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Automation in Pneumonia Detection

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***Abstract*— Pneumonia is a commonly known disease that causes an infection on respiratory system, where it causes inflammation in one or both lungs. In such disease happened in a restricted area are difficult to diagnose simply without any assisted vision. Thus, *'Automation in Pneumonia Detection'* is developed, and it is a model system using a Machine Learning model trained for pneumonia radiographic images detection from the collected chest X-ray image data. Unlike other researchers' method, this system has relied solely on the Shallow Learning approach with simple texture analysis feature obtained an accurate detection performance and results. The traditional technique is constructed with extracted features of the chest X-ray image and to classify its types and classes determining if a person is normal or infected with pneumonia viral or bacterial. The model aims to alleviate the challenges occur and to get its reliability and easy to interpret images for medical descriptive visual.**

Keywords—Pneumonia; Automation; Detection; X-ray image; Shallow Learning

I. Introduction

Malaysia has been struck again with the outbreaks and it has taken the lives of so many people around the globe; where the disease is widely caused by an infection towards a respiratory system and identified as Pneumonia where scientifically causes inflammation on the alveoli causes of fluids that filled into it. Thus, the air sacs inside the alveoli filled with fluids make it hard for oxygen to be transfer into the blood cells, and possible to lead to fatality. Pneumonia is seriously deadly, and the infection primarily affects people with low immunes, such as infants, young children, and senior citizens. In Malaysia, the press released in 2019 recorded that pneumonia top the second chart with 11.8% by the Department of Statistics Malaysia (DOSM) after the *Ischemic heart diseases* [1]. It infects the body at the most restricted area, lungs, to be diagnosed. The infection in the lungs can possibly because of bacterial or even viral.

In addition, both viral and bacterial are the type of pneumonia that mostly attacks a person the most, while others followed by fungal and atypical, also known as walking pneumonia [2]. The disease happens when the air sacs filled with fluids by the inflammation, then causes the oxygen hard to be transferred through all parts of the body. In consequence, it leads to shortness of breath, cough, chills, fatigue, chest pain and others [2]. On top of that, this research is to find an alternative way to classify viral and bacterial pneumonia because of its identical appearance on X-ray images. Moreover, bacterial can be treated with antibiotics. Thus, it is beneficial to be able to differentiate it well, so that any action can be taken immediately. Along with that, many doctors are faces with low aid supports and insufficient doctors related [4, 5] who are skills to measure and diagnose the radiographic images. Besides that, it is said that bacterial usually affects directly from air sacs in the lungs, while viral affects the bronchial tubes, because of its locality and from where it comes, as viral is a germ from outsides that need a host for it to reproduce and grow. Accordingly, with its restricted location, it causes hard to clarify the images [3] simply through X-ray.

The system proposed implied due to pandemic outbreaks on how to classify and differentiate the radiographic images between normal with Pneumonia infections, viral and bacterial since diagnosis the images for any symptoms and abnormalities could be cumbersome in a short time [6]. Other than that, for the implication avoiding human mistakes for the interpretations. Thus, the model aimed to reduce the challenges that occur and to get its reliability and easy to interpret images for medical descriptive visual.

II. MATERIALS

A. Collecting Dataset

The experiment is using the image processing technique, thus image datasets are collected. The X-ray images were used for detection and gathered from the Kaggle dataset. The total of images taken is about 150 images with every class collected for 50 images accordingly, the normal, viral pneumonia and bacterial pneumonia images. However, during the process, the images are then separated for the training and testing with a ratio of 80:20.

Fig. 1. Images of Normal and Pneumonia Type

B. System Tools

The system built and run wholly using MATLAB R2019a tools, the platform where it accelerates the science for engineers and scientists in any aspects with its complete tools for programming and numeric.

III. METHODS

Digitizing images for classifications are not a new thing at all. As artificial intelligence (AI) is a main-driven for emerging technology, it is mainly used in many areas to operate complexity and reduce scarcities [5] and human errors. Hence, the research and findings are to prove the image processing method to perform such operations to analyze and able to classify the images between normal and pneumonia (*viral and bacterial*) infected images. Image automation in classification has been operated with many techniques up until now. Thus, technology growing year by year to find the suitable method for automation to avoid human error and reduce the time taken, also to overcome the limited aids and resources availability.

The application applied using machine learning (ML), specifically shallow learning (SL) for a supervised technique classifying the labelled X-ray images from collected dataset such as normal, bacterial pneumonia and viral pneumonia.

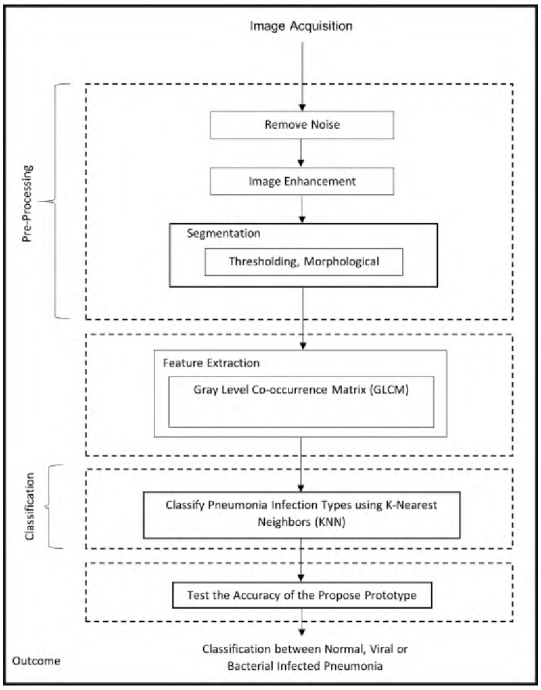

Fig. 2. System Framework Method

A. Technique

Image processing is applied in many fields of sciences and non-sciences related. There are consists of few common steps of processes:

1) Image acquisition: The projected images are digitized and collected from the Kaggle dataset consists of types of pneumonia and normal images.

2) Resize image: The image selected on the system resized into 800x800 row-column size.

3) Image Enhancemnet: To filter and denoise resized image into a clearer image with controlled image contrast. To get a balanced contrast control, the system used contrast-limited adaptive histogram equalization (CLAHE) and average filter.

4) Segmentation: To select the interest region automatically from the system using thresholding and morphological.

5) Feature Extraction: The gray level Co-occurrence matrix (GLCM) is used to extract the image feature values accordingly, with image features contrast, correlation, energy and homogeneity. GLCM also known as the second order feature under statistical methods out of three orders.

6) Classification: To classify the X-ray image whether the image shown and processed is a normal, viral or bacterial. The classification model used is K-nearest neighbors (KNN) model under the supervised technique for image detection.

B. Equations

In image processing, equations are not an exception as the application used a statistical structure and method for the image classification, and mostly used during the feature extraction process. It calculates and tables the image difference combinations value. Therefore, it provides the informative texture of processed image and enable it to classify the processed X-ray images between normal, bacterial, and viral images.

The GLCM is knowingly with its tabulation data of image elements level. It finds the difference of gray combination image elements level, then gets its rows and columns value, exchanging the gray levels. Subsequently, it combines both co-occurrence matrix image with the transposed matrix, then normalized it. Refer to the equations, (1) – (4), can be assume that the Pij as its normalized symmetrical GLCM, while N represents number of gray levels in image by quantization levels:

$$Energy = \sum_{i,j=0}^{N-1} (P_{ij})^2 \qquad (1)$$

$$Contrast = \sum_{i,j=0}^{N-1} P_{ij}\,(i-j)^2 \qquad (2)$$

$$Correlation = \frac{\sum (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum (x_i - \bar{x})^2 (y_i - \bar{y})^2}} \qquad (3)$$

$$Homogeneity = \sum_{i,j=0}^{N-1} \frac{P_{ij}}{1 + (i-j)^2} \qquad (4)$$

Other than that, the classification, KNN also measuring its distance, where the algorithm works by finding the shortest distance between the training and test samples. Although KNN is knowingly known as one of a simple method, with its adaptability and sturdy to large data and noise, its performance is a match as the other complex classifiers. The distance method used is Euclidian, (5).

$$distance(a,b) = \sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2} \qquad (5)$$

IV. RESULTS AND FINDINGS

The testing results of classifying the pneumonia images are divided into three classes and trained under KNN model classifier, using Euclidean distance before carried out the final evaluation. The features extraction data values are then loaded into the classifier after training and read the data using nearest the K value selected that is possible nearest to the data. The suitable distance was selected, the Euclidean (Equal) with its nearest neighbors value = 4. The result is then displayed.

Table 1 below indicates the summarized results of x-ray images detection for testing. The total of images for testing for every classes are 10 images for each. Based on the three classes of images, the overall testing accuracy obtained involving 30 images in total. The overall accuracy using the Accuracy formula equation (6).

$$Accuracy = \frac{TP}{Total\ Images} X\ 100 \qquad (6)$$

Table 1. Summarized testing images results

Type of Classes	Total Number of Tested Images	Classified X-ray Images	
		True	*False*
Bacterial	10	9	1
Normal	10	9	1
Viral	10	8	2

The TP stands for the True Positive of the images, the total number of correct images classified after the process. It will then be divided by the total of images tested and multiply by 100 to get the percentage. Thus, the system classified the images correctly with the accuracy of 86.67% as more than a half for each class is classified accurately referred to Table 1 above.

V. CONCLUSIONS

The obtained results referring to the detection model and the system functionality visibly for the users are tested. The automation model is using the simple supervised model, KNN as its classifier with texture analysis features a technique to find its possible accuracy. This automation system includes the classification model with a few support features to help support the technique to gathered accurate data classification detection. This classification model system is meant for the clinician and researchers for research purposes to classify the radiographic images using Shallow Learning accurately.

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