attributes				
Veb Brows	ser							Х
< :	> URL	http://cisco.co	om/create_accou	nt.html			Go	Stop
			Registrati Usernan Passwor	ne: admin d: •••••	r Accour	tion		

Figure 15: creation of a user

Smartphone0						—		$\times$
Physical Con	fig Desktop	Programming	Attributes					
Web Browser								×
< >	RL http://cisco.o	com			Go		Stop	
		Reg	istration	Server Login				
Don't have a	n IoT accour	Usernan Passwor nt? <u>Sign up no</u>	Sig	n In				

Figure 16: coordinate of the previously created user



Figure 17: no device connected yet

## 2.2.2. The administrator machine

Here, you must first connect the machine to the gateway as shown in Figure 52, then activate the DHCP service on the machine.

Physical	Config	Deskt	op Programming	Attributes		
GLO	DBAL	$\sim$			Wireless0	~
	tings n Settings RFACE eless0 stooth		Port Status Bandwidth MAC Address SSID		54 Mbps 000B.BEE7.9130 HomeGateway	⊡ On
			Authentication Disabled WPA-PSK WPA 802.1X Encryption Type	<ul> <li>WEP</li> <li>WPA2-PSK</li> <li>WPA2</li> <li>Method:</li> </ul>	WEP Key PSK Pass Phrase User ID Password MD5 User Name Password AES	~
			DHCP     Static     IPv4 Address     Subnet Mask     IPv6 Configuration     Automatic     Static     IPv6 Address     Link Local Address	FE80::20B:BEFF:FE	192.168.3.101 255.255.255.0	

Figure 18: configuration of the administrator machine

Physical Config Desktop	Programming Attributes Global Settings
Algorithm Settings	
INTERFACE	Display Name Laptop
Wireless0	Interfaces Wireless0 ~
Bluetooth	Gateway/DNS IPv4

Figure 19: dynamic addressing

2.2.3. The gateway

Home Gateway0					_	$\times$
Physical Config	GUI	Attributes				
GLOBAL Settings Algorithm Settings INTERFACE Internet LAN Wireless	<	IP Configuration ○ DHCP ④ Static IPv4 Address Subnet Mask Default Gateway DNS Server	2	ettings 09.165.200.2 55.255.255.252 09.165.200.1 0.0.0.10		

Figure 20: configuration of the internet interface of the gateway

🖗 Home Gateway0			_	$\times$
Physical Config GUI	Attributes			
GLOBAL ^ Settings Algorithm Settings	IP Configuration	LAN Settings		
INTERFACE Internet LAN	IPv4 Address Subnet Mask	192.168.3.1 255.255.255.0		2
Wireless				
~				

Figure 21: configuration of the LAN i, nterface of the gateway

Home Gateway0			- 0	>
Physical Config	GUI	Attributes		
GLOBAL			Wireless Settings	
Settings		SSID	HomeGateway	٦
Algorithm Settings		2.4 GHz Channel	6 - 2.437GHz	
INTERFACE				Ě
Internet		Coverage Range (meters)	250,00	믝
LAN		Authentication		
Wireless		O Disabled 📿 WEP	WEP Key	
		O WPA-PSK O WPA2-PSK	PSK Pass Phrase temp1234	
		O WPA O WPA2		
		RADIUS Server Settings		
		IP Address		
		Shared Secret		
		Encryption Type	AES ~	
				-1
	5			

*Figure 22: configuration of the wireless interface* 

## 2.2.4. Raspberry pi

To connect the raspberry to the gateway, simply click (left click) on the raspberry, go to "config", then to "wireless3", set the gateway password.

GLOBAL	~		Wireless3	
Settings	Port Status			
Igorithm Settings	Bandwidth		300 Mbps	
Files	MAC Address		000B.BED0.CBBB	
INTERFACE	SSID		HomeGateway	
Wireless3	5512		nonicoateway	
Bluetooth	Authentication	O WEP	WEP Key	
		WPA2-PSK	PSK Pass Phrase temp1234	
		O WPA2	User ID	
			Password	
	O 802.1X	Method:	MD5	
			User Name	
			Password	
	Encryption Ty	pe	AES	~
	IP Configuration	on		
	O Static		192.168.3.106	
	Subnet Mask		255.255.255.0	
	IPv6 Configur Automatic Static			
	IPv6 Address		(	

Figure 23: configuration of the raspberry pi wireless interface and dynamic IP address assignment

GLOBAL	
Settings	Gateway/DNS IPv4
Algorithm Settings	DHCP
Files	O Static
INTERFACE	Default Gateway 192.168.3.1
Wireless3	
Bluetooth	DNS Server 10.0.0.10
	Gateway/DNS IPv6
	Automatic
	○ Static
	Default Gateway
	DNS Server
	loT Server
	O None
	O Home Gateway
	Remote Server
	ServerAddress
	User Name
	Password
	Connect
	Connect
~	

*Figure 24: dynamic ip address assignment to raspberry default gateway and dns server* 

## 2.3. Configuration for the reception of emails

### 2.3.1. Configuration of the Raspberry pi

To configure the raspberry so that it can receive messages, you must:

-click on the raspberry

-choose "programming"

-define the name of the program and choose the language (we chose "python" later "email python"

Create Project	×
Enter a project name and	select the project type.
Name: email	
• Template	
Email - Python	•
Global Script Project	
MQTT Broker - (Python)	•
	Create Cancel

Figure 25: Creation of 'email

Finally, click on "create".

After that we go to the interface and click on "main". We will therefore have a basic program for sending emails that we are going to modify.

### **2.3.2.** Configuration of the server

After doing this work, we return to the server for a new configuration

For this, we will follow the following procedure:

- click on the server,

- choose "email"

-define users and passwords. (We have defined 3 users so one sender and two recipients).

All this after the email services are activated and also that the domain name is correctly defined.

Server lo I Physical Config	Services Desktop Programming Attributes	_		~
SERVICES HTTP DHCPV6 TFTP DNS SYSLOG AAA NTP EMAIL FTP IOT VM Management Radius EAP	EMAIL SMTP Service POP3 Service		+ - Change Password	
				Ac

*Figure 26: email service (creation of logins and passwords)* 

## 2.3.3. Configuration of the computer

Click on pc, choose "Desktop" then "email" and "email configuration".

onfigure Mail		Desktop	Programming	Attributes	
	1				3
User Informa					
Your Name:		sms			
EmailAddres	55	sms@cisco	.com		
Server Inform	mation				
ncoming Mai	ail Server	10.0.0.10			
Outgoing Ma	ail Server	10.0.0.10			
ogon Inform	mation				
User Name:		sms			
Password:					
Save		move			
Save					Clear Reset

Figure 27: Configuration of email

### RESULTS

After configuring the equipment and writing the algorithm, we will compile our program by clicking on "run".

After configuring our system equipment (router, central server, cloud server, IoT server, DNS server, gateway, door, siren, motion detector, Raspberry pi, administrator machine, user) [4], and l writing the algorithm, we can then run our program.

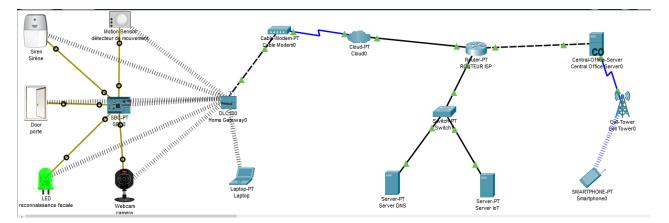
Open New			
main.py	1		Reload Copy Paste Undo Redo Find Replace Zoom:+ -
		1	<pre>from email import * from time import *</pre>
		3	•
			def main():
		5	pinMode (4, OUT)
		6	pinMode (5, INPUT)
		7	pinMode(0,OUT)
		8	pinMode(1,INPUT)
		9	pinMode(2,OUT)
		10	pinMode(3,OUT)
		11 -	<pre>def onEmailReceive(sender, subject, body):</pre>
		12	<pre>print("Received from: " + sender)</pre>
		13	present ( resultant ) resultant )
		14	<pre>print("Body: " + body)</pre>
			<pre>def onEmailSend(status):</pre>
		16	<pre>print("send status: " + str(status))</pre>
			<pre>def main(): TracilOlicate seture(</pre>
		18 19	EmailClient.setup( "mcu@cisco.com",
		20	"cisco.com",
		21	"mcu",
		22	"password"
		23	)
		24	/ EmailClient.onReceive(onEmailReceive)
		25	EmailClient.onSend(onEmailSend)
		26 -	while True:
	_	27 -	if (digitalDead(1) HTCH) .
		28	

## *Figure 42*: *Execution of the program* [4]

Appendix A presents the source code of the program used to simulate our door control system by facial recognition [4] on Pocket Tracer.

3.1. First case: Face detected and recognized

There is facial recognition, materialized by the activation of the LED, the door opens.



*Figure 43*: Opening of the door [4]

An email is sent to the administrator to report the opening of the door.

	Compose Rep	Ny Receive Delete	Configure Mail
	From	Subject	Received
3	mcu@cisco.com	alerte inconnu	lun. juil. 18 2022 03:17:58
4	mcu@cisco.com	alerte inconnu	lun. juil. 18 2022 03:17:41
5	mcu@cisco.com	alerte inconnu	lun. juil. 18 2022 03:17:07
6	mcu@cisco.com	alerte reconnaissance	mar. juil. 19 2022 22:46:03
7	mcu@cisco.com	alerte reconnaissance	lun. juil. 18 2022 03:18:45
<			>

*Figure 44:* mail for the door opening [4]

3.2. **Second case**: Face detected and not recognized There is no facial recognition and the alarm activates itself.

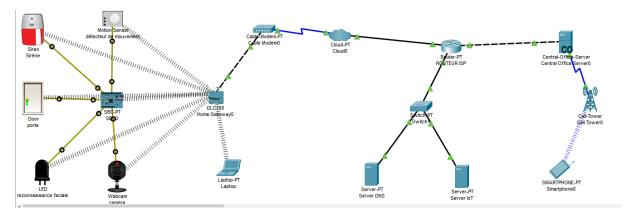


Figure 45: Activation of the alarm [4]

An email is also sent to the administrator in this case.

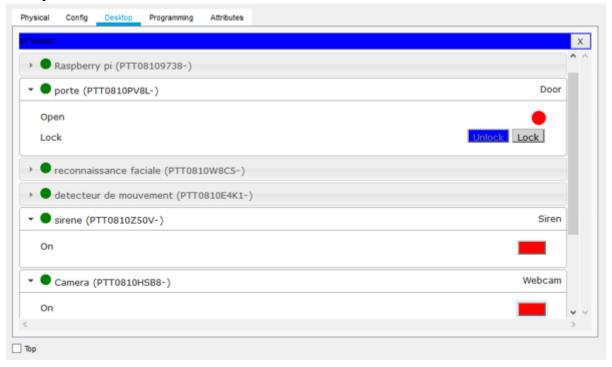
	Compose	eply Receive Dele	configure Mail
	From	Subject	Received
1	mcu@cisco.com	alerte inconnu	lun. juil. 18 2022 03:19:55
2	mcu@cisco.com	alerte inconnu	lun. juil. 18 2022 03:19:31
3	mcu@cisco.com	alerte inconnu	lun. juil. 18 2022 03:17:58
4	mcu@cisco.com	alerte inconnu	lun. juil. 18 2022 03:17:41
5	mcu@cisco.com	alerte inconnu	lun. juil. 18 2022 03:17:07
<			>

Figure 46: Receival of the message

3.3. Monitoring Interface

Il est possible de contrôler les équipements de notre système à travers le téléphone. En effet, l'administrateur peut, à travers son téléphone, activer ou éteindre la caméra, ouvrir ou fermer la porte ou encore permettre ou éteindre la sirène. Pour cela tous ces équipements doivent être connectés au serveur IoT en mode « remote ».

La figure ci-dessous présente l'interface de commandes des différents équipements à travers le smartphone.



*Figure 47*: Administration of equipment via smartphone [4]

### IV. CONCLUSION

This work highlights the design and simulation of a video surveillance system with facial recognition on the Packet Tracer network simulator. This system is an Internet of Things (IoT) application that uses a Raspberry Pi nanocomputer on which a camera is connected, and exploits cloud services to store the faces of people with authorization to enter the company. The solution we propose is a didactic tool. It can therefore be used by teachers for students for educational purposes.

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