JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

Deep Learning based Bio-lens for Microorganism Image Classification

[1]Dr. P. Mohanaiah, [2]R. V. R. Abhiram,[3]SK. Namaji,[4]P. Likith,[5]Y. Siddardha
[1]Professor,[2,3,4,5]UG Scholar, Dept. Of ECE
[1,2,3,4,5]N.B.K.R. Institute of Science & Technology (Autonomous), Vidyanagar.

ABSTRACT:

The application of Machine Learning for microorganisms, especially type of microorganism recognition, becomes attractive because it can reduce the analyzing time of microorganism classification and eliminate human error compared to the classic biological techniques. Therefore, the recognition of microorganisms based on Deep Learning increases the efficiency and accuracy of the diagnostic process for infected patients. Deep Learning is a type of Machine Learning that uses a deep layered structure called an Artificial Neural Network (ANN). This project proposes the possibility of using image classification and deep learning methods to recognize the type of microorganism, comparing cell image data-quality between our standard-resolution dataset and high-resolution dataset. The experimental results have shown that microorganism cell images from microscope are able to be recognized.

I.INTRODUCTION:

Identifying microorganisms is a useful diagnostic method, especially for infected patients. In general, the classic methods of classifying and identifying microorganisms are mainly based on biotechnology, such as observing the appearance of colonies of microorganisms grown on petri dishes which includes properly selected readings, colony count, Gram stain methods, biochemical tests, antibiotic tests, etc. . . However, this classical method takes a long time, and the expertise and work experience of the laboratory staff. Therefore, specific procedures for microbial identification are attractive to reduce analysis time and increase the accuracy of the diagnostic process [1, 2, 3]. The main characteristics of bacteria and yeast can be recognized in the form of the color of the Gram stain, the shape and arrangement of the cells. Artificial intelligence (AI), specifically machine learning techniques, are used in computers or specialized systems to classify images by category. Supervised machine learning algorithms are important for data analysis and image classification [4]. Later, many studies that used machine learning algorithms were investigated to develop special systems for biological image classification [5, 6]. Microscopic image analysis continues to help doctors diagnose diseases more accurately. However, bacteria are different and their cells are very irregular in shape, while yeast can change their cell shape significantly when living in different environments (eg. This biodiversity also influences the identification process. Therefore, the classification and identification of microorganisms based on appearance and arrangement is a major challenge for identification systems, in two ways basics of three types of bacteria and one type of yeast: round and cylindrical, as well as differences in the arrangement of their cells, were identified.

MOTIVATION

The traditional in vitro microorganism laboratory is an expensive and time-consuming process that requires trained personnel to correctly and accurately classify the microorganisms present in harvested samples. Longer incubation periods or incorrect classification assumptions may pose a risk to public health and safety, which may result in disease or other serious adverse events. Fully automated systems allow visual inspection and accurate classification of microscopic samples and can provide accurate classification solutions in less time than before. Such systems can be installed in many places, such as laboratories for faster analysis, drinking water sources and power lines for early detection of drinking water contamination, hospitals and other conference facilities. much. It is easy to understand the importance of fast and accurate computer models trained to detect E. coli through static images or video.

OBJECTIVES

The goal of this paper is to develop, train, and test a computer vision model based on deep neural networks to achieve efficient microorganism classification. The system must be able to analyze the images of microorganisms captured over time. To achieve this, the computer processing unit must be connected to a camera and an optical microscope with enough magnification to clearly observe the microscope. Deep neural network models should be trained using a dataset of images with similar features to those taken in real-world applications. An image set was created by collecting 168 continuous images of E. coli. Photographs of the data set were taken using a world-class optical microscope and a digital camera. There are three categories of photos: cocci, bacilli, and clusters. These categories represent different characteristics of E. coli to be classified. In order to increase the size of the data set and improve the efficiency of the training, data enhancement methods such as image transformation and transformation are used. Apply image analysis techniques to datasets to improve image quality and improve training and classification quality. Going forward, think about methods that work well. Several parts of the model were trained on the dataset using YOLO [24], specifically the YoloV5 algorithm [12] developed by Ultralytics [13]. All the work is done through the Google Collaboratory platform, which can use powerful graphics processing units to speed up the process faster than traditional computers [14].

II.LITERATURE SURVEY:

The ViT model applies transformers in the field of natural language processing to the field of computer vision. The main contribution of this model is to prove that CNN is not the only choice for image classification tasks. Vision transformer divides the input image into fixed-size patches and then obtains patch embedding through a linear transformation. Finally, the patch embeddings of the image are sent to the transformer to perform feature extraction to classification. The model is more effective than CNN on super-large-scale datasets and has high computational efficiency (Dosovitskiy et al., 2020).

The BoTNet is proposed by Srinivas. This network introduces self-attention into ResNet. Therefore, BoTNet has both the local perception ability of CNN and the global information acquisition ability of Transformer. The top-1 accuracy on ImageNet is as high as 84.7%, and the performance is better than models such as SENet and Efficient-Net (Srinivas et al., 2021).

T2T-ViT is an upgraded version of ViT. It proposes a novel Tokens-to-Token mechanism based on the characteristics and structure of ViT. This mechanism allows the deep learning model to model local and global information. The performance of this model is better than ResNet in the ImageNet data test, and the number of parameters and calculations are significantly reduced. In addition, the performance of its lightweight model is better than that of MobileNet (Yuan et al., 2021).

DeiT is proposed by Touvron et al. The innovation of DeiT is proposes a new dist.illation process based on a dist.illation token, which has the same function as a class token. It is a token added after the image block sequence. The output after the transformer encoder and the output of the teacher model calculates the loss together. The training of DeiT requires fewer data and fewer computing resources (Touvron et al., 2020).

With the development of technology, good results are achieved using computer-aided EM classification. In Kruk et al. (2015), a system for automatic identification of different species of microorganisms in soil is proposed. The system first separates microorganisms from the background using the Otsu. Then shape features, edge features, and color histogram features are extracted. Then the features are filtered using a fast correlation-based filter. Finally, the random forest (RF) classifier is used for classification. This system frees researchers from the tedious task of microbial observation.

In Amaral et al. (1999), a semi-automatic microbial identification system is proposed. The system can accurately identify seven species of protozoa commonly found in wastewater. The system first enhances the image to be processed and then undergoes data collection and complex morphological operations to generate a 3D model of EMs. The 3D model is used to determine the species of protozoa. In Amaral et al. (2008), a semi-automatic image analysis procedure is proposed. It is found that geometric features have good recognition ability. It is possible to detect the presence of two microorganisms, Opercularia and Vorticella, in wastewater plants. In Chen and Li (2008), an improved neural network classification method based on microscopic images of sewage bacteria is proposed. The method uses principal component analysis to reduce the extracted EM features. Also, the method applies the daptivate accelerated back propagation (BP) algorithm to learn image classification.

An automatic classification method with high robustness of EMs is suggested in Li et al. (2013), which describes the shape of EMs in microscopic images by Edge Histograms, Extended Geometrical Features, etc. The support vector machine classifier is used to achieve the best classification result of 89.7%. A shape-based method for EM classification is suggested in Yang et al. (2014), which introduces very robust two-dimensional feature descriptors for EM shapes. The main process of this method is to separate EMs from the background. Then a new EM feature descriptor is used and finally a SVM is used for classification.

A new method for automatic classification of bacterial colony images is proposed in Nie et al. (2015), which enables the classification of colonies in different growth stages and contexts. In addition, the method mainly uses a multilayer middle layer CNN model for classification and uses the patches segmented from the CDBN model as input. Finally, a voting scheme is used for prediction. The results show that the method achieves results that exceed the classical model.

III.PROPOSED METHOD:

In this project, we propose a new implementation of an automatic microbial image classification system based on machine learning using the Matlab environment. The proposed system first implements a neural network framework using machine learning techniques and is trained using a database of image features of all the microscopic features predicted during database creation. . Once the database is built and the system is trained, the system is put out for testing using random test samples to test the effectiveness of the process.

Fig 1:Schematic Block Overview of the Proposed System.

This project proposes that image classification and deep learning techniques can be used to identify bacteria and yeast, and compare the quality of cell image data between standard and high-resolution datasets. . The proposed system first acquires a test image of a microorganism and enters the processing area before processing and adjusts the visual quality and information quality of the test microorganism image by properly removing the noise and the result of a state of being. The OTSU segmentation technology is used to segment the experimental microbial images before processing, and K-means clustering is used to correctly classify the segmented objects of the experimental microbial images based on similarity. The discrete microwave transform is applied to the group of separated objects, and the underlying coefficients are obtained directly.

IV.RESULTS

Fig.2: Database Creation

Fig. 3: Input test image

After testing, generation of ML model with CNN occurs, by entering the value of *no. of hidden layers required (15 is good).*

Fig 4:Final output

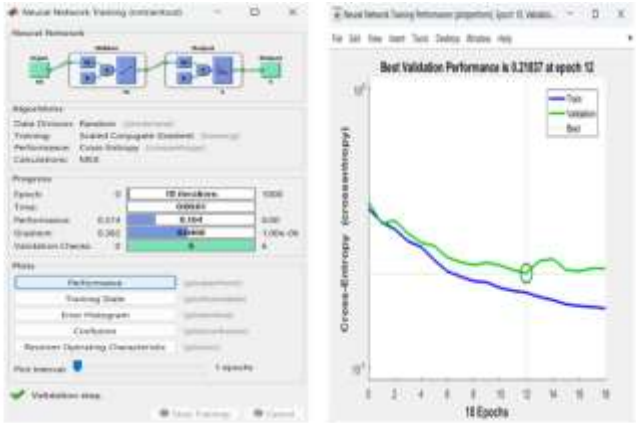

Fig 5:Neural network Performance

V.CONCLUSION

Experimental results confirmed that through image classification and deep learning methods, machine learning can be used to identify seven genera and microspecies with different shapes and requirements. The experimental results compare the results using existing standard resolution datasets with datasets prepared to achieve the highest accuracy in micro-species use cases. By increasing the number of training Epochs, the training accuracy and verification accuracy reached more than 90% for high-resolution images and hand-held images. Additionally, training and testing with standard resolution image datasets is more accurate than using high resolution image datasets. Microscopic image classification system using a machine learning framework can be used to train seven standard image clusters of different microspecies. However, the test results show that the sample images should be similar to the training image set. Therefore, the accuracy of standard resolution image collections can be improved in the future. However, this study was limited to seven genera and microspecies. We consider more than seven different types of microorganisms improving accuracy for mobile and tablet cases.

REFERENCES

[1] B. Zieliński, A. Plichta, K. Misztal, P. Spurek, M. Brzychczy-Wøoch, D. Ochońska, “Deep learning approach to bacterial colony classification,” Plos one, vol. 12, September 2017.

[2] K. Lim, S. Hyun Park, J. Kim, H. Seonwoo, PH. Choung, J. H. Chung, “Cell image processing methods for automatic cell pattern recognition and morphological analysis of mesenchymal stem cells – An algorithm for cell classification and adaptive brightness correction,” Journal of Biosystems Engineering, vol. 38, pp. 55-63, February 2013.

[3] L. Shamir, J. D. Delaney, N. Orlov, D. M. Eckley, I. G. Goldberg, “Pattern recognition software and techniques for biological image analysis,” Plos computational biology, vol. 6, November 2010.

[4] A. Singh, N. Thakur and A. Sharma, "A review of supervised machine learning algorithms," 2016 3rd International Conference on Computing for Sustainable Global Development (INDIACom), New Delhi, 2016, pp. 1310-1315.

[5] L. Nanni, S. Brahnam, S. Ghidoni and A. Lumini, "Bioimage Classification with Handcrafted and Learned Features," in IEEE/ACM Transactions on Computational Biology and Bioinformatics, vol. 16, no. 3, pp. 874-885, 1 May-June 2019.

[6] F. Xing, Y. Xie, H. Su, F. Liu and L. Yang, "Deep Learning in Microscopy Image Analysis: A Survey," in IEEE Transactions on Neural Networks and Learning Systems, vol. 29, no. 10, pp. 4550-4568, Oct. 2018.

[7] Y. LeCun, L. Bottou, Y. Bengio, and P. Haffner, “Gradient-based learning applied to document recognition,” Proceedings of the IEEE, November 1998.

[8] Chen, W., Liu, P.-Y., Lai, C.-C., & Lin, Y.-H. (2022). Identification of environmental microorganism using optimally fine-tuned convolutional neural network. Environmental Research, 206, 112610–112610. https://doi.org/10.1016/j.envres.2021.112610

[9] Yang, H., Li, C., Zhao, X., Cai, B., Zhang, J., Ma, P., Zhao, P., Chen, A., Jiang, T., Sun, H., Teng, Y., Qi, S., Jiang, T., & Marcin Grzegorzek. (2023). EMDS-7: 56 Environmental microorganism image dataset seventh version for multiple object detection evaluation. 14. https://doi.org/10.3389/fmicb.2023.1084312

[10] Sun, L., Xu, Y., Rao, Z., Chen, J., Liu, Z., & Lu, N. (2022). YOLO Algorithm for Long-Term Tracking and Detection of Escherichia Coli at Different Depths of Microchannels Based on Microsphere Positioning Assistance. 1–5.

[11] Park, J., Baek, J., Kim, J., You, K., & Kim, K. (2022). Deep Learning-Based Algal Detection Model Development Considering Field Application. Water, 14(8), 1275. https://doi.org/10.3390/w14081275

[12] Jubayer, F., Soeb, J. A., Mojumder, A. N., Paul, M. K., Barua, P., Kayshar, S., Akter, S. S., Rahman, M., & Islam, A. (2021). Detection of mold on the food surface using YOLOv5. Current Research in Food Science, 4, 724–728. https://doi.org/10.1016/j.crfs.2021.10.003

[13] Ultralytics | Revolutionizing the World of Vision AI. (n.d.). Www.ultralytics.com. Retrieved November 15, 2023, from https://www.ultralytics.com

[14] Maria Rocha, M. (2022). Object Detection in GPR Data Using Classical Vision and YOLOv5 (pp. 1–15).

[15] Ma, L., Yi, J., Nicharee Wisuthiphaet, Earles, M., & Nitin Nitin. (2022). Accelerating the Detection of Bacteria in Food Using Artificial Intelligence and Optical Imaging. Applied and Environmental Microbiology, 89(1). https://doi.org/10.1128/aem.01828-22