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Improving Accuracy in Face Mask Detection based on Artificial Intelligence Compared with Viola-Jones Method for Pandemic Control

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Abstract

Aim: This project aims to improve accuracy in Face Mask detection based on Artificial Intelligence compared with Viola-Jones method for Pandemic Control. **Materials And Methods:** Artificial Intelligence based method and Viola-Jones method are chosen as two groups and each group with 15 samples respectively, which are collected using the training image datasets. G Power =0.8. **Result:** The independent sample t-test result shows that the Accuracy in (%) is improved for Artificial Intelligence-based method with a mean (98.82) when compared with the Viola-Jones method (89.61) with a two tailed significance (p=0.000). **Conclusion:** The analysis shows that the accuracy in Artificial Intelligence-based Facemask detection is significantly better compared to the Viola-Jones method.

Keywords

Deep learning, Artificial Intelligence, Novel Facemask Detection, Accuracy, Viola-Jones, Pandemic

INTRODUCTION

Wearing a facemask is very crucial in pandemic control. Artificial intelligence is ready and contains many pre-trained for face, eye, mask, smile. Deep learning algorithms are found useful in face mask detection (Loey et al. 2021a)**,** (Tomás et al. 2021). If people wear a mask, the system will permit them, if not then it will give the buzzer to wear a mask to prevent them from virus transmission (Barnawi et al. 2021) . Viola-Jones was designed to detect frontal faces the best rather than faces looking sideways, upwards or downwards. The Viola-Jones algorithm looks for hundreds of these kinds of features in the face. Application of machine learning algorithms in face mask detection is presented (Boulos 2021).Applications of face mask detection algorithms are COVID -19 prevention with highest accuracy with reduced time delay (Sethi, Kathuria, and Kaushik 2021; Loey et al. 2021a; Vadlapati, Senthil Velan, and Varghese 2021).

In the last 5 years, several research papers on face detection have been published in which 100 research articles were published in IEEE Xplore and 350 papers are published in Google Scholar. It is evident in the domain of medical research that wearing a face mask is an effective measure to control the spread of COVID infection (Dey, Howlader, and Deb 2021). Artificial intelligence with python is used for speech recognition and for other purposes. In facial recognition systems, an algorithm is applied to get the identity of the individuals in the image (Ng et al. 2021). If all the features are found from the face, a sub-image may be constructed (Venkateswarlu, Kakarla, and Prakash 2020). A deep learning approach for face mask detection is presented (Snyder and Husari 2021). Image super resolution for detection of face mask is presented (Qin and Li 2020). There are a very limited number of facemask detectors installed in the crowded place. It is now very important to set up facemask detection to ensure the safety of the public.
Previously our team has a rich experience in working on various research projects across multiple disciplines (Venu and Appavu 2021; Gudipaneni et al. 2020; Sivasamy, Venugopal, and Espinoza-González 2020; Sathish et al. 2020; Reddy et al. 2020; Sathish and Karthick 2020; Benin et al. 2020; Nalini, Selvaraj, and Kumar 2020).The lacunae in the existing research are that there is a lack of accuracy in real time face mask detection techniques. The goal of this research is to improve the accuracy of real-time detection of face masks for pandemic control using a novel facemask detection system .

MATERIALS AND METHODS

This study was conducted in the Embedded System Lab, Department of Electronics and Communication Engineering at Saveetha School of Engineering. This project was done using Python IDE software. 15 samples are taken for each group with the total sample size of 30. G power is 0.8.

In the sample preparation for Group 1, Viola-Jones Object Detection algorithm is selected. 15 samples are taken from this group. Viola-Jones is powerful and proven to perform well in real-time face detection.

In the sample preparation for Group 2, Artificial Intelligence based facemask detection technique is used. It can be used for a variety of applications, but it focuses on deep neural network training and inference. 15 samples are taken from this group.
Python IDE software is used for the novel facemask detection for various values of frames per second and the corresponding accuracy values using Artificial Intelligence are noted down. The same process is followed for Viola-Jones method and accuracy values are noted down.

Statistical Analysis

The statistical software used in SPSS (Sanjaya and Rakhmawan 2020).The obtained values from the simulation tool are given to SPSS to calculate the average, standard deviation, and significance. In this research work, the independent variables are image sets and the face mask detection algorithms and the dependent variables are frames per second and accuracy.

RESULTS

The total sample size considering group 1 and group 2 is 30. Python IDLE is used for simulation. The independent t-test has been carried out and found that the accuracy (1.548) is higher than the Viola-Jones accuracy. Significance value is $p < 0.05$.
Figure 1 shows the real-time novel facemask detection using Artificial Intelligence algorithm. Figure 2 shows the comparison of accuracy per frames per second for Artificial Intelligence and Viola-Jones methods. Figure 3 shows the comparison of mean accuracy (+/- 1SD) for the group 1 (Artificial Intelligence) and group 2 (Viola Jones).The deep learning concept in Artificial Intelligence provides better accuracy than the Viola Jones method.

Table 1 shows the variation of frames per second values for the groups (Viola-Jones and Artificial Intelligence) and the corresponding accuracy. Table 2 shows the t-Test analysis results with mean and standard deviation of Artificial Intelligence and Viola Jones methods. Table 3 shows the Independent sample t-test shows statistical insignificance between Artificial Intelligences and Viola Jones.

DISCUSSION

The accuracy in the novel FaceMask detection based on Artificial Intelligence is compared with the Viola-Jones method. The independent sample t-test result shows that the accuracy in (%) is improved for the Artificial Intelligence-based face mask detection method with a mean (98.82) when compared with the Viola-Jones method (89.61) with a significance (p=0.007).

In face mask detection, the backbone techniques are machine learning and computer vision (Sethi, Kathuria, and Kaushik 2021). Face Mask Detection system uses an Artificial intelligence to recognize if a person captured on camera is wearing a mask or not (Sethi, Kathuria, and Kaushik 2021).This technology can be integrated into any existing or new IP cameras to detect people without a mask (Lazaro et al. 2021). If the camera captures a face without any mask, a notification can be sent out to the administrator (Barnawi et al. 2021).By utilizing a collection of multi stage detections of the pre-processing level, learning-based strategy is implemented for identifying masks over faces in public places to mitigate the spread of coronavirus is exhibited (Saravanan et al. 2022). In addition to face mask detection, social distancing is also monitored using the camera and an alarm is raised if the conditions are not satisfied (Saravanan et al. 2022) (Huang et al. 2016). The main constraint of Viola -Jones method is it needs full view of frontal faces (Tedjojuwono and Sulaiman 2021; Anthoniraj 2021). These limitations reduce the effectiveness of the algorithm but still they are acceptable (Loey et al. 2021b; Balasubramaniam 2021; Loey, Smarandache, and Khalifa, n.d.). AI based smart devices for face mask detection along with alert messages through mobile are presented (Barnawi et al. 2021). It is shown that the model trained with CNN, tenser-flow and keras algorithms provide 96% accuracy in face detection systems (Barnawi et al. 2021).

The limitations of face mask detection are the sensitivity to pose variations. Facial texture may change by head movement or different camera positions, resulting in inaccurate values.The implemented model will make a significant contribution to the public health care system. It could be extended in the future to ensure proper wearing of face masks.

CONCLUSION

This work focused to improve accuracy in face mask detection based on Artificial Intelligence compared with Viola-Jones method for Pandemic Control. The analysis shows that the accuracy in Artificial Intelligence-based Facemask detection is significantly better compared to the Viola-Jones method.

DECLARATION

Conflict of interest

No conflict of interest in this manuscript.

Author Contributions

Author RL was involved in sample set preparation, statistical analysis and paleograph. Author DS was involved in idealization, data declaration, concrete-suggestion, and structuring the report.

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Tables and Figures

Table 1. Variation of Accuracy for the groups (Viola-Jones and Artificial Intelligence) and the corresponding Frames per second values.

S.No	Group (Viola Jones)	Frames Per Second (FPS)	Accuracy (%)	Group (Artificial Intelligence)	Frames Per Second (FPS)	Accuracy (%)
1	1	100	77.61	2	100	92.2
2	1	120	78.61	2	120	92.7
3	1	140	81.77	2	140	94.74
4	1	160	82.6	2	160	90.11
5	1	180	81.2	2	180	90.26
6	1	200	76.2	2	200	94.71
7	1	220	78.8	2	220	95.56
8	1	240	79.9	2	240	97.86
9	1	260	64.88	2	260	94.84
10	1	280	82.2	2	280	94.2
11	1	100	86.8	2	100	90.41
12	1	120	87.77	2	120	97.86
13	1	140	86.21	2	140	96.8
14	1	160	76.2	2	160	94.87
15	1	180	79.21	2	180	98.8

TABLE 2. The t-Test analysis of Mean and Standard deviation of Artificial Intelligence and Viola Jones parameters.

	Group	N	Mean	Std. Deviation	Std.Error Mean
Accuracy	Viola-Jones	15	89.6120	2.41971	.62477

	Artificial Intelligence	15	98.8267	2.22190	.27614

TABLE 3. Independent sample t-test results that shows statistical insignificance between Artificial Intelligences and Viola Jones

Levene's Test for Equality of Variances				**t-test for Equality of Means**					**95% Confidence Interval of the Difference**	
F			Sig.	t	df	Sig (2-tailed)	Mean Difference	Std.Error Difference	Lower	Upper
Accuracy	Equal variances assumed	8.309	.089	-10.788	25	0.000	-13.06933	.68307	-15.55081	-10.58786
	Equal variance not assumed			-10.788	25.967	0.000	-13.06933	.68307	-15.55959	-10.57908

Fig. 1. Real-time novel facemask detection using Artificial Intelligence.This algorithm clearly detects faces with mask and without mask

Fig. 2. Comparison of accuracy per frames per second for Artificial Intelligence and Viola-Jones methods.There is a significant improvement in accuracy using the Artificial Intelligence based facemask detection compared to Viola-Jones method.

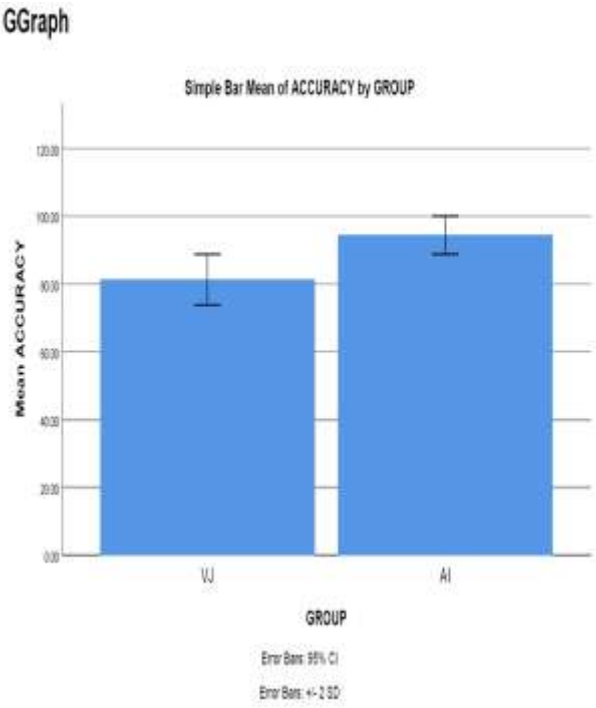

Fig. 3. Comparison of Mean Accuracy (+/- 1SD) for the group 1 (Viola Jones) and group 2 (Artificial Intelligence).The machine learning concept in Artificial Intelligence provides better accuracy than the Viola Jones method. X axis represents Groups 1&2 (Artificial Intelligence and Viola-Jones), Y axis represents mean accuracy with +/- 1 SD