Kitchengam' Criteria on the Use of Algorithms in a Person's Pattern Detection, which Contribute to Safety, Surveillance and Energy Efficiency: Study of Art

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Abstract—Among the technological evolution is the application of algorithms in cameras for the detection and recognition of people, being a contribution to the security and surveillance in commercial, home areas, and smart cities. The objective of this research is to know and identify algorithms in the detection of patterns of a person, considering the criteria of Kitchengam. For this purpose, the following research questions were asked: Q1) How many studies refer to algorithms in pattern recognition? Q2: What types of algorithm models exist in an environment related to pattern recognition? and Q3: What types of pattern recognition algorithms currently exist? The search process was carried out in the digital libraries IEEE Xplore, ACM Digital Library, Springer Link and Science Direct (Elsevier). Obtained 1402 potentially eligible studies and obtained a final sample of 28 papers considered as main research studies. The results obtained allow us to consider the Support Vector Machines model with 92% recognition and the Viola-Jones algorithm with effective detection of 97,53%, are a contribution to the surveillance and safety of people within the recognition and detection of a person's pattern, considering also as a challenge its feasibility focused on energy efficiency, in domestic, business and smart cities.

Keywords—Algorithms in detection, algorithm models, systematic review, viola-jones, Kitchengam criteria, energy efficiency.

1 Introduction

Currently, the use of technologies associated with energy efficiency in terms of video surveillance systems is gaining ground in our environment. The recognition of

actions is a topic studied in computer vision and has applications related to video surveillance, human-to-computer iteration and security videos, despite great research, this is far from being a problem solved. The challenges are intraclass according to [1].

The algorithms developed for the recognition of people are necessary with the evolution of the technology that contributes in the design of programs. It is a topic that is considered for implementation in smart cities, offices, homes and companies, the authors [2] state that human silhouette recognition systems can be connected to the internet of things (IoT).

Among the difficulties with the recognition of a silhouette (occlusions, self-obstructions, variability of visual appearance, unpredictable temporal behavior, etc.) is the tracking of a variable and unknown number of objects that makes the problem more challenging, so there are reasons like observations to resolve detection errors [3].

The research strategy for systematic review was based on research questions and its search was referenced in four digital libraries. We obtained 1402 potentially eligible studies; after applying the exclusion criteria, we obtained 93 studies considered relevant and obtained a final sample of 28 articles considered as main studies.

The results achieved allow us to conclude with a state of the art on algorithms in the detection of patterns of people and to determine that their application will contribute to surveillance and security, considering also as a challenge its feasibility focused on energy efficiency, in domestic and business areas, among others.

There are several factors that motivated this research, being the application for the safety of people, those that are considered as the most important and according to [4], mention that facial recognition systems play a vital role in many applications, including surveillance, biometrics and security, so the authors in [5] state that the Viola-Jones algorithm is currently one of the most used to solve problems of finding a person's face [6].

In this research, it is determined that there are different proposals for the recognition of objects, facial expressions, faces, human patterns. The authors state in [7], [8], [9] and consider that facial recognition methods based on local characteristics use information from the face (eyes, nose, mouth) to identify globally.

The aim of the research is to know and identify algorithms in the detection of a person's patterns, considering Kitchengam's criteria. Therefore, the following questions are proposed to allow us to validate the process and the information obtained in the search for algorithms. Q1) How many studies refer to algorithms in the detection of patterns of people? Q2) What types of algorithm models exist in an environment related to the detection of a person's patterns? and Q3) What types of algorithms currently exist in the detection of a person's patterns?

This document is organized as follows; Section 2 presents the related materials and methods on the subject of our research. Section 3 focuses on the analysis of the results obtained on the algorithm and models in recognition of the image or silhouette of a person. Section 4 describes the discussion of the results achieved. Finally, there are the conclusions of this research.

1.1 Related studies

An easy technique in color image processing is captured by traditional RGB cameras. In [10], [11] the human body was represented in terms of silhouette, images extracted by the RGB camera, which are used as input to an HMM-based framework.

Computer Vision [12], offers detection and recognition of human silhouettes that are fascinating applications for the IoT. The combination of recognition using Computer Vision [13], can display greater security system on an IoT platform for smart homes, since it has the ability to match a person in the wrong place or with incorrect intensions [14].

Given the difficulty of estimating positions, some approaches take implicit positions [15]. For example, in [10] they extract rectangular oriented patches from images and spatial computing histograms of rectangles oriented as characteristics [12], for various benefits that can improve people's lifestyles. whereas in intelligent homes by recognizing human silhouettes with the use of the Internet of things, things such as doors, lights, windows, irrigation systems, household appliances can be controlled and robotized, which in turn makes it possible to be process efficient and to save energy.

In a face recognition system, the database consists of images of each person that the system has to recognize, this system is possible with several images of the same person that could be included in a database. A face recognition algorithm processes the captured image and compares the images inside the database, if it found a match, then the person is identified, if the search does not match, then the person is reported as unidentified, according to the authors [16], [8].

In pattern recognition, they propose a new recurring DNN architecture for the re-identification of people based on video, this system-based architecture that combines recurrence and temporary grouping of appearance data with learning representation, by using a Siamese network architecture to learn an invariant representation for the video sequence of each person, introducing time grouping and recurring layers, this network proposed by the authors [17], it combines time step data into a single feature vector for the entire input sequence, resulting in improved performance.

2 Systematic Review

A systematic review of the literature was developed in three main processes, considering the criteria expressed by [18], [19] and the suggestions used by [20]. Research planning, information search and results found.

2.1 Research planning

To achieve our purpose, the following research questions were developed:

Q1: How many studies refer to algorithms in pattern recognition?

Q2: What types of algorithm models exist in an environment related to pattern recognition?

Q3:What types of pattern recognition algorithms currently exist?

Table 1. Search string results

Source	Potentially elegible studies	Studies relevant	Studies principal	%
ACM Digital Library	147	19	3	11%
IEEE Xplore	213	25	9	32%
Science Direct	358	28	11	39%
Springer Link	684	21	5	18%
TOTAL	1402	93	28	100%

For the construction of the search terms of the information were considered suggestions of the authors [19], such as keywords that relate to research questions, identification of alternative terms and synonyms of keywords such as search terms, search engines used as search medium in: IEEE Xplore, ACM Digital Library, Springer Link and Science Direct (Elsevier), searching for information through the use of logic operators, AND and OR as connectors and keywords that will be used to develop the information search chain (journal articles, books and conference proceedings). Both, inclusion and exclusion criteria were considered for this study.

As a basic criterion for inclusion, articles were considered to be available in full text in journals and books, articles may be from a literature review and/or systematic review, articles related to research questions and the search range of articles from 2010 to 2019. The exclusion criterion excludes articles that do not meet the inclusion criteria. In the search chain the protocols were defined considering the author [20], the sources of information were also selected and the search strategy was created. The following keywords were used: Recognition of patterns, Recognition of images, recognition of a person's, Recognition of a person's image patterns, Algorithms of recognition of a person's image patterns and the logical relationship was established using the AND connector. Recognition of a person's image patterns AND Algorithms of recognition of a person's image patterns y Algorithms of recognition of a person's image patterns AND Recognition of a person's image patterns.

The search was considered through specific fields (Title, Abstract, Key, Document title, Publication title) and delimited descriptors, dates, typology etc.

2.2 Search for information

The criteria set out in section 2.1 were considered in order to perform the information search process shown in Figure 1.

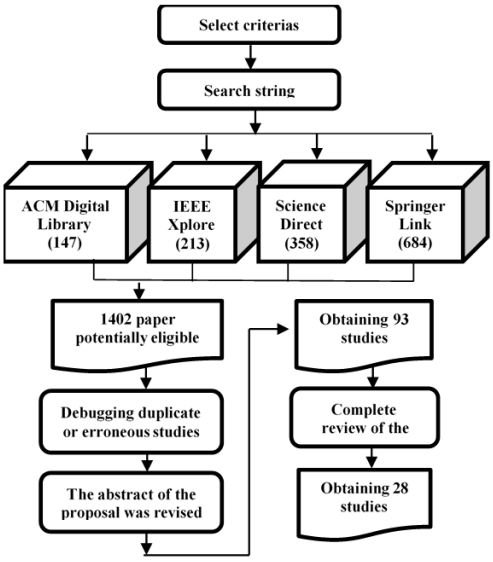

Fig. 1. .Information search Process diagram

In Figure 1, the criteria set out in the previous section were considered. The information search process was performed by applying the search string to each of the data sources and, as a result, a total of 1402 articles were obtained, see Table 1.

A review and selection of articles that did not meet the established criteria or that were duplicated in different sources of information was carried out. Subsequently, the summary of the articles found was revised and a total of 1309 research papers were deleted, obtaining 93 relevant studies from this process, from which the complete content of each of these articles was reviewed, obtaining 28 main studies, see Figure 2, and from the analysis of these articles were obtained papers related to models and types of algorithms in the detection of patterns of people.

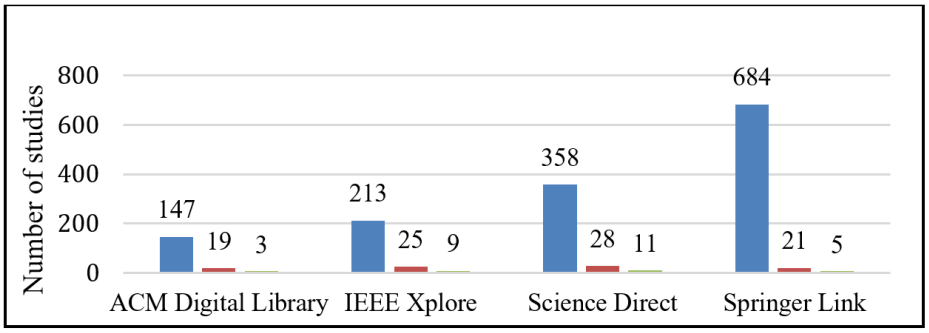

Fig. 2. Results obtained

2.3 Results found

Results found that refer to Q1, on the algorithms in pattern recognition.

This section shows the overall results in relation to Q1: How many studies refer to algorithms in pattern recognition? these results were classified according to data sources, highlighting potentially eligible studies, relevant studies and main studies as well as shown in Table 1.

Table 2. Search results by years

Years	ACM Digital Library	IEEE Xplore	Science Direct	Springer Link	Total
2010	0	1	0	0	1
2011	0	2	0	0	2
2012	1	0	2	1	4
2013	1	0	0	2	3
2014	0	1	1	0	2
2015	0	0	1	0	1
2016	0	1	2	0	3
2017	1	3	0	1	5
2018	0	1	3	1	5
2019	0	0	2	0	2
Total	3	9	11	5	28

As a result of the search carried out, 28 main articles were considered, which are referenced and are related to patterns of image recognition of a person, among which models and algorithms were found to describe our research.

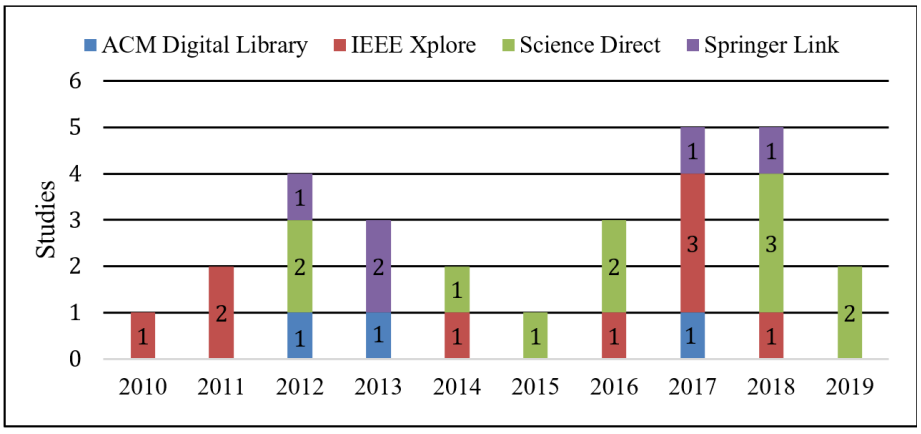

Fig. 3. Studies found by year

Table 2 indicates the year, which corresponds to each article found with the topics mentioned in section 2.1 and in figure 3, the graphed data related to the libraries with the years in which the search articles were published.

Results found regarding Q2, on the types of algorithm models that exist in an environment related to pattern recognition.

In reference to Q2: What types of algorithm models exist in an environment related to pattern recognition? as a result several pattern recognition models were found, which for this research project are described below.

Table 3. Models in recognition of found patterns

Model	Application	Characteristics	Technology	Ref.
Convolutional Neural Network (dCNN)	Applied in security systems for cities or public institutions, with a database and high-resolution cameras.	It uses an independent, attribute-tagged dataset	Tags with attributes of people for the intended dataset and combination with the independent dataset for the final round of adjustment.	[23]
Hidden Markov	Used in app security systems for Smartphones, which contain servers to store videos or recognition pattern shots.	It is important in computational methods for the classification of human physical activity	Recognition of different activities carried out by humans. Appropriate in the application in pattern recognition.	[21]
Regions with Convolutional Neural Networks (Faster R-CNN)	This model can recognize people, objects, pets, cars, etc., and applied in security systems for police or military institutions	Composed of two modules. The Convolutional Neural proposing regions and the Fast R-CNN detector, which uses the proposed regions, in the unified system to the object detection network.	It is a system that takes an image of one size as input and output to a set of proposed rectangular objects, this proposed model is used with Convutional Neural.	[31] [32]
Support Vector Machines (SVM)	Used for the recognition of human activity through video recordings, especially for the survival and safety of people.	Assign new data from various categories, making it a non-probabilistic binary linear classifier.	Nonlinear human recognition system that effectively updates classification parameters when a new framework is presented and classified.	[24], [25]

In Table 3 are described the models in recognition found as the Hidden Markov which is a statistical model to describe the characteristics of a stochastic process [21], and also the Neural Convolutional Network (dCNN) is a model that is used to classify images, group them by similarity and perform a recognition of objects within scenes.[22] These models are based on algorithms that can identify faces, people, traffic signals, tumors and many other aspects of visual data, as considered [23] and the Support Vector Machines (SVM) model which is a supervised learning model with algorithms associated with learning that analyze the data used for its grading and regression analysis, according to [24] and [25].

In the search in relation to the detection of the image or silhouette of a person, models of recognition of human activity were considered and based on these models, see Table 3. Different authors conducted their research on the recognition of people through the application of patterns in recognition of movement of people [26].

We found the recognition models described in Table 4, of the result of the research, in which the authors describe the parameters in accuracy, capture, recognition and time, which are applied in the recognition of patterns.

Table 4. Parameters applied by models in pattern recognition

Models	Accuracy	Captures	Recognition	Time	Ref.
Convolutional Neural Network (dCNN)	95.49%	92.4%	89.45%	1676s/epoch	[33]
Hidden Markov	82.38%	84%	66.67%	n/t	[20]
Regions with Convolutional Neural Networks (Faster R-CNN)	69.9 %	78.8%	69.9%	0.5 fps	[31]
Support Vector Machines (SVM)	89.3%	90.5%	92%	5.5 pictures/sec	[34]

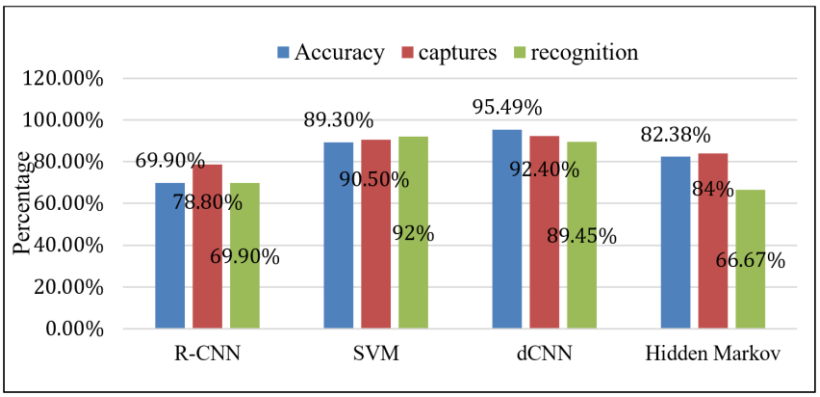

Fig. 4. Parameters Applied in Pattern Recognition

In Figure 4, the recognition models are based on the relationship allow the recognition of an image based on the parameters accuracy, capture, recognition with their respective percentage of application in pattern recognition.

Results found in reference to Q3, on current pattern recognition algorithm types In relation to Q3: What types of pattern recognition algorithms currently exist? It is shown as a result based on the research work developed, the types of algorithms that allow image recognition.

Table 5. Types of algorithms found

Algorithm	Characteristic	Advantage	Disadvantage	Ref.
Adaboost	It is a meta-algorithm for boosting formulated by Freund and Schapire. Part of a series of weak classifiers.	Used to select features and train classifiers. Dramatically increases the speed of the detector.	Use weak classifiers and call them multiple times. Generate a single hypothesis with the combination of generated hypotheses.	[27] [35]
EigenFaces	t is a facial recognition method based on component analysis approaches.	Evaluates 23x28 pixel images in order to compare interpolarization and similar measurement methods in momentum or shot recognition.	It is an algorithm that is not coupled with (SVM) Support vector machine and (ANN) Artificial Neural Network.	[8], [9], [16]
Kanade-Lucas-Tomasi	t is used to obtain the most important information on the face. Techniques that use appearance and models	It is faster than traditional techniques to examine many potential matches between images.	It is based on the creation of a subspace in which the images are represented based only on the most relevant characteristics.	[30]
rv-tSNE	Eliminates the problem of data discrimination and the variation in the data is further reduced by taking a joint probability distribution with covariance matrix	Reduces high-dimensional data by dimensional data and increases the accuracy of action recognition, thus reducing the misclassification rate.	Transform the high-quality feature space into a low-quality feature space..	[36]
Viola-Jones	It is based on a series of weak denominated Haar-like-feactures classifiers that can be calculated efficiently using an integral image.	It stands out for its low computational cost and allows it to be used in real time.	Occlusion is a problem for this algorithm since it could not detect efficiently.	[28], [4], [37], [38]

Table 6. List of algorithm types

Algorithm	Effective detection	Distance	Recognition pattern	Ref.
Adaboost	64.00%	4m.	Facial recognition	[39]
EigenFaces	78.26%	5m.	Face recognition	[40]
Kanade-Lucas-Tomasi	95.30%	7m.	Face recognition	[30]
rv-tSNE	86.70%	5m.	Human silhouette recognition	[36]
Viola-Jones	97.53%	7m.	Detects a person's face, nose, eyes, mouth, or upper body.	[5]

Based on the research process developed, the following types of algorithms have been found see Table 5, in which are detailed advantages and disadvantages that were applied for the development of the algorithm based primarily on the application of Matlab for pattern recognition.

Considering the ratio of algorithms shown in Table 6, two algorithms with the highest percentage in effective detection were compared: Viola-Jones and Kanade-Lucas-Tomasi [28], whose main pattern is facing recognition and the results are shown in Table 7, according to [29].

In Table 7, scalar parameters are described as a result of the facial detection of an image considering that in this way a lot of work and errors are saved by not having to scale the whole image.

Table 7. Facial detection results

Algorithm	Front image	Left profile	Right profile	Looking up	Looking Down	Total
Viola-Jones	97%	90%	88%	80%	80%	**87%**
Kanade-Lucas-Tomasi	90%	85%	83%	80%	80%	**84%**

3 Analysis

This section describes the report of the analysis based on the results obtained with answers to each of the questions posed in section 2.1 and the analysis of the number of studies obtained through the data sources. Science Direct, in which the largest number of major studies was found, 11 studies representing 39%, followed by IEEE Xplore with 9 studies representing 32%, Springer Link with 5 studios representing 18% and the ACM digital library with 3 studios representing 11%.

The Viola-Jones algorithm has several advantages over the Kanade-Lucas-Tomasi algorithm, such as feature selection, which is highly sophisticated and an invariant detector that locates scales, according to [30]. On the other hand, the Kanade-Lucas-Tomasi algorithm is faster than most traditional methods, as is the case with the Viola-Jones algorithm, the facial characteristics are clearer.

3.1 Analysis of algorithms in pattern recognition

Regarding the search for studies that refer to algorithms in Q1 based pattern recognition, it is considered that in the orderly search of algorithms, the main studies of this work were chosen with the aim of knowing and identifying the algorithms in the recognition of patterns of a person, providing key words to the sources of information according to the relevant and potential studies, the process of information for this research was carried out by applying the search chain that allowed a certain process to each of the data sources and, as a result, a total of 1402 articles were obtained, several of these documents refer to the recognition of parts of the human being, in this case more information based on the recognition of a person's face was found.

3.2 Analysis of the types of algorithm models that exist in an environment related to pattern recognition

Q2 proposed: What types of algorithm models exist in an environment related to pattern recognition? with the aim of recognizing people or human activities, improving the systematic process and using digital libraries, the different types of algorithm models and their applications for pattern recognition represent similarities in their systems. Considering that the results enunciate outstanding models such as: Hidden Markov with 66.67% recognition, also the Convolutional Neural Network (dCNN) with 89.45% recognition formed in an independent data set, and the model Support Vector Machines (SVM) with 92% of recognition.

These are based on algorithms that can identify faces, people, traffic signals, tumors, and many other aspects of visual data, which indicate that they can be used to classify images, group them by similarity, and perform object recognition within scenes. Whereas the algorithms associated with learning allow the data used for grading and regression analysis to be analyzed.

3.3 Analysis of pattern recognition algorithm types

In relation to Q3: What types of pattern recognition algorithms currently exist? We analyzed the problem for the development of the type of algorithm in recognition of related patterns efficiently through an integral image using techniques based on appearance and models, thus allowing a better operation with the application and recognition of each one. In order to recognize patterns, data acquisition and feature extraction must be considered, among the types of algorithms in recognition are Adaboost, Eigenfaces, Kanade-Lucas-Tomasi, rv-tSNE and Viola-Jones, each with a similar function, and with properties used in facial recognition or human actions that represent its effectiveness in the field of image detection.

4 Discussion

In relation to the three research questions, in Q1: It was determined that was found in this study 1402 articles, of which 28 refer to algorithms and models in human pattern detection, where it explains its characteristics and its application in different areas related to security as well as the technological environment.

With reference to Q2: There are several models related to the environment in the detection of patterns of a person, whereas the article explains four models with their respective characteristics and parameters applied in the detection of patterns, being the Support Vector Machines the most discussed for its application in recognition with 92%.

With respect to Q3: Currently there are different types of algorithms and depending on the application or use to be carried out, it describes the five algorithms found on recognition and detection, among which is considered Viola-Jones with 97.53% in real-time effective detection, considering a series of Haar-like-feactures sorters.

Viola Jones' algorithm employs a method of approximation based on appearance. It is divided into two stages: a first stage of learning the classifier based on a large number of positive examples and negative examples, and a detection phase by applying this classifier in relation to the images not known as considered [5].

Finally, according to the results obtained, the document provides the algorithms that allow people to be detected. The description in their ordered systems makes it effective at the time of its development. The background of the image, on the other hand, does not affect the detection process at all, since the program marks with a frame type grid and does not analyze what surrounds it.

5 Conclusion

The absence of personnel, the increase in the cost of maintenance and the high costs of energy, are a continuing concern for, small, medium and large scale. In view of this, technological advances are aimed at improving the quality of life, safety, efficient use of energy, and reducing economic costs, all this is possible through technical aids such as sensors, controlled motors or cameras, all connected to each other.

the demand for solutions for the home, business and smart cities is currently higher, both for security and comfort reasons and for the pursuit of energy efficiency. And video surveillance is now a need for smart homes, businesses and cities, as they represent solutions that ensure safety and efficiency and contribute to sustainability.

Given this, we consider relevant the studies to establish improvements with the use and selection of algorithms for the detection of patterns of people, models and types that have been applied. Because it is thanks to these technological advances that continuous improvements are established for the detection of people and represent part of the technological revolution that helps security, energy efficiency and sustainability at global level.

In this paper, with the systematic review of the literature on algorithms in the detection of patterns of a person, considering the criteria of Kitchengam, we found 1402 potentially eligible studies. After applying the respective exclusion criteria, we obtained 93 studies considered relevant and obtained a final sample of 28 articles considered as main studies for our research.

The conclusions of this work related to the research questions outlined and that are based on studies that refer to algorithms in the detection of patterns of people, models and types that have been applied. Algorithms are considered a basic tool to solve a problem in a defined and precise way.

We found articles with studies referring to the algorithms of pattern recognition, which describe the different characteristics of each one of them, being the Adaboost algorithm that increases the speed of the detector, the Eigenfaces algorithm that evaluates images in an order to compare Inter polarization.

One of the fastest algorithms for examining potential matches is the Kanade-Lucas-Tomasi; the Viola-Jones algorithm is used in real time, and finally the rv-tSNE algorithm that recognizes the human silhouette by increasing the accuracy of the recognition of actions.

These algorithms are currently used, although there are different, which allow more options in their scalability.

In the research based on the review of the literature on algorithms in the detection of patterns of a person, we found algorithms that allow starting from the processes of extraction of characteristics, segmentation and description in each object, which is represented by a collection of descriptors. The types of algorithms such as Adaboost, Viola-Jones, Kanade-Lucas-Tomasi are those that evaluate and use features and classifiers to select data with which the algorithm is executed as a pattern in image detection.

This research concludes that the Viola-Jones algorithm with 97.53% is more effective in its detection and currently one of the most used to solve problems of finding and detecting a person's face, being a contribution to the surveillance and safety of people in specific areas.

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