International Journal of Innovation Scientific Research and Review
Vol. 05, Issue, 03, pp.4249-4253, March 2023
Available online at http://www.journalijisr.com
SJIF Impact Factor 2023: 6.599

IJISRR

ISSN: 2582-6131

Case Report

CLASSIFICATION OF BRAIN HEMORRHAGE (CT SCANS) USING TEXTURAL FEATURE AND CNN DEEP LEARNING

[1,] *Mohammed-Elbasheir, [2]Somia-Badawi, [2]Ahmed-Khalid, [3]A.M.Ibrahim

[1]Faculty of computer Science, Elrazi University, Khartoum, Sudan.
[2]Applied college, Najran University, Najran, Saudi Arabia.
[3]Sudan Technical University, Khartoum, Sudan.

Received 17th January 2023; Accepted 18th February 2023; Published online 30th March 2023

ABSTRACT

This study acts in image processing and analysis in computerized-aid so as to increase the accuracy of diagnosis in reporting the classification of the brain haemorrhage type. To do image processing, one needs many techniques but there is a need to offer an improvement for the algorithm of image processing to expand preciseness. This project provides an algorithm for CT scan image. The way has three processes: Segmentation (parsing into small parts), feature extraction (knowing features), classification (reporting) using Neural Network of MATLAB. Reconstruction was used before to do the current project process but it was time-consuming. Reconstructed images change their features many times so it is difficult to use automation here because of different types of brain bleeding and their shapes. Textural features are entropy (random), mean, variance, inverse. They are calculated on gray-level co-occurrence matrix. The algorithm given is used to classify one of four brain bleedings: Cerebellar (back brain part), Extra-dural(outside brain case), Intraventricular (brain cavity area), Subdural (between brain and skull). The experiment conducted in Elrazi University in Sudan Khartoum city, besides the CT scans images collected from Al-Saahah Hospital in Sudan in Khartoum city and others images from the internet.

Keywords: Brain Hemorrhage, CNN Algorithm, Classification, Feature Extraction, Computed tomography (CT).

INTRODUCTION

Nerves and vessel bleeding or brain one is when blood vessels burst causing leakage in brain or between it and the skull. Stating the type of brain bleeding is necessary to decide the suitable medical treatment. Computer-aided diagnosis helps increase the physician's ability. It is called CAD. It reduces work-load for radiologist staff. Thus, digital medical imaging or image processing and analysis is crucial for evaluation and diagnosis. It is of different techniques and stages. Computed tomography (CT) is known as a non-invasive technique to scan the human body. It is done using radiation and sensors. it pictures the brain inside with vessels and tissues. It is used for unconscious ill persons where their vital signs are not stable to use (MRI) magnetic resonance imaging [1]. CT scan gives little detail about the brain so it needs computation. Each pixel conveys its corresponding gray value. Hemorrhage regions can be stated based on difference of gray value. CT scan images (in different angles) are used for analysis for abnormalities present [2]. Researchers face limitations of available head images due to partial volume effects which affect the edges producing low brain tissue contrast. As well, and because of the inherent resolution limitations of CT scan, all material boundaries are unclear so the result voxel (= a point in three dimensions' space) can be affecting factor on other voxels [3]. Therefore, to ease the old system of CT scan, automated neural network in MATLAB is used.

The objectives of this paper is to: 1) Using MATLAB to do CT scan image on brain bleeding. 2) Making a way to distinguish the four bleeding types using Neural Network (CNN) toolbox in MATLAB. 3) To verify the accuracy of the system by testing outside images not the ones of the training. Besides, the scope of this study is on the image analysis ways using feature extraction which is by choosing the best group of texture using Classification (by convolution neural network CNN) and evaluation system accuracy (Using external images) to classifying the type of hemorrhage. The Relevancy and Feasibility for this study, anyone can be a victim to blood bleeding; however, the important step is to diagnose it first. Determining the type of brain hemorrhage aims at analyzing the image of CT scan of the meant patient. Hence, doing the computer-aided diagnosis or medical image analysis is a stepping up stone of saving lives. It provides with details about the textural features of the blood bleeding as well as the severity and the cause of that type. MATLAB does segmentation and classification. Because there are not many databases of head CT scan images, the researchers used images from Al-Saahah Hospital in Sudan in Khartoum city and others images from the internet.

***Corresponding Author: Mohammed-Elbasheir,**
1Faculty of computer Science, Elrazi University, Khartoum, Sudan.

RELATED WORKS

In order to differentiate between the four types of brain bleeding and to state other cases, neuro-imaging is needed. It depends on the patient's symptoms. The most common imaging is CT scan. The textural features build the last report or the final classification based on the location of brain bleeding [4].

The first right list are the subsets chosen to be analyzed, so they are caused by: 1) Cerebellar = hypertension, lesion. 2) Intraventricular = hydrocephalus. 3) Extradural = piling of blood outside dura. 4) Subdural = piling of blood inside arachnoid [5].Imaging Techniques for Evaluating Blood Bleeding of Brain: 1) CT scan (e.g., abscess). 2) MRI (e.g., ischemic). 3) Ultrasound B scan. CT scan is chosen as the best way for detecting brain bleeding. When classifying images, the texture is important, the more features in the texture are there in the image, the more the analysis is and the more are the properties to be characterized. Here segmentation and classification are suitable for human vision system where using texture plus brightness and data equal text one [6]. The function of this system includes: 1)

Recognition of objects. 2) Perception of depth. 3) Identification of different textures. In segmentation techniques Zhang said that dividing a digital image into a group of pixels is called segmentation. It is giving detailed data automatically to be analyzed based on statistical pattern[7]. Kaiping gave algorithm that segments brain images and points out both cerebra and spinal fluid regions ignoring the abnormal ones[8]. Ruthman suggested a technique uses the image local edges (thresholding)[9].Tong recommended to use segmenting the same parameters and analyzing the clustered data of other compared images [10].We chose the thresholding way to detect the skull first. Then, proceeding the foreground objects of the image, using morphological reconstruction to recall bleeding positions. Last, we put the bleeding brain layers together to be detected for their textural features = the last step is to put them all in the Neural Network classifier CNN application[11].Imaging techniques that are used in evaluating hemorrhage includes CT scan. CT scan where in its stroke protocol includes; non-contrast, CT angiography, and perfusion. CT scan images are known to be good in detecting mass lesions like brain abscess and acute hemorrhage. However, it is not that good in detecting ischemic stroke (Duncan & Ayache, 2000) [12]. The main goal of CT scan is to distinguish the stroke mimics and detect hemorrhages. On the other hand, MRI have better sensitivity and resolution than that of CT scan. Thus, it is good in detecting ischemic (blood drought) stroke unlike CT scan [13].

The aim of pattern recognition is to state the shapes and sub shapes present in a given image; here an algorithm is used to recognize: 1) The bleeding place (interest post). 2) Detecting selected features. 3) Classification (CNN).There are three basic ways for feature extraction and classification of pattern recognition:1) Statistical way. 2) Syntactical/structural reading.3) Spectral technique.

In this research, used features extracted using co-occurrence matrix method based on statistical description of gray level of an image which used in ResNet50 [14]. Four features are only used: entropy, energy, variance, and inverse difference. Padma and Suka found that only four features can give the highest accuracy of the last report. They are called the parameters[13].For the recognition and pattern in MATLAB in this work the researchers used the textural features to be used for the Neural Network Pattern recognition is based on the promising results of Padma and Sukare search wherein they primarily used 13 textural features in different combinations for classification. As a result, they found that only a combination of four features namely: entropy, energy, variance and inverse difference mean feature, gives the highest accuracy and that employing more than five features will decrease the accuracy [13]. Besides, Fig.1 explains a traditional CNN architecture. Convolution Neural Networks (CNN) are one of the most marked theories of deep learning, where multiple layers of neurons are piled in a solid manner.

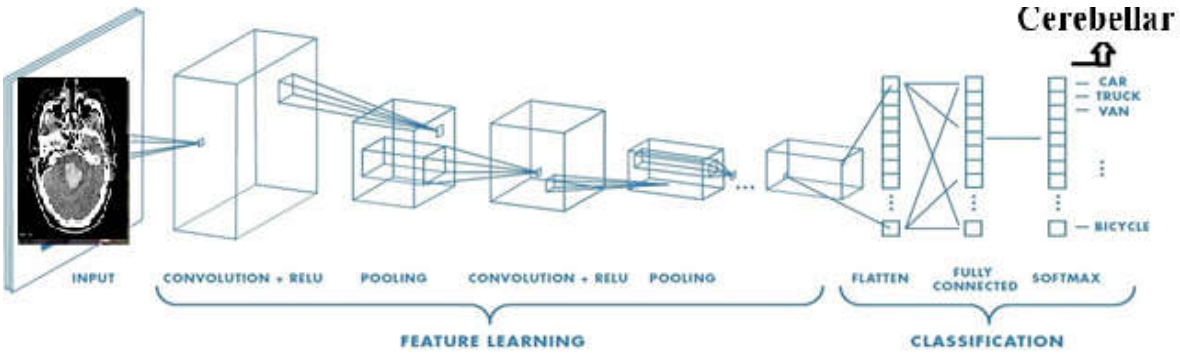


Figure 1: CNN Convolution neural network

DenseNet [15] is a CNN model, which they take place of convolution non-linear and pooling layers with intensive blocks and transition layers exploiting the original, CNN layers except the first convolution layer [16]. Fig.2 shows out the first DenseNet model with three intensive blocks and two transition layers.

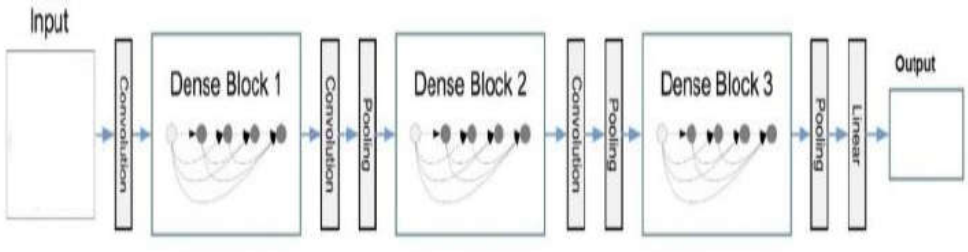


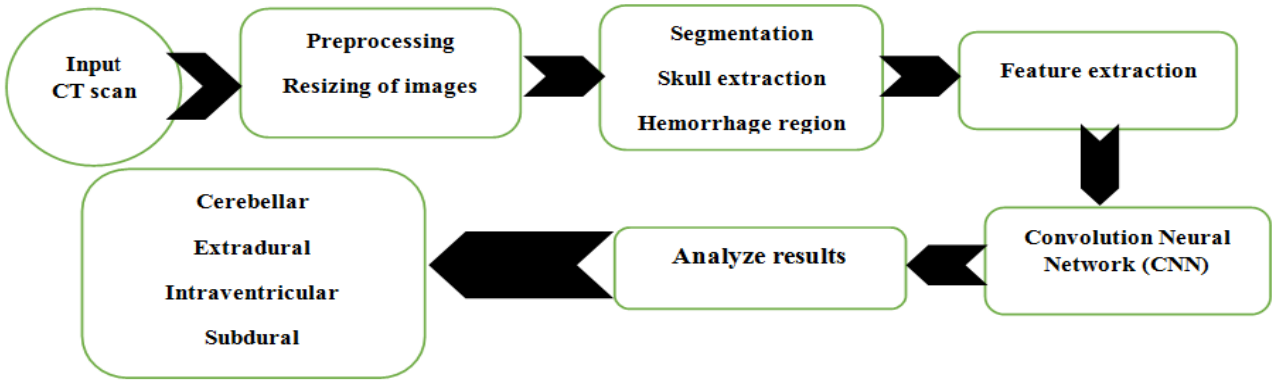
Fig.2. DenseNet with three dense blocks architectures [15] [16].

THE METHOD BASED ON FEATURE EXTRACTION AND CNN

Computer based textural analysis system algorithm using MATLAB (Math Work) tools, the method is composed of three processes:

1) Segmentation
2) Feature extraction
3) Classification (CNN Algorithm)

The following diagram Fg.3 explains how the given input image passes through the suggested application:



Fg.3 Suggested CNN classification of Brain Hemorrhage

When used MATLAB for images processing the image is a group of values arranged in a form of a matrix. MATLAB does operations on such matrices using its toolbox to do transformations on images namely on the grayscale ones. Values are called pixels for one-dimension point and voxels for three-dimension one [17].For Segmenting an Image, Segmentation is dividing an image into portions with the same particulars. The division is done in sections: 1) Gray level. 2) Texture. 3) Brightness contrast. Besides, Segmentation is two types: Contextual that is implemented inside the image i.e. studies the connections of the same image. And the other type is Non-contextual that needs to group images based on the global attributes. The first type is featured by having the possibility of gathering pixels of the same gray level. So, GLCM in the stage of feature extraction, the image is passed via a statistical extraction tool; the Gray Level Co-occurrence Matrix It is a matrix where the number of rows and columns is equal to the number of gray levels in the image. GLCM is a technique using statistics of inspecting textures that considers the spatial connection of pixels [18]. It is also called gray-level spatial dependence matrix. It gives how the frequent pairs of pixels with a specific spatial connection appear in an image. The GLCM provides several statistics using the gray coprops. These sets of values are called the training sets which will feed into the Neural Network for training purposes Classification Algorithm (CNN Algorithm).These textural features from GLCM are further extracted for all images of the four types of brain bleeding to be later on used as the database and then they will be fed into the Neural Network system which CNN algorithm used here for pattern recognition and classification[18].The algorithm gives difference's readings of the four-brain bleeding types' values. So, the efficiency relies on the adequate input database of both training and target sets.

Collecting and Classifying Hemorrhage images

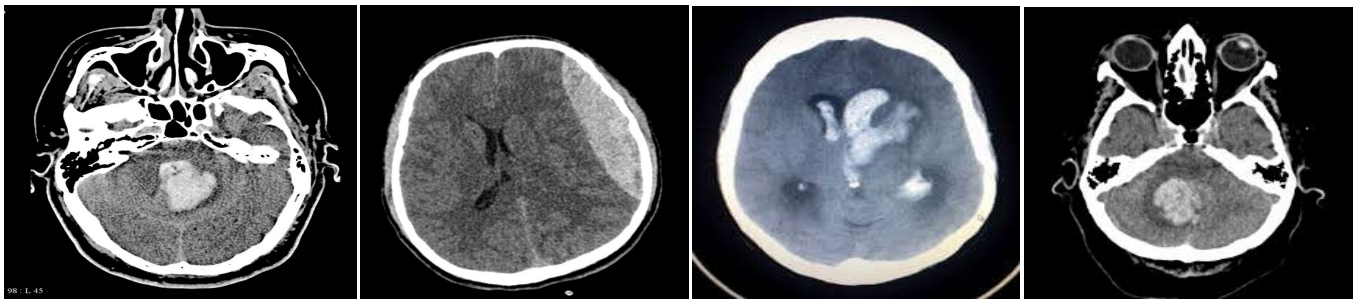
The four types of bleeding were collected from the internet to be a dataset for training in neural networks by convolution neural network. Besides, the researchers collected areal CT scan images of patients were from Al-Saahah Hospital in Khartoum city in Sudan as dataset samples of Hemorrhage. The categories of the brain bleeding are classified by some technicians and field experts of Elrazi University in Sudan faculty of Radiology. The aforementioned experts classify these expected categories in accordance with their sorting distinctions and contrast features to be as a dataset for further phases of processing, comparison, sorting and diagnosis. Then classified according to the four types of hemorrhage by experts of the radiology field which will be as a test set images.

EXPERIMENT AND RESULT ANALYSIS

The researchers did the following activities using MATLAB tools within the dictated time:

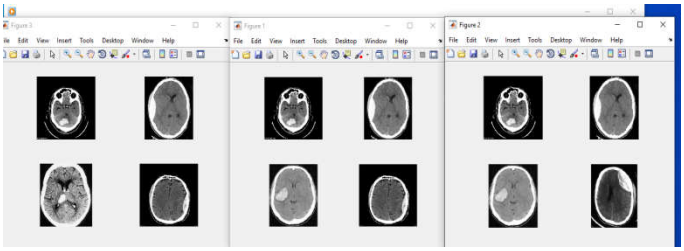
1. Textural feature extraction.
2. Feeding the textural feature's values into the database to create neural networks for the examined images.
3. Testing external CT Scan images to classify the four brain bleeding types using CNN algorithm, which the four types:

   I. Cerebellar.
   II. Extradural.
   III. Intraventricular.
   IV. Subdural bleedings.



Cerebellar Extradural IntraventricularSubdural bleedings

The process depends on providing more images in the database to be compared late in the values equation. Therefore, the more images there are for training and testing, the more the Neural Network can compare between the values and understand which type of image belong to which type of brain bleeding. In using one type of brain bleeding image versus three types, the result was not accurate as when the researchers used one versus another type. Reviewing the results, the researchers verify that the algorithm CNN works well in classifying between the four types of brain bleeding types. It is observed that one vs. another system has more promising results compared to one vs. three systems because the Neural Network can distinguish more between just two hemorrhages compared to the four other types of brain bleeding at once. The results of this research between (60 to 70%) of the real experiment which did in this study. Fortunately, these values can still be improved by increasing the number of input images and having good quality of input CT Scan images. This research concludes to some results, after MATLAB App has been experimented according to the algorithm of CNN and its theories, the results are ranging between 60% to 70%. This is attributed to the complicated optionalizing process the application performs for four categories at the same time; i.e. when the application process these categories separately the results are 100%. In contrary, the application somehow gives a misoption for the examined bleed category. Further amendments should focus on separate dataset for each category. The researchers justify the failure here to the chose similarities between the four categories of the brain bleeding CT scans images. Fig.4 shows the suggested CNN classification with many times of tests.



Fg.4 Applying Suggested CNN classification of Brain in Math works

However, the research suggests an overcome to the challenge, a separate sub-app is designed in MATLAB to examine, sort and classify each category apart. The compatible category is chosen after a multi-step examination. A coming research should be indexed to this study to break down the current study's challenge so as to offer an enlightened result for some application. Fig.5 illustrates the result of selected image after did CNN classification of tests.

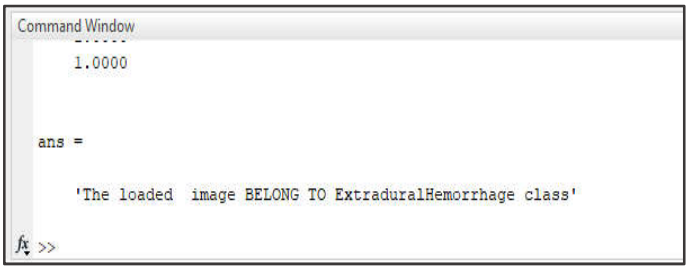


Fig.5 The result of selected image BELONG to Extradural Hemorrhage class

CONCLUSIONS

Differentiate between the four types of brain hemorrhage and to identify other conditions, neuroimaging is required. However, there is no specified type of neuroimaging way. Mostly it depends on its availability, eligibility and the presence of patient contraindications. Yet, having mentioned that, the most common and used neuroimaging modality is the CT scan due to its convenience and availability. To sum up, our focus was on the classification of brain hemorrhage based on the textural features of the four chosen subsets of intra-brain hemorrhages. We can classify each as either intra-axial (within the brain) or extra-axial hemorrhage(space between the brain and skull) named derived from their respective location of injury. Intra-axial hemorrhage subset types include cerebellar, intraventricular, lobar, and pontine hemorrhage whereas extra-axial hemorrhage subset types involve extradural hemorrhage, subdural hemorrhage and subarachnoid hemorrhage. Each of the subsets of hemorrhage have different space, demographics, treatment and prognosis. Within these subsets of brain hemorrhage, we chose to characterize between four types of brain hemorrhage which are; cerebellar, extradural, intraventricular and subdural hemorrhage. Cerebellar hemorrhage is primarily rooted from poorly controlled hypertension and also by an underlying lesion like any vascular malformation. While intraventricular hemorrhage (IVH) indicates the presence of blood in the ventricular system of the brain. This occurrence is responsible for the development of hydrocephalus in many cases of patients. On the other hand, extradural hemorrhage (EDH) is known to be the accumulation or piling of blood between the outer layer of dura and the skull. EDH is quite distinct due to its typical biconvex in shape.EDH is commonly associated with patients with trauma and skull fracture. Whereas subdural hemorrhage (SDH) is the accumulation of blood in the space between the dura and arachnoid mater of the meninges around the brain. Similar with EDH, it is usually caused by head trauma. The classic appearance of SDH is a crescent-shaped that spread diffusely over the affected hemisphere. Stroke caused by brain hemorrhage may catch you unaware for it can happen suddenly, develop quickly and can damage the brain within minutes. In some cases, a stroke may continue to develop for several hours to a day or two. Stroke symptoms may sometime be very confusing for physicians and patient. In order for patients to be suitable in receiving therapy depends solely on the accuracy and immediate evaluation of the cerebrovasculardisease. In other words, physicians must quickly assess the person with suspected stroke since they cannot afford to lose the narrow time window that they have for the effectiveness of surgery and therapy. Besides, researchers recommend that more studies should be done on using MATLAB algorithm in analyzing the image of interest without depending on outside resources from far labs.

REFERENCES

1. GENANT, Harry, et al. Computed tomography. In: Non-invasive measurements of bone mass and their clinical application. CRC Press, 2020. p. 121-149.
2. POGORELOV, Konstantin, et al. Bleeding detection in wireless capsule endoscopy videos—Color versus texture features. Journal of applied clinical medical physics, 2019, 20.8: 141-154.
3. ALDOMA, Aitor, et al. Tutorial: Point cloud library: Three-dimensional object recognition and 6 dof pose estimation. IEEE Robotics & Automation Magazine, 2012, 19.3: 80-91.
4. AZIZKHAN, Richard G. Complex vascular anomalies. Pediatric Surgery International, 2013, 29: 1023-1038.
5. HASEGAWA, Harutomo; CROCKER, Matthew; MINHAS, Pawan Singh. Oxford Case Histories in Neurosurgery. Oxford University Press, 2013.
6. Seletchi E. D. and Duliu O. G., 2007, "Image processing and data analysis in computed tomography", Rom. Journ. Phys., Vol. 52, No. 5, pp. 667–675.

7. Zhang Y., Brady M., and Smith S., 2001, " Segmentation of Brain MR Images through hidden Markov random field model and the expectation-maximization algorithm", IEEE Transactions on Medical Imaging, pp.45-57.
8. Kaiping W., Bin H., Tao Z. and Xianjun S. 2007, "A Novel Method for segmentation of CT Head Images", International conference on Bio informatics and Biomedical Engineering", pp. 717-720.
9. Ruthman V.E., Jayce E.M., Reo D.E., Eckaidt M.J., 1993, "Fully automated segmentation of cerebro spinal fluid in computed tomography", Psychiatry research: Neuro imaging, 50, pp. 101-119.
10. Tong H.L., Faizal M., Fauzi A. and Ryoichi K., 2009, "Segmentation of CT Brain
11. Using Unsupervised Clusterings", Journal of Visualization, 12, pp. 31-138.
12. LI, Qing, et al. Medical image classification with convolutional neural network. In: 2014 13th international conference on control automation robotics & vision (ICARCV). IEEE, 2014. p. 844-848.
13. DUNCAN, James S.; AYACHE, Nicholas. Medical image analysis: Progress over two decades and the challenges ahead. IEEE transactions on pattern analysis and machine intelligence, 2000, 22.1: 85-106.
14. PADMA, A.; SUKANESH, R. Automatic classification and segmentation of brain tumor in CT images using optimal dominant gray level run length texture features. International Journal of Advanced Computer Science and Applications, 2011, 2.10.
15. FIRDAUS, Nanda Maulina; CHAHYATI, Dina; FANANY, Mohamad Ivan. Tourist attractions classification using ResNet. In: 2018 International Conference on Advanced Computer Science and Information Systems (ICACSIS). IEEE, 2018. p. 429-433.
16. G. Huang, Z. Liu, K. Q. Weinberger and L. Van der Maaten, (2017, July). Densely connected convolutional networks. In Proceedings of the IEEE conference on computer vision and pattern recognition (Vol. 1, No. 2, p. 3).
17. Mohammed-Elbasheir, Somia-Badawi, Ahmed-Khalid, Samia-abdalrahman4, Hind-Khalid, "Applying CNN Algorithm to Classification of Anybody Carrying Gun to Protect Muslim in Mosque for any Attacking and Shoots". IJISET - International Journal of Innovative Science, Engineering & Technology, Vol. 10 Issue 01, January 2023 ISSN (Online) 2348 – 7968 | Impact Factor – 6.72
18. NÜESCH, Joachim. Element-sensitive X-ray imaging and computed tomography using energy-selective photodetection. 2010. PhD Thesis. Université de Neuchâtel.
19. SHATNAWI, Maad, et al. Deep learning approach for masked face identification. International Journal of Advanced Computer Science and Applications, 2022, 13.6.

****