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by SOUMIK ROY

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Bangla Sign Language (BdSL-D1500) Numerals Classification using CNN Based Transfer Learning Models

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***Abstract*—In recent years, researchers in the field of Artificial Intelligence have shown a lot of interest in several Bengali sign languages using Convolutional Neural Network technology with the help of Deep Learning, finding unique hand gestures to actually imitate the letters and numerals of that particular sign language. Bengali sign language is becoming more crucial that should be adopted in our society so that the hearing impaired and speech impaired people find an easy way of identifying it so that they are not excluded from our fast-paced modern society. In this research, we propose a method which will classify Bangla Sign Language Numerals using CNN based Transfer Learning Models. Bangla sign language images show substantial changes from natural images, primarily due to differences in color of hands or variations in exposure of light that causes misinterpretation of the original numerical digits. In order to test the success rate of these methods, we have tested with test datasets consisting of 1010 images and 10 classes. Our proposed model should be able to help Bengali hearing impaired and speech impaired people in an efficient and easy way.**

***Index Terms*—HandDetection,BanglaSignLanguage,Densenet201, MobileNet**

I. Introduction

Bengali, also known as Bangla is one of the most widely spoken languages in the world. Bangla ranks fifth most spoken language in Asia. With over 272 million speakers, it is the seventh most spoken language in the world (Saumya, 2023). Around approximately 9.6% of the population in Bangladesh, which is roughly 13.7 million individuals according to the 2011 census, suffer from hearing impairment or deafness, which is defined as a hearing loss of 40 decibels or more.Bengali sign language plays an important role in encouraging communication and social engagement for the hearing impaired and speech impaired people in Bangladesh. Although Bengali sign language plays a significant part in communication within the hearing and speech impaired population, it's a complicated language and importance to the society have not been completely explored in academic research. In our rapidly developing society, several researchers are currently seeking an efficient solution for the hearing and speech impaired people through the application of Deep Learning through a CNN-based model. We have used the DenseNet121, DenseNet201, VGG16 and MobileNet model to classify the dataset. The application of deep learning strategies to Transfer Learning Models for the aim of identifying Bangla sign language is what makes this work stand out from others. This is done using a carefully selected practice dataset that is as big in subject matter.

II. Literature Review

The research paper innovatively [1] (Hossen et al., 2018) utilized a Deep Convolutional Neural Network featuring the VGG16 architecture. Remarkably, they achieved impressive recognition rates of 96.33% during training and 84.68% during validation, despite working with limited data sets. This outcome underscores how adopting transfer learning using pre-trained networks can enhance image classification performance for intricate tasks such as sign language identification in Bengali sign language samples over building models from scratch, which proved less effective by comparison within this context.

(Rahaman et al., 2014) presents [2] a real-time computer vision-based Bengali Sign Language recognition system. It uses a Haar-like feature-based cascaded classifier for hand detection and K-Nearest Neighbors (KNN) Classifier for sign recognition. The system can recognize 6 Bengali Vowels and 30 Bengali Consonants, trained with 3600 images and tested with another 3600 images. It achieved high recognition accuracy, with 98.17% for vowels and 94.75% for consonants,

showcasing its effectiveness in real-time sign language recognition with limited data.

(Purkaystha, Datta, Islam et al., 2017) delves [3] into the application of a neural network (CNN) for accurately identifying handwritten Bengali characters. The study showcases accuracy rates across character categories, achieving 98.66% accuracy for numerals, 94.99% for vowels, 91.60% for compound letters, 91.23% for alphabets, and 89.93% for nearly all Bengali characters. These findings highlight CNN's effectiveness in tackling the morphology found in Bengali characters, which presents challenges.

(Ahmed, S., Shaafi, A. I., Tabsun, F., Shah, F. M., Reyadh, A. S. et al., 2019) employ [4] a CNN model for recognizing handwritten Bengali alphabets. By using an extensive dataset of more than 76,000 images that illustrate diverse writing patterns, the model attained exceptional accuracy levels, reaching up to 95%. The study distinguishes itself by utilizing both a varied and sizable dataset in combination with sequential CNN architecture, resulting in significant advancements compared to previous studies towards recognition systems dealing with complex Bengali handwriting styles.

(Das et al., 2017) [5] presents a Bengali handwritten vowel recognition scheme using mathematical morphology and a weighted decision tree. This novel method categorizes characters based on their structural anatomy, like 'bowl', 'lobe', and 'arm', achieving fast and accurate recognition without needing training samples. The approach is particularly notable for its efficiency and accuracy, offering a promising alternative to more complex machine-learning techniques for handwritten character recognition in languages with intricate scripts like Bengali.

(Naskar, 2020) presents [6] a model called BDNet, a deep CNN specifically designed for recognizing Bengali handwritten numeral digits. This model utilizes a densely connected network architecture, which is trained end-to-end with innovative preprocessing and data augmentation techniques. It achieves a remarkable test accuracy of 99.78% on the ISI Bengali handwritten numeral dataset, marking a significant improvement over previous models and demonstrating the effectiveness of densely connected networks in handwriting recognition.

[7] The paper "Bengali Handwriting Recognition and Conversion to Editable Text" by Sadia Chowdhury, Farhan Rahman, Wasee Mohammad Shafiqul Islam, and Hasan U. Zaman presents a system for converting Bengali handwritten text into digital, editable format. This research utilizes fields such as machine learning, neural networks, and image processing to recognize and digitize Bengali handwriting, a language richly used by millions globally. The system aims to facilitate digitalization in various sectors, making Bengali handwriting more accessible and manageable digitally.

The paper titled [8] (Mandal, 2019) focuses on a new technique for normalizing online handwritten Bengali characters. It involves resizing characters to a uniform size and shape while maintaining pen movement angles. The approach also converts characters into a 3D matrix, enhancing recognition accuracy. This method achieved a 96% accuracy rate on 2655 Bengali handwritten basic characters, showcasing its effectiveness in online handwriting recognition.

The paper [9] (Mandal, 2018) presents a novel dehooking algorithm for online Bengali handwriting recognition. It focuses on removing hooks, common artifacts in fast writing, from online handwritten characters and words. The algorithm works by identifying abrupt changes in turning angle and fading pixel distances. This technique enhances the accuracy of character recognition, with a testing accuracy of 97.02% on 4000 Bengali characters. This approach significantly contributes to the field of online handwriting recognition for Bengali script.

The paper [10] (Mukti et al., 2018) delves into an unconventional technique to identify Bengali handwritten characters. The method relies on utilizing Fourier Transform and Euclidean Distance Metric towards this objective. To conduct their research, the scholars constructed a sample of 800 manuscripts for examination, attaining a recognition accuracy rate of 98.88%. Such pioneering methodology emphasizes how merging Fourier Transform with distance metrics can contribute significantly to handwriting identification process.

In this paper [11] (Kamran et al., 2018) explain the method to demonstrate the process made in Bengali handwritten digit recognition. Here many deep learning models like Densenet,Resnet and various augmentation methods are used. The top three teams—Backpropers, Digit Branch, and Dekhi ki hoi—achieved accuracy scores of 0.99359, 0.99296, and 0.99177 respectively. In summary, this event represented a significant step towards refining machine learning approaches in Bengali digit recognition and established a community for AI research in Bangladesh.

Bengali handwritten [12] The major topic of the paper is Bengali handwritten digit recognition using the ResNet34 and ResNet50 designs that were elaborated by (Hasan et al., 2018). By achieving a remarkable accuracy of Resnet34 99.3359%, the study shows how preprocessing and data augmentation may improve model performance. Future developments in applications for computer vision appear promising when more deep neural network architectures are investigated for more difficult recognition tasks, especially in the area of Bengali digit recognition.

(Shawon et al., 2018) [13] wrote about how deep convolutional neural networks (CNN) is used for Bengali handwritten digit recognition. With a noteworthy testing accuracy of 92.72% where Training and validation accuracy was 99.59% and 98.57%, they demonstrated how well their method worked to address the problems posed by enhanced and raw photos.I think this study opens the door for more developments in the field of Bengali digit identification by providing insightful information.

The paper [14] (Mandal 2018) presents a creative method for skew identification and correction in online Bengali handwritten words in this paper. The proposed method, which focuses on the width and height of words, acquired a high accuracy of 97.05% after testing on 3364 words. Further study may be able to develop the algorithm for a wider range

of handwriting styles and integrate it with more extensive handwriting recognition systems.

(Islam , Khan 2019) [15] describe a unique CNN-based object identification model in paper. The model has a remarkable ability to identify and locate handwritten characters and operators in Bengali, with a mean average accuracy (mAP) of 98.6% using the Hishab dataset. Furthermore, the model shows excellent classification accuracy on CMATERdb 99.0833% and NumtaDB 99.6252%. Subsequent research endeavors may concentrate on augmenting the model's aptitude to manage an expanded spectrum of mathematical formulations.

The research [16] by (Noor Islam , Rahimi 2018) presents an ensemble approach that combines many CNN models to recognize handwritten Bangla numerals. Between LeNet-5 and ResNet-18 the accuracy was high in ResNet-18 94.10%. Even under difficult noise settings, the method produced a remarkable accuracy of over 96% utilizing an augmented dataset of 114,000 specimens.To improve robustness, future studies may examine improving the ensemble process and expanding the dataset.

(Rahman et al., 2019) [17] present the VGG-11M model, an enhanced variant of the VGG-11(to identify handwritten Bengali numbers)architecture in this paper. It has demonstrated impressive accuracy, scoring 99.80% on the ISI dataset, 99.66% on the CMATERDB dataset, and 99.25% at 32x32 resolution on the NUMTADB dataset. All things considered, this work is a noteworthy breakthrough in Bengali numeral recognition, providing a model that surpasses current CNN designs in this domain.

(Rabby et al., 2018) [18] provide a CNN-based model for handwritten character recognition in the Bangla Language in this paper. Notable validation accuracy was attained by the model on many datasets: CMATERdb (98%), ISI (96.81%), BanglaLekha-Isolated (95.71%), and a mixed dataset (96.40%). BornoNet has limits when trained on noise-free data and has difficulty identifying over-written characters despite its high accuracy. Future research to enhance dataset quality and model resilience against noise and complicated character structures is recommended by the authors.

III. Methodology

In this study, the dataset collected from kaggle with 1010 images is read , analyzed and then converted in order to provide uniformly sized, normalized images.We used VGG-16, the neural network architecture whose epoch value was 75 and the steps per epoch was 500 with image size 224.In Densenet121 epoch was 100. Moreover, we used Densenet 201 And Mobilenet in this paper. In mobile net the batchsize was 968 and epoch wasm30 and Densenet 201 epoch was used 50.Vgg16 resulted in 91 percent and Densenet121 resulted in 94.95 percent performance.

IV. Experiment Result Analysis

In order to test our method, the pictures below show the results of hand detection in different backgrounds and positions.The Transfer Learning Models have been trained with publicly available datasets of 13990 images and 10 different classes. With our proposed system we have achieved the following results: DENSENET201 Test Accuracy is 0.94 percent, Mobilenet accuracy is 0.966 percent .The model using CNN was able to achieve a test accuracy of 0.99 in DenseNet121 and VGG16 on the Bengali sign language numeral test dataset. This accuracy is very high considering the size of the dataset.

V. Figures

A. VGG-16

Fig. 1. VGG-16 MODEL

B. DENSENET-121

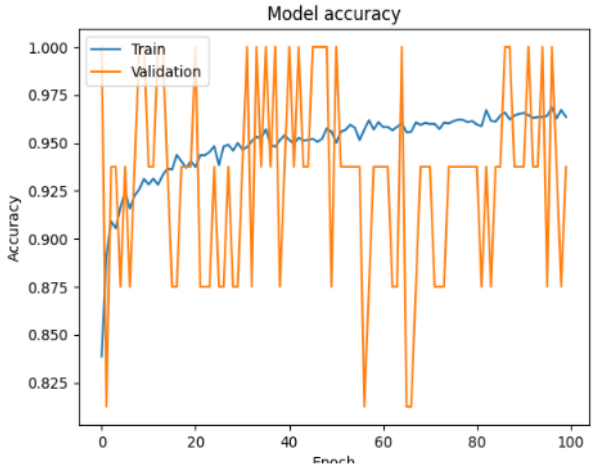

Fig. 2. DENSENET-121 MODEL

C. DENSENET-201

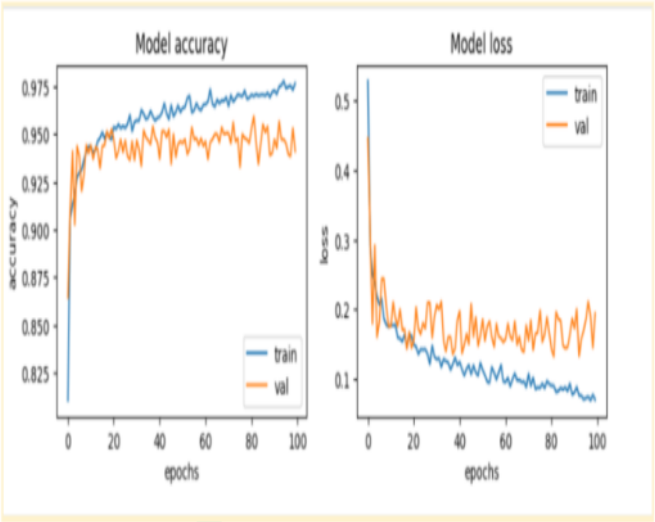

Fig. 3. DENSENET-201 MODEL

D. MOBILENET

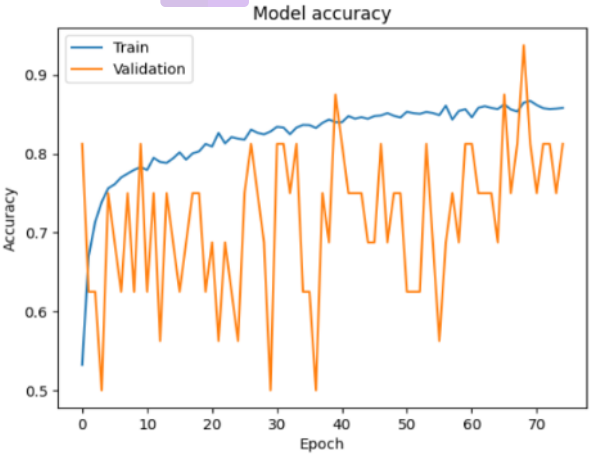

Fig. 4. MOBILENET

CONCLUSIONS

Implementing Bangla Sign Languages, hearing and speech impaired people will be able to work and study with the help of technology in many places. They will not have to deal with any of the problems they do now in Bangladesh, which is still a developing country. Whether it be what we did in the research paper or what other researchers are researching, we can tell that we are moving closer and closer to find a solution of how we can develop more in Bengali sign language and we can see that we are improving day by day. Our research paper included four transfer learning models such as, DenseNet121, VGG16, DenseNet201 and VGG19, in order to give better accuracy. It was determined that DenseNet121 and VGG16 gave the best and performed very well in the test run with various visualization and performance statistics, and was able to achieve the test accuracy of 0.99. However, both of these two models might have some certain limitations like the model might find it difficult to distinguish between different skin color, in different light exposure and so forth. Such limitations will cause an error in the final test result. Again, if our tested model is used in another hand gesture, there will be no guarantee that the result will come out the same as our test result. The dataset and research paper will be made available to the public which will allow both the researchers and the hearing and speech impaired people to actually benefit from our research paper and we can hope that our research paper may contribute to the development of a high efficient model in the upcoming future.

REFERENCES

[1] M. Hossen, A. Govindaiah, S. Sultana, and A. Bhuiyan, "Bengali sign language recognition using deep convolutional neural network," in *2018 joint 7th international conference on informatics, electronics & vision (iciev) and 2018 2nd international conference on imaging, vision & pattern recognition (icIVPR)*. IEEE, 2018, pp. 369–373.

[2] M. A. Rahaman, M. Jasim, M. H. Ali, and M. Hasanuzzaman, "Real-time computer vision-based bengali sign language recognition," in *2014 17th international conference on computer and information technology (ICCIT)*. IEEE, 2014, pp. 192–197.

[3] B. Purkaystha, T. Datta, and M. S. Islam, "Bengali handwritten character recognition using deep convolutional neural network," in *2017 20th International conference of computer and information technology (ICCIT)*. IEEE, 2017, pp. 1–5.

[4] S. Ahmed, F. Tabsun, A. S. Reyadh, A. I. Shaafi, and F. M. Shah, "Bengali handwritten alphabet recognition using deep convolutional neural network," in *2019 International Conference on Computer, Communication, Chemical, Materials and Electronic Engineering (IC4ME2)*. IEEE, 2019, pp. 1–4.

[5] P. Das, T. Dasgupta, and S. Bhattacharya, "A bengali handwritten vowels recognition scheme based on the detection of structural anatomy of the characters," in *Progress in Intelligent Computing Techniques: Theory, Practice, and Applications: Proceedings of ICACNI 2016, Volume 1*. Springer, 2018, pp. 245–252.

[6] A. Sufian, A. Ghosh, A. Naskar, F. Sultana, J. Sil, and M. H. Rahman, "Bdnet: bengali handwritten numeral digit recognition based on densely connected convolutional neural networks," *Journal of King Saud University-Computer and Information Sciences*, vol. 34, no. 6, pp. 2610–2620, 2022.

[7] S. Chowdhury, F. R. Wasee, M. S. Islam, and H. U. Zaman, "Bengali handwriting recognition and conversion to editable text," in *2018 Second International Conference on Advances in Electronics, Computers and Communications (ICAECC)*. IEEE, 2018, pp. 1–6.

[8] G. Mandal, P. De, and D. Bhattachya, "A novel approach of normalization for online handwritten characters using geometrical parameters on a 2d plane," *International Journal of Computational Intelligence & IoT*, vol. 2, no. 2, 2019.

[9] G. Mandal, "An innovative approach of dehooking for online handwritten bengali characters and words," 2018.

[10] M. H. Mukti, Q. Saad-Ul-Mosaher, and K. Ahammad, "Bengali longhand character recognition using fourier transform and euclidean distance metric," *European Journal of Engineering and Technology Research*, vol. 3, no. 7, pp. 67–73, 2018.

[11] S. A. Kamran, A. I. Humayun, S. Alam, R. M. Doha, M. K. Mandal, T. Reasat, and F. Rahman, "Ai learns to recognize bengali handwritten digits: Bengali. ai computer vision challenge 2018," *arXiv preprint arXiv:1810.04452*, 2018.

[12] M. M. Hasan, M. R. U. Islam, and M. T. Mahmood, "Recognition of bengali handwritten digits using convolutional neural network architectures," in *2018 International Conference on Bangla Speech and Language Processing (ICBSLP)*. IEEE, 2018, pp. 1–6.

[13] A. Shawon, M. J.-U. Rahman, F. Mahmud, and M. A. Zaman, "Bangla handwritten digit recognition using deep cnn for large and unbiased dataset," in *2018 international conference on Bangla speech and language processing (ICBSLP)*. IEEE, 2018, pp. 1–6.

[14] G. Mandal, "An unprecedented approach of skew detection and correction for online bengali handwritten words," *International Journal of Advanced Research in Computer Engineering & Technology (IJARCET)*, vol. 7, no. 2, p. 6, 2018.

[15] M. N. A. Islam and S. K. Khan, "Hishabnet: detection, localization and calculation of handwritten bengali mathematical expressions," *arXiv preprint arXiv:1909.00823*, 2019.

[16] R. Noor, K. M. Islam, and M. J. Rahimi, "Handwritten bangla numeral recognition using ensembling of convolutional neural network," in *2018 21st international conference of computer and information technology (ICCIT)*. IEEE, 2018, pp. 1–6.

[17] M. M. Rahman, M. S. Islam, R. Sassi, and M. Aktaruzzaman, "Convolutional neural networks performance comparison for handwritten bengali numerals recognition," *SN Applied Sciences*, vol. 1, no. 12, p. 1660, 2019.

[18] A. S. A. Rabby, S. Haque, S. Islam, S. Abujar, and S. A. Hossain, "Bornonet: Bangla handwritten characters recognition using convolutional neural network," *Procedia computer science*, vol. 143, pp. 528–535, 2018.

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Wrong Article You may have used the wrong article or pronoun. Proofread the sentence to make sure that the article or pronoun agrees with the word it describes.