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Nature-inspired solution for coronavirus disease detection and its impact on existing healthcare systems

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ABSTRACT

Coronavirus is an infectious life-threatening disease and is mainly transmitted through infected person coughs, sneezes, or exhalas. This disease is a global challenge that demands advanced solutions to address multiple dimensions of this pandemic for health and wellbeing. Different types of medical and technological-based solutions have been proposed to control and treat COVID-19. Machine learning is one of the technologies used in Magnetic Resonance Imaging (MRI) classification whereas nature-inspired algorithms are also adopted for image optimization. In this paper, we combined the machine learning and nature-inspired algorithm for brain MRI images of COVID-19 patients namely Machine Learning and Nature Inspired Model for Coronavirus (MLNI-COVID-19). This model improves the MRI image classification and optimization for better diagnosis. This model will improve the overall performance especially the area of brain images that is neglected due to the unavailability of the dataset. COVID-19 has a serious impact on the patient brain. The proposed model will help to improve the diagnosis process for better medical decisions and performance. The proposed model is evaluated with existing algorithms and achieved better performance in terms of sensitivity, specificity, and accuracy.

1. Introduction

Recently, one of the dangerous and life-threatening viruses called Coronavirus (COVID-2019) has been disseminated all over the world and responsible for several deaths. This crisis is started in December 2019 in Wuhan city of China and rapidly disseminated at an International scale \cite{1}. It is a serious global challenge that demands medical experts, researchers, and governments to deal with this potential threat. The medical experts have suggested some control and prevention measures to deal with this disease such as isolation, cleanliness, and extra care strategies. However, these strategies are not fully adopted or not possible to implement on human beings especially in illiterate and high dense populated areas in developing countries. On the other hand, a major part of the world is suffered from economic challenges during lockdown especially people working on daily wedges. Government has not sufficient funds to fulfill their financial and domestic survival needs. In past, the healthcare sector has various disease challenges for humans and cause serious
respiratory, hepatic, and enteric diseases such as malaria, smallpox, and polio. The existing healthcare systems have different challenges and factors like lack of medical facilities, violation of standards and operating procedures, weak governance, and public attitude towards the protection measures. Although with time, the development of microscopic studies allowed scientists to visualize microorganisms [2], Pasteurization, vaccination, and some other broad disease control measures are adopted to control the COVID-19 such as sanitization, public awareness, nutrition, and hygiene measures.

The existing healthcare systems are emerged with various new and smart technologies and changed the traditional layout of the health system. New and integrated information and communication technologies have changed the traditional healthcare systems by using more advance and intelligent systems [3]. These new technologies are adopted for different medical procedures in healthcare systems start from data gathering to disease diagnosis. Smart sensor nodes for patient monitoring and diagnosis have gained popularity to facilitates the patients at their place with convenience and without any physical presence at the hospitals and medical centers. The question is how these new technologies handle any new type of medical emergency like the recent coronavirus. Also, how the healthcare systems tackle and control and monitor the disease especially which are spread by human-to-human transmissions such as flu, corona, and other types of infections. Although the primary objective is to control the spreading of these diseases by using any means which are beneficial for human beings.

Nature-inspired approaches have been adopted for various multidisciplinary fields related to computer science. Nature-inspired algorithms have been designed to tackle the complex optimization issue and find the optimal optimization to solve the problem. The inspiration in these algorithms is nature as a main and most suitable entity for solving complex problems. Various types of nature-inspired solutions have been adopted for computation based on living organism behavior such as ants, dragonflies, fishes, wolves, and dung beetle [4]. These approaches have used a set of constraints for an optimal solution by using a performance index which is known as the objective function. The nature-inspired solution is also explored and exploited in the search space by using hunting and food search methods of animals and achieve the objective. Nature-inspired solutions are further categorized into two basic types including evolutionary and swarm intelligence-based algorithms. The evolutionary type is using nature system behavior such as a genetic algorithm. On the other hand, swarm intelligence is using the collective behavior of natural swarms such as ant colony and bat algorithms. Nature-inspired algorithms are also used to detect the COVID-19 and predict the disease for reference. These algorithms are used for X-ray image segmentation for feature extraction. The early detection and diagnosis of COVID-19 are very helpful. However, these natures inspired algorithms are not explored especially for COVID-19.

In this paper, we review the COVID-19, its causes, and its impacts in detail. The Paper also discusses the related work to tackle this disease until now and also discussed some possible technological solutions to control the virus. This paper also proposes machine learning and nature-inspired solution namely MLN-COVID-19 for MRI image classification and optimization to detect the disease and improve the existing healthcare systems. The other objectives of this paper are as follows:

- Discuss COVID-19, its origin, causes, and prevention.
- Discuss the related work to tackle the COVID-2019.
- Proposed a machine learning model to improve the existing healthcare systems to handle the diseases.
- Proposed a Nature-Inspired solution for COVID-19 detection and contact tracing.
- Conclude the paper with possible suggestions to control the COVID-2019

The rest of the paper is organized as follows: Section 2 presents the detail about COVID-2019, its impact on human life, and causes. Section 3 illustrates the related work until now to deal with COVID-2019. Section 4 presents the proposed model to tackle the COVID-2019. Section 5 presents the experimental results to evaluate the proposed model and existing solutions’ performance. The Paper concludes in section 6 with future directions.

2. COVID-2019

Coronavirus is one of the dangerous respiratory viruses transmitted through human-to-human or animal-to-human interaction. This virus belongs to the zoonotic pathogen and Severe Acute Respiratory Syndrome (SARS) and the Coronavirus family. In past, the multiple epidemics occurred such as SARS in 2002, with 800 deaths, Middle East Respiratory Syndrome (MERS-CoV) in 2012 with 860 deaths [5]. World Health Organizations (WHO) declared the virus COVID-2019 as a health emergency virus and as a pandemic for the world. This virus is disseminated from Wuhan city, Hubel province of China, and has been rapidly disseminated all over the world. According to the WHO [6], till 12 April 2020, there are 1,696,588 confirmed cases observed from six regions, and more than 4105,952 deaths have been reported. Europe is one of the highest regions where around 880,106 confirmed cases are reported. The transmission of this virus is through human-to-human interaction, droplet, feco-oral, and direct contact. Till now, there is not any type of vaccine or antiviral treatment has recommended. Although, there are various preventive measure has been proposed to deal with this infection like raising awareness, care, isolation, and sanitization. The clinical features of COVID-19 and laboratory abnormalities are different. It is observed in an electron microscope, that the coronavirus is around 60 nm to 140 nm in diameter and looks like a crown. In past, this type of virus origin reported from bats to humans through palm civet cats in China. At that time, the virus caused severe acute respiratory disease, and around 8422 people were infected with 916 deaths [7]. Again in 2012, another Middle East Respiratory Syndrome Coronavirus (MERS-CoV) emerged in Saudi Arabia from camels and around 2494 people are infected with 858 deaths [8].

The COVID-2019 virus is transmitted all over the world through human interaction. The infected droplets are spreading 1 to 2 m. The virus is remaining viable on the surface based on atmosphere and material properties. Sodium hypochlorite and hydrogen peroxide are common disinfectants. The infection rate of COVID-2019 is high due to its spreading by inhalation of droplets and infected surfaces.
The human nose, mouth, and eyes are the main areas where the virus enters the human body. According to authors in [9], the basic reproduction rate of 2 to 6.47. The common clinical properties of COVID-2019 are cough, headache, fever, fatigue, breathlessness, and myalgia. This virus is indistinguishable from other viruses where the patient leads to pneumonia and respiratory failure and cause of death.

2.2. Treatment and preventions

The first and initial treatment from COVID-2019 in isolation where the physical distance is maintained among humans to control the virus transmission to other humans. The initial treatment of the patient is maintaining nutrition and hydration and controlling the cough and fever issues. The usage of antibiotics especially oseltamivir is not recommended in positive cases. In serious or hypoxic patients have been treated by providing oxygen by using nasal prongs, nasal cannula, or ventilators. Based on a study conducted in Wuhan city [10], 76% of patients are treated with oxygen and 71% are treated with antibiotics and 27% are treated with immune globulin therapy. However, all suggestions related to medicines needed more evidence. Plasma therapy is also recommended where the plasms are extracted from positive recovered patients and transplanted in infected patients. However, these experiments are not recommended without proper approval. The Healthcare system still believed in prevention treatments where isolation is recommended even at home with sunlight for the destruction of the virus. Most care is recommended for front-line healthcare workers because, in 2002, around 21% of health workers were infected [11].

3. Related work

Li, et al. [12] conducted a study to classified coronavirus disease and explored the relationship between images. This study uses a single-center study on COVID-19 patients which are divided into three main types mild, common, and severe patients. The quantitative analysis is performed by summing up acute lung inflammatory lesions. The severity score is set by summing up the five lobe scores and compared for clinical classification. After conducting the experiments on patients and observed the mild level patients are relatively high and CT tests are not suitable and feasible as an independent screening tool. The results indicated that the visual quantitative analysis is high and reflects on the COVID-19 classification. In another study [13], the authors used chest CT scans of COVID-19 patients and identified the most common findings. The common findings from images are used to evaluate the disease and its impact on patients’ chests. This analysis is based on the radiologist’s opinion to identified the new cases. However, this type of strategy has a limited scope and not applicable to big data analysis. Also, the radiologist’s opinion varies due to its experience, CT image quality, and availability of comparison images.

Some other advanced methods like Artificial Intelligence (AI) for diagnosis and control of the COVID-19 disease and help the medical experts. In [14] authors proposed a deep learning method to assist the radiologist for fast identification of CT images. The authors used different patient data collected from hospitals and trained the multi-view fusion model by using deep learning and screen patients with COVID-19. This model achieved accuracy, sensitivity, and specificity. Authors in [15] proposed a diagnosis method for COVID-19 by using the AI method on CT slices and ten conventional neural network models. These experiments are conducted for diagnosis and achieved the best performance. This study also determined the accuracy, specificity, and sensitivity and recognized that RestNet-101 is recognized as a COVID-19 infection with high sensitivity. In another study [16], the authors designed an AI-based system for COVID-19 diagnosis and quantitative measurement by using computed tomography.

Authors in [17] discussed the COVID-19 pandemic and current healthcare systems and proposed five challenges and their solutions by using machine learning and AI methods. The existing challenges are a shortage of resources such as medical kits, ICU beds, ventilators, and other oxygen facilities. Another challenge is treatment plans like vaccination development and therapeutics for COVID-19. Expediting clinical trials are also not effective to control this disease. The authors presented various machine learning and AI-based solutions to address these challenges. Authors in [18], presented the low-cost blockchain and AI methods for monitoring and tackling COVID-19 disease. The proposed system is using a mobile phone application where users add their identifiers before pre-testing. This system is based on a built-in geographical information system to track the positive COVID-19 patients. Further, this system is connected with international and local databases. Whereas the AI system helps for collected data analysis. Authors in [19], discussed the children’s mental health issues due to the COVID-19 pandemic. The authors discussed unique factors like social isolation, public health crises, and economic recession. The new technologies need to implement in schools to reduce the existing barriers and treat children with mental healthcare. The authors proposed a model to engage the school community and mental health agencies to deliver the services within the school.

The new technologies have been adopted to address the healthcare system’s weaknesses. As discussed in the literature, few factors are related to the good governess, medical resources, and healthcare standards or policies. These factors have their importance to reduce any new health emergency. On the other hand, new technologies have been adopted to overcome the risk of any new medical emergency. These new technologies are helpful to collect, track and monitor the data and further analyze for decision making.

4. Proposed machine learning and nature inspired solution for COVID-19

We discussed the existing studies on COVID-2019 control, prevention, and treatment literature. However, the nature-inspired and technological aspect is still ignored to control the disease in various countries. This section presents the best possible machine learning-based nature-inspired solution to control the COVID-2019 namely Machine Learning Nature Inspired Mode for COVID-19 (MLNI-COVID-19). The proposed model is based on two modules including machine learning and nature-inspired solutions. The basic idea
behind the proposed model is to develop a model for better visual contents in Magnetic Resonance Images (MRI) for COVID-19 patients. Patient with severe COVID-19 has faced various abnormalities and functionalities in the brain. The main objective of this model is to extract the MRI neuroimaging findings in patients with severe COVID-19 infections. The MRI images are based on radio waves with a detailed internal structure of the brain. The feature extraction from images is one of the complex and challenging tasks. The MLNI-COVID-19 model improves the quality of MRI images by using the clustering method for image segmentation. There are several steps involved to design the proposed model including data collection for input, preprocessing for noise removal, inversion recovery, and enhancement. In the enhancement phase, the model improves the image contrast for easily distinguishing the objects. After enhancement, the inversion recovery phase is initiated to reduce the insensitive and magnetic field. The next phase is segmentation and then feature selection is performed. Fig. 1 shows the steps involved in the proposed model.

In the first step, the collection of MRI images of severe COVID-19 patients is a challenging task because of not the availability of images related to microstructure changes in the central nervous system after infection. For this step, we used SARS-CoV-2 data. We used around 50 recovered patients and distributed them into control and non-control categories. The data is collected from different hospitals with the help of medical experts. The second phase is preprocessing where the images are enhanced to detect the unwanted and suspicious regions by using the inversion recovery technique. The RGB to grey conversion is also performed here. In most of MRI images, the noise and corrupted factors reduce the image accuracy. The filters (Gaussian high pass) are utilized to remove the noise and sharpening plus contrast stretching is also adopted for preprocessing. Some other methods are applied in the preprocessing phase like histogram matching, non-brain tissue stripping, and field correction. These methods are adopted from [20]. In the segmentation phase,
the images are break into small parts for feature extraction and the k-mean algorithm is adopted by selecting the centroids of images. The existing studies have used random selection for initial centroids which leads to slow convergence and results will be of poor quality. We used the vital criteria for centroid selection by using the highest density point and minimum distance that separates the centroids. This process reduces the intensity values where k-mean randomly placed the space k for region evaluation.

After segmentation, the next step is feature extraction and reduction by using Gabor and GLCM filters to extract the features from segments. This phase extracts texture, shape, and intensities. The PCA method is used to eliminate the number of features for accurate classification. The main objective of feature extraction is to decreasing the data by using the measurement of certain properties. After this process, the next step is to use a classifier and detect the findings. The last step after classification is an analysis of images.

4.1. Feature classification

The feature selection is subset selection by using machine learning methods. The forward and backward techniques are applied and a ranking-based feature is selected by using a two-tailed t-test for measuring the mean difference. There is a total of 80 features where 27 belong to texture, 5 for shape and 20 for intensity, and 20 for orientation features and 15 are sensitivity features. The distribution of features is based on three levels including A, A2, and A3 respectively. Table 1 shows the distribution of the feature.

| Features  | A1→T1w | A2→T2w | A3→F |
|-----------|--------|--------|-------|
| Texture   | 8      | 9      | 10    |
| Shape     | 2      | 1      | 2     |
| Intensity | 4      | 7      | 9     |
| Orientation | 4   | 4      | 5     |
| Sensitivity | 4    | 4      | 7     |
| Total     | 22     | 25     | 33    |

4.2. Classification

For the data classification, the proposed model used Support Vector Machine (SVM) and Principle Component Analysis (PCA). The SVM is used for discriminative classification by separating the hyperplane and SVM provides supervised learning for classification and regression tasks which generates non-overlapping partitions and usually employs all attributes. We also use the PCA method for reduction. In the PCA classification method, we reduce the dimensionality of the data set and make a correlation of variables with each other. The PCA process also tests the MRI images and is identified by projecting the image into the Eigenspace to gain the corresponding set of weights and then compared the set of weights of the faces ion training set. Low dimensional feature issue can be examined where Let $B = (B_1, B_2, B_3, B_4, \ldots, B_i, \ldots, B_n)$ denotes the $n \times X$ data matrix and $B_1$ is a face vector of dimension n, where n denotes the total pixel of MRI image and X is the face images in the training set. The PCA method is used for linear transformation from the original image vector to a projection feature vector.

$$A = C^T B$$

(1)

In the above Eq. (1), the $A$ presents the $d \times X$ feature matrix, d denotes the dimension of feature vector and C is transformation matrix and $n \times d$ is transformation matrix where columns are the eigenvectors corresponding to the d by using Eq. (2).

$$\nabla e_i = l e_i$$

(2)

In the above Equation, the $\nabla$ denotes the eigenvectors values of the matrix where the total number of scatter matrix I and the mean image is identified as

$$I = \sum_{i=1}^{n} (B_i - \mu)(B_i - \mu)^T, \mu = 1/X \sum_{i=1}^{n} B_i$$

(3)

After analyzing the linear transformation $C^T$ the scatter of the transformed feature vectors ($D_1, D_2, \ldots, D_X$) D is $C^T I C$. In the PCA method, the projection $C_{opt}$ is selected to maximizing the determinant of total scatter of projected sample as presents in Eq. (4).

$$C_{opt} = \arg\max\{\nabla e_i | C^T IC\} = [D_1, D_2, \ldots, D_n]$$

(4)

In the above Eq. (4), the $\{c_i, i=1,2,\ldots,D\}$ is the set of n-dimensional eigenvectors of $I$ corresponding to the D largest Eigenvalues. Also, the input vector or face vector in an n-dimensional space is decreased to a feature vector in a D-dimensional subspace.

4.3. Classifier training

Artificial Neural Networks (ANN) are used for classifier training such as vector machine, radial basis function, learning vector quantization, and conventional neural networks. For classification, we used these algorithms and then check the accuracy of each algorithm and found that SVM has more accuracy for this study. The training time is also shorter compared to other algorithms.

Table 1

| Selected Features Distribution | A1→T1w | A2→T2w | A3→F |
|--------------------------------|--------|--------|-------|
| Texture                        | 8      | 9      | 10    |
| Shape                          | 2      | 1      | 2     |
| Intensity                      | 4      | 7      | 9     |
| Orientation                    | 4      | 4      | 5     |
| Sensitivity                    | 4      | 4      | 7     |
| Total                          | 22     | 25     | 33    |
transforms the input space up to a higher dimensional feature space by using a non-linear mapping method and then constructs the separate hyperplane with maximum distance close to the training set. The learning algorithm analyzes the data for regression and classification. This algorithm trains on training data and the trained model then classify the test data. The SVM algorithm can only have trained on labeled data and it cannot operate on unlabeled data or unsupervised data. After this process, the next step is segmentation on test datasets. Segmentation is issued in MRI image division into patchwork regions where each part is homogenous in some sense. Segmentation is one of the methods for diagnosis the objects from MRI images [21]. All voxels have passed into SVM and then turn their output where the probabilities of the voxel are related to six classes. The voxel has been assigned to the class which has the highest probability. Networks are trained with six label classes. Six classes are also included for network results. This process provides a clear contrast between soft tissues and makes more clear the texture of organs. Segmentation is the initial step applied to MRI images especially for low-level images where the processing will apply to transform the greyscale or color image into a high-level image. The segmented MRI image where Gray Matter (GM), White Matter (WM), air, and ventricles are observed.

### 4.4. Nature inspired solutions

Different types of techniques have been adopted for image processing such as deep learning, navigation, and networking. In this section, we discuss some nature-inspired solutions for optimization Monkey Search Optimization (MSO). Most of the nature-inspired solutions are based on two basic habits of a specimen including mating and food search. Monkey search optimization has been used and one of the smart optimization methods [22]. We applied the MSO solution to remove the background and pictorial region and feature extraction and selection from MRI images belong to COVID-19 patients. Monkeys are moving in groups for food search, we use this behavior and considered that all images are forest and the background region is a non-edible region by the monkeys [23]. The monkeys are finding the boundary between the edible and non-edible regions. In MRI images, we divided the regions like abundance, less abundance, and least abundance and related it with monkey food types like leaves are low-quality food, fruits are better quality and insects is high-quality food. In the image, the background area is removed if it is low-quality food, and select high-quality food when there is anything in the image region for extraction and segmentation for further process.

#### 4.4.1. Searching behavior of monkeys

Monkeys have different habits and activities such as climbing, watching, jumping, exploration, cooperation, and somersault for finding the global or local optimum. Fig. 2 shows the different activities of monkeys and their relationship with the proposed algorithm in MRI images.

The MSO is adopted where a segmentation process is initiated for removal of the image background region and feature extraction. We have a decision variable vector $A_i = (a_1, a_2, a_3, \ldots, a_n)^T$ and the objective function for minimization as $f(A)$. The $\Delta A_i = (\Delta a_1, \Delta a_2, \Delta a_3, \ldots, \Delta a_n)^T$ is a randomly generated vector, and the $f(A)$ function is at the point and $A$ expressed as $(f_1(A), f_2(A), \ldots, f_n(A))^T$ and is represented as Eq. (1).

![Fig. 2. Monkey Activities and Link with Optimization](image-url)
After the initial population of monkeys, the next step is to climb the process where the random position for monkeys denotes as $A_i = (a_1, a_2, a_3, \ldots, a_n)^T$ to reach the border of the image and select the border area. There are two types of processes small and large climb. After this process, the next step is watching where the scanning is initiated for better values. After this, the next phase is the cooperation process, where the optimal solution in one iteration is assumed $A_i = (a_1, a_2, a_3, \ldots, a_n)^T$ and monkeys jump for better quality food. In the end, the monkeys are looking for a somersault process where they reach better quality food and identified the classified regions. Once all the monkeys have reached the global optimization then they will be verifying and confirm the process for cross-validation and terminate the process. The Friedman, ‘Iman and Davenport’ and Holm statistical tests are carried out to compare and verify the predictive performance and its enhancement. Friedman and ‘Iman and Davenport’ showed that there is a significant difference between the proposed predictive model and the whole multiple predictive models since the p-value of Friedman and ‘Iman and Davenport’ level of significance is $(\alpha) < 0.05$ and $(\alpha) < 0.01$. In other words, the Friedman and ‘Iman and Davenport’ tests rejected the null hypothesis (i.e. all the results of the predictive models based on equivalent accuracy).

5. Experiment results

The experiments on the proposed model are carried out with qualitative imaging analysis which is one of the well-known methods in clinical scenarios. We performed three tests including sensitivity, accuracy, and specificity. The false positive, negative, and error rate are measured. The classification is conducted by using the widest performance parameters. Table 2 shows the training and test COVID-19 patient’s images.

The ANN is used during training including the number of input layer units, several hidden layers, learning rate, and error rate. The experimental results of normal and abnormal classification are listed in the above Table. The classification is the accuracy percentage is 98%, sensitivity 90.8%, and specificity 98%. All the features have 98% accuracy using Principle Component Analysis (PCA). The extracted features components are classified and achieved around 98% accuracy. Miss-classified images mean where we face difficulty to learn features for representation. Table 3 presents the classification rates based on true-positive, true-negative, false-positive, and false-negative in terms of sensitivity, specificity, and accuracy.

The proposed model MLNI-COVID-19 is evaluated with existing classification algorithms including Multiscale fuzzy c-means (MsFCM) [24] and semi-automatic method [25]. These methods are applied to brain MRI images for COVID-19 diseases. The COVID-19 is a new disease and till now very few nature-inspired solutions have been applied for optimization especially for brain abnormalities. MsFCM is based on PCA and SVM where the semi-automatic method is based on DWT and SOM. MsFCM uses a diffusion filter to process the MRI images and applied a fuzzy C-mean classification method. For the comparison, MsFCM on synthesized images with various contrast McGill brain MRI images database are used. On the other hand, the semi-automatic method has been developed for the segmentation of brain MRI images. This method has adopted eight MRI slices of patients. This method is based on a fuzzy classification. This method has used 300 MRI images and showed a higher level of agreement with manual rates. The main issue in fuzzy mean methods is utilizing high computational resources. The proposed model MLNI-COVID-19 is compared with existing algorithms as shown in Table 3 and Fig. 4.

Table 4 shows the experimental results obtained using the proposed model trained NN-based classifier and two existing methods. The proposed model has higher performance in terms of accuracy, specificity, and sensitivity. The results obtained from the classification process is graphically presenting in Figure 6, 7, and 8 respectively.

Fig. 3 shows the better performance of the proposed model MLNI-COVID-19 compared to the existing MsFCM and semi-automatic method. The proposed model results are continuous training. The highest results are achieved with the simple and more efficient design of the proposed model. The impact of accuracy has a significant role in the performance of the algorithm for achieving the more consistent diagnosis of MRI images. The results indicated that the proposed model is better in both environments including test and training images. The proposed model is a rapid, easy to handle and operate, inexpensive solution for COVID-19 brain MRI image classification.

Fig. 4 shows the comparison of the results of the proposed model with existing methods MsFCM and semi-automatic methods in terms of specificity. The proposed model results have better results compared to MsFCM. The specificity refers to an ability where we identify the true negative rate with continuous training. On the other hand, the semi-automatic method also has fewer sensitivity results. But the MsFCM is at 80% whereas the proposed model has a higher 90% specificity. The highest results are achieved with the simple and more efficient design of the proposed model. The impact of specificity has a significant role in the performance of an algorithm for achieving the more consistent diagnosis of MRI images. The results indicated that the proposed algorithm is better in both environments including test and training images. The proposed algorithm is a rapid, easy to handle and operate, inexpensive solution for brain MRI image classification.

### Table 2

| Total Images | No of images in the training set (200) | No of images in testing set (100) |
|--------------|---------------------------------------|-----------------------------------|
|              | Normal | Abnormal | Normal | Abnormal |
| (Images are very less) | 300 | 100 | 100 | 50 | 50 |
Fig. 5 shows results comparison of the proposed model with existing methods. MsFCM method in terms of sensitivity. The proposed model results are better compared to MsFCM. The sensitivity refers to the ability in which the test is identifying with a true positive rate. However, the MsFCM is at 79% whereas the proposed model is at 87% which is a good sign of success. The proposed model is more effective and simple in terms of processing and classification. The impact of sensitivity has a broad impact on overall performance for achieving the more consistent diagnosis of MRI images. The results indicated that the proposed model is better in both environments including test and training images. The proposed model is a fast solution, especially for MRI image classification.

Table 3
Comparison Analysis

| Image Grades | Classified Images | Miss-Classified Images | Accuracy | Specificity | Sensitivity |
|--------------|-------------------|------------------------|----------|-------------|-------------|
| Grade I      | 30                | Nil                    | 98%      | 90.8%       | 98%         |
| Grade II     | 30                | Nil                    | 97%      | 91%         | 97%         |
| Grade III    | 30                | 2                      | 96%      | 89%         | 96%         |
| Grade IV     | 30                | 2                      | 94%      | 87%         | 93%         |

Table 4
Comparison Analysis

| S/No | Approaches          | Accuracy (%) | Specificity (%) | Sensitivity (%) |
|------|---------------------|--------------|-----------------|-----------------|
| 1    | MsFCM               | 85%          | 84%             | 89%             |
| 2    | semi-automatic method| 90%          | NA              | NA              |
| 3    | Proposed MLNI-COVID-19 | 98%          | 90.8%           | 98%             |

Fig. 3. Accuracy of the proposed algorithm with existing algorithms

Fig. 4. Specificity of the proposed algorithm with existing algorithms
6. Conclusion

COVID-19 virus has a serious impact on human health, especially on the brain. There are various abnormalities are observed in MRI images of COVID-19 patients. This paper presented a machine learning and nature-inspired model for MRI image classification, feature extraction, and optimization. The well-known nature-inspired algorithm is used called Monkey Search Optimization for optimization. Machine learning has gained a lot of popularity, especially for MRI image classification. The proposed model combined with the machine learning model and nature-inspired algorithm for brain MRI images of COVID-19 patients namely Machine Learning and Nature Inspired Model for Coronavirus (MLNI-COVID-19). This model improves the MRI image classification and optimization for better diagnosis. This model has achieved better performance especially in the area of brain images which is neglected due to the unavailability of the dataset. COVID-19 has a serious impact on the patient brain. The proposed model is helpful to improve the classification and optimization by using a nature-inspired algorithm. The proposed model is evaluated with existing algorithms and shows better performance in terms of sensitivity, specificity, and accuracy. In the future, we will use a large dataset to evaluate the proposed model performance.

Credit Author Statement

Kashif Naseer Qureshi: Conceptualization, Methodology, Visualization, Investigation
Adi Alhudhaif: Software, Validation, Reviewing and Editing
Maria Ahmed Qureshi: Data curation, Writing, Software, Validation
Gwanggil Jeon: Visualization, Investigation, Reviewing and Editing

Declaration of Competing Interest

None.

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