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Covid-19 Detection Using CT Scan based on Gray Level Co-Occurrence Matrix

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Abstract

The Coronavirus pandemic is one of the biggest problems the world has faced in the 21st century and this virus is a virus that infects the lung and causes breathing problems. In this research the program is designed for the purpose of reading images of the type CT scan, this study used 654 case these cases split in to two classes (infect , not infect), there are two phases in this study, training phase and testing phase. After training the training data store in database, the second phase is testing at first is pre-processing step which increase contrast, then remove lung by labelling the most contrast connected pixels and subtract labelling pixels from original image, the next step is noise removal by applying three filters (mean, median, Gaussian), after that applying gray level co-occurrence matrix (GLCM) in four directions ($0^\circ$, $45^\circ$, $90^\circ$ and $135^\circ$), then extract features from GLCM, in this study 10 features was extracted from each GLCM matrix, then compare between testing features and training database to specify the case is infect or not, in this study get accuracy 94% for detect the location of infection and detect the lung is infect or not.

Keywords: COVID-19; GLCM; Haralick Features; CT scan

1. Introduction

In Dec. 2019, a disease outbreak has been reported in Wuhan, China, with a new coronavirus that has been referred to as the Severe Acute Respiratory Syndrome Coronavirus II (SARS-CoV2) [1]. The World Health Organization (WHO) after that named this disease as the Coronavirus Disease 2019 (COVID-19). On Mar. 11, 2020, WHO have announced the COVID-19 as pandemic [2], with 10021401 confirmed cases and 499913 reported deaths all over the world, by Jun. 29, 2020 [3]. The computer vision systems’ development has supported medical applications like the increase in image quality, organ texture classification and organ segmentation. The analyses of the tumor properties and time series (2), detection and segmentation (3) of tumor modules are a few of machine learning applications in the area of the bio-medical image processing [4]. Compared to the chest X-ray, the CT has more clear information and it offers better judgement accuracy hence, this research work considered only the CT for the examination. Rodriguez-Morales et al.27 present a review of the detection and prediction of COVID-19 pneumonia infection [5]. The current procedures used in the identification of the virus require an experienced radiologist, hence automatic detection would be essential to reduce the assessment time for radiologists. The work in 28 reviews the recent image processing techniques.

In this research, 654 CT images have been utilized for the classification of COVID-19. Prior to the process of the classification, data-set samples have been classified as coronavirus / non-coronavirus (i.e. infected / non-infected) [6]. Feature extraction approaches with the use of the Euclidian distance and gray level co-occurrence matrix have been utilized throughout the COVID-19 image classification. The results have shown that the suggested approach may be

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utilized for the diagnosis of COVID-19 as an assisting system [7]. For further studies, refer to [8], [9], [18]–[27], [10]–[17]

2. Dataset

Dataset used in this study contains 654 CT scan images and is classified as the follows:
   a. First part contains healthy CT scan image of any infection. This part contains 410 CT scan images.
   b. The second part contains the CT scan images with non-infection. This part contains 244 images

The dataset is split into two parts. The first part consists of 70% images used for training system. The second part consists of 30% images used for testing the proposed system. Figure 1 illustrate CT scan images of dataset.

![Figure 1: (a) illustrate samples of infection images of CT scan in dataset (b) illustrate samples of non-infection images of CT scan in dataset](image)

3. Proposed System

The presented section describes the suggested approach for efficient segmentation and detection of infection from CT scan images which includes five steps (pre-processing, image enhancement, segmentation, features extraction and classification).

3.1. Proposed System Architecture

This step represents the proposed system work as flowchart show in Figure 2 that illustrates the training steps. Figure 3 illustrates the testing steps. The steps of the work are identified in details. The training steps can be split into two parts, the first part is the pre-processing of images, while the second part is applying GLCM and feature extraction. Figure (2), illustrates flowchart of training part, Figure (3) illustrates testing part.
Dataset contains set of images

Pre-Processing Apply (contrast, convert to gray, and lung removal)

Noise Removal Removing types of noise by using filters (Mean, Median, and Gaussian)

Feature extraction using gray level co-occurrence matrix

Store features that extract from previous steps in Database

Load testing image

Pre-Processing Apply (contrast, convert to gray, and skull stripping)

Noise Removal Removing noise by using filters (Mean, Median, and Gaussian)

Feature extraction using gray level co-occurrence matrix

Apply Euclidian distance between extracted features and training features

COVID 19

Non COVID 19

Figure 2: Block diagram of training dataset

Figure 3: Block diagram of testing steps
3.2. Proposed System Steps

A few steps of pre-processing will be done to the raw input CT scan image; thus, images will be transformed to adequate form for more processing. In such step, the raw image will include a lot of undesired information (noise). Initially a tracking algorithm is used.

Step 1: Loading CT scan image
Step 2: Increase contrast of loading image.
Step 3: Every one of the elements corresponding to a gray value between (0 and 255).
Step 4: Using a 2D matrix for storing the image.
Step 5: Lung elimination by read pixels of image and search about first white pixel then label first row of lung, then begin with label every pixel connect with labelling pixels.
Step 6: Subtract extracted lung from gray image.

3.3. Noise Removal

Image Enhancement might be defined as a process used to enhance the appearance of images with regard to better visibility and contrast. At this part the images which are 457 image input to preprocessing in order to optimize the CT scan images. This images are classify into types of diseases. The first step in this part is apply three filters which are (mean, Gaussian, and median filters), these filters will removing the noise and enhance the image. In mean filter, a mask size will be determining the loss of details and degree smoothing. Also, the noise that is randomly vary below and over normal brightness value might be decreased via averaging neighborhood of values. Median filter is one of the majorly recognized statistics filters, it is replacing the pixel value by the median regarding grey levels in pixel’s neighborhood, while the pixel original value will be involved in computations of median, such filters are widely utilized due to the fact that in specific random noise types, they will be providing efficient capabilities of noise-reduction, with significantly less blurring in comparison to the small size linear smoothing filters. Also, such filters are especially important with the existence of unipolar and bipolar impulse noise. Gaussian filter: As soon as calculating an adequate kernel, Gaussian smoothing will be achieved with the use of standard convolution approaches. Actually, the convolution might be fairly quickly achieved as the equation for 2-D isotropic Gaussian was separated into x as well as y components.

3.4. Apply GLCM and Feature Extraction

One of the statistical approaches for examining the textures considering the pixel spatial relations is the GLCM, such approach is characterizing the image texture via estimating how frequently pixel pairs with certain values as well as in certain spatial relationships exists in the image. This achieves the extraction related to the statistical measures from such matrix. GLCM is created via gray-co-matrix function through estimating how regularly a pixel with the intensity (grey-level) value (for example) row happens in certain spatial relationship to the pixel with a value by column and row. The relation is specified as the picture elements in terms of features present and the pixel to adjacent. At this step system will determine shape of extracted region in order to allow to recognize lung contain COVID 19.

4. Experimental Results

The first steps is pre-processing which is applying contrast step to increase the light of testing image
Then convert image to gray scale Figure (4) illustrates dataset, and the result of contrast and convert to gray scale.
The second step is lung removal by labelling high contrast and connected region with lung. Figure (5) illustrates lung labelling, and then subtract the labelling region from original image to remove lung.

Applying three filters to remove noises from the images and enhancement them.
A. Applying Mean Filter
Mean filter is the first filter was apply in pre-processing, this filter will remove some types of noises like grain noise from the images, and by using the mask of mean filter will compute average of neighbors pixels and remove noise.

B. Applying Median Filter
Median filter is most common filter to remove and clean the images from noises, median filter can greatly reducing the time of the cleaning.

C. Applying Gaussian Filter:
Gaussian filter remove the random variation brightness information from images, by applying Gaussian filter, the types of noises remove are: (Salt and pepper noise, Gaussian noise, and Speckle noise).

Then Applying GLCM, the GLCM read texture of tumor in four angles (0°, 45°, 90°, and 135°) to generate four matrices for each image. Table (1) illustrates GLCM for first testing image, Table (2) illustrates GLCM for second testing image. Table (3) illustrates GLCM for third testing image. Table (4) illustrates GLCM for fourth testing image.

| Table (1) illustrates GLCM for first image test |
|-----------------------------------------------|
| 14825 127 112 27 17 67 178 58 |
| 204 143 132 32 8 1 0 0 |
| 152 204 647 269 29 5 2 0 |
| 46 37 362 928 352 28 9 0 |
| 19 8 48 442 1406 450 122 0 |
| 25 1 8 56 547 1391 765 10 |
| 86 2 3 14 135 839 1465 42 |
| 43 2 0 0 1 22 45 12 |

| Table (2) illustrates GLCM for Second image test |
|-----------------------------------------------|
| 13323 273 118 34 16 25 58 36 |
| 210 193 133 72 15 7 0 0 |
| 92 109 253 225 45 6 6 2 |
| 21 42 194 798 309 45 7 2 |
| 15 8 31 276 809 338 31 2 |
| 34 3 6 21 302 785 260 4 |
| 90 1 1 4 33 216 504 43 |
| 36 0 1 0 2 9 38 20 |

| Table (3) illustrates GLCM for third image test |
|-----------------------------------------------|
| 18882 226 55 53 37 67 223 134 |
| 219 617 253 38 11 11 9 10 |
| 83 246 751 271 68 28 19 2 |
| 52 48 284 885 404 75 39 8 |
| 38 12 90 394 1034 377 114 15 |
| 58 14 37 96 356 815 399 38 |
| 176 16 18 60 147 402 1110 188 |
| 87 2 2 17 27 44 214 113 |

| Table (4) illustrates GLCM for fourth image test |
|-----------------------------------------------|
| 14779 100 42 16 10 6 31 41 |
| 111 113 67 25 3 1 0 0 |
| 43 89 190 93 29 2 0 0 |
| 10 13 124 384 139 19 4 0 |
| 7 2 19 153 393 129 14 3 |
| 8 1 2 18 128 401 112 2 |
| 35 0 1 1 18 111 417 40 |
| 38 0 0 0 0 3 45 41 |

From this matrixes extract features for each testing image as Table (5)
Table (5) illustrates features extracted from testing images

|        | Contrast | Correlation | Energy | Homogeneity | Mean   | Standard Deviation | Entropy | RMS  | Kurtosis | Skewness |
|--------|----------|-------------|--------|-------------|--------|--------------------|---------|------|----------|----------|
| Image 1| 0.1187   | 0.9798      | 0.2332 | 0.9418      | 1.9064 | 0.5737             | 0.6839  | 1.5969| 1.7449   | -0.4768  |
| Image 2| 0.334    | 0.959       | 0.126  | 0.8694      | 1.5703 | 0.6728             | 0.7127  | 1.5969| 1.4839   | 0.1819   |
| Image 3| 0.45     | 0.9633      | 0.1259 | 0.842       | 1.2276 | 0.8179             | 0.7522  | 1.586 | 1.551    | 0.3254   |
| Image 4| 0.2052   | 0.9574      | 0.1718 | 0.9053      | 1.4422 | 0.5016             | 0.7163  | 1.5969| 2.2041   | 0.6301   |

Now system apply Euclidian distance to compare between testing image and training database to specify the testing image with COVID 19 or not and location of it as in Figure (6).

Figure (6): illustrated final result of some testing samples and specify location of COVID 19 in CT scan images

5. Conclusion

a. The algorithms and approaches that have been utilized in this system, particularly in the feature extraction stage, are simple and utilize less amount of the memory. It is easy to understand and involves no complicated mathematical formulas.

b. Ability of the system can be increased with the use additional characteristics in the input dataset.

c. Time consuming for execution of all step in proposed system is less than two second.

d. The accuracy of the proposed system reached 94% on a used dataset.

f. Determine whether there is a COVID 19 or not as well as in order to facilitate the work of the doctor in the diagnosis and alert if nothing is noticed in the picture.
The filters were used to filter CT scan image, which are mostly snouted due to the movement of the patient or the device that was picked up poorly.

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