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Escuela Académico Profesional de Ingeniería Empresarial

Tesis

Approach to the Luxand Face Facial Recognition System Aimed at the Detection of People in the Criminalistics Unit of the PNP In Huancayo City, Peru

Michelle Haydee Benavides Canchari
Mariam Corayma Salcedo Gonazales
Estefanny Yessica Caceres Aldana
Wilson Anthony Lazo Tapia
Diana Paola Chipana Gago

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Yo: Mariam Corayma Salcedo Gonzalez, con Documento nacional de identidad (DNI) N° 72723010; teléfono 982308940; estudiante de la Escuela Académico Profesional de Ingeniería Empresarial.

Yo: Estefanny Yessica Caceres Aldana, con Documento nacional de identidad (DNI) N° 77282396; teléfono 963820316; estudiante de la Escuela Académico Profesional de Ingeniería Empresarial.

Yo: Wilson Anthony Lazo Tapia, con Documento nacional de identidad (DNI) N° 70237739; teléfono 947198655.

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Approach to the Luxand Face Facial Recognition System Aimed at the Detection of People in the Criminalistics Unit of the PNP in Huancayo City, Peru

Michelle H. Benavides Canchari

Professional Academic School of Management Engineering, Faculty of Engineering, Universidad Continental, 73990056@continental.edu.pe

Mariam C. Salcedo Gonzalez

Professional Academic School of Management Engineering, Faculty of Engineering, Universidad Continental, 72723010@continental.edu.pe

Estefanny Y. Cáceres Aldana

Professional Academic School of Management Engineering, Faculty of Engineering, Universidad Continental, 77282396@continental.edu.pe

Wilson A. Lazo Tapia*

Faculty of Engineering, Universidad Continental, 70237739@continental.edu.pe

Diana P. Chipana Gago

Faculty of Engineering, Universidad Continental, dchipana@continental.edu.pe

Throughout Latin America, citizen security has been negatively affected, due to the increase in criminal acts and the lack of optimal management of the security system in the different countries, in addition to the deficiency of technological equipment that covers all needs of the police forces to fulfill their obligations. In Peru, one of the aspects that most harms citizen security is the lack of a video surveillance system that provides people detection functions. That is why the objective of this article is to efficiently influence the improvement of the process of detecting people in the criminalistics unit of the PNP (Peruvian National Police) in Huancayo city, Peru. For this research, the Engineering - Cascade Model methodology was used, which confers four stages: requirements analysis, design, construction, and testing. Regarding the results, the Degree of similarity indicator reached a value of 89% and the Police relationship with the community indicator obtained a result of 93%. When making the comparison with a high-level investigation, similar results were observed, which shows the reliability of our article. With this, we can conclude that the implementation approach of the Luxand Face facial recognition system in the criminal unit really had a significant effect on the detection of people, being considered an advanced technology project that meets the needs of citizen security.

CCS CONCEPTS • Security and privacy~Biometrics

Additional Keywords and Phrases: Degree of similarity, Detection, Facial recognition, Video surveillance cameras

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1 Introduction

Throughout Latin America, citizen security has been negatively affected, due to the increase in criminal acts and the lack of optimal management of the security system in the different countries, in addition to the deficiency of technological equipment that covers all needs of the police forces to fulfill their obligations [1]. Specifically in Peru, one of the aspects that most harms citizen security is the lack of a video surveillance system that provides people detection functions [2].

One of the problems is the insufficient research on facial recognition issues through police images with the use of video surveillance cameras [3]. In Peru, citizen insecurity is quite serious, which is why a system based on facial recognition increases the satisfaction of society in relation to security tools [4]. Biometric technology, which makes use of the unique properties of each person, is a valuable resource for security in several fields, which contributes to a more effective and rapid identification, since it reduces the need for patrolling by the authorities because the system can operate 24 hours a day [5]. Specifically, facial recognition is easy and simple to access because it can be found in various programs, identifying and recognizing facial points that are registered through a database [6].

* Corresponding author

The automatic recognition of facial points is widely used, thus automating security activities with face identification and verification [7]. Facial recognition-based security systems are efficient for video surveillance of streets and crowded areas, adapting to variations in face poses and angles [8]. In addition, the algorithms of facial recognition systems have been improved to allow the identification of people despite the fact that they have various accessories on their faces [9]. Therefore, this technology is used by security authorities to locate lost people or identify people who have committed crimes and are wanted by the authorities [10]. In citizen security, it is recommended to use facial recognition since it is the most reliable and viable technology for the identification of people [11].

Likewise, in the article "Face Recognition for Criminal Identification: An Alert System in Suspects Scenarios", it is mentioned that in Peru there is no adequate technology to optimize the process of detecting people, it also shows the importance of a facial recognition system. to be able to identify people in the country in real time and allows to know the percentage of optimization in the time of detection through an analysis of their facial features and a comparison with the police database [12]. The article "Acceptance of facial recognition as a measure of surveillance and security" manages to demonstrate that the fact of recognizing faces can be perceived as a measure in relation to security for society [13]. In addition, the book "Trends: Keys to understand the future and build the present" explains the case of the implementation of a surveillance system with facial recognition in another country, in addition to explaining how this system has been developed and the results it has achieved., with the aim of contributing to citizen security [14]. In the context of a pandemic in which various investigations related to facial recognition systems were carried out; one of the most outstanding indicated that the performance of the programs used for the detection system is related to the characteristics of the face and the use of a mask [15]. However, this was not an obstacle for the technology because there are new methodologies that focus on the upper parts of the face (eye, eyebrow, and forehead) with 93% accuracy in face detection [16].

The research problem is the development of the implementation of the facial recognition system Luxand Face oriented to the detection of people, presenting as an objective to efficiently influence the improvement of the process of detection of people in the criminalistics unit of the PNP (National Police of Peru) in Huancayo city, Peru, taking into account that two variables were studied, the detection system based on facial recognition and the people detection process. The rest of the document is organized as follows, section 2 contains the methodology, section 3 contains the results, section 4 contains the discussion and section 5 contains the conclusions.

2 METHODOLOGY

A detection system based on facial recognition is necessary, since it allows the criminology unit of the National Police of Peru to locate wanted people, it also has the security necessary to avoid violating the personal data of the population [17]. Figure 1 shows the independent variable, which is the facial recognition based detection system, and the dependent variable, which is the people detection process. The dependent variable is affected by the independent variable since it goes from being a poor people detection process to being an efficient people detection process, as it is shown in Figure 2.

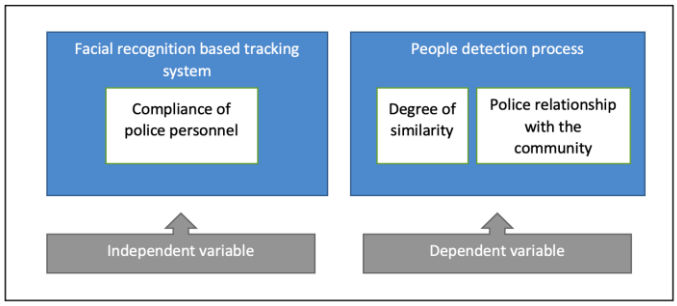

Figure 1: Table of research variables

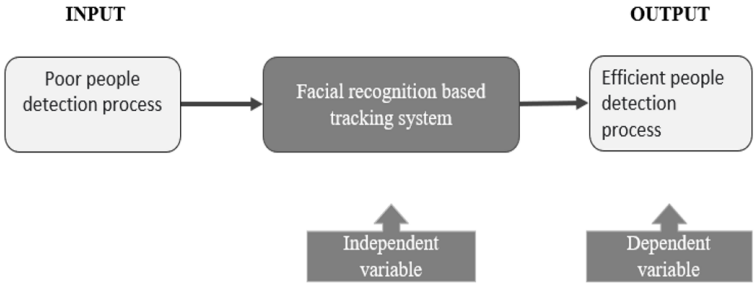

Figure 2: Systematic model of the research problem

According to the book Investigation Methodology written by Hernández, R.; Fernández, C. and Baptista, M., mention “The quantitative approach (which symbolizes, as we explained, a set of processes) is sequential and demonstrative. Each stage precedes the next and we cannot "jump" or avoid steps.” [18]

For the development of this research work, the Engineering - Waterfall Model methodology was used, as it is shown in Figure 3, because it presents an approach aimed at systems and software projects, and is based on an automatic learning technique used to solve problems of classification. It is based on the idea of dividing the problem into several stages or "levels" and applying a model to each of them. Each level uses the output of the previous level as input, and in turn provides an output for the next level [19].

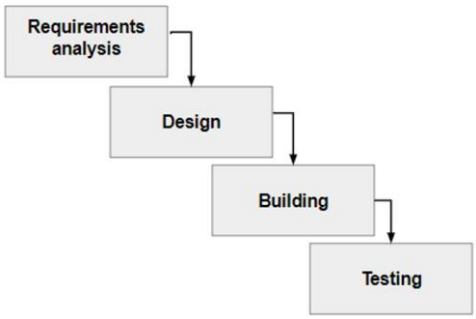

Figure 3: Waterfall Model methodology

2.1 Requirements analysis

To start with the prototype of the system, it is essential to compile the requirements focused on it, since the person in charge of the project must obtain the necessary information to evaluate the requirements, based on said information, the functionality and performance of the system, as well as the objectives set. Table 1 presents the requirements related to the business, the stakeholders, and the solution.

Table 1: Requirements analysis

Need	Determine the development of the implementation of the facial recognition system Luxand Face oriented to the detection of people in the criminalistics unit of the PNP in Huancayo city, Peru.		
Business requirements			
ID	Description		
NB1	Optimize the degree of similarity		
NB2	Strengthen the police relationship with the community		
Stakeholder requirements			
ID	Description	Owner	Relationship
SR1	Generate compliance from police personnel	Head of the criminology unit of the PNP	NB1
SR2	Increase community trust in police forces	police personnel	NB2
Solution requirements			
ID	Description		
Functional requirements			
FR1	The system must detect the faces of the people sought	System manager	SR1, SR2
FR2	The system should notify in case of similarity of facial features	System manager	SR1
Non-functional requirements			

NFR1	Police personnel must have the necessary technological equipment	Head of the criminology unit of the PNP	FR1, FR2
NFR2	The system must have a comprehensive database for photographs	Programador del sistema	FR1
Transition requirements			
TR1	Train police personnel from the criminology unit		

SOLUTION	Approach to the Luxand Face facial recognition system aimed at the detection of people in the criminalistics unit of the PNP in Huancayo city, Peru.

2.2 Design

For the design, the previously analyzed requirements must be met, in addition to developing the programming codes and algorithms of the system prototype, focusing on the structure attributes, detail of the procedure and the characterization of the program and interfaces.

Figure 4 shows the first model of the system that starts with the camera to recognize people's faces linked to a laptop that is connected to the Internet to connect to the Luxand FaceSDK System program that will work cyclically for optimal work.

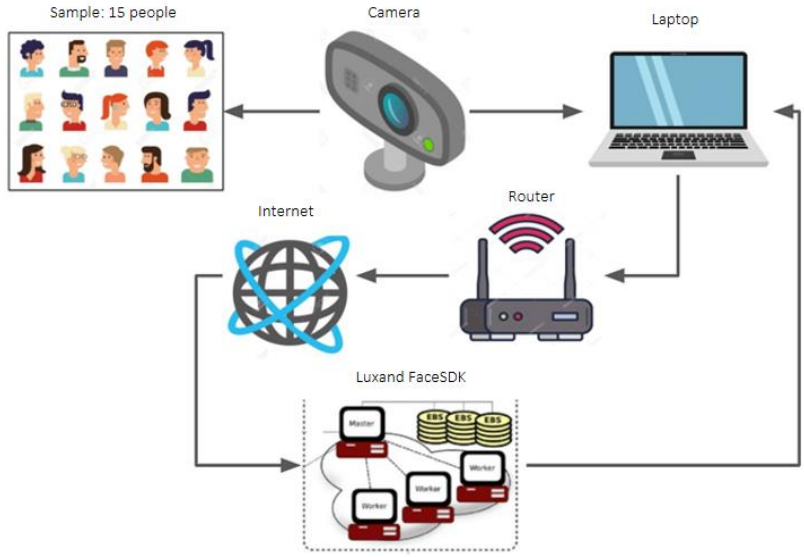

Figure 4: Design of the first model of the system

Figure 5 shows the process of detecting people where the person responsible of the detection management interacts with the head of the criminalistics unit of the PNP.

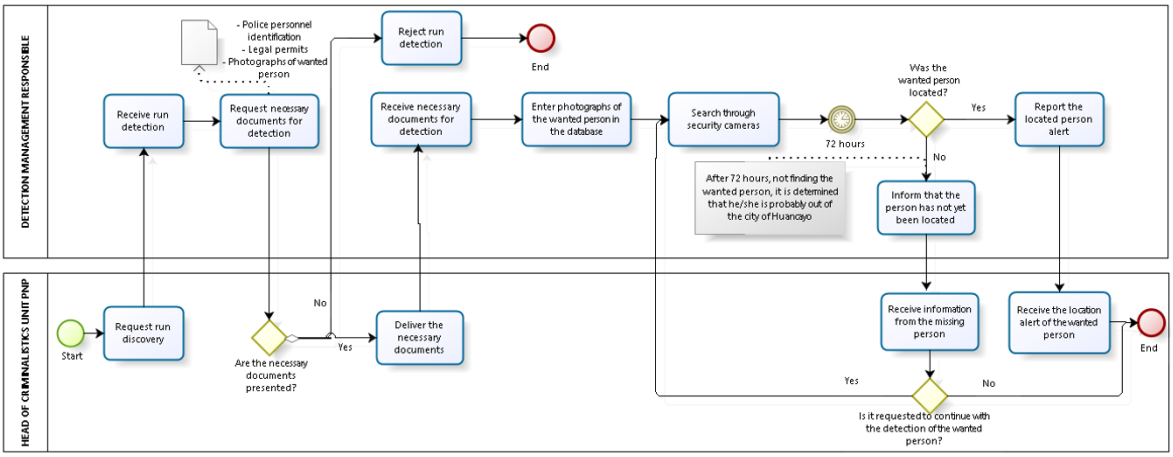

Figure 5: People detection process modeling

2.3 Building

In this phase, the prototype of the system is put into operation according to what was previously designed to be able to carry it out, checking its internal and external operation. It will be done mechanically if the design is detailed.

In figure 6, it shows the installation of the prototype and how they interact with each other.

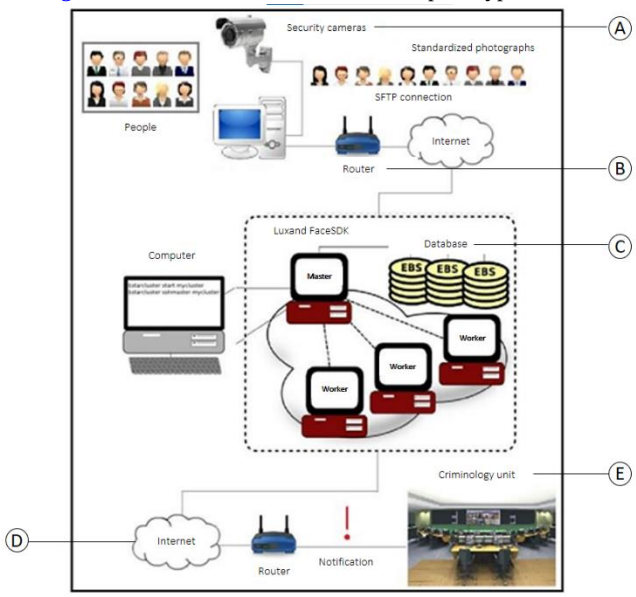

Figure 6: Installation and connection of equipment

A.- Security cameras: Instruments that allow monitoring in real time and lead to investigations on the recognition of humans in order to guarantee a safe environment [20].

B.- Router: “Routers or routers are the interconnection devices that allow each packet sent to reach its destination following the most feasible path or route.” [21]

C.- Database: A set of data and the way they are organised The first databases were hierarchical and network databases, developed during the 1960s. They exposed procedural query interfaces (as opposed to descriptive ones), so that accessing specific information in one of these systems was similar to navigating to a specific file within a file system [22]. The database for facial recognition helps to register and compare a greater number of registered facial points of a person for comparison [23].

D.- Internet: The internet has become part of our daily life, ceasing to be an alternative and optional space to become a point of obligatory use, it originates needs and in turn creates products that satisfy [24].

E.- Criminalistics Unit: “It is the science that integrates the set of scientific technical knowledge applicable to the investigation of the crime, in order to establish, through studies and analysis of the indications and/or evidence, the means of proof, form and circumstances of its perpetration, as well as the identification of the perpetrator(s) and implicated.” [25]

Figure 7 shows the Luxand FaceSDK system which allows the recognition of people through a camera, identifying several points of the facial features of the people that are captured by the video surveillance camera connected to the system, on the other hand the application allows register and store in a database the faces of people so that they can be identified later.

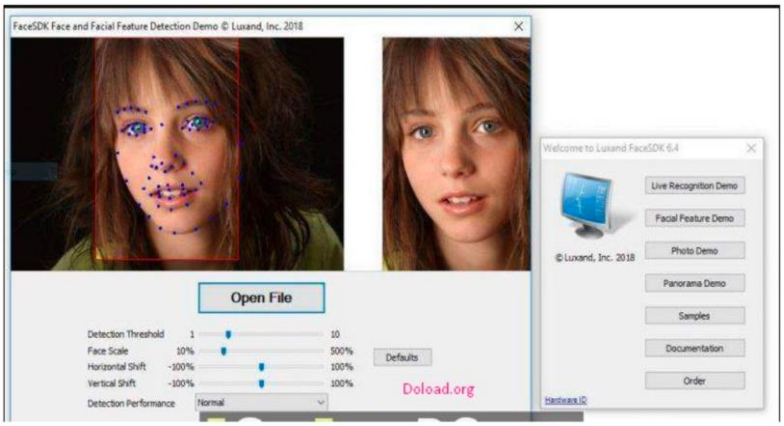

Figure 7: **Luxand Face SDK System**

2.4 Testing

After installing the system prototype, the tests will have to be carried out. The prototype tests are carried out internally and externally, checking its functions to ensure that the results required by the client are produced. Figure 8 shows how the program manages to correctly recognize two people from the sample, since it identifies them from the database, this is thanks to the fact that both faces were registered in the system, from the front and in profile, and it is evident that the names of both people in the sample are correctly identified.

Figure 8: **Face Recognition System Test**

Figure 9 shows the recognition of 70 facial points of the person who is registered in the system, this function of the system is essential to differentiate each person registered in the database, because the group of facial points of each person form a unique recognition [26]. This type of program, such as the Kinect sensor, executes recognition of the entire region of the face in general, for this, a robust recognition is generated with a system that detects specific facial points [27].

Figure 9: **Facial dot recognition system test**

3 RESULTS

"According to the book Investigation Methodology written by Hernández, Roberto; Fernández, Carlos and Baptista, María del Pilar, the pre-test and re-test method consists in that this measurement instrument is applied two or more times to the same group of people or cases after a certain period." [18] In the research work, the Pre-test and Re-test and Post.test methodology will be analyzed and carried out in the criminology unit of the Peruvian National Police in Huancayo city. That is why the statistical software SPSS Statistics was used to carry out the analysis and discussion of results.

- Indicator: Degree of Similarity

Figure 10 shows the descriptive statistical results of the Degree of Similarity indicator can be observed according to the results in the statistical software SPSS (Spanish version):

Statisticians

	N			Dev.		
	Valid	Lost	Average	Deviation	Minimum	Maximum
Similaritypretest	15	0	,3200	,11307	,15	,55
Similarityposttest	15	0	,8949	,06154	,71	,97

Figure 10: **Descriptive analysis - Degree of similarity**

For the Degree of Similarity indicator, in the Pre-Test an average value of degree of similarity of 32% per person was reached. In the same way, after the implementation of the detection system based on facial recognition, an average value of degree of similarity of 89.49% per person was reached, which indicates that the implementation of said system generates a noticeable increase in the indicator. On the other hand, in the Pre-Test, the standard deviation had the following value of 0.11; and in the Post-Test, it had a value of 0.06, which is why it can be stated that the standard deviation decreased, which means that the dispersion of the degree of similarity has been reduced [28].

- Indicator: Police relationship with the community

Figures 11 and figure 12 show the police relationship with the community since "it turns out to be a fundamental informant when measuring police performance." [29]

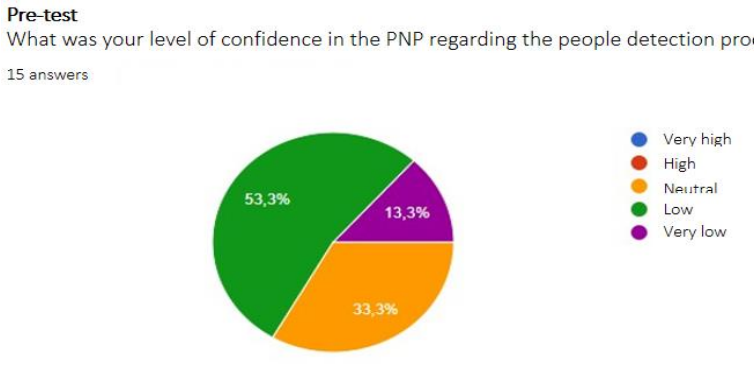

Figure 11: **Police relationship with the community - Pre-test**

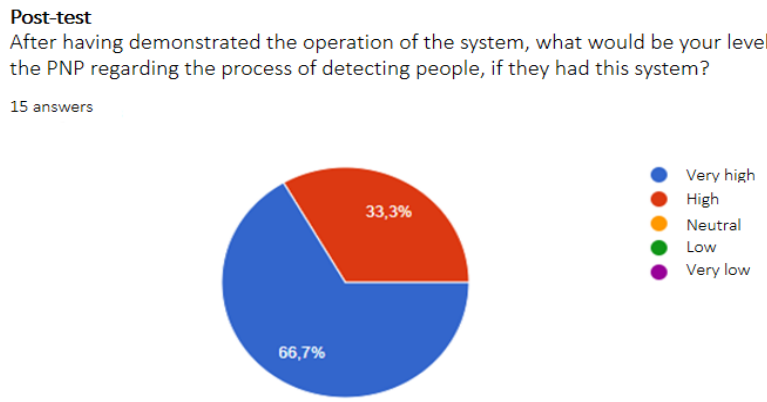

Figure 12: **Police relationship with the community - Post-test**

The following figure 13 shows the descriptive statistical results of the Police Relations with the Community indicator according to the results in the statistical software SPSS (Spanish version):

Statisticians

	N			Dev.		
	Valid	Lost	Average	Deviation	Minimum	Maximum
Relationshippretest	15	0	,4400	,13522	,20	,60
Relationshipposttest	15	0	,9333	,09759	,80	1,00

Figure 13: **Descriptive analysis - Police relationship with the community**

For the Police relationship with the community indicator, in the Pre-Test an average value of police relationship with the community of 44% was reached. In the same way, after the implementation of the detection system based on facial recognition, an average value of police relationship with the community of 93.33% was reached, which indicates that the implementation of said system generates a relevant increase in the indicator. On the other hand, in the Pre-Test, the standard deviation had a value of 0.13; and in the Post-Test, this had a value of 0.09, which is why it can be concluded that the standard deviation decreased, which means that the dispersion of the degree of similarity has decreased [29].

The table 2 shows the comparison of the results that were taken before carrying out the simulation and after the simulation. The data shared by the PNP of Peru was used as a pre-test and the data that was collected within the simulation was used as a post-test, having a non-probabilistic sample due to the pandemic [30], considering a total of 15 adults.

Table 2: **Comparative table of pre-test and post-test**

N°	Degree of similarity		Police relationship with the community	
	Pre-test	Post-test	Pre-test	Post-test

1	40%	87,88%	40%	80%
2	35%	95,45%	60%	100%
3	35%	89,39%	40%	100%
4	30%	96,97%	40%	100%
5	25%	93,94%	60%	100%
6	20%	90,91%	60%	80%
7	45%	90,91%	40%	80%
8	25%	96,97%	20%	100%
9	35%	89,39%	40%	100%
10	20%	87,88%	60%	100%
11	35%	89,39%	40%	100%
12	55%	86,36%	20%	80%
13	45%	71,21%	60%	100%
14	20%	89,39%	40%	80%
15	15%	86,36%	40%	100%

The approach to the Luxand Face facial recognition system aimed at the detection of people in the criminalistics unit of the PNP in Huancayo city has the following analysis:

It increases the average degree of similarity, thus improving the recognition of people more quickly, with the detection of facial points [31]. Apart from this, the police relationship with the average community increases, which shows a greater trust of people with the police regarding the process of detecting people with the use of the system.

4 discussion

For the discussion, we took the article "Development of a Security System Based on Facial Recognition Oriented to the Management and Diversion of Criminal Attacks" as a reference, to compare the methodology and results [4]. The methodology that was used in our article is the waterfall model engineering methodology, which has 4 phases that are requirement analysis, design, construction, and testing. On the other hand, in the other article it is the extreme programming methodology which also has 4 phases of planning, design, coding and testing. Both methodologies are similar in that they allow you to emphasize the adaptability of a project; the main difference that is made in these two methodologies is that the other article in phase 4 is focused on the programming of the facial recognition system and in our article, it is based on the installation of an already established program that meets all the requirements. requested by users to then test and validate its operation. Regarding the results, in our article we measure the indicators of the degree of similarity and of the police relationship with the community, unlike the other article that only measures the degree of satisfaction of the security software. Although the results of police relations with the community and satisfaction with the security software were obtained using a similar tool, and the results in both cases were 93%, it is necessary to highlight that the comparative article did not use an indicator to measure the development of the system already installed, to have accurate data on the functionality of the system. On the other hand, our article shows a pre- and post-installation evaluation of the system. According to everything detailed, our article makes use of an accurate methodology and shows the calculations of the indicators to measure the implementation of the system, for which it is concluded that its implementation in the criminalistics unit of the PNP in Huancayo, Peru is favourable.

5 conclusions

The article carried out shows that the development of the implementation of the facial recognition system Luxand Face, oriented to the detection of people efficiently influences the improvement of the process of detecting people for the criminalistics unit of the PNP in Huancayo city, Peru. The development of the implementation of the facial recognition system Luxand Face oriented to the detection of people efficiently influences the degree of similarity, thus allowing more accurate and reliable results to be obtained, in the same way, this approach positively influences

the police relationship with the community, allowing the population to have greater confidence and security in the police of their city. We are currently in the process of implementing the Luxand Face facial recognition system in the criminalistics unit of the PNP in Huancayo city. In this way, we will make a second article that shows the implementation made.

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