



North Technical University. Cristian Germán Design of a system of video surveillance IP and alarm 1
based on movement, using free software on a single board computer, for the company color 2000 in the
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UNIVERSIDAD TÉCNICA DEL NORTE
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SCIENTIFIC ARTICLE

Theme:

**DESIGN OF A SYSTEM OF VIDEO SURVEILLANCE IP AND ALARM BASED
ON MOVEMENT, USING FREE SOFTWARE ON A SINGLE BOARD
COMPUTER, FOR THE COMPANY COLOR 2000 IN THE CITY OF IBARRA**

AUTHOR: CRISTIAN GERMAN CANACUAN IPIALES

DIRECTOR: ING. OMAR OÑA

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Design of a system of video surveillance IP and alarm based on movement, using free software on a single board computer, for the company color 2000 in the city of Ibarra

Canacuan Cristian Author, Oña Omar Director
cgcacuan@utn.edu.ec, oronia@utn.edu.ec
North Technical University

Abstract — In the present degree, the design of an IP video surveillance system and alarm based on movement was made, using free software on a single board computer, for the company Color 2000 of the city of Ibarra, with the purpose of alerting on the presence of intruders in the monitored areas and improve the efficiency of the operating personnel. The comparative method with similar proprietary systems was used to design and identify the main characteristics of this IP video surveillance system and alarm, it was determined that it requires applications such as: image capture, motion detection, warning of the presence of an intruder, the possibility of local and remote access, additionally added features that conventional video surveillance systems do not possess such as: remote system control by means of applications, notification by means of Telegram messages. The system was adapted to the needs of the company which were determined in an interview with the manager, later covered by the creation of files interpreters of commands (scripts). The system is compatible with Windows and Linux platforms and accessible from the local or remote network.

Keywords

Video surveillance IP, Single board computer, Raspberry PI 3.

I. INTRODUCTION

The Color 2000 Warehouse dedicates its work to the commercialization of automotive, architectural and metalworking paint, color preparation and

complementary sales, the strength of this business is the experience of more than ten years in the market and its wide automotive line, which they are elements that differentiate this company from the competition. Account with its matrix located in the Av. Jaime Rivadeneira Opposite the Luis Leoro Franco Coliseum and its branch in the Av. Teodoro Gómez 15-18 and Gral. Julio Enríquez. The Color 2000 Warehouse in its communications infrastructure does not have a video surveillance and alarm system in any of its dependencies, it currently has the residential internet service contracted with CNT EP both in its headquarters and in the branch. The absence of a video surveillance system in the warehouse causes insecurity towards its customers, employees and company as such, the problem lies in the lack of remote and local monitoring of events occurring in its facilities in real time.

The functions carried out by the warehouse management do not allow interactively and full-time management of the activities carried out in the company, such as monitoring compliance with tasks assigned to employees, inventory control, sales monitoring and other elements. Many times there are internal losses or the staff does not fully comply with the tasks assigned at work. The Color 2000 Warehouse is visited daily by hundreds of customers, the influx in the matrix of the company causes the activities to focus on customer service. In these circumstances, management indicates that this is where product thefts and material losses are caused by the carelessness of the workers. Management also mentions that many of the tasks assigned to employees are not met in time, generating delays and losses.

The recording of events that occurred in the Color 2000 Warehouse and storing them by means of video and images obtained with technology that uses free software gives rise to a scalable, flexible and robust video surveillance system which will allow remote and local monitoring. The use and implementation of these video surveillance systems in today's society allow safeguarding the integrity of people and companies by keeping them under surveillance and at the same time generating an environment of comfort and security, in a simple, immediate and even with the possibility of having access to the screen of a mobile phone.

II. BASIC CONCEPTS

A. Video surveillance systems.

The video surveillance systems are a set of devices that provide the user with numerous possibilities that allow him to solve his needs in an efficient and effective way, managing the cameras for the monitoring of a site either locally or remotely. The objective of this system is the supervision, control and eventual recording of physical activity in a local, space or environment in general. It is called a closed circuit because, unlike traditional television, it only allows limited and restricted access of the content of the images to some users. [1]

1) *IP video surveillance systems*: In recent years, video surveillance technology has undergone a revolution as a result of the application of IP technology in the sector. IP video or IP video surveillance, like many other types of communications such as e-mail, Web servers or IP telephony, are made through networks, whether wired or wireless. All the audio / video flow is made through the same common network infrastructure, which brings many advantages over traditional CCTV systems.



Figure 1. Basic outline of an IP video surveillance system.

B. Single board computers.

A computer with a reduced board or also known as a SBC (Single Board Computer) device, is a complete computer in a single circuit, which has all the features of a functional computer in a single small card. In short, it houses everything you need for proper operation on the motherboard. Throughout the present work, some of these devices and their characteristics will be mentioned. Currently, these devices are booming mainly due to the good performance ratio and its low price. In recent years, the SBC or mini PCs have undergone a great evolution and development, increasing their performance and features, to the point of being used as a common computer. [2]

1) *Raspberry PI*: It is a computer SBC (Single Board Computer) of low cost of very small size can be compared to the size of a credit card, was created primarily for the purpose of teaching children to program computers. This device was developed by the Raspberry Pi Foundation at the University of Cambridge, which aims to teach computers in schools. [3]

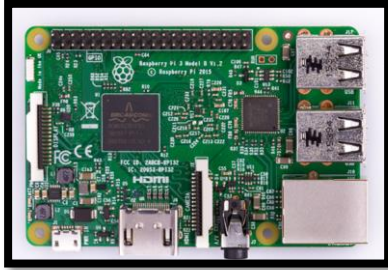


Figure 2. Board of Raspberry PI 3.

C. Free Software.

When we speak of free software, we refer to the freedom of the users to execute, copy, distribute, study, change and improve the software. We refer especially to four kinds of freedom for software users:

- Freedom 0: the freedom to execute the program, whatever our purpose.
- Freedom 1: the freedom to study the operation of the program and adapt it to your needs, access to the source code is an indispensable condition for this.
- Freedom 2: the freedom to redistribute copies and thus help your neighbor.
- Freedom 3: the freedom to improve the program and then publish it for the good of the entire community, access to the source code is an indispensable condition for this.

Free software does not mean that it is "Non-commercial". Any free program will be available for commercial use, development and distribution. The commercial development of free software has stopped being exceptional and in fact that commercial free software is very important. [4]



Figure 3. Linux Distributions.

1) *Scripts*: It is a file that contains a set of commands that are executed sequentially, from the first to the last. The objective is to automate the task of entering the commands one by one in the command console, and execute the commands that we want to perform in an agile and automatic way.

2) *Free Software of IP Telephony: Asterisk* it is a distribution on which a VoIP communications platform can be deployed. In it we can find the pre-installed Asterisk packages, the AsteriskGUI graphical interface, the DAHDI framework, as well as the necessary components so that we can correctly execute all the installation and configuration of our platform. As an optional package, it offers the FreePBX graphic interface. Based on Fedora and CentOS, it offers stability and package compatibility to make it easier for us to develop or install software. [5]

3) *Free software for camera management: Motion* is a program that monitors the video signal from one or more cameras and is able to detect if a significant part of the image has changed; In other words, movement can be detected. The program is written in C and is made for the Linux operating system. Motion is a tool based on the command line whose output can be in jpeg format, files ppm or MPEG video streams. Motion is strictly command-line driven and can be executed as a daemon. It is the perfect tool to monitor your property, focusing only on those images that are interesting. [6]

D. Applied Technologies.

1) *IEEE 802.3 Standard (Ethernet)*: Ethernet is the most used local area network technology today, it is the most popular LAN technology, IEEE 802.3 defines the rules for the configuration of an Ethernet network which handles two physical aspects and corresponding to the physical layer and the data link layer respectively.

2) *IEEE 802.15 Standard (Bluetooth)*: Wireless communications technology that was established for short range, admitting voice and data transmission creating a personal area network (PAN). This is a system that widens the spectrum by frequency

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jumps, working in ISM bands of international availability at 2.4 GHz. Bluetooth specification 2.0 applied an improved transmission speed of up to 3 Mbits / s; In addition, this technology follows the trend to reduce energy consumption. [7]

3) *Advanced Mobile System (SMA)*: This is the service that allows subscribers to make and receive voice calls, SMS and access data connections through an application such as social networks. This final service transmits, broadcasts and receives signals, images, sounds, data, voice or information of any nature.

III. EXPERIMENTAL DEVELOPMENT

A. *Analysis of the Current Situation.*

Through an interview with the manager it was determined that there is a need for a video surveillance system that allows monitoring in the company's matrix, due to cases in which the company presents losses caused by the theft of products. The management also mentions that access to the warehouse where the products are stored must be monitored, in order to avoid loss of products and monitor the activities of the company's employees.

The company with the purpose of protecting the material goods has installed a conventional alarm system, which triggers a siren when the contact sensors are activated at the main entrance and its emergency exit, it should be noted that the company has only protected main accesses, The architectural infrastructure of the company consists of windows both on the first floor and on the second floor, this could be used by criminals to access the facilities and subtract the goods.

On the first floor, due to the influx of customers and the development of operational staff activities, a monitoring approach using video surveillance is required in order to record on video the events that occurred during the working day. On the second floor you should monitor the storage of products and access to them, you must have a backup in the form of video and images.

To complement the alarm system already installed in the company, an alarm system based on motion

detection must be incorporated and alert the owner manager of the intrusion into the company's facilities through a call to his mobile phone, sending an email with images of the event and sent a message via WhatsApp or Telegram to the number of the manager since the attention response to social networks is faster nowadays.

The aim of safeguarding the integrity of clients and employees of the company Warehouse Color 2000 and to offer a quality service in both attention and security, monitoring and surveillance are part of the mission of this company therefore it is important to keep a record of the activities that are carried out and supported in the form of video and images.

The design of this video surveillance system focuses on the infrastructure of the matrix where the company Warehouse Color 2000 works, this infrastructure consists of two floors on which this design is based. On the first floor of this institution are located the main access areas, customer service, auxiliary exit and the shelving section, counters and showcases of the products offered by this company. On the second floor the warehouse is located for the storage of products, this area is a single space without divisions.

B. *System Requirements.*

For the analysis of the requirements of the system, reference is made to the ISO / IEC / IEEE 29148: 2011 standard. The video surveillance system aims to monitor the areas defined through the interview with the manager of the company Warehouse color 2000. The requirements are the starting point for the development of this project, directly relate the needs of the user with the solutions that will provide the fulfillment of the objectives of this project, to understand this in a clearer way, the actors that intervene directly in this system.

C. *Hardware and Software Selection.*

For the operation of the system, the following basic components were selected: a small board computer: Raspberry PI 3, video capture devices and

images: Imexx IME-41674 camera, USB HUB: 7 HUB.

The operating system was selected: Raspbian, the camera management software: Motion and the IP telephony software: Asterisk.

D. System design

Next, the operation of the video surveillance and alarm system by motion detection is presented by means of a block diagram showing its elements and the structure it will have. In figure 4 this mentioned diagram is shown.

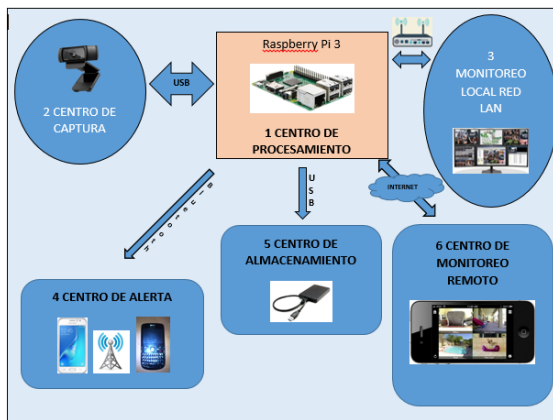


Figure 4. System Block Diagram.

The processing center where the configuration made in the reduced board computer will act, manages the capture of images and video, storage, presentation for local and remote monitoring, data storage, system control and alarm.

Diagram of connections:

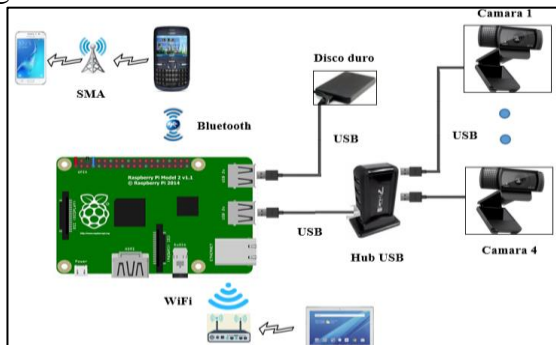


Figure 5. System connections diagram.

1) Calculation for disk capacity:

| | |
|--|-----------|
| Number of webcams | 4 |
| Number of hours per day that you are recording data | 24 hours |
| Resolution of the image | 640 x 480 |
| Type of image compression | JPEG |

Storage per hour:

$$\text{Capacity / hour} = \text{Tamaño_img} * \text{Núm_imagenes}$$

$$\text{Capacidad/hora} = \frac{22 \text{ KB}}{\text{Tamaño_imagen}} \times \frac{2 \text{ imagenes}}{\text{segundos}} \times \frac{3600 \text{ segundos}}{\text{hora}}$$

$$\text{Capacity / hour} = 158,4 \text{ MB/hora}$$

Storage per day:

$$\frac{\text{Capacidad}}{\text{día}} = \frac{\text{Capacidad}}{\text{hora}} \times 24 \text{ horas}$$

$$\frac{\text{Capacidad}}{\text{día}} = \frac{158,4 \text{ MB}}{\text{hora}} \times 24 \text{ horas}$$

$$\text{Capacity / day} = 3,8016 \text{ GB/day}$$

Total system storage per day

| Cámaras Web | Horas de Grabación | MB/Hour | GB/Hour | Total, por Cámaras (Gb) |
|-------------------------------------|--------------------|---------|---------|-------------------------|
| CAM1 | 24 | 158,4 | 0,1584 | 3,8016 |
| CAM2 | 24 | 158,4 | 0,1584 | 3,8016 |
| CAM3 | 24 | 158,4 | 0,1584 | 3,8016 |
| CAM4 | 24 | 158,4 | 0,1584 | 3,8016 |
| Total system storage per day | | | | 15,2064 |

With a disc of 1 TeraByte (TB), it is concluded that the time available for a continuous recording is 67 days; if this time is exceeded, the recording will be made on the Raspberry Pi card, producing the memory saturation, that is, the system stops working; then it is recommended to download the information every 30 days.

2) Addressing:

| Device | IP Address | Gateway |
|----------------|-------------------|-------------|
| Raspberry Pi 3 | 192.168.1.12 | 192.168.1.1 |
| Webcam 1 | 192.168.1.12:8081 | 192.168.1.1 |
| Webcam 2 | 192.168.1.12:8082 | 192.168.1.1 |
| Webcam 3 | 192.168.1.12:8083 | 192.168.1.1 |
| Webcam 4 | 192.168.1.12:8084 | 192.168.1.1 |
| Monitoring | 192.168.1.13 | 192.168.1.1 |

3) Installation of the operating system:

- Raspbian

It is designed for Raspberry plates, being a versatile, stable and reliable system which allows to develop multiple applications, under this operating system operates the video surveillance and alarm system based on motion detection. For the installation of the operating system in the Raspberry Pi 3 it is necessary a micro SD card of minimum 4Gb, for this project a micro sd card of 16 Gb class 10 was used to obtain greater speed in the transmission of data.

- Administration

Remote desktop between Windows and Linux through a graphical interface if you need to install a remote connection client in Windows in addition to the one that comes by default, you must enter the following command: `sudo apt -get install xrdp`.

4) Installation of the video and camera manager:

- Motion software installation.

First you must execute the following commands: `sudo apt-get update && sudo apt-get upgrade`

Repositories and installed programs are updated.

For the installation of Motion, enter the command in the terminal:

`sudo apt-get install motion.`

To configure the software, you must edit the configuration file found in: `/etc/motion/motion.conf`, within this file you enter the general information for the behavior of the Motion Camera Manager. Afterwards, you must create and configure a file. For each camera that is included in the system, these individual configuration files are called threads and contain information specific to each camera.

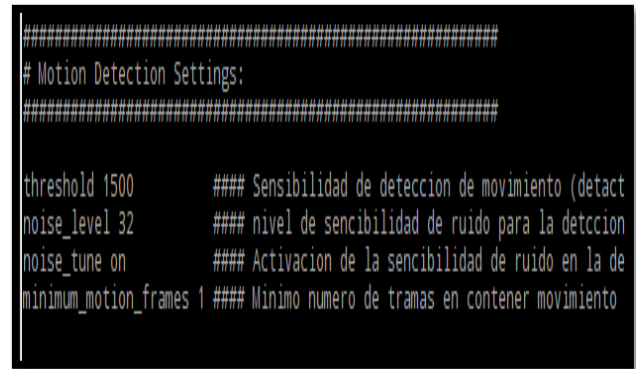


Figure 6. Motion detection configuration.

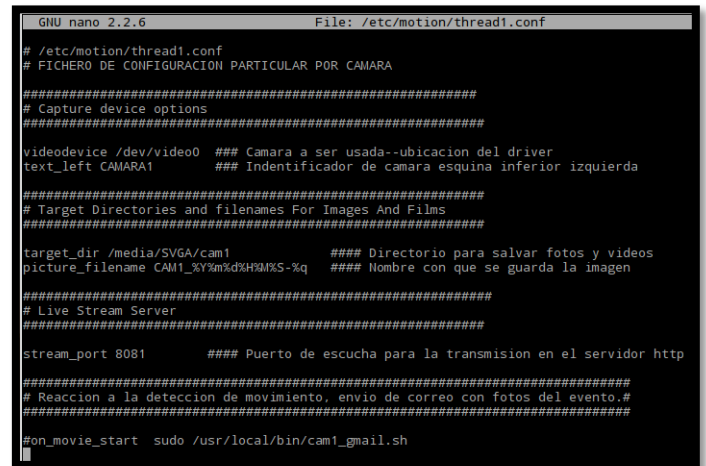


Figure 7. Camera configuration.

5) System web interface:

- Apache2 software installation

This software is used for the presentation of the video obtained by the system's cameras through a web interface, the installation of the software is done by executing the following command in the terminal: `sudo apt-get install apache2.`

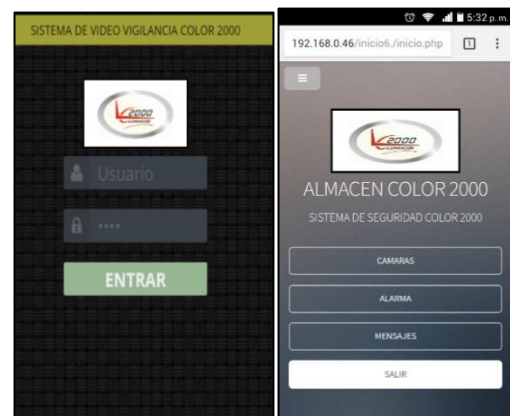


Figure 8. Web Interface.

6) Installation of the control and call manager:

- Installation of Asterisk software

Command: `sudo apt-get install asterisk asterisk-mobile`

The Asterisk software requires the configuration of five files located in the `/etc/asterisk/` directory: `sip.conf`, `extensions.conf`, `users.conf`, `modules.conf` and `chan_mobile.conf` inside these files the configuration for the operation is made of the alarm based on motion detection.

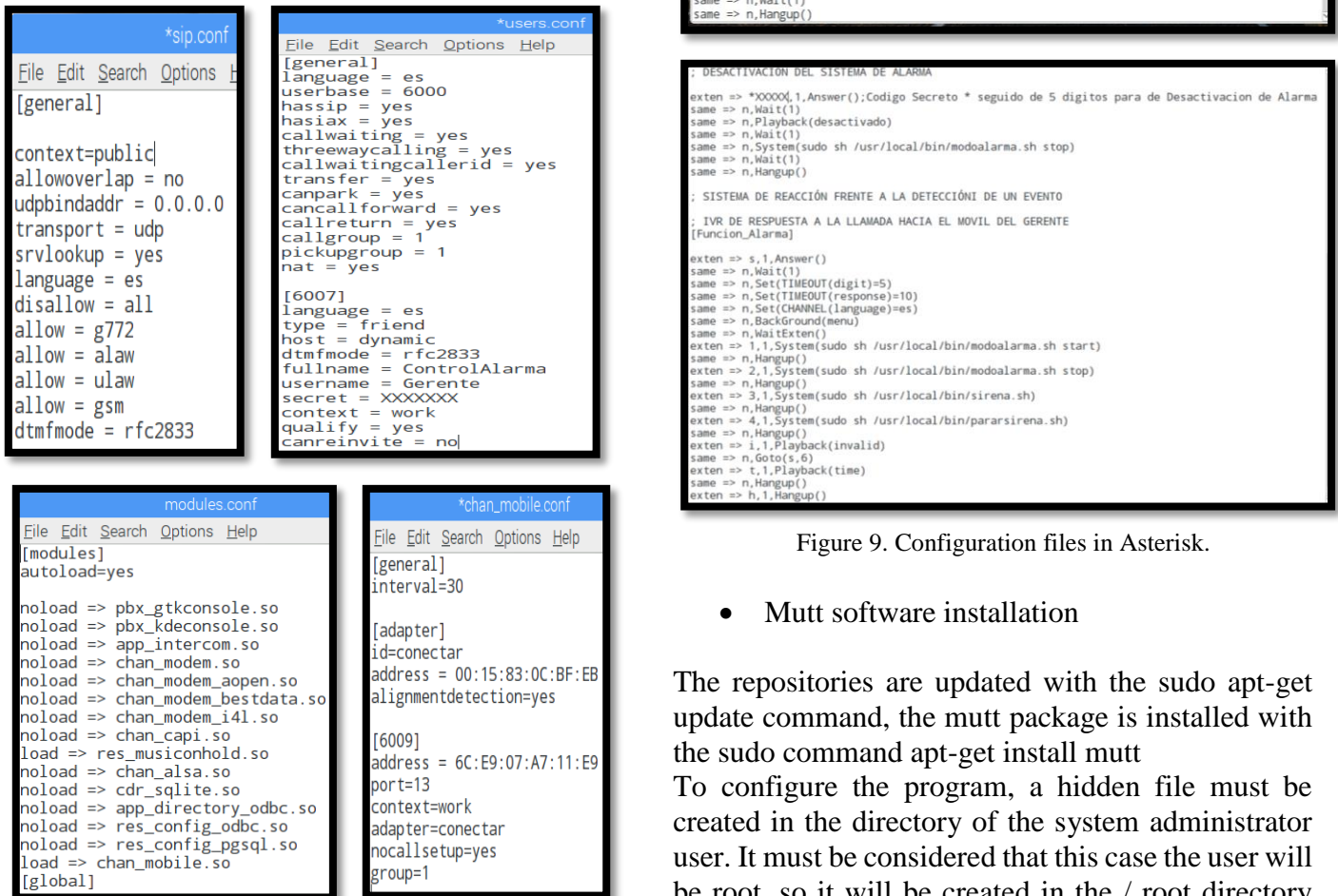


Figure 9. Configuration files in Asterisk.

- Mutt software installation

The repositories are updated with the `sudo apt-get update` command, the mutt package is installed with the `sudo apt-get install mutt` command. To configure the program, a hidden file must be created in the directory of the system administrator user. It must be considered that in this case the user will be root, so it will be created in the `/root` directory with the following command: `sudo nano /root/.muttrc`, replace 'xxxxxxxx' with the password of the Gmail email.


```

GNU nano 2.2.6 File: /root/.muttrc
set from = "svcolor2000@gmail.com"
set realname = "Almacen ColorDosMil"
set imap_user = "svcolor2000@gmail.com"
set imap_pass = "xxxxxxxxxx"
set folder = "imaps://imap.gmail.com:993"
set spoolfile = "+INBOX"
set postponed = "+[Gmail]/Drafts"
set header_cache = ~/.mutt/cache/headers
set message_cachedir = ~/.mutt/cache/bodies
set certificate_file = ~/.mutt/certificates
set smtp_url = "smtp://svcolor2000@smtp.gmail.com:587"
set smtp_pass = "xxxxxxxxxxxx"
    
```

Figure 10. Configuration file in Mutt.

- Telegram software installation

To make the system more interactive, that is, to become a communication tool with the security cameras, a Python program was used with a not very well known but very powerful library called Pexpect. First clone the repository to install Telegram messenger CLI with the following command: `git clone -recursive https://github.com/vysheng/tg.git && cd tg`.

We install the following libraries: `sudo apt-get install libreadline-dev libconfig-dev libssl-dev lua5.2 liblua5.2-dev libevent-dev`.

We run the configuration file and compile the program

```

./configure # automatic program settings
make # compile the program
    
```

We execute the program, passing it the public key `./bin/telegram-cli -k tg-server.pub`

When executed for the first time, the program asks us for a telephone number with the following format `+ 593XXXXXXXXXX` the mobile number of the project is entered. If we are not registered yet the program will ask if we want to register, ask for our first and last name. Subsequently send a verification code to our mobile. Then we can add the contacts.

```

phone number: +593981595810
code ('CALL' for phone code): 43534
User Almacen ColorDosMil online (was online [2017/01/30 23:22:08])
> contact_list
Criss Movi
> msg Criss_Movi hola
[23:21] Criss Movi <<< hola
User Criss Movi online (was online [2017/01/30 23:26:59])
User Criss Movi marked read 1 outbox and 0 inbox messages
User Almacen ColorDosMil offline (was online [2017/01/30 23:22:07])
User Criss Movi is typing
[23:22] Criss Movi >>> Hola
User Criss Movi offline (was online [2017/01/30 23:22:33])
>
    
```

Figure 11. Telegram.

7) Creation of Scripts for the control and alert of system events:

The scripts presented below contain a sequence of commands that will be executed for the control of the alarm system. These scripts will be managed by the Asterisk software and the web interface.

```

GNU nano 2.2.6 File: modoalarma.sh
#!/bin/sh

case $1 in
start)
sudo killall -9 motion
sudo sed -i 's/#on_event_start/on_event_start/' /etc/motion/motion.conf
sudo sed -i 's/#on_movie_start/on_movie_start/' /etc/motion/thread1.conf
sudo sed -i 's/#on_movie_start/on_movie_start/' /etc/motion/thread2.conf
sudo sed -i 's/#on_movie_start/on_movie_start/' /etc/motion/thread3.conf
sudo sed -i 's/#on_movie_start/on_movie_start/' /etc/motion/thread4.conf
sudo sed -i 's/#on_movie_start/on_movie_start/' /etc/motion/thread5.conf
sudo /usr/bin/motion
;;
stop)
sudo killall -9 motion
sudo killall -9 mpg123
sudo rm -f /var/spool/asterisk/outgoing/alarmevent.call
sudo sed -i 's/#on_event_start/#on_event_start/' /etc/motion/motion.conf
sudo sed -i 's/#on_movie_start/#on_movie_start/' /etc/motion/thread1.conf
sudo sed -i 's/#on_movie_start/#on_movie_start/' /etc/motion/thread2.conf
sudo sed -i 's/#on_movie_start/#on_movie_start/' /etc/motion/thread3.conf
sudo sed -i 's/#on_movie_start/#on_movie_start/' /etc/motion/thread4.conf
sudo sed -i 's/#on_movie_start/#on_movie_start/' /etc/motion/thread5.conf
sudo /usr/bin/motion
;;
esac
    
```

Figure 12. Script control.

Figure 13. Scripts alarm.

The scripts presented below contain a sequence of commands that will be executed to alert events.

```

cam_event1.sh
#!/bin/sh

# Efectuamos la llamada
sudo /usr/local/bin/llamada.sh
# Reproducimos un fichero de audio por los altavoces
sudo /usr/local/bin/sirena.sh &
    
```

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```

*llamada.sh
File Edit Search Options Help
# Efectuamos la llamada
sudo cat << EOF > /tmp/Alarma.call
Channel: Mobile/6009/0991388775
Callerid: alarma
MaxRetries: 3
RetryTime: 25
WaitTime: 40
Context: Funcion_Alarma
Extension: s
Priority: 1
EOF
sudo chown root /tmp/Alarma.call
sudo mv /tmp/Alarma.call /var/spool/asterisk/outgoing/

*cam1_gmail.sh
File Edit Search Options Help
##### foto_gmail.sh:###
#!/bin/bash

#variable que contiene la fecha hora minuto y segundo
sleep 1 #tiempo para iniciar en una secuencia completa
date=$(date +"CAM1_%Y%m%d%H%M%S")
ruta="/media/SVGA/cam1"
#Enviar imagen a Gmail
sleep 3 #tiempo pra que se generen las imagenes por la camara de video vigilancia en el directorio
echo "Alarma activada por movimiento CAMARA 1" | mutt -s "Imagenes capturadas" cristfutw3.a@gmail.com
  
```

Figure 14. Scripts of alert events.

IV. IMPLEMENTATION AND OPERATING TESTS.

The tests were performed to verify the operation of the video surveillance and alarm system based on motion detection.

It was verified that the installed software works and starts correctly depending on the configuration files of each software, it was initiated by the recognition of the cameras by the Motion software and the operation of the first mode of the monitoring system was tested, with the control activation and deactivation of the alarm system through the Asterisk software locally and remotely.

The functionality of the second mode of the system was verified, so that all the alerts programmed in the event control scripts were received. It verified the generation of the call, the firing of the siren, sending messages both by mail and by Telegram.

Finally, the access to the local system was verified and remotely by means of a Smartphone and from a laptop computer, the presentation of the video on the website was checked on a monitor in the store establishment of the Warehouse Color 2000.

A. Implementation:

Following the requirements analyzed in the current situation the system was installed and in the following figure is the design plan installed in the infrastructure of the Warehouse color 2000.

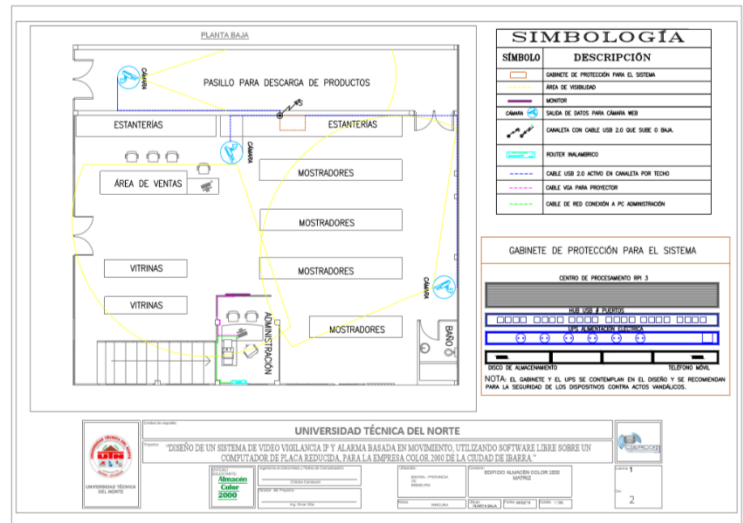


Figure 15. Design plan ground floor.

B. Access methods for administration and configuration of the video surveillance system.

The remote desktop connection to the system was verified where it is possible to manage and make configurations if they are required, the verification was done in the local network of the company, a Laptop, Tablet and a Smartphone were used. For the connection using the Tablet and Smartphone, the Remote ToGo application was used

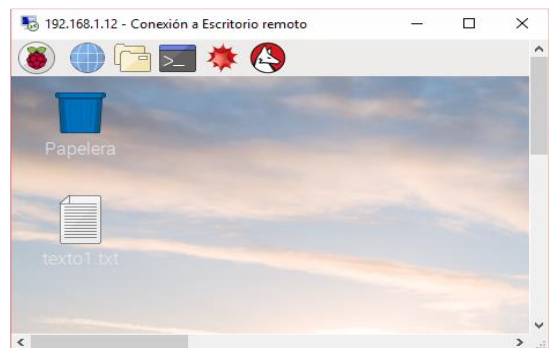


Figure 16: Remote access to Raspbian interface.

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C. Verification of the operating modes of the system.

1) Verification of Solo Monitoring mode:

In the next step, the functionality in the video surveillance system was checked, starting the system in single monitoring mode, for this the web interface was accessed through a browser and the Raspberry IP address was entered with the corresponding listening port to each camera, the visualization of video transmitted in local network and Internet captured by each camera was verified.

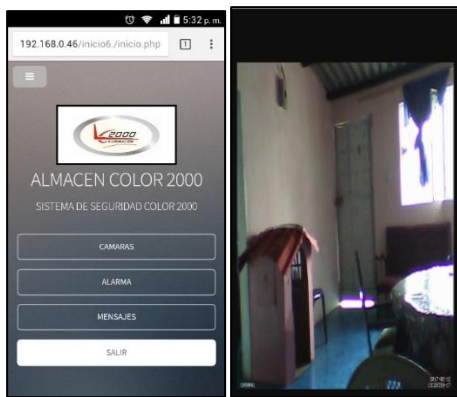


Figure 17. Viewing cameras.

2) Verification of the Alarm and Monitoring mode:

Verification of motion detection and event control.

In the first instance, the sound reproduced by the loudspeakers corresponds to the execution of the alarm activation script (sirena.sh) and the mpg123 software that manages the reproduction of the sound.

Simultaneously, an email is sent with images corresponding to the intrusion, this action is executed by the script (camx_gmail.sh), it is managed by the mutt software. An instant message is sent through Telegram, this is managed by the script (mesj_tel.py) and managed by the Telegram software.

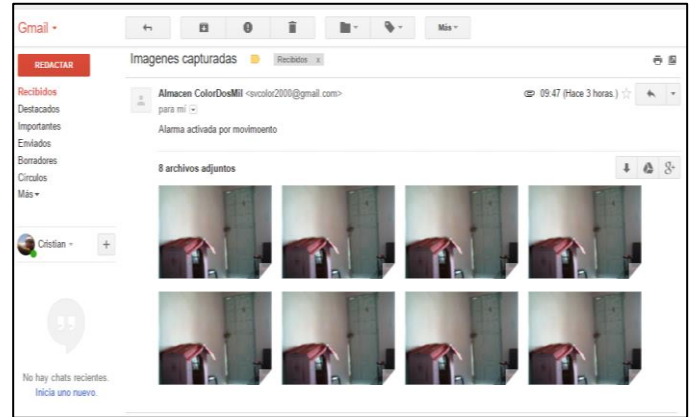


Figure 18. Motion detection events.

D. Method of local and remote control for the video surveillance system.

The activation of the system in Alarm and Monitoring mode is done with a Softphone installed in the Manager's Smartphone. The activation is done by typing the secret code and calling the Asterisk IP voice switch that will manage the control of the alarm system on or off. The operation of the control requires connection to the local network or internet connection.

The activation of the system within the local area network was tested, using the Zoiper softphone with SIP account installed on a tablet with Android operating system.

First verified that the software is in line with the

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switchboard installed in the Raspberry Pi is indicated by a symbol seen at the top, enter the application, enter the activation code and make the marking the switchboard will respond with an audio indicating the activation or deactivation of the system.

The same procedure was performed with the web interface of the system.

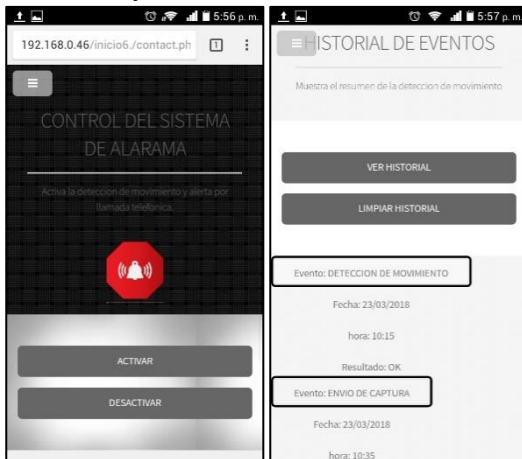


Figure 19. Control per web interface.

The activation of the system was tested from the internet, using Zoiper with an IAX account installed on a tablet, it was verified that the software is in line with the switchboard, we enter the application, enter the activation code and the marking is done, it will respond with an audio indicating the activation or deactivation of the System.

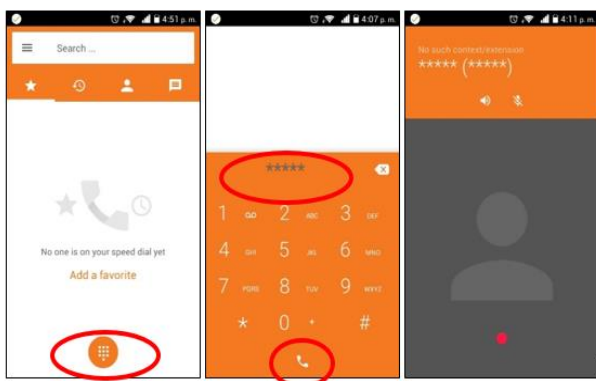


Figure 20. Control per application Zoiper.

V. CONCLUSIONS.

The elaboration of this design focused on the company matrix Warehouse Color 2000 allows to

solve security problems and the improvement of productivity of operative personnel by means of monitoring of the video surveillance system.

The components for the video surveillance and alarm system are not heterogeneous, this indicates that the system can work with either webcams, IP cameras or with mixed interaction, it can support all kinds of equipment brands without problems, as long as it is checked its compatibility with the Raspberry PI 3.

The reduced plate computer Raspberry Pi 3 proves to be a reliable and robust equipment which took advantage of its features and functionalities as if it were a conventional computer, where it was developed in full operation of this system, it should be noted that it can support improvements to the video surveillance and alarm system without affecting its functionality.

The module for the connection with the voice gateway to the mobile telephony network (cell phone with Bluetooth), fulfills its function fully, alerting by means of a call to the manager of the company and presented the options for the event.

The integration of alerts through applications such as WhatsApp or Telegram makes this system a functional tool improving the way of control and notification about an event using social networks of daily use.

The design of this project is an alternative solution of video surveillance and personalized alarm, for the operation in the matrix of the company Warehouse Color 2000, it is developed to compete against video surveillance systems owners offered in the market.

Through the development of a cost-benefit analysis, it is concluded that the possible implementation of this system improves productivity and creates an environment of safety and comfort for the operating personnel, administrative staff and customers of the company.

There is a wide variety of video surveillance systems that incorporate features such as those presented in this degree work, however they have a high cost

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because they are proprietary systems and do not incorporate all the features that this project offers.

VI. RECOMMENDATIONS

To protect the equipment from vandalism, unauthorized access and damage due to bad weather, it is suggested to place the equipment in a safe place in a small rack for communications equipment.

If the implementation and configuration of the system is carried out by a person other than the author, it is advisable to carefully read the configuration section of the Motion software for camera management in Chapter 3.

It is advisable to use a charger with the specifications suggested by the manufacturer of the reduced plate computer Raspberry Pi 3, where it indicates that it must be from an output of 5v to 2.5 A.

To add more webcams to the system, you must do it through a USB hub with its own power. This is suggested by the capacity of 4 USB ports on the Raspberry Pi 3 board and due to the power consumption of the webcams.

If you want to add more cameras to the system, it is suggested to follow the guide for the addition of equipment and based on the sections webcam or IP camera.

If the increase of IP cameras for the system is considerably high, it is suggested to carry out an evaluation of the bandwidth consumption, in order to avoid access problems to the monitoring applications. If the result shows a deficiency in the bandwidth, it is advisable to increase it.

It is advisable to follow the guide for the correct maintenance of the video surveillance and alarm system based on motion detection, which is suggested to be carried out each month.

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Omar R. Oña Rocha, Director



Professional in Electronic Engineering and Telecommunications. He is currently a professor at the Faculty of Engineering in Applied Sciences (FICA) at the Universidad Técnica de Norte in the Electronics and Communication Networks Engineering Career (CIERCOM), in areas such as electrical circuits, electronics, electronic circuits, digital systems and other related fields. He has experience in the field of Technical Consultancy, preventive and corrective maintenance of computer equipment, installation and maintenance of networks. Through his service he has worked constantly and unconditionally in the development of electronics and telecommunications projects.

Cristian G. Canacuan Ipiales, Author



He was born in Ibarra province of Imbabura on July 18, 1991. He completed his secondary studies in the Experimental Eduacative Unit "Teodoro Gomez de la Torre", obtaining the bachelor's degree in the specialty of Mathematical Physicist Currently, he graduated from the Technical University of the North in the Engineering Degree in Electronics and Communication Networks.