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A Review of Smart Safety AI based Face Mask Detection and Classification for the Protection of Workers

Ms. Snehal Tandale[1] and Dr. Sachin Bhoite[2]
[1]Department of Information Technology & Data Science, Vidyalankar School of Information Technology, Department of Information Technology & Data Science, Mumbai, India
Email: snehaltandale29@gmail.com
[2]Department of Computer Science and applications, Dr. Vishwanath Karad, MIT World Peace University, Department of Computer Science & Applications, Pune, India
Email: sachin.bhoite@mitwpu.edu.in

***Abstract*—The safety of workers is critical, as they are often exposed to infectious materials. Ensuring their safety involves providing them with proper personal protective equipment (PPE) such as face mask. Not only wearing mask is important but also wearing correct type of mask is equally important. Different workers require to wear different type of mask depending upon the work they do. So in this case, face mask detection and classification is essential for workers to ensure their health and safety by preventing the transmission of infections. The AI based system automatically monitors and ensure compliance with mask wearing protocols. This includes improving the precision and reliability of detection algorithms in various conditions and with different types of masks. The system of detection and classification will not only promote the safety of workers' health but will also reduce the risk of spreading diseases to the public. There are systems which only detects or classifies the masks but does not include detection and classification at the same time. Also different sectors require their workers to wear different types of mask for safety. The system of detection and classification at the same time will be helpful for all sectors where their workers are required to wear correct type of mask and follow the security protocols.**

***Index Terms*— AI- based surveillance, Face mask detection, Deep learning algorithms, Computer vision, Workers safety, PPE Compliance**.

I. INTRODUCTION

For sanitation workers, face mask is essential for safeguarding their health by minimizing exposure to potentially harmful pathogens and particles found in waste. Face Mask ensures adherence to safety regulations, reduces the risk of illness transmission, and enhances operational efficiency by automating compliance monitoring. Due to this fierce, the paper outlines the various methods of detecting and classifying of face mask. The detection will help us to check if the sanitation worker is wearing mask or not and following protective measures, classifying will help us know if they are wearing the correct type of mask or not. The methods are implemented using deep learning algorithm. Not only sanitation workers will be protected but also all other sector workers will be protected. Deep learning algorithms processes and analyse images, making them suitable for dynamic

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environments where quick decisions can be taken. The following are the objectives of the review study: -

- This study aims to critically evaluate existing approaches, algorithms, and models applied in the field, including DL techniques like CNNs, SVMs, and ensemble methods.
- This review aims to highlight key challenges, gaps in existing research.

II. Literature Review

YOLO-based approaches have shown promising results in face mask detection. A study using YOLO V3-tiny achieved an accuracy of 95%, significantly outperforming CNN, which achieved 84% accuracy (A & Jaisharma, 2022) [1]. Another research proposed a cascaded model combining YOLO V3, Facenet, and Mobilenet, achieving an impressive 99.2% accuracy for mask detection (Bharathi et al., 2021) [4]. However, a comparative study found that an improved YOLO v4 algorithm achieved 85.87% accuracy, which was lower than CNN's 92.65% accuracy (Kandan & Vidhya, 2023) [3]. CNN has consistently demonstrated high performance across multiple studies. One research comparing KNN, SVM, and CNN found that CNN achieved the highest accuracy of 96.83% in face mask detection (Naufal et al., 2021) [2]. Another study reported CNN achieving an outstanding 98.6% accuracy (Anirudh et al., 2022). The effectiveness of CNN is further supported by its superior performance compared to improved YOLO v4 (Kandan & Vidhya, 2023) [3].

Hybrid models combining deep learning architectures with traditional machine learning classifiers have also shown promise. A MobileNetV2-SVM hybrid model achieved 98.17% accuracy, while a MobileNetV2-KNN model reached 95.22% accuracy (Singh et al., 2022) [6].

These results highlight the potential of combining feature extraction capabilities of deep learning models with the classification strengths of traditional algorithms.

DL has become a leading method for detecting and classifying face masks.Su et al. (2022) proposed an algorithm that combines transfer learning and deep learning. Similarly, Addagarla et al. (2020) explored the use of deep transfer learning techniques, including YOLOv3 object detection. These studies demonstrate the power of deep learning in achieving accurate mask detection and classification. [17]

Naufal et al. (2021) conducted a comparative analysis of KNN, SVM, and CNN for face mask detection. The study emphasizes the importance of choosing suitable classification algorithms tailored to the specific needs and constraints of each application. [18]

Kayali et al. (2021) found that the ResNet50 network achieved superior results in classifying different types of masks.[19] Random forest model performed well in admission prediction system developed by Dhrvesh K et al. in their paper [30]. In this study about individual explanatory features which can be used by the students to analyse and improve their performance are not provided [31]. ML gives the expertise to anticipate the features impacting the company based on traditional data [32].

The deep CNNs offers promising prospects for efficient and accurate auto object identification in biodiversity research [33].

The algorithms comparison conducted in the paper primarily focuses on the results of validation testing to make decisions regarding the selection of algorithms for detection purposes and which is a unique [34, 35].

III. Types of Face Masks and its Application

Table I shows the images of different types of facemask, their names, what do they protect us from and the sectors where they are used. This table gives an insight to different sectors that can implement DL models to protect their workers.

Face mask detection as well as classification can help ensure the safety of workers across various sectors, with each sector requiring different types of masks as outlined in Table I.

Table II consist of various studies carried out on detecting and classifying of facemask. Each study either uses a single model or multiple models. These models either check for a mask or non-mask image or else it classifies the type of mask. In the above table the work done by the researchers include only detecting and classifying face mask and non-mask or the type but it does not include any security alert.

TABLE I. VARIOUS TYPES OF FACE MASK

Sr No	Image	Name	Uses	Application
1.		N95 Respirator Mask	Protects against airborne particles, bacteria, and viruses (e.g., COVID-19, TB). Used in healthcare and industrial settings.	Hospitals, Industrial plants, Sanitation sites, Waste management
2.		Surgical Mask	Protects against large respiratory droplets. Used in healthcare, surgery, and for general public use to prevent droplet transmission.	Hospitals, Clinics, Public places (for general use)
3.		Cloth Mask	Provides minimal protection, used by the general public for daily use to reduce the spread of droplets.	Public places, Workplaces, Schools, Homes
4.		KN95 Respirator Mask	Similar to N95, used for filtering airborne particles, primarily in industrial settings and for personal use.	Industrial settings, Public transportation, Hospitals
5.		Dust Mask	Protects against non-toxic dusts in construction, mining, and woodworking.	Construction sites, Workshops, Mining operations, Agriculture
6.		P100 Respirator Mask	Provides protection against both oil- and non-oil-based particulates, used in industrial environments with high contamination risk.	Heavy industrial environments, Chemical plants, Mining
7.		Face Shield with Mask	Used with a mask for additional protection against splashes, sprays, and large droplets.	Healthcare settings, Industrial work, Laboratories, Dental clinics

IV. COMPARATIVE STUDY

TABLE II. COMPARATIVE STUDY

Sr No	Algorithm	Accuracy	Dataset	Reference
1.	MobileNetV2	99%	Kaggle	[7]
		99%	RMFD	

Sr No	Algorithm	Accuracy	Dataset	Reference
2.	ResNet for feature extraction	RMFD: SVM 99.64%	RMFD	[8]
	Decision Trees, SVM and Ensemble Algorithm for classification process	SMFD: SVM 99.49%	SMFD	
		LFW: SVM 100%	LFW	
3.	ResNet50	98.20%	Dataset was not mentioned but the model was trained on 45,000 face images that showed images for mask and non- mask.	[9]
4.	YOLOV3	96%	Dataset was not mentioned but model was trained with 650 images were used for mask and non-mask	[10]
5.	ResNet101v2	98%	FMC	[11]
			FMD	
			MFR2	
			MAFA	
6.	MobileNetV2 and Single Shot Detector (SSD)	85%	Custom dataset consisting of different types of face mask	[12]
7.	VGG-16	99.81%	MAFA, Masked Face-Net, and Bing	[13]
	MobileNetV2	99.6%		
	Inceptionv3			
	ResNet-50			
	CNN			
8.	R-CNN	68.72%	COCO Dataset	[14]
9.	MobileNetV2	92.64%.	Kaggle's Dataset	[15]
10.	Yolo-v4	99.98%	Medical Masks Dataset	[16]
			Face Mask Dataset	
11.	CNN	98%	Kaggle's Dataset	[20]
	MobileNetV2			
12.	CNN	96%	Github	[21]
13.	For Detection YOLOv3 with EfficientNet	96.03%	Custom Dataset Qualified Mask or Unqualified Mask	[22]
	For Classification Transfer Learning and MobileNet	97.84%		
14.	MobileNet-V2 with SVM	97.11%	A small dataset of 1,376 facial images	[23]
15.	CNN	97.42%	SMFD	[24]
	VGG16	98.97%		
16.	ResNet-50 with MT-CNN	81.3%	Custom Dataset	[25]
17.	MobileNet and Global Pooling block	99%	DS1	[26]
		100%	DS2	
18.	Mask Detection ResNet-50	97.81%	Custom Dataset	[27]
	Mask Classification MobileNetV2			
19.	Mask Detection YOLOv3	97.84%	Mask Detection Public Face Mask Detection Dataset	[28]
	Mask Classification MobileNet		Mask Classification Custom	
20.	Mask Detection CNN	89.24%	FDDB LFW	[29]
	Mask Classification CNN	98.63%		

V. CONCLUSION

This review explores automated methods for detecting and classifying different types of masks, while also assessing whether they are being worn correctly. Further research is needed to develop and evaluate an effective AI and machine learning framework for real-time face mask detection and classification. Implementing alert system along with detecting and classifying face mask can act as surveillance system which can helpful for the protection of workers across various sectors. But also the challenge is lack of dataset. The current data set includes image firstly for training and validating images for mask and non-mask, secondly, dataset includes images for different types of mask like N95, Cloth, Surgical and thirdly includes images to check if they have worn it correctly or not. But there is no such dataset which includes all of the above said images in to one dataset. Availability of dataset will help improve the models to correctly identify and this will ultimately help the society in maintaining public hygiene, reducing the spread of diseases and protect the workers.

REFERENCES

[1] A, N., & Jaisharma, K. (2022). A Deep Learning Based Approach for Detection of Face Mask Wearing using YOLO V3-tiny Over CNN with Improved Accuracy. 4, 1–5. https://doi.org/10.1109/icbats54253.2022.9758925

[2] Naufal, M. F., Yoshua, A. A., Prayuska, Z. A., Kusuma, S. F., Sugiarto, D., Dinata, N. S., & Lauwoto, Y. A. (2021). Comparative Analysis of Image Classification Algorithms for Face Mask Detection. Journal of Information Systems Engineering and Business Intelligence, 7(1), 56. https://doi.org/10.20473/jisebi.7.1.56-66

[3] Anirudh, K., Chaurasiya, V., Ravi, A., & Charan, V. S. (2022, February 19). Face Mask Detection Using Machine Learning. https://doi.org/10.1109/sceecs54111.2022.9740913

[4] Bharathi, S., Hari, K., Senthilarasi, M., & Sudhakar, R. (2021, October 9). An Automatic Real-Time Face Mask Detection using CNN. https://doi.org/10.1109/stcr51658.2021.9589008

[5] Kandan, C. M., & Vidhya, K. (2023). Face Mask Detection and Recognition with High Accuracy on Live Streaming Video Using Improved Yolo V4 and Comparing with Convolutional Neural Network (pp. 673–681). springer nature switzerland. https://doi.org/10.1007/978-3-031-25088-0_59

[6] Singh, P., Goel, N., Rani, R., Dev, A., & Sharma, A. (2022, October 13). Face Mask Detection using an Automated Hybrid Deep Learning Method in the COVID Scenario. https://doi.org/10.1109/icrito56286.2022.9964589

[7] R. P. Sidik and E. Contessa Djamal, "Face Mask Detection using Convolutional Neural Network," 2021 4th International Conference of Computer and Informatics Engineering (IC2IE), Depok, Indonesia, 2021, pp. 85-89, doi: 10.1109/IC2IE53219.2021.9649065

[8] Mohamed L, Gunasekaran M, Mohamed Hamed T, Nour Eldeen K, A hybrid deep transfer learning model with machine learning methods for face mask detection in the era of the COVID-19 pandemic,Measurement, Volume 167,2021, 108288, ISSN 0263-2241,https://doi.org/10.1016/j.measurement.2020.108288.

[9] Shilpa S, Mamta K, Trilok K,Face mask detection using deep learning: An approach to reduce risk of Coronavirus spread,Journal of Biomedical Informatics,Volume 120,2021,103848,ISSN 1532-0464

[10] M. R. Bhuiyan, S. A. Khushbu and M. S. Islam, "A Deep Learning Based Assistive System to Classify COVID-19 Face Mask for Human Safety with YOLOv3," 2020 11th International Conference on Computing, Communication and Networking Technologies (ICCCNT), Kharagpur, India, 2020, pp. 1-5, doi: 10.1109/ICCCNT49239.2020.9225384.

[11] Ricardo M, Vicente G, Gilberto R, J. Salvador S, Deep transfer learning for the recognition of types of face masks as a core measure to prevent the transmission of COVID-19, Applied Soft Computing,Volume 125,2022,109207,ISSN 1568-4946,https://doi.org/10.1016/j.asoc.2022.109207.

[12] Yadav, Shashi. (2020). Deep Learning based Safe Social Distancing and Face Mask Detection in Public Areas for COVID-19 Safety Guidelines Adherence. International Journal for Research in Applied Science and Engineering Technology. 8. 1368-1375. 10.22214/ijraset.2020.30560.

[13] Hussain, Shabir & Yu, Yang & Ayoub, Muhammad & Khan, Akmal & Rehman, Rukhshanda & Wahid, Junaid & Hou, Weiyan. (2021). IoT and Deep Learning Based Approach for Rapid Screening and Face Mask Detection for Infection Spread Control of COVID-19. Applied Sciences. 11. 10.3390/app11083495

[14] J. Gathani and K. Shah, "Detecting Masked Faces using Region-based Convolutional Neural Network," 2020 IEEE 15th International Conference on Industrial and Information Systems (ICIIS), RUPNAGAR, India, 2020, pp. 156-161, doi: 10.1109/ICIIS51140.2020.9342737.

[15] Preeti N, Rachna J, Agam M, Rohan A, Piyush K, Jude H,SSDMNV2: A real time DNN-based face mask detection system using single shot multibox detector and MobileNetV2,Sustainable Cities andSociety,Volume 66,2021,102692,ISSN 2210-6707, https://doi.org/10.1016/j.scs.2020.102692.

[16] Degadwala, Sheshang & Vyas, Dhairya & Chakraborty, Utsho & Dider, Abu Raihan & Biswas, Haimanti. (2021). Yolo-v4 Deep Learning Model for Medical Face Mask Detection. 209-213. 10.1109/ICAIS50930.2021.9395857.

[17] Addagarla, S. K., Chakravarthi, G. K., & Anitha, P. (2020). Real time multi-scale facial mask detection and classification using deep transfer learning techniques.

[18] Naufal, M. F., Kusuma, S. F., Prayuska, Z. A., et al. (2021). Comparative analysis of image classification algorithms for face mask detection.

[19] Kayali, D., Dimililer, K., & Sekeroglu, B. (2021). Face mask detection and classification for COVID-19 using deep learning.

[20] Sharadhi AK, Gururaj V, Shankar SP, Supriya MS, Chogule NS. Face mask recogniser using image processing and computer vision approach. Global Transitions Proceedings. 2022 Jun;3(1):67–73. doi: 10.1016/j.gltp.2022.04.016. Epub 2022 Apr 3. PMCID: PMC8976695.

[21] Islam, Md. Shahriar & Moon, Eimdadul & Shaikat, Md & Alam, Mohammad. (2020). A Novel Approach to Detect Face Mask using CNN. 800-806. 10.1109/ICISS49785.2020.9315927.

[22] Su, X., Gao, M., Ren, J. et al. Face mask detection and classification via deep transfer learning. Multimed Tools Appl 81, 4475–4494 (2022). https://doi.org/10.1007/s11042-021-11772-5

[23] A. Oumina, N. El Makhfi and M. Hamdi, "Control The COVID-19 Pandemic: Face Mask Detection Using Transfer Learning," 2020 IEEE 2nd International Conference on Electronics, Control, Optimization and Computer Science (ICECOCS), Kenitra, Morocco, 2020, pp. 1-5, doi: 10.1109/ICECOCS50124.2020.9314511.

[24] Negi, Alok & Berwal, Krishan & Chauhan, Prachi & Rajput, R.. (2021). Deep Neural Architecture for Face mask Detection on Simulated Masked Face Dataset against Covid-19 Pandemic. 595-600. 10.1109/ICCCIS51004.2021.9397196.

[25] S. E. Snyder and G. Husari, "Thor: A Deep Learning Approach for Face Mask Detection to Prevent the COVID-19 Pandemic," SoutheastCon 2021, Atlanta, GA, USA, 2021, pp. 1-8, doi: 10.1109/SoutheastCon45413.2021.9401874.

[26] Venkateswarlu, Isunuri & Kakarla, Jagadeesh & Prakash, Shree. (2020). Face mask detection using MobileNet and Global Pooling Block. 1-5. 10.1109/CICT51604.2020.9312083.

[27] Sheikh, B., Zafar, A. RRFMDS: Rapid Real-Time Face Mask Detection System for Effective COVID-19 Monitoring. SN COMPUT. SCI. 4, 288 (2023). https://doi.org/10.1007/s42979-023-01738-9

[28] Su X, Gao M, Ren J, Li Y, Dong M, Liu X. Face mask detection and classification via deep transfer learning. Multimed Tools Appl. 2022;81(3):4475-4494. doi: 10.1007/s11042-021-11772-5. Epub 2021 Dec 9. PMID: 34903950; PMCID: PMC8656443.

[29] Hongxin Zhang, Liying Chi, End-to-End Spatial Transform Face Detection and Recognition, Virtual Reality & Intelligent Hardware, Volume 2, Issue 2, 2020, Pages 119-131, ISSN 2096-5796, https://doi.org/10.1016/j.vrih.2020.04.002.

[30] Dhruvesh K, Rashmi P, Rushabh S, Sachin B (2019) Engineering college admission preferences based on student performance. Int J Comput Appl Technol Res 8(09):379–384. ISSN: 2319-8656.

[31] Shubham Khandale and Sachin Bhoite, "Campus Placement Analyzer: Using Supervised Machine Learning Algorithms", IJCATR, vol. 8, no. 09, 2019, ISSN 358-362.

[32] A. Kulkarni, D. Bhandari and S. Bhoite, "Restaurants rating prediction using machine learning algorithms", International Journal of Computer Applications Technology and Research, 2019.

[33] T. Surabhi, B. Sachin and C. Advait, "Deep Convolutional Neural Networks for Automated Butterfly Species Recognition and Classification", 2023 5th International Conference on Inventive Research in Computing Applications (ICIRCA), pp. 778-783, 2023.

[34] Vishwakarma S., Bhoite S., "Classification of Corn Leaf Disease using Resnet18, Alexnet and VGG16" (ACT2024), 2, pp. 1333 – 1339.

[35] Amondkar M., Bhoite S. "Machine Learning Approach for Onion Leaf Disease Detection: A Case Study in Maharashtra, India" (ACT2024), 2, pp. 1249 – 125.