Journal of Theoretical and Applied Information Technology
31st December 2023. Vol.101. No 24
© 2023 Little Lion Scientific
ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

AN IOT FRAMEWORK FOR ACCURATE DIAGNOSIS OF COVID-19 TO ELIMINATE FALSE POSITIVES USING RESNEXT

[1]A. PHANI SRIDHAR, [2]DR.P.V.LAKSHMI
[1]Department of CSE, Aditya Engineering College (A), Surampalem.
[2]Department of CSE, GITAM (Deemed to be university), Visakhapatnam
[1]Phani.addepalli@aec.edu.in, [2]vpanga@gitam.edu

ABSTRACT

Background: Novel Corona Virus is increasing day by day; it is needed to identify the formal techniques and innovative trendy approaches. The responsive effort in short times is needed. Objective: The aim of this study was to consequently, display things that recognize COVID-19 pneumonia accurately. This examine work is pointing to particularly offer assistance with the conclusion of COVID-19. Methods: The proposed work is centred on the headway of an AI-based examination of CT pictures of the cutting edge crown infection. The proposed system classifies CT pictures utilizing balanced Resnet appear name ResNext. The Convolutional layers of particular sizes were utilized in each of the confined ways of Resnet illustrated. In Resnext, 32 channels are bound together at the same bottleneck and convolve them. This made it conceivable to perform indistinguishable changes to gather convolution in 32 bunches, which compares to the initial 32 courses. The proposed show effectively separated between viral pneumonia and COVID-19 influenced lung CT pictures. The accuracies of DenseNet, mobileNet and VggNet are 90.91,75.24 and 35.75 respectively for testing as shown in table 4. Results: False positives are identified among normal images, Covid effected images and viral pneumonia images. Also the validation loss and validation accuracy of the training process is to be processed and observed. The training loss is also calculated and observed. The training accuracy and validation accuracy both reached 100%. The final testing accuracy of the proposed model is 100%. The performance comparison of existing methods with the proposed method is also observed. The proposed method obtained better classification accuracy when compared to the existing deep learning models DenseNet, mobileNet and VggNet. The accuracies of DenseNet, mobileNet and VggNet are 89.3, 72.72 and 30.30 respectively for training. Conclusion: The clinical execution of the PCR test for COVID-19 pneumonia is not accurate. This paper points to assist make stride the AI examination stage for COVID-19 pneumonia investigate and make strides the precision of AI choice and judgment. The proposed demonstrate gotten an exactness of 100% in dispensing with wrong positives delivering accurate COVID-19 detection.

Keywords: *COVID-19, lung CT, Resnet, ResNext, viral pneumonia, Reverse Transcriptase Polymerase Chain Reaction (RT-PCR)*

1. INTRODUCTION

The unused coronavirus contamination (COVID-19) that happened around the conclusion of 2019 is quickly spreading around the world, and a large number of patients are enduring from the infection. In the early Admirable 2020, the aggregate number of tainted individuals around the world was almost 32 million and the number of passings was almost 980,000 [1]. The total number of contaminated individuals in India is almost 3,47,93,333 and the number of passings is almost 4,79,997 and the number proceeds to extend. Exact diagnostic methods are required to supply fitting treatment for COVID-19 patients and avoid transmission to others. As of now, Turn around, Transcriptase Polymerase Chain Response (RT-PCR) is frequently utilized for COVID-19 testing, but its affectability has been appeared to be as mono as 42-71%. On the other hand, the affectability of the COVID-19 tests utilizing CT images is as high as 97%. Since India encompasses an expansive number of CT imaging gadgets, it may be valuable to utilize CT pictures in COVID-19 review [2]. To arrange to bolster utilizing CT pictures and point to measure the doctor's judgments; it is essential to set up a strategy for quantitatively assessing the

condition of the lungs employing a computer. Hence, within the execution of this investigate, AI based picture investigation is proposed to distinguish COVID-19 in lung CT images[23]. The alveolar locale wealthy to discuss shows up blackish on CT due to its high X-ray transmittance (typical portion). When irritation happens here, the X-ray transmittance diminishes and an iced glass-like shadow is shown (iced glass shadow) [3]. When the cell invasion gets to be more strongly, the X-ray transmittance assist diminishes, and the shadow gets to be white and uniform (union) as appeared in Figure 1.

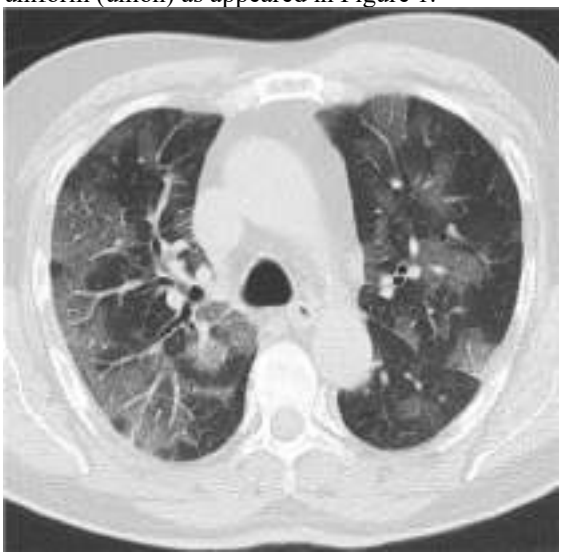


Figure 1. Lung CT picture influenced by COVID-19.

The objective of performing a CT check is to dispense with the untrue positives got within the RT-PCR test. The indications of covid are common with numerous common wellbeing issues. The CT filter advises the precise level of disease within the lung. This gives the specialists a much needed affirmation to perform treatment. The automatic discovery of COVID-19 from lung CT pictures ought to be able to distinguish between viral pneumonia and genuine COVID-19. The digitization of therapeutic pictures makes it conceivable to store restorative pictures such as CT, MR, PET, etc. in a computer. These days, the gear utilized for producing look is additionally sharp and can be integrated with clouds. This makes a difference for IoT applications to be created with such information where online examination can be performed within the cloud. Coordination shrewd IoT methods with existing healthcare framework might increment the efficiency of the general framework. The AI investigation can be performed within the cloud exceptionally rapidly and precisely [24][25].

Suri et al., (2021) [4] realization of a strategy for AI to precisely distinguish the boundary of the lung locale indeed in cases where it is troublesome to distinguish the boundary of the lung locale due to aggravation. Three districts interior the lung locale agreeing to the degree of harm programmed classification into locales.

Mu, Nan et al., (2021) [5]] prepare employments with AI / machine learning advances such as neural systems and clustering.

Li, Xin et al., (2020) [6] Cloud foundation and abbreviationareutilized.ThiscollectsCT pictures from residential clinics,etc.,performs preparing suchasanonymization, exchanges them to the cloud computing and collects them. Picture handling analysts will get to this cloud stage to inquire about and create a restorative picture AI.

Angelov et al.,(2020) [7]Information is greatly vital in restorative picture AI. Especially within the inquire of restorative picture AI, it is imperative to memorize AI utilizing different pictures obtained not as it were in one healing centre but moreover in different clinics. This cloud stage empowers such therapeutic picture AI investigate, and picture handling analysts are gathering around this cloud stage.

Agarwal et al., (2021) [8] AI precisely recognizes indeed in cases where it is troublesome to distinguish the boundary of the lung locale and naturally classifies the locale interior the lung locale into three locales concurring to the degree of injury COVID-19 pneumonia ordinariness of chest CT pictures[19][20] AI is precisely decided.

Yang et al., (2020) [9] restorative pictures counting CT pictures that have been anonymized have been exchanged from residential healing centers to the restorative enormous information cloud stage. A component that amasses an expansive sum of therapeutic picture information at ultra-high speed and rapidly investigates and utilizes it by interfacing clinical destinations, cloud framework, and picture preparing analysts at colleges, etc. with an ultra-high-speed communication organize. This cloud stage stores more than 160 million pictures, indeed in the event that it is constrained to CT pictures.

Michael J. Horry et al. [10] created a show for overstressed restorative experts as a moment combine of eyes through brilliantly profound learning picture classification models. The creators recognize a reasonable Convolutional Neural Organize (CNN) show through the beginning comparative consider of a few prevalent CNN models. They at that point optimize the chosen VGG19 show for the picture

modalities to appear how the models can be utilized for the exceedingly rare and challenging COVID-19 datasets.

Ehsan Ali Al-Zubaidi et al. [11] have connected convolutional neural systems (ConvNets) with the discovery of the precision of computed tomography (CT) coronavirus pictures that help therapeutic staffs in clinics in categorization chest CT-coronavirus pictures at an early organize. The ConvNets are able to consequently learn and extricate highlights from the restorative picture dataset.The objective of this consider is to prepare the GoogleNetConvNet engineering, utilizing the COVID-CT dataset, to classify 425 CT-coronavirus pictures[21][22].

Ophir Gozes et al. [12] proposed a framework that utilizes vigorously 2D and 3D profoundly learning models, altering and adjusting existing AI models and combining them with clinical understanding. We conducted numerous review tests to analyze the execution of the framework within the location of suspected COVID-19 thoracic CT highlights and to assess the advancement of the illness in persistent over time employing a 3D volume audit, producing a Crown score. The think incorporates a testing set of 157 worldwide patients (China and U.S).

The goal of this study presented by Fátima A. Saiz et al. [13] is to create a fast strategy todetect COVID-19 in chest X-ray pictures utilizing profoundly learning procedures.

For this reason, an protest detection architecture is proposed, prepared and tried on a open accessible dataset composed with 1500 pictures of non-infected patients and contaminated with COVID-19 and pneumonia. The most objective of our strategy is to classify the persistent status either negative or positive COVID-19 cases. The objective of this investigate is to create a stage for AI investigation of unused coronavirus CT pictures. At the new stretch, the phenomenon of identifying effected should be able to distinguish between COVID-19 and viral pneumonia using the suggested algorithm.

2. OBJECTIVE

The goal of this study presented by Fátima A. Saiz et al. [13] is to create a fast strategy to detect COVID-19 in chest X-ray pictures utilizing profoundly learning procedures. For this reason, a protest detection architecture is proposed, prepared and tried with a open accessible dataset composed with 1500 pictures of non-infected patients and contaminated with COVID-19 and pneumonia. The most objective of our strategy is to classify the persistent status either negative or positive COVID-19 case. The objective of this investigate is to create a stage for AI investigation of unused coronavirus CT pictures. The algorithm should be able to distinguish between COVID-19 and viral pneumonia [16][17][18].

However, in arranging to form the picture acknowledgment CNN is more profound and more exact, there were two problems: CNNs with 20 to 50 layers or more are learned by essentially expanding the number of convolutional layers. At that point, indeed, in case clump normalization was utilized, the learning mistake got to be large and the exactness dropped essentially. This result implied that the acknowledgment exactness did not make strides as anticipated indeed in case a more profound CNN show was learned with the layered structure so far. Therefore, to propose a deeper CNN structure, it is necessary to solve this problem.

Subsequently, to arranging to propose a more profound CNN structure, it is vital to unravel this problem. If too much profound demonstrate is prepared, the optimization time will be long since the measurement of the parameter space will rise and the parameter space will end up more extensive. In this manner, indeed in case one comes up with an instrument that empowers exceedingly exact learning from a more profound CNN, it would like to maintain a strategic distance from an exponential increment in learning time due to that. In other words, there was a issue of planning an instrument that may well be learned in a brief time and did not drop into a neighbourhood solution.

3. MATERIALS & METHODS

Residual Neural Networks is structure broadly utilized as the spine of convolutional neural networks (CNN), commonly known as ResNet. may be a Profound CNN show with a basic structure in which leftover pieces utilizing skip associations are associated in the arrangements shown in Figure 2.

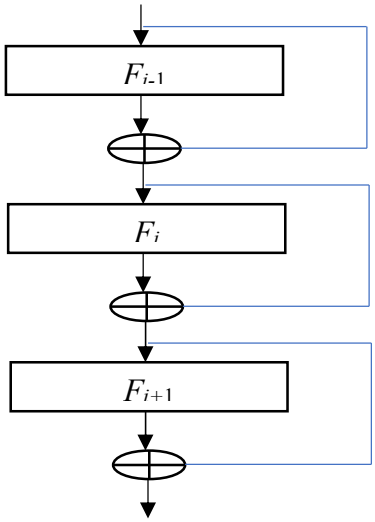


Figure 2: ResNet network structure.

ResNet uses a residual learning model. In the residual learning model, i Residual map in the second residual block is $F(x)_i$. The error is divided into (including 2 to 3 convolution layers) and propagated little by little, and a prediction model is constructed as an addition model of the residual mapping group at the time of testing. Thanks to multiple skip connections, a large number of routes are created. As a result, a small error can be propagated to a large number of branched paths, so that each convolution layer can be learned even with a considerably deep ResNet.

With VGGNet and InceptionNet, which were at the cutting edge at that time, even if CNN tried to deepen more than 20 layers, the error could not be propagated well to the inner layers due to the problem of gradient loss and gradient explosion, and the accuracy dropped. It was closed. On the other hand, with ResNet, thanks to the introduction of residual learning, it is possible to learn the identified CNN from large-scale image data as a "good" and highly accurate model even with a CNN with a considerably deep number of layers (50 to 150 layers). The identification accuracy of the ImageNet dataset has been greatly improved.

3.1 Residual learning using residual blocks

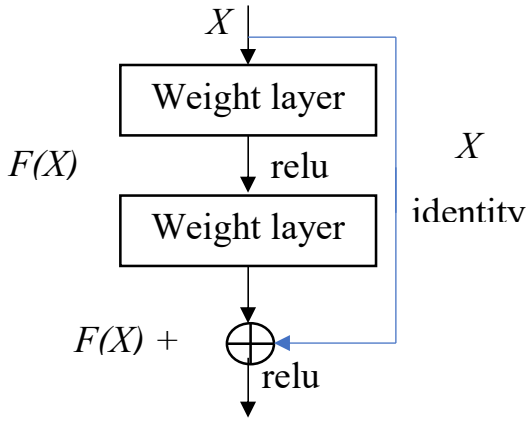


Figure 3: Residual block

A component called Remaining Square was proposed as a component of ResNet as appeared in Figure 3. In ResNet, by utilizing the remaining piece as an essential component and extending the CNN from 50 to 150 layers, both transmission of the starting expression to the ultimate layer and rearrangements of optimization are achieved. In CNN with no leftover association such as AlexNet and VGGNet , the convolutional layer and ReLu were basically associated straightforwardly in arrangement. On the other hand, within the remaining piece, a skip association is additionally embedded in parallel for each convolution layer bunch (each 2 to 3 layers). The effect of this skip association is the representation of the $input_x$. Too, within the leftover association way, the remaining (mapping)f(x) expression is changed utilizing each layer. At that point, at the conclusion of the leftover piece, the two branches are combined by including: H(x)= f(x)+x (1)
The remaining squares of this condition (1) are in arrangement. N ResNet is designed by interfacing individually.That is, the leftover within the input expression (1) to include up the added substance composition outline rehashed a few times is the prediction show for the whole ResNet. As a result, it got to be a show in which signals and blunders engender through different courses in which either two branches are chosen, whether forward proliferation or back propagation. Therefore, when learning ResNet, the remaining blunder could be a small little, rather than optimizing the capacity of the whole arrange. It can be engendered back to the way of. Subsequently, it gets to be outfitted learning isolated into optimizations (littler measure) of each remaining function. Thus, ResNet is in general the misfortune of yield is isolated in a number of ways, gotten from each way a little

blunder from F(x) little and one by optimization since it, optimization has facilitated compared to plain CNN. In this manner, indeed a profound demonstrate comprising of 50 or more convolutional layers of a 3 × 3 part can be learned accurately for the primary time. The department on the skip association side does not fundamentally need to be in character outline, and a few layers g embed g(x) to alter the expression small. In any case, through the tests of the consequent, it was moreover appeared that skip association with the personality outline is vital for ResNet. After that, it is standard for ResNet and ResNext to utilize the leftover piece of Eq. (1) that receives the skip association of the identity outline without embedding any layer [15].

3.2 Cascade learning

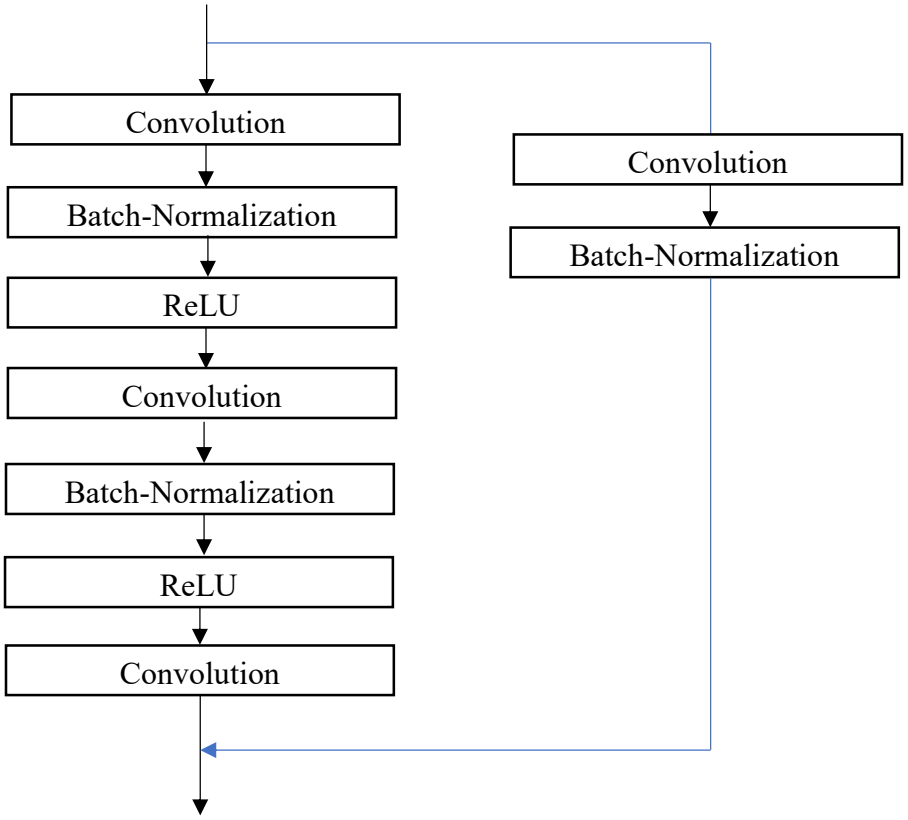
A little work that interfaces large capacities of the whole demonstrate in the arrangement, such as the "cascade learning" demonstrated and "Boosting". The instrument and behavior of ResNet's remaining learning show is comparable to "added substance models such as cascade learning and outfit learning, which are added substance blend functions. In each leftover block, follow the way on the character outline side, Residual mistake Take after the way on the side there are two courses. In this manner, on the chance off that N times the remaining pieces are associated, the full number of courses will be 2^N ended up. For example, if three leftover squares are concatenated, the whole number of ways through which the subordinate is engendered is added up to 2^3. In any case, within the case of ResNet, which has N = 50 layers and N = 100 layers, the number of ways through which the subsidiary proliferates gets to be enormous.Here, ResNet may be an expansive number of mini networks (= leftover work) with a shallow in general blunder. F_i Let us think of it as an outfit learning show comprising of). At that point, person F_i can be seen that the sum of the mistake engendered to is less, which the optimization merges more effectively (speedier) than without the remaining block. In the ResNet 50 layer / 101 layer / 152 layers, a leftover piece utilizing three bottleneck sort "1 x 1, 3 x 3, 1 x 1" convolution layers is received as appeared in figure 4. The unique leftover way comprises of two convolutional layers. It has such complexity and calculation time. On the other hand, the estimate of the convolution bit is changed to "1 × 1-> 3 × 3-> 1 × 1 (once 1 × 1 convolution decreases the measurement and the calculation stack is decreased)", whereas the number of channels is It shapes a bottleneck sort that changes as "tall measurement (256)-> moo measurement (64) –> tall measurement (256)". As a result, ResNet can too get the good thing about "moving forward calculation proficiency whereas keeping up precision" by receiving the bottleneck sort, as in Inception. This ResNet-50 layer / 101 layer / 152 layer is significantly more exact than the ResNet-34 layer, and the precision gets superior and superior as the number of layers increments. The conduct of "is nice" can presently be accomplished brilliantly, indeed on the chance off that the number of layers increments [19].

3.3 ResNext model

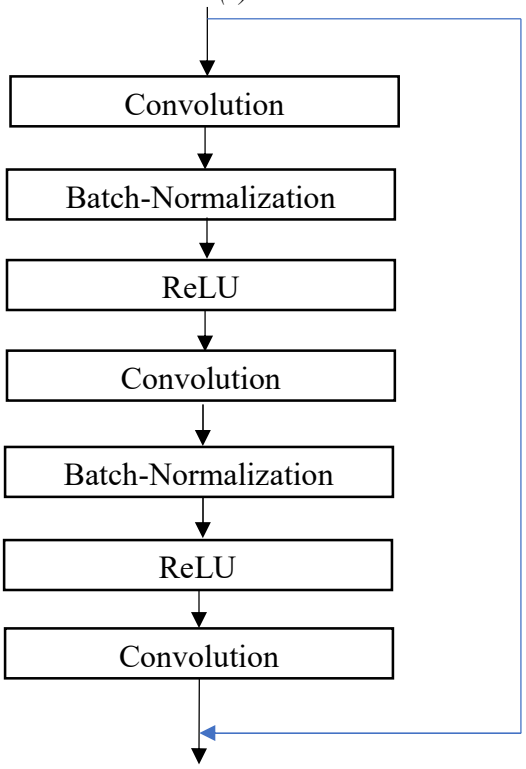
ResNext is an progressed form of ResNet. By utilizing the assembled convolution isolated i nto 32 bunches as the comparable representation of the bottleneck of the leftover square, the exactness advancement of ResNet was accomplished. It makes stride in calculation productivity and demonstrates prec ision by basically expanding the number of gathered divisions in square units without expanding the generally profundity or by and large width.

Input Layer	Convolution	Batch Normalization	ReLU	Max Pooling	Set 1	[Set 2] x 2	Set 1	[Set 2] x 3	Set 1	[Set 2] x 5	Set 1	[Set 2] x 2	activation	Average pooling	Fully connected

(a) Proposed Resnext architecture



(b) set 1

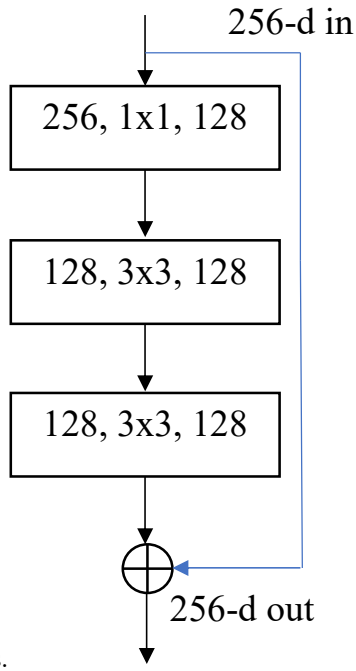


(c) Set 2

Figure 4: Layers in the proposed Resnext architecture

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

Figure 4 (a) appears in the general design of the Resnext. The layers Input Layer, Convolution, Clump Normalization, ReLU, Max Pooling are associated with department layers. The department layers Set 1 and Set 2 are appeared in figures 4 (b) and 4 (c) individually. The ultimate layers are enactment, normal pooling and completely associated. Set one comprises of Convolution, Bunch Normalization, ReLU, Convolution, Group Normalization, ReLU, and Convolution in department 1 and Convolution, Clump Normalization in department 2. Set 2 comprises of Convolution, Clump Normalization, ReLU, Convolution, Group Normalization, ReLU, and Convolution in department 1 and character in department 2. The convolution layers are coupled in with parallel



channels.

Figure 5: cascaded convolution blocks.

Figure 5 shows the identical leftover piece in which the channels are coupled. The 32 channels are coupled together shaping an add-up to of 128 channels (32 courses x 4 channels = 128 channels).Since the split-transform-merge proposed in the beginning has been effective as a conventional strategy, the instrument remains in ResNet. Changing the leftover way side of ResNet to a structure in which 32 bottlenecks are orchestrated in parallel. The number of courses to isolate G= =32 is called cardinality (in scientific terms) within the dissertation. Therefore, a branch-transformation-combination sort the left over square. The bottleneck that gets to be the output feature outline of the initial input 256-64-256 channels is separated into the highlight outline of "256-4-256 channel yield" x 32 ways (= 32 densities) and extended. And in 32 pathways convoluted after exclusively at the same bottleneck structure (transformation), it has been 32 once more highlight the outline yield from these bonds is outlined. Proportionate transformation to the remaining square for ResNeXt. Identical representation of Figure. 5 in which 32 ways are associated within the channel heading. Remaining squares utilized in ResNeXt: The operation identical to the operation performed by the parallel 32 ways in Figure. 5and is performed as it one way of one bunch convolution layer. The precision is made stride indeed with the leftover square with different ways (extended).

4. RESULTS & DISCUSSIONS

Within the improvement of this AI examination stage, Kaggle dataset has been utilized, which contains 251 CT pictures to identify COVID-19 disease.

The genuine PCR test comes about and the judgment comes about of COVID-19 pneumonia ordinariness by the radiologist were included in the pneumonia CT pictures.The inquireabout and advancement of restorative picture AI, a assorted and high quality picture dataset, is amazingly imperative for learning AI.

Journal of Theoretical and Applied Information Technology
31st December 2023. Vol.101. No 24
© 2023 Little Lion Scientific
ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

Table 1: input CT image data

Classes	Image 1	Image 2	Image 3	Image 4
Covid				
Normal				
Viral Pneumonia				

Table 1 shows the input images present in the dataset. First Row contains the images with COVID-19 infection. Second row shows normal CT lung images. Third row shows CT images with viral pneumonia. The proposed algorithm is capable of differentiating between COIVD-19 infection and viral pneumonia. This is important because false positives need to be eliminated as much as possible.

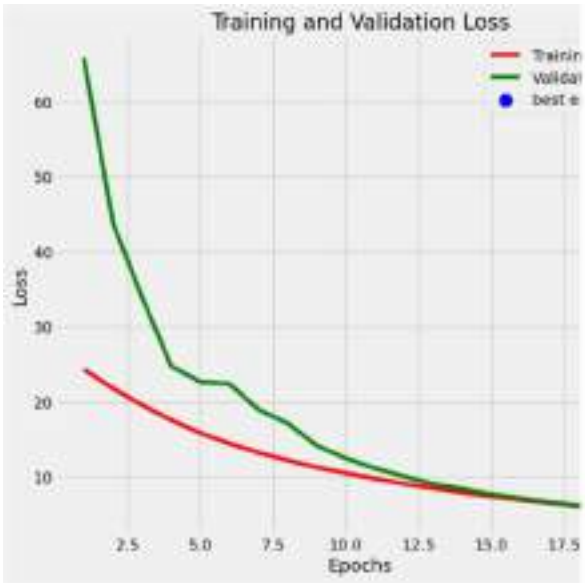


Figure 6: (a) Validation Loss and (b) validation Accuracy

Figure 6 shows the validation loss and validation accuracy of the training process. The training loss value decreased from 60 and the validation loss decreased from 25. The training accuracy and validation accuracy both reached 100%. The final testing accuracy of the proposed model is 100% as shown in Table 2.

Table 2: ResNetModel Metrics

Metric	Value
Accuracy	100%

Table 3 shows the performance comparison of existing methods with the proposed method. The proposed method obtained better classification accuracy when compared to the existing deep learning models DenseNet, mobileNet and VggNet. The accuracies of DenseNet, mobileNet and VggNet are 89.3, 72.72 and 30.30 respectively for training [14].

Table 3: Comparison of training parameters

	Training			
	Dense Net	**mobile Net**	**VggNet**	**Proposed ResNext model**
Accuracy (%)	89.39	72.72	30.30	**100.00**

The accuracies of DenseNet, mobileNet and VggNet are 90.91,75.24 and 35.75 respectively for testing as shown in table 4. Here, results show the accuracies, but not the validation of images.

Table 4: Comparison of testing parameters

	Testing			
	Dense Net	**mobile Net**	**VggNet**	**Proposed ResNext model**
Accuracy (%)	90.91	75.24	35.75	**100.00**

5. CONCLUSION

The clinical execution of the PCR test for COVID-19 pneumonia is not accurate. This paper points to assist make stride the AI examination stage for COVID-19 pneumonia investigate and make strides the precision of AI choice and judgment. ResNext is made with the module structure of ResNet in intellect. The assemble is arranged by stacking this module numerous times, but by receiving the number of ways (cardinality) as a hyper parameter in expansion to the routine profundity and width, a clear arrange plan is realized. This structure of the AI demonstrated has effectively classified the three categories of pictures, COVID-19 infection, tainted CT checks, ordinary lung

CT looks and CT checks with viral pneumonia which is inadequate in the existing works. The end of false positives within the fundamental objective of using CT looks for the assurance of the COVID-19 disease. The precise discovery of COVID-19 in patients would help specialists decide the exact course of treatment.Theproposed demonstrate gotten an ex actness of100%in dispensingwith wrong positive s delivering accurate COVID-19 detection. Thus the objective is achieved for identifying false postivies with in a huge set of images.

REFERENCES

[1] Borges do Nascimento, Israel Júnior, NensiCacic, Hebatullah Mohamed Abdulazeem, Thilo Caspar von Groote, Umesh Jayarajah, IshankaWeerasekara, MeisamAbdarEsfahani et al. "Novel coronavirus infection (COVID-19) in humans: a scoping review and meta-analysis." *Journal of clinical medicine* 9, no. 4 (2020): 941.

[2] Jin, Shuo, Bo Wang, Haibo Xu, Chuan Luo, Lai Wei, Wei Zhao, Xuexue Hou et al. "AI-assisted CT imaging analysis for COVID-19 screening: Building and deploying a medical AI system in four weeks." *MedRxiv* (2020).

[3] Chen, Haixia, Li Ai, Hong Lu, and Hongjun Li. "Clinical and imaging features of COVID-19." *Radiology of Infectious Diseases* 7, no. 2 (2020): 43-50.

[4] Suri, Jasjit S., Sushant Agarwal, Rajesh Pathak, VedmanvithaKetireddy, Marta Columbu, Luca Saba, Suneet K. Gupta et al. "COVLIAS 1.0: Lung Segmentation in COVID-19 Computed Tomography Scans Using Hybrid Deep Learning Artificial Intelligence Models." *Diagnostics* 11, no. 8 (2021): 1405.

[5] Mu, Nan, Hongyu Wang, Yu Zhang, Jingfeng Jiang, and Jinshan Tang. "Progressive global perception and local polishing network for lung infection segmentation of COVID-19 CT images." *Pattern Recognition* 120 (2021): 108168.

[6] Li, Xin, Chengyin Li, and Dongxiao Zhu. "Covid-mobilexpert: On-device covid-19 screening using snapshots of chest x-ray." *arXivpreprint Xiv:2004.03042* (2020).

[7] Angelov, Plamen, and Eduardo Almeida Soares. "SARS-CoV-2 CT-scan dataset: A large dataset of real patients CT scans for SARS-CoV-2 identification." *MedRxiv* (2020).

[8] Agarwal, Mohit, Luca Saba, Suneet K. Gupta, Alessandro Carriero, Zeno Falaschi, Alessio Paschè, Pietro Danna, Ayman El-Baz, Subbaram Naidu, and Jasjit S. Suri. "A novel block imaging technique using nine artificial intelligence models for COVID-19 disease classification, characterization and severity measurement in lung computed tomography scans on an Italian cohort." *Journal of Medical Systems* 45, no. 3 (2021): 1-30.

[9] Yang, Xingyi, Xuehai He, Jinyu Zhao, Yichen Zhang, Shanghang Zhang, and PengtaoXie. "COVID-CT-dataset: a CT scan dataset about COVID-19." *arXiv preprint arXiv:2003.13865* (2020).

[10] Horry, M.J., Chakraborty, S., Paul, M., Ulhaq, A., Pradhan, B., Saha, M. and Shukla, N., 2020. COVID-19 detection through transfer learning using multimodal imaging data. IEEE Access, 8, pp.149808-149824.

[11] Al-Zubaidi, E.A. and Mijwil, M.M., 2021. Medical Image Classification for Coronavirus Disease (COVID-19) Using Convolutional Neural Networks. Iraqi Journal of Science, pp.2740-2747.

[12] Gozes, O., Frid-Adar, M., Greenspan, H., Browning, P.D., Zhang, H., Ji, W., Bernheim, A. and Siegel, E., 2020. Rapid ai development cycle for the coronavirus (covid-19) pandemic: Initial results for automated detection & patient monitoring using deep learning ct image analysis. arXiv preprint arXiv:2003.05037.

[13] Saiz, F.A. and Barandiaran, I., 2020. COVID-19 Detection in Chest X-ray Images using a Deep Learning Approach. Int. J. Interact. Multim. Artif. Intell., 6(2), pp.1-4.

[14] S. V. Kogilavani,J. Prabhu, R. Sandhiya, M. Sandeep Kumar, UmaShankar Subramaniam, Alagar Karthick, M. Muhibbullah, and Sharmila Banu Sheik Imam COVID-19 Detection Based on Lung Ct Scan Using Deep Learning Techniques, https://www.hindawi.com/journals/cmmm/2022/7672196/

[15] Tulin Ozturk, Muhammed Talo, Eylul Azra Yildirim, Ulas Baran Baloglu, Ozal Yildirim, and U. Rajendra Acharya "Automated detection of COVID-19 cases using deep neural networks with X-ray images".

[16] Hammam Alshazly, Christoph Linse, Erhardt Barth and Thomas Martinetz, "Explainable COVID-19 Detection Using Chest CT Scans and Deep Learning".

[17] Navid Ghassemi et al "Automatic Diagnosis of COVID-19 from CT Images using CycleGAN and Transfer Learning ".

[18] Akshayaa Vaidyanaathan et al, "An externally validated fully automated deep

learning algorithm to classify COVID-19 and other pneumonias on chest computed tomography ".

[19] Appari, Neeraj Venkatasai L. Kanojia, Mahendra G., "Soft computing and image processing techniques for COVID-19 prediction in lung CT scan images ".

[20] Hossein Mohammed Riami et al. "Application of Machine Learning in Diagnosis of COVID-19 Through X-Ray and CT Images: A Scoping Review "

[21] Agata Gielczyk et al, "Pre-processing methods in chest X-ray image classification".

[22] Muhammad Attaullah et al, "Initial Stage COVID-19 Detection System Based on Patients' Symptoms and Chest X-Ray Images "

[23] Sejuti Rahman et al, "Deep Learning Driven Automated Detection of COVID-19 from Radiography Images: A Comparative Analysis ".

[24] Prof. Shailaja Udetewar et.al, "A Review Paper on Covid-19 Detection using Deep Learning ".

[25] Haydan Gunraj et al, "COVIDNet-CT: A Tailored Deep Convolutional Neural Network Design for Detection of COVID-19 Cases From Chest CT Images".