Algorithm for the Recognition of a Silhouette of a Person from an Image

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***Abstract*—The tasks of recognizing people from images or videos are still considered complex for a computer because the pattern of a person has many variants and can be confusing with the pattern of an object or an animal. The objective of this research was to construct an algorithm that allows identifying the silhouette of a person from an image captured by a camera. The methodology used was a review of the literature and a framework that proposed three basic components: The unidentified pattern, the identification process, and the recognized pattern. Once the algorithm model was put to a test as a function of the Mat lab (Support Vector Machines (SVM)), the identification of patterns with people was achieved in four ways, when a person is upright.**

***Index Terms*—recognition of patterns, recognition of images, recognition algorithms**

I. Introduction

The use of pattern recognition technologies is becoming more frequent. Its progress is evidenced in applications such as Facebook where the recognition of faces, violent images, images of sex, etc. have been perfected. According to [1] human activity, recognition systems are developed as a part of a framework that allows the continuous monitoring of human behaviors in the area of assisted living, rehabilitation and entertainment, detection of sports injuries, elderly care and surveillance in smart homes.

According to Lin *et al.* [2] recognition tasks are considered complex for a computer, because they have problems in the processes of object classification, edge detection, motion tracking, etc. For this reason, there are different proposals for human recognition, such as the identification of people through a set of VIPER data proposed by Tao *et al.* [3], which considers a scheme that works through wireless networks of sensors where a system of recognition of human behavior of a person is deployed, such as its robustness or flexibility as well as several developed methods and techniques to detect people in images [4].

The authors Sun *et al.* [5] propose that every process, algorithm, model, etc., is based on the effective recognition of human activity (HAR) which consists of understanding what people are doing from their position, figure, movement or other space-time information derived from their video sequences. According to Benabdelkader *et al.* [6], the detection of a person's image is based on the recognition of different types of images that relate human motions such as running, limping, jumping, etc. In addition, it has long been a subject of study in biomechanics, kinesiology, psychophysics and physical medicine.

Based on the review of the literature that has been made, the following problems can be evidenced:

- The tasks of recognizing images or patterns are still considered complex for computers.
- The recognition of the human silhouette still has deficiencies.

Considering the problems posed, the general objective of this research was to construct an algorithm that allows identifying the silhouette of a person from an image captured by a video camera.

To fulfill the general objective, it was necessary to develop the following tasks:

1) Carry out a systematic review of the literature on the models and algorithms that allow recognizing the image of a person using video cameras through patterns.

2) Develop an algorithm to identify the silhouette of a person from an image.

The methodology of this research work includes a) A systematic review of the literature on the subject raised above, b) The construction of an algorithm to identify the silhouette of a person from an image.

This document is structured as follows:

Chapter II shows the background, which explains a review of the evolution of image recognition over time.

Chapter III shows a previous review, which shows the main models and algorithms available for pattern recognition.

Chapter IV details the methodology used to conduct the review of the literature and the framework used to construct the proposed algorithm.

Chapter V the proposed algorithm is explained.

Chapter VI the results of the application of the algorithm are shown. Finally, the conclusions reached in the present study are detailed.

II. Background

The work of recognition of images of human beings has been proposed by several authors. In 2001, the

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authors Bobick and Davis [7] proposed a static vector image where the value of the vector at each point is a function of the properties of movement in the corresponding spatial location in a sequence of images represented in two templates with values for the recognition of the human being, starting with the combination of two binary values and their sequence. Consequently, a recognition method was developed that combined temporal templates with stored instances in views of known actions.

Based on the algorithm of Self-Organized Maps (SOM), in 2012, the authors Li and Xu [8] proposed an algorithm using vectors of initial patterns and recognition of human actions based on three stages. The first stage, classifying a training vector established in two subsets by vector variance. The second stage, classifying the subsets to join the vectors of similar patterns and the last stage by selecting a certain number of pattern vectors from the subsets classified to form the initial pattern library.

In 2013, the authors Wang *et al.* [9], based their study on human recognition considering several methods, as well as a proposed new system of human recognition online, which is able to classify people with adaptation skills using an incremental classifier with a system that allows the extraction and selection of characteristics that are implemented, depending on the characteristics of color and texture in the person's appearance Lu *et al.* [10].

From 2001 to 2018 the research on the recognition of people analysis has been progressing and developing, with the implementation of Information and Communication Technologies (ICT), reaching broad applications based on algorithms to solve security problems and surveillance, forensic, man-computer interface, multimedia communications, automatic controls, industrial automation, smart electrical networks and control systems. According to Lu *et al.* [10], human recognition from video sequences and tracking people in a network of cameras is a key skill for such systems.

III. Previous Review

A. Recognition Models Found

In the review carried out, several models of pattern recognition were found, for this investigation, three recognition models have been considered, these are shown in Table I.

TABLE I. Recognition Models

Model	Description	Characteristics	Technology	Ref.
Hidden Markov	It is a statistical model to describe the characteristics of a stochastic process.	Hidden Markov Models (HMM) is very important in computational methods for the classification of human physical activity.	Recognition of different activities performed by humans is very appropriate to apply in the recognition of patterns	[11]
Support Vector Machines (SVM)	Model with algorithms associated with learning that analyzes the data used for classification and regression analysis.	It assigns data to one or another category, converting it into a non-probabilistic binary linear classifier.	Non-linear human recognition system that effectively updates the classification parameters when a new framework is presented and classified.	[10]
Convolutional Neural Network (CNN)	It is a model that is used to classify images, group them by similarity and perform object recognition within scenes.	It is formed in an independent data set labeled with attributes. It is based on algorithms that can identify faces, people, traffic signals, tumors, and visual data aspects.	Predict attribute labels of people for the data set that is intended and combine with the independent data set for the final adjustment round.	[12]

According to Table I, the found models consider as useful tools for the recognition of patterns of the image of a person is the programming languages Open CV and Matlab.

B. Algorithms Found

In the research carried out, the algorithms shown in Table II have been found. This table also details the advantages and disadvantages that the authors presented when applying the respective algorithm in their research.

TABLE II. Algorithm Found

Algorithm	Advantage	Disadvantage	Reference
MCMC	The MCMC algorithm learns the set of latent movements that are selectively shared between multiple trajectories and between different activities efficiently.	It has several limitations, for example, the assumption of independence.	[5]
Hibrido IMU	They obtain precise orientations of the extremities and good performance under fast movements of inertial sensors	Needs inertial sensor data, missing from publicly available reference points for video-based trackers	[13]
WSMTAL	Divide human attributes into multiple types, where each contains several incompatible attributes and only one of them can be positive.	Convolutional Neural Network (CNN), does not need more training on the destination data sets.	[12]

C. Algorithms Found with Dataset

Table III shows the algorithms found, and have been classified according to what is proposed (Santos et al., 2017). Table III shows the range of detection, accuracy, efficiency, and feasibility compared to other algorithms that are responsible for the recognition of a person's image patterns.

TABLE III. Algorithms Found with Dataset

Ref.	Algorithms	Dataset	Results
[10]	Incremental SVM Classifier	CASIA Gait Database	A correct classification rate of 98.46% was

			achieved, knowing only 5% of the Dataset at the beginning of the experiment.
[14]	HOG y SVM	INRIA	Detection range: 94.2%
[15]	1. Depth Images 2. RGB Images 3. Multi-model uniform deep learning (MMUDL)	RGBD-ID Dataset.	Accuracy in a range of 20 1. 92.4% 2. 92.4% 3. 98.0%
[16]	Shog and rhog Algorithms	set randomly from the 6000 images The SCOVIS	1. SVM 94% for rHOG and sHOG 2. 95% sHOG and rHOG
[17]	1. LK OF action descriptor 2. Joint action descriptor	Weizmann dataset	Precision: 1. 86.00% 2. 98.6 %
[18]	1. Knn 2. Naive bayes 3. Neural network 4. Svm 5. Adaboost	UMAFD DATASE.	Precision: 1. 90.40% 2. 88.10% 3. 91.07% 4. 92.86% 5. 93.91%

IV. Methodology

A. Methodology for the Review of the Literature

For the review of the literature, the following databases have been included: ACM Digital Library, IEEE Xplore, Science Direct and SpringerLink. Also, to carry out the search, the following strings were proposed:

- Recognition of a person's image patterns
- Algorithms of recognition of a person's image patterns
- Recognition of a person's image patterns and Algorithms of recognition of a person's image patterns
- Algorithms of recognition of a person's image patterns and Recognition of a person's image patterns

Once the search strings detailed above were applied, the results shown in Table IV were obtained:

TABLE IV. Search Results

Source	Potentially eligible studies	Studies Relevant	Studies principal	%
ACM Digital Library	5964	132	2	3,50%
IEEE Xplore	3064	719	12	20,50%
Science Direct	7829	451	8	14,00%
Springer	10936	836	36	62,00%
TOTAL	17793	2138	58	100,00%

In the search carried out, 58 main articles related to patterns of recognition of a person's image were considered, among found were models that allow such recognition, the most relevant data found are shown in the chapter of "Previous review" of this document.

B. Framework for the Proposal

The proposal is based on the framework shown in Fig. 1.

Figure 1. Framework for the proposal.

where, from a captured image, which contains an unidentified pattern, we proceed with the process of identifying the corresponding pattern to a person, and as a result, we obtain the respectively identified pattern.

V. Proposal

Considering the contributions of the articles found based on the SVM algorithmic model proposed by Lu *et al.* [10], different tests were developed to reach the proposed objective. Among the procedures, an analysis and verification of the application of the algorithms found were considered. After this, a matrix of the algorithms found with their characteristics was established and thus the sequence flow chart could be established, see Fig. 2, and finally coding the algorithm, which allowed to recognize the image of a person in 4 positions (front side, left side, right side, and back side) see Fig. 3.

A. Flowchart Description

From the developed research, the flowchart of Fig. 2 is proposed, which allows us to functionally describe the codes found, their application and execution, for which the code was developed for reading an image through 3 stages, see Table V.

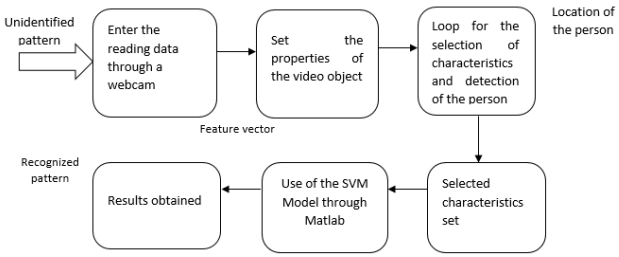

Figure 2. Flowchart proposed for the recognition of people.

B. Development Stages for the Code

The algorithm was developed in three stages using Matlab 2015 ªand Matlab 2017 ª, below, it is detailed:

1) Stage 1

Stage 1 corresponded to the search of different algorithms and the development of the code based on human pattern recognition models. From these the code was developed that allowed us to identify people, which when detected at a distance in a range of 4 to 5 meters they were marked in a yellow group, having

shortcomings in the time of their identification and subsequent capture.

2) Stage 2

Stage 2 consisted of improving the code so that it can recognize the pattern of people in images, videos and real-time in a range of approximately 3 to 5 meters away. In this stage, several tests were done with three different computers that included a built-in webcam.

3) Stage 3

It is considered in stage 3 to improve the algorithm that has been working so that it facilitates in recognizing the image pattern of a person in 4 positions, front side, the left side, right side and backside in a more effective and efficient way.

C. Representation of the Algorithm

Data: obj, peopleDetector, obj_p, frame, bboxes, f
1. input: obj, peopleDetector
2. name set of properties about obj
3. while (true)
frame= step of obj
bboxes= step peopleDetector and frame substract
obj_p=(rectangle, frame) , (bboxes , person)
Output:imshow
f= findobj('tag','webcam')
if (empty(f))
close(f)
break
end
pause (0.05)
4. end while

VI. Results

A. Results of the Development of the Code by Stages

The process we followed to develop the algorithm was divided into three stages, each stage representing an improvement of the previous stage starting with stage 1, which were developed in three computers with different processing characteristics.

Unlike [2], to show the results obtained in their research on human recognition with the incremental SVM classifier, they were based on the CASIA step database, considering that [11] it was based on the same basis of data of 4606 images that are divided into 10 groups at random, to perform the recognition rate. As a result of the development of the code, the matrix was elaborated that allows us to describe the found failures, see Table V.

TABLE V. Failures Found

Stages	Failures	Type of camera	Software
1	Only captured images and fixed videos. It captured the silhouette of a human person in real time at a distance of 5 meters.	TOSHIBA Web Camera – HD	Matlab 2015 [a]
2	Image captured in real time, at a distance of 3 meters. If the person moves or stands aside, he/she stops detecting the silhouette or pattern.	TOSHIBA Web Camera – HD	Matlab 2015 [a]
3	Image captured in real time, at a distance of 3 meters, If the person moves or sideways stops detecting the silhouette or pattern.	TOSHIBA Web Camera – HD	Matlab 2017 [a]

B. Development of the Proposed Algorithm for the Recognition of a Person

The applied algorithm for the recognition of a person's image and Fig. 3 shows us the execution of the code in Matlab 2017 [a] version which recognizes the image of a person in the 4 positions as the front side, the left side, right side and back side to a distance of 4-5 meters.

Figure 3. Recognition and detection of a person in 4 different positions.

VII. Conclusions

In conclusion, the use of the SVM in the Matlab tool for the recognition of people patterns is highlighted. In this study an important incursion has been made in this field, tests have been carried out that allow the recognition of patterns in four ways, especially when the person is upright, however, because the pattern of a person may present more variants, it is necessary to extend the range of patterns to make the algorithm more functional.

As future work, we want to establish an algorithm that facilitates recognizing the pattern of people in a more efficient way, considering that this differentiates the person from an object or an animal, to facilitate the detection of people from an image or a video, and that this application can be used in areas such as home automation.

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