BALTIC JOURNAL OF LAW & POLITICS
A Journal of Vytautas Magnus University
VOLUME 15, NUMBER 4 (2022)
ISSN 2029-0454

Cite: Baltic Journal of Law & Politics 15:4 (2022): 304-312
DOI: 10.2478/bjlp-2022-004032

Improving Accuracy in Face Mask detection based on Dlib in Raspberry Pi Compared with Viola-Jones method for Pandemic Control

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Received: August 8, 2022; reviews: 2; accepted: November 29, 2022.

Abstract

Aim: This project aims to Improve Accuracy in Face Mask detection based on Dlib compared with Viola-Jones method for Pandemic Control. **Materials And Methods:** Dlib based method and Viola-Jones method are chosen as two groups each 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 is improved for Artificial Intelligence-based methods with a mean (96.89) when compared with the Viola-Jones method (73.76) with a two tailed significance (p=0.007). **Conclusion:**The analysis shows that the accuracy in Dlib based facemask detection is significantly better compared to the Viola-Jones method.

Keywords

Deep Learning, Novel Facemask detection, Raspberry Pi, COVID-19, Dlib, Machine Learning.

INTRODUCTION

Hospitals and organizations can use a Face Mask Detection System to monitor and warn whether any visitors or personnel are wearing masks during their shift (Ouahab et al. 2021) .If a health professional is discovered without a mask, they will be notified and reminded to wear one, and visitors will be asked to do so as well (Winahyu, Wardihani, and Beta 2021). Also, if persons who are forced to wear a mask are quarantined, the system may keep an eye on them and detect whether they are wearing one, sending an automatic notification, or reporting to the authorities (Kumar and Pavan Kumar 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. 2021; 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. Thre are two steps in face recognition systems- detection and

identification of faces in the image (Kumar and Pavan Kumar 2021)**;** (Costa et al. 2021; Yuan et al. 2017). Viola-Jones approch detects full view -no occlusion, no head-turning, no rotation faces in images. This algorithm searched fpr several features and if found, a face in that image may be constructed (Niu and Chen 2018).The COVID-19 pandemic around the world has encouraged decision-makers and various elements of society to take part in various fields and contribute to suppressing the spread of COVID-19. Machine learning and computer vision are one of the branches of Artificial Intelligence (AI) and can be developed in various image recognition. (Jothi 2021; Saravanan et al. 2022a) (Nagrath et al. 2021). In this study, a machine learning Application Program Interface (API) was used, namely Tensorflow and the pre-trained CNN model, and the Raspberry Pi, which is a mobile device as a system for detecting masks.The analysis was conducted to determine the accuracy, precision and recall of the results of system implementation ((Oliva, Hassan, and Mohamed 2021).When the model is run on the Raspberry Pi device, an accuracy percentage of 96% is produced on testing with image file input and 91% on testing with video input (realtime), 100% precision on testing with image file input, and 80% on testing with video input (realtime). In the true positive rate (recall) performance, it was found 92% on tests with image file input and 100% on tests with video input (realtime) (Militante and Dionisio 2020). The quality of the dataset can be improved using higher computational resources (Ouahab et al. 2021).

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 real-time detection accuracy in order to create a novel face mask 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.

In the sample preparation for Group 1 Viola-Jones Object Detection algorithm is chosen with 15 samples. The benefits of using the Viola-Jones algorithm are high detection rate ,can distinguish faces from non-faces from arbitrary images, low false positives and applicable in real-time.

In the sample preparation for Group 2, Dlib is a free C++ library that implements machine learning methods such as classification, regression, clustering, data transformation, and structured prediction. 15 samples were collected from this material. Dlib is capable of detecting 68 distinct facial landmarks, including the chin and jawline, eyebrows, nose, eyes, and lips. Beyond crude face detection, facial areas can be extarcted based on those landmark points.

For the detection of face masks, there are only a few datasets available. The majority of them are either artificially created and do not accurately represent the real scenario. As a result, selecting the best dataset for the SSDMNV2 model took some time and effort. The proposed method uses a mix of open-source datasets and images, including data from Mikolaj Minkowski's Medical Mask Dataset on Kaggle and the Prajna Bhandary dataset on Pyimage Search.

Statistical Analysis

The statistical software used in SPSS (Huang et al. 2016). The obtained values in terms of accuracy is fed as an input to SPSS to calculate the mean, standard deviation, and significance. In this research work, the independent variables are the accuracy of Dlib and the convolutional neural network which detects a face in an image.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 mean accuracy (96.89) is higher than the Viola-Jones mean accuracy (73.76). Significance value is p = 0.007.

Figure 1 shows the image obtained by real-time novel facemask detection using Dlib. Figure 2 shows the image obtained by real-time novel facemask detection output using Dlib Raspberry Pi using the Dlib algorithm. Figure 3 shows the comparison of accuracy per frames per second for Dlib based method and Viola-Jones method. Figure 4 shows the comparison of mean accuracy (+/- 1SD) for the group 1 (Dlib based method) and group 2 (Viola Jones).The deep learning concept in the Dlib based method provides better accuracy than the Viola Jones method.

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

DISCUSSION

The accuracy in the novel FaceMask detection based on the Dlib is compared with Viola-Jones method. The independent sample t-test result shows that the accuracy in (%) is improved for the Dlib method with a mean (96.89) when compared with the Viola-Jones method (73.76) with a significance (p=0.007).

Raspberry Pi (Rpi) is designed as a System on Chip where all complex circuits are on a single circuit board (Winahyu, Wardihani, and Beta 2021; Pajankar 2020). Raspberry Pi is made accessible to hardware programming with GPIO pins (Brownlee 2019). Modules to interact using Wi-Fi to the internet are also available (Winahyu, Wardihani, and Beta 2021; Ajay 2021). RPi has pre-trained models and the Dlib locates 68 coordinates (x, y) that map the facial points on a individual face (Saravanan et al. 2022b; Howard 2021).The process takes 20 milliseconds to manually check defaulters (Brownlee 2019)(Saxena 2021).A Raspberry Pi-based face mask detector is presented in the work (Pawar et al. 2021)(Qin and Li 2020). By utilizing a collection of single and two-stage detections of the pre-processing level, a performed learning-based strategy for identifying masks over faces in open places to abridge the community spread of coronavirus is exhibited in this work (Gulbetekin, n.d.).

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.Future scope involves the additional measures to be considered for pandemic control like social distancing in addition to proper wering of face masks.

CONCLUSION

This work focused to improve accuracy in face mask detection based on Dlib in Raspberry Pi compared with Viola-Jones method for Pandemic Control. The analysis shows that the accuracy in Dlib 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.

Acknowledgment
The authors would like to express their gratitude towards Saveetha School of Engineering, Saveetha Institute of Medical and Technical Sciences (Formerly known as Saveetha University) for providing the necessary infrastructure to carry out this work successfully.

Funding
We thank the following organizations for providing financial support that enabled us to complete the study.
1. VK Technologies, Trichy.
2. Saveetha University
3. Saveetha Institute of Medical and Technical Sciences.
4. Saveetha School of Engineering.

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Tables and Figures

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

S.No	Group (Viola-Jones)	Frames Per Second (FPS)	Accuracy (%)	Group (Dlib)	Frames Per Second (FPS)	Accuracy (%)
1	1	100	88.36	2	100	97.55
2	1	120	88.65	2	120	97.85
3	1	140	87.99	2	140	98.26
4	1	160	83.69	2	160	99.5
5	1	180	86.45	2	180	99.8
6	1	200	70.23	2	200	98.57
7	1	220	83.64	2	220	98.65

8	1	240	87.36	2	240	98.14
9	1	260	87.33	2	260	98.53
10	1	280	80.55	2	280	98.68
11	1	100	82.35	2	100	94.56
12	1	120	89.38	2	120	96.53
13	1	140	89.65	2	140	98.62
14	1	160	88.66	2	160	98.11
15	1	180	79.36	2	180	98.65

Table 2. The t-Test analysis of Mean and Standard deviation of Dlib and Viola Jones parameters.

	Group	**N**	**Mean**	**Std. Deviation**	**Std. Error Mean**
Accuracy	Viola-Jones	15	73.7600	3.24667	.83829
	Dlib	15	96.8967	3.34733	.86428

Table 3. Independent sample t-test shows statistical insignificance (p=0.007) for Accuracy between Dlib and Viola Jones methods

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	.007	-13.490	28	0.000	-9.21467	.68307	-10.61387	-7.81546
	Equal variance not assumed			-13.490	19.269	0.000	-9.21467	.68307	-10.64300	-7.78633

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Fig. 1. Real-time novel facemask detection using Dlib

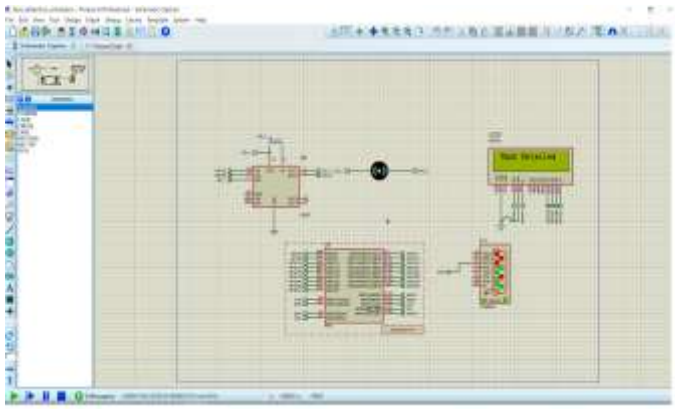

Fig. 2. Real-time novel facemask detection output with Raspberry-Pi using the Dlib algorithm.

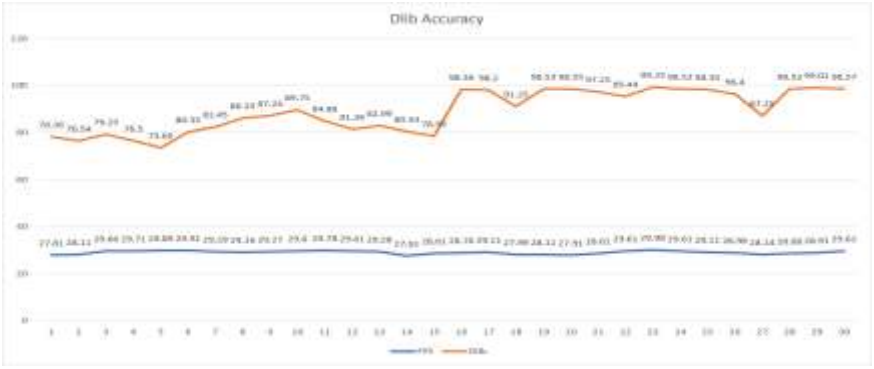

Fig. 3. The above graph is based on frames per second on the Raspberry Pi camera, which has a native resolution of 5 megapixels and a fixed focus lens onboard.

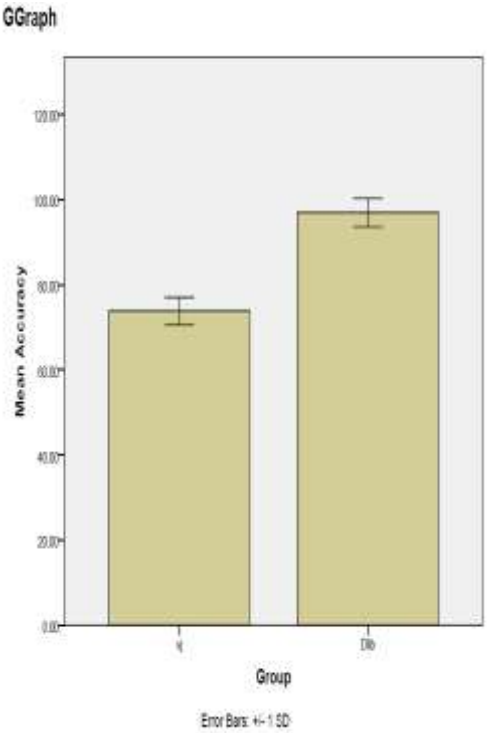

Fig. 4. Comparison of Mean Accuracy (+/- 1SD) for the group 1 (Viola Jones) and group 2 (Dlib).The pre-trained models with higher number of coordinates in Dlib provides better accuracy than the Viola Jones method. X axis represents Groups 1&2 (Artificial Intelligence and Viola-Jones), Y axis represents mean accuracy with +/- 1 SD