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Hand Joint Position Analysis System for the Care of Patients with Rheumatoid Arthritis

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ABSTRACT

According to the studies carried out in advance, the medical area has analysed the patient's condition visually by applying a common methodology to all patients based on their knowledge of the disease, making a mistaken assessment due to the complexity of the disease, which varies according to the length of time the patient has been suffering from it. The problem posed by this disease rheumatoid arthritis is the bad evaluation by means of radiographs of the hands, relying on the criteria of the doctor when treating the disease with his experience, making serious mistakes when the quality of the image is not correct when interpreting a first stage disease with an advanced one, therefore, it is important to evaluate rheumatoid arthritis by means of an image treatment in a safe way for a better diagnosis of the patient. The aim of this research is to develop a hand joint position analysis system for the care of patients with rheumatoid arthritis to help doctors detect tuberculosis earlier and more accurately and to avoid prolonged infections that could be fatal for patients. The methodology used for this research is based on taking a computerized X-ray of both hands and applying image processing using a computer, the image processing is carried out using MATLAB by applying the various processing tools to detect these conditions. According to the tests performed, it was observed that the system detects the state of the patient with rheumatoid arthritis with an efficiency of 96.14% in its operation, standing out satisfactorily with respect to other systems for its high efficiency of image analysis of patients with the MATLAB tool. It concludes that this system can be used in different circumstances of the patient's condition, from the initial stage of arthritis to an advanced stage of the patient's disease.

1. Introduction

Rheumatoid arthritis is determined as an inflammatory disease with spontaneous irruption that affects the joints of the hands and feet and can affect any organ of the human body to Nithyashree

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et al., [1]. From an epidemiological perspective, this chronic disease affects women in a ratio of 4:1 to men regardless of age, with an incidence point above 50 years of age to Santos *et al.*, [2]. Likewise, arthritis is considered the most common rheumatic disease after osteoarthritis, being among the three main causes of disability worldwide to Li *et al.,* [3], being the cause of 65% of morbidity in the elderly to Castillo *et al.*, [4] with a number of patients increasing due to the inefficiency in its treatment in the face of a progressive joint disease that progresses rapidly in the first year, requiring early treatment in order not to present permanent joint alterations to Morita *et al.*, [5].

The manifestations of rheumatoid arthritis are due to the main appearance of polyarthralgia inflammation that affects the joints of the hands and feet symmetrically and bilaterally to Díaz *et al.*, [6] causing pain due to the presence of deformities that would indicate the degree of functional disability that affects the quality of life of the patient who suffers from it to Pérez *et al.*, [7], although the treatment of rheumatoid arthritis has a clinical diagnosis, the use of various therapeutic schemes has also been observed, such as the use of corticosteroid hormones, disease-modifying drugs and non-steroidal anti-inflammatory drugs that Sometimes it is complicated for elderly patients due to the toxicity of the drugs used to Moran *et al.*, [8]. Faced with this situation, the use of natural medicine is used as an alternative, which promises to present prolonged results on the improvement in the health of patients with rheumatoid arthritis, even though there is no generalized study on the efficacy of natural medicine on the treatment of rheumatoid arthritis. rheumatic diseases to Vizcaino *et al.*, [9], causing uncertainty about the application in patients.

According to the manifestations of rheumatoid arthritis, it is appropriate to conduct early treatment of this chronic disease characterized by being progressive to improve the prognosis and quality of life of the patient, in the face of this disease that has no cure and stands out due to inadequate treatment to Rodríguez *et al.*, [10]. on the patient based on the consumption of antirheumatic drugs to calm the pain for a couple of hours to Carrasco *et al.*, [11], without performing any rehabilitation therapy or knowing the current state of his disease due to ignorance of the progressivity of rheumatoid arthritis, causing a blow to the economy of the patient for the various consultations with the doctor, as well as hospitalization and medications, to all this, add the degree of disability that would make it impossible for the patient to be able to work or carry out any activity to Rodríguez *et al.*, [12]. This last condition of the patient is related to the progression of the disease and may limit the patient's ability to conduct activities with the hands or feet due to the painful inflammation that causes bone erosion and joint deformity to Santucci [13].

At present, doctors normally evaluate patients by feeling, visualizing or by x-rays of the hands or feet to Pérez *et al.*, [14], being procedures that are supported according to the criteria of the doctor with the disease, with the possibility of an inaccurate evaluation. that would complicate the patient's health by not determining if the disease is advanced to Franco *et al.*, [15]. This is why it is important to evaluate rheumatoid arthritis early so that the patient can receive treatment according to the progression of his disease and avoid musculoskeletal disorders.

This research aims to address the limitations of national health systems in applying technologies to analyse hand joint positions, displacing the normal way of assessing the patient by feeling or visualizing the condition of the hand without the assurance of treating the patient correctly, hence the importance of this system that will analyse hand joint positions for the care of rheumatoid arthritis in various conditions.

The objective of this research is to develop a system of analysis of the positions of the joints of the hands for the care of the patient with Rheumatoid Arthritis in order to determine the current state of the patient's disease and prevent any disability that would make it impossible for him to carry out any physical activity with hands. The development of the system is based on taking a computerized x-ray of both hands to apply image processing using a computer. The treatment of the

images is conducted by means of MATLAB, applying the various processing tools that will be developed during the investigation.

In section II, a review of the literature regarding the research conducted is conducted. In section III, the methodology of the system is conducted, presenting it in a block diagram. In section IV, the Processing of the system for the diagnosis of the disease is conducted. In section V, the results obtained by the system are conducted. In section VI, the discussion of the system is conducted against developed systems. In section VII, the conclusion and recommendation of the system is made.

2. Literature Review

This chronic disease responsible for affecting the joints of the hands, characterized by being progressive and causing severe pain in the patient due to the deterioration of the joints, is disadvantageous when it is in an advanced stage due to the disability that patients would face in their lives daily, as well as the disadvantage of being able to perform physical activities. Therefore, it is essential that the doctor determine the disease early to treat the patient according to the progression of his disease and control it through systems that generate accurate information. For example: In Singh *et al.*, [16], researchers mention that rheumatoid arthritis is a gradual condition that alters the structure of the hand, being considered the main disease that causes disability when it is in an advanced stage accompanied by pain on the patient, likewise , have observed that this disease has been increasing in patients with adulthood in a surprising way due to the various repetitive activities and acute injuries that they have suffered throughout their lives, causing damage to the joints and causing rheumatoid arthritis, therefore, they decided develop a machine learning system focused on the localization of rheumatoid arthritis applied in elderly patients. The researchers' procedure is based on the development of artificial intelligence to perform automatic learning constantly and this can improve the precision regarding the detection of rheumatoid arthritis through its repetitive algorithm, managing to store all the detection information. Based on a neural network and visualized by means of a computer, all the information on the patient's disease so that the doctor determines the appropriate treatment based on the information provided by the system. As a result, they presented an 88.74% efficiency in the detection of rheumatoid arthritis for the elderly, reaching the conclusion that their proposed system presents an improvement during the detection of this disease that affects many people over time. long of the world

In Fujimura *et al.*, [17], the researchers mention that the tool commonly used by doctors up to now is the location of arthritis by means of scanned images of the hands, being a procedure that requires a lot of time and a lot of work on the part of the doctor so that can determine the results of the patient through a partial review, producing a variability in the results of their medical evaluation compared to other colleagues due to the experience that each one has with the treatment of the disease, therefore, they decided to develop an evaluation system of Senile rheumatoid arthritis by means of a Convolutional Neural Network. The researchers' procedure is based on the development of a Convolutional neural network to locate rheumatoid arthritis through its algorithm that will detect the stages of the disease, using a group of image data evaluated by the attending physician to identify diseases of the joints of the hands that are not in their exact positions compared to healthy patients. As a result, they presented 90.41% efficiency in the evaluation of patients with rheumatoid arthritis, reaching the conclusion that their proposed system works automatically when evaluating the joints of the hands with respect to their positions.

In Fayyaz *et al.*, [18], the researchers mention that the disease capable of generating pain due to swelling and reduced function of the joints is due to rheumatoid arthritis, classified as a progressive and incurable disease due to the various eruptions suffered by the joints. of the hands, as well as the

cause of fever and lack of appetite, given this, doctors have been evaluating patients over the years through abstract analyses due to the difficult schematic nature that is presented, therefore, they decided to develop an Automatic evaluation system for patients with rheumatoid arthritis through digital image processing. The researchers' procedure is based on evaluating the stage of the patient in relation to the disease by means of the algorithm developed by the authors, applying different methods for image treatment and analysing the areas affected by rheumatoid arthritis, detailing it by means of an image and visualized by means of a computer to automatically identify the precise data of the condition in the hands. As a result, they presented a 91.77% efficiency in the appreciation of patients with this chronic disease, reaching the conclusion that their proposed system can detect if patients are in an advanced stage without having any inconvenience in its operation.

In Wang *et al.*, [19], the researchers mention that the inflammation of the joints and the surrounding tissues are produced by rheumatoid arthritis, a long-term disease that has been increasing in an ascending manner for various reasons, for example, the inefficiency in the diagnosis of the patient by the Applied methodology that is based on the skill of the doctor, commonly used by most specialists, even though it does not generate reliable results, likewise, an outstanding method for the identification of rheumatoid arthritis is based on SPECT, an essential tool that has had safe results. about the disease, therefore, they decided to develop a digital imaging scanning system based on the SPECT procedure applied in patients with rheumatoid arthritis. The researchers' procedure is based on the preprocessing of the set of images found in a database of patients with rheumatoid arthritis of different conditions to continue processing the set of images in a complete way to classify them by means of the SPECT methodology. and compare the results against healthy patients, making the doctor evaluate the patient about the progression of his disease. As a result, they presented a 94.90% efficiency in the comparison of patients with rheumatoid arthritis and healthy patients, reaching the conclusion that their system allows diagnosing patients with arthritis safely by using the SPECT methodology.

In Kumar *et al.*, [20], the researchers mention that rheumatoid arthritis, commonly distinguished as rheumatoid, causes a malfunction in the patient's immune system such as autoimmune inflammation of the bones and joint diseases, generating severe pain in the affected part, being treated through medications that temporarily relieve pain or through abstract analyses of the patient's condition that do not generate a reliable result, eventually affecting the patient for not receiving treatment according to their condition in the face of an incurable disease, therefore, decided to develop a LD-based rheumatoid arthritis predictive system using thermal imaging. The researchers' procedure is based on predicting chronic disease through a deep learning model that allows diagnosis of arthritis based on analysis of thermal images of the patient's hands, helping in the training approach to perform image treatment. safely and predict the presence of the chronic disease that afflicts many people to date. As a result, they presented a 93.7% efficiency in the prediction of rheumatoid arthritis in patients analysed, reaching the conclusion that their learning model can be used as a tool for many doctors specialized in this disease.

3. Methodology

In the methodology section, the analysis of the positions of the hand joints is conducted through computed radiography images, reaching to visualize the current state of the patient's disease and prevent any disability that would make movement with the hands impossible. For the execution of the system, two important aspects such as precision and security in the analysis are considered because the results will serve as a basis for doctors, according to these particularities a block diagram is conducted specifying the processes of the system, as seen in Figure 1.

According to Figure 1, the analysis system of the positions of the joints of the hands is based on the performance of a set of methods that will be developed through MATLAB to evaluate the condition of the patient's disease and prevent the disability that would cause the rheumatoid arthritis.

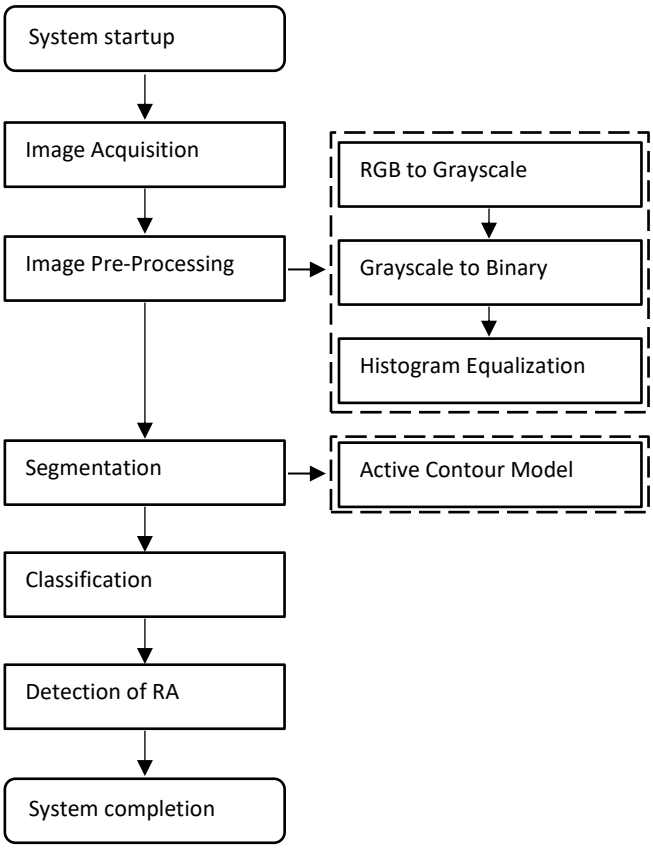


Fig. 1. Block diagram of the proposed analysis system

3.1 Image Acquisition

The acquisition of the images is conducted by means of a computed x-ray of both hands, allowing a broader and deeper panorama that helps doctors diagnose and treat medical conditions. Through computed radiography, patients are exposed to a small dose of ionizing radiation that produces images of the interior of the body, making it possible to detect fractures or degenerative disorders of the hands, as well as demineralization of the subchondral bone that occurs in any joint that present pain. It should be noted that the computed radiography applied to the patient must be posteroanterior or frontal of both hands for a more complete visualization of early bone lesions not visualized by means of traditional radiology, such as fractures or erosions. Likewise, it is important that the images acquired are 800x800 in size to be loaded into the proposed system for subsequent processing, as shown in Figure 2.

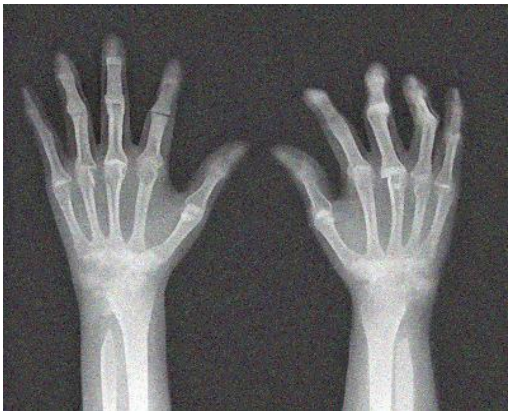


Fig. 2. Homomorphic filtering for images

3.2 Image Pre-Processing

The preprocessing of the computed images of the posteroanterior part of both hands of the patient is based on applying several procedures that would improve the properties of the computed images acquired at the initial stage. The images acquired in the initial stage need to improve their stabilization and facilitate the analysis processes for their subsequent treatment in accordance with what is established by the system, since they normally have errors that generate very or few penetrated images that would make it difficult to identify lesions with greater security. The pre-processing of the images is conducted by means of MATLAB software due to its variety of functions that would improve the characteristics of the images, leaving it ready for its complete image treatment.

Image pre-processing consists of 3 steps, first an RGB to grayscale conversion is applied to the computed x-ray image, then the conversion of the grayscale x-ray image is applied to a binary image, improving the overall contrast of the computed image using histogram equalization.

3.2.1 Conversion to grey scale

The image acquired in the initial stage is generally considered RGB (Red, Green, Blue), named after the colour images, which, by mixing these three primary colours, many combinations can be created different chromatics. To evaluate an RGB (Red, Green, Blue) image by means of the MATLAB software, it is necessary to declare it through the commands specified below:

```
% Upload images
RGB= imread ( "image.jpeg" );
%Show image
imshow (RGB);
```

The first step for image treatment is the conversion of the RGB (Red, Green, Blue) image to grey scale (RGB2GRAY), changing the intensity of each colour in values from 0 – 1 and thus not spending many resources during image processing. The formula that performs the conversion to grayscale (RGB2GRAY) by means of the MATLAB software is through the commands specified below:

```
% Upload images
RGB= imread ( "image.jpeg" );
%Show image
```

```
imshow (RGB);
% Declare variable for greyscale
I = rgb2gray(RGB);
%Show image
figure
imshow (I);
```

This procedure is essential since it provides us with values in the range 0 – 255, facilitating processing and filter applications.

3.2.2 Conversion to grey scale

After having the image in grayscale, it is required to carry out a conversion process called Binary (imbinarize) which consists of replacing all the pixel values of the input image that are above a globally determined threshold by 1 and replace the other values by 0. The formula that performs the conversion to binary (imbinarize) by means of the MATLAB software is through the commands specified below:

```
% Upload images
RGB= imread ( "image.jpeg" );
%Show image
imshow (RGB);
% Declare variable for greyscale
I = rgb2gray(RGB);
%Show image
figure
imshow (I);
% Save image
imwrite ( I, "gray.png " );
% Declare variable for binary
BW = imbinarize (I);
%Show binary image
imshow (BW)
```

3.2.3 Histogram equalization

Histogram equalization improves the overall contrast of the image by changing the intensity values to match both the output and the specified image histograms. This histogram equalization process (histeq) aims to equalize a plane with 64 bins (by default) so that the image pixels are distributed evenly. The formula that performs the equalization of histograms (histeq) by means of the MATLAB software, is carried out with the commands specified below to the image in binary:

```
% Upload images
RGB= imread ( "image.jpeg" );
%Show image
```

```
imshow (RGB);
% Declare variable for greyscale
I = rgb2gray(RGB);
%Show image
figure
imshow (I);
% Save image
imwrite ( I, "gray.png " );
% Declare variable for binary
BW = imbinarize (I);
%Show binary image
imshow (BW)
% Histogram equalization function
imhist (BW,64)
T = histeq (BW);
%Show image
figure
imshow (T)
imhist (T,64)
```

Figure 3 shows the analysis of the preprocessing of the image acquired in the initial stage, appreciating a noticeable improvement that would facilitate the following system processes.

(a) (b)

Fig. 3. (a) Initially acquired image for analysis (b) Histogram equalization function

4. System Processing

System processing continues to develop the following processes to analyse the joint positions of the hands to determine the current disease status of the patient. After conducting the pre-processing for noise reduction, pixel levelling and contrast enhancement, we continue with two important processes, as mentioned in Figure 1, starting with the segmentation process that allows the regions to be divided. of the image, then we perform feature extraction to classify the values according to the processing analysis. To this end, images of patients with different conditions with rheumatoid arthritis were used as a database, keeping the size at 800x800 for a uniform evaluation.

4.1 Segmentation

The segmentation process is conducted by means of active contour model to slice the computed image into specific regions, based on the characteristics of the pixels by locating discontinuities in the values, revealing the edge arrangement. The segmentation process is evaluated by means of the Image function Segmenter, being a common tool applied in medical images for the detection and cataloguing of pixels on the image, representing an erosion in the patient's hand by expanding or reducing the predefined lines.

The Image function Segmenter performs a repetitive sequence that segments the X-ray image and details the region of the affected hand. Likewise, it suppresses parts that do not make up the part of the hand. The formula that performs the segmentation of the image (imageSegmenter) by means of MATLAB, uses commands specified below to the image in binary:

```
% Upload images
RGB= imread ( "image.jpeg" );
%Show image
imshow (RGB);
% Declare variable for greyscale
I = rgb2gray(RGB);
%Show image
figure
imshow (I);
% Save image
imwrite ( I, "gray.png " );
% Declare variable for binary
BW = imbinarize (I);
%Show binary image
imshow (BW)
% Histogram equalization function
imhist (BW,64)
T = histeq (BW);
%Show image
figure
imshow (T)
imhist (T,64)
% Image segmentation
imageSegmenter (T)
%Show image
imshow (T)
```

4.2 Classification

After conducting the segmentation process for the fragmentation of the image in specific regions of the hand, we continue with the classification process based on the evaluation of rheumatoid arthritis by the doctor, unlike the various evaluation methods that are based implicit knowledge that is difficult to transmit to the patient. In the same way, this evaluation is described by means of images

or figures that are classified into six ranges by assigning scores from 0 (normal) to 5 (poor condition), as shown in Figure 4.

According to the patient's condition, the shape of the hand joint positions will reflect different. When comparing the cuts of the 0 and 1 scores, we observed little difference in full evaluation by the doctor when analysing the cut image, although this evaluation may vary according to the patient's condition, classifying differently when there is a coincidence of patterns. Similarly, scores 4 and 5 identify parts of the hand that are in poor condition due to the progression of rheumatoid arthritis, for this reason, the doctor must recognize the positions of the joints and, based on the result, must classify the state of the joint.

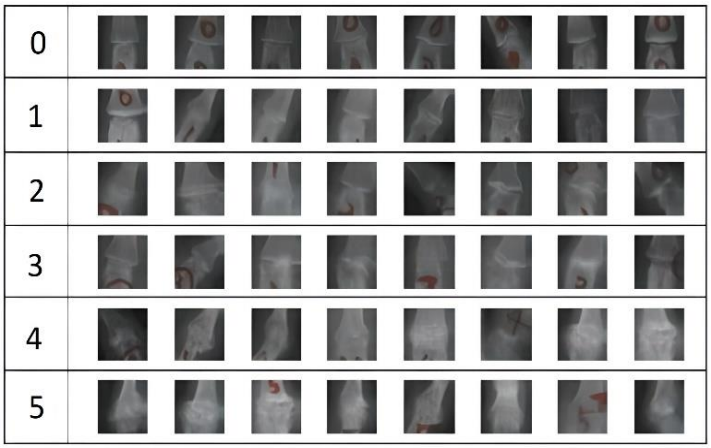


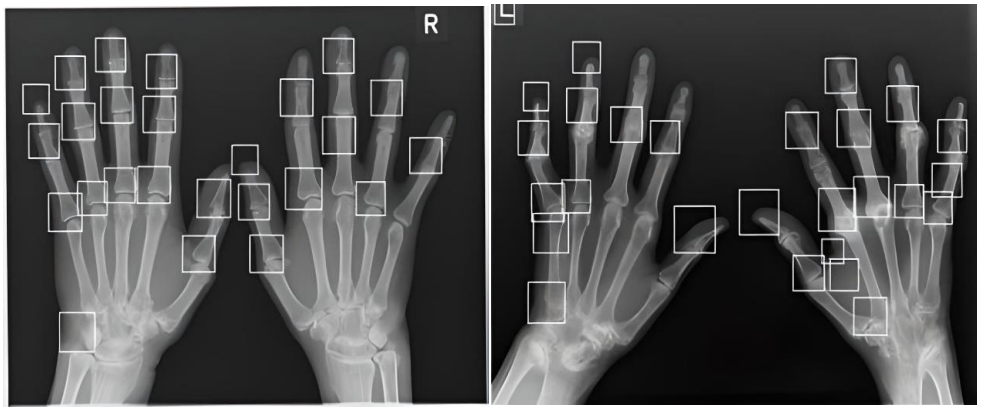
Fig. 4. Classification of computer image according to values

4.3 Rheumatoid Arthritis Screening

The detection of rheumatoid arthritis is conducted by means of the appreciation of the system to analyse the positions of the joints of the hands and classify according to the specified score. If a confusing evaluation occurs, the system can correct it by feeding back the information when reintroducing it again, maintaining control over the patient's evaluation.

To detect rheumatoid arthritis, a base of 50 computer images of rheumatoid arthritis patients of different conditions was acquired, based on it, the system will analyse different rheumatoid arthritis conditions by classifying the score of each cropped image. Therefore, the system performs automatic learning that allows the different shapes of the joints to be recognized more quickly.

The tool used to analyse the positions of the joints was based on the MATLAB programming platform, performing the recognition tests with the basis of computerized images, as seen in figure 5, the posteroanterior computerized image is inserted into the system in early condition for its analysis, showing the 27 points (bones of the hand) of the joints of the hand with a propensity for progressive subluxation due to brief erosions and narrowing of the joint space. According to Figure 5 (a), the system manages to analyse the positions of the joints of the hand correctly, on the other hand, in Figure 5 (b), the system fails to analyse all the positions of the joints of the hand. correctly, giving feedback on the information so that I can evaluate again correctly.



(a) (b)

Fig. 5. (a) Analysis of the hand in correct form (b) Analysis of the hand incorrectly

5. Results

With the progress of the hand joint position analysis system, the set goal of caring for the Rheumatoid Arthritis patient is conducted, so that doctors are supported to pinpoint the status of the patient more safely to prevent disabilities due to this progressive disease that would limit the patient from daily activities.

According to Table 1, the fundamental characteristics of the system for analysing the positions of the joints of the hands are presented, where essential characteristics are specified on its optimal management, resulting in benefits for patients by preventing the complexity of the disease by analysing their condition early, replacing the conventional method that stands out due to the doctor's experience with the disease and the ineffectiveness of its results.

According to Table 1, the hand joint position analysis system detects the state of the patient with rheumatoid arthritis with an efficiency of 96.14% in its operation, standing out satisfactorily compared to other systems due to its high efficiency. image analysis of patients with the MATLAB tool.

Table 1
Characteristic of the patient analysis system

System evaluation	
Patient study	computer imaging
Programming	MATLAB
Part analysed	hands
time required	20 minutes
efficiency	96.14%

With the progress of the system, the data that will determine the condition in which the patient is facing rheumatoid arthritis is needed by analysing the 27 points of both hands, visualizing erosions or fractures in the joints that can cause pain or some disability. Likewise, the time required to analyse is essential for the safety generated by the results on this progressive disease.

The fundamental data to implement this system is the use of the MATLAB software, accompanied by the indicators that complement the system to validate its optimal operation by the various tests conducted. Likewise, it does not generate a high cost in its development, which is why it is fully accessible to many medical centres to expedite the time of care for patients to treat them early.

The interest of carrying out the analysis system of the positions of the joints of the hands for the care of the patient with Rheumatoid Arthritis, is the contribution in the medical area for a faster evaluation that avoids putting the patient at risk against this progressive disease, making it currently important due to the short time required to prevent crowding in closed places such as medical centres.

For the proper management of the system, it must be considered that the computerized image of the patient must be correct, appreciating all the joints of the hands so that the pre-processing is applied and prepare it for the complete processing to determine the classification according to the evaluation of hand joint positions.

6. Discussion

Now there are different systems aimed at locating rheumatoid arthritis in patients who suffer from this chronic disease prematurely to determine the condition in which this disease is found, because it has different stages that become more complicated over time, likewise, handle different methodologies to meet their goal of termination and provide a tool to doctors due to the limitations they have to face this progressive disease that has a growing number of people who suffer from it, for this reason, it is important to manage systems that facilitate the detection of this disease.

In addition, it is highlighted that this system uses its own techniques that allow the diagnosis of the condition in which the patient with rheumatoid arthritis is found, providing the appropriate information to the doctor so that he can establish the corresponding treatment. Likewise, it differs from various systems aimed at localizing rheumatoid arthritis, for example, the research conducted by Singh *et al.*, [16] where the researchers decided to direct an automatic learning system focused on localizing rheumatoid arthritis applied to elderly patients. Obtaining as a result an efficiency of 88.74%, but this system does not use a reliable analysis due to the few trials that its algorithm has had in real situations, complicating its location in patients with arthritis due to the lack of reliability in its results.

The research conducted by Fujimura *et al.*, [17], where the researchers decided to direct an evaluation system for senile rheumatoid arthritis through a Convolutional Neural Network. Obtaining as a result an efficiency of 90.41%, but this system does not perform a precise evaluation of the positions of the joints when the patient is in an advanced stage, limiting its operation due to its unreliability, likewise, the doctor would doubt in taking as a reference the results shown by the system.

The investigation conducted by Fayyaz *et al.*, [18], where the researchers decided to direct an automatic evaluation system for patients with rheumatoid arthritis through the treatment of digital images. Obtaining as a result an efficiency of 91.77%, but this system does not apply a preprocessing to the images obtained for the evaluation, so it directly performs the treatment regardless of the noise that may exist in said analysed image, likewise, it can generate confusing results if the processed image has high noise.

The investigation conducted by Wang *et al.*, [19], where the researchers decided to direct a digital image exploration system based on the SPECT procedure applied in patients with rheumatoid arthritis. Obtaining as a result an efficiency of 94.90%, but this system, when using the SPECT methodology in patients, is limited to the need to use rapid rotation around the patient, as well as the rapid alteration of noise on the image.

The investigation conducted by Kumar *et al.*, [20], where the researchers decided to direct a predictive system for rheumatoid arthritis based on DL using thermal images. Obtaining as a result an efficiency of 93.7%, but this system develops a difficult methodology to manage, likewise, it does

not remove the noise from the scanned images prior to analysis, which would complicate the results. Next, the comparison will be made in Table 2 of this system (a) with our developed system (b).

Table 2
Comparison between two detection systems, applying different methodologies

	a	b
Process	Manual	Automatic
Patient study	Scanned image	X ray
Programming	Python	MATLAB
Part analysed	Hands	Hands
Accuracy	93,70%	96,14%

7. Conclusion and Recommendation

Since the completion of the system, it is concluded that its high efficiency of image analysis helps professionals to determine with greater security and confidence the results obtained from the patient to assess early the difficulties that this progressive disease can affect patients with arthritis.

Since the completion of the system, it is concluded that the use of the system in the different conditions of the patient, in the initial or advanced stage, is completely beneficial and important to visualize the causes of pain due to swelling and deformity in the joints of the hands that goes causing this disease.

Since the completion of the system, it is concluded that the system of analysis of the positions of the joints of the hands for the care of the patient with Rheumatoid Arthritis, allowed to replace the limited conventional form of analysis on the patient that is based on the experience of the specialist and results disadvantageous to some patients because of a lack of confidence in determining their disease status that would worsen over time.

Since the completion of the system, it is concluded that the algorithm developed on the MATLAB platform was essential due to its various tools that it must perform image processing on the patient's hands to analyse the positions of the joints. It should be noted that it is a powerful language that allows you to perform mathematical calculations and is used by a wide variety of professional areas.

Since the completion of the system, it is concluded that its development is totally accessible due to the low cost that it would allow, being able to be implemented in all medical centres or hospitals due to the speed in its analysis and the security generated by its results on the condition in which it is Find the patient's joints.

In the future, a mobile application will be added to the hand joint position analysis system that allows the doctor to analyse the joints remotely to avoid patients having to attend the health centre.

The recommendation to the doctor to have a correct computerized image of both hands so that the system analyses it more fluently to determine the analysis of the positions of the hand joints.

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