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Computer Vision Based Social Distancing Detection

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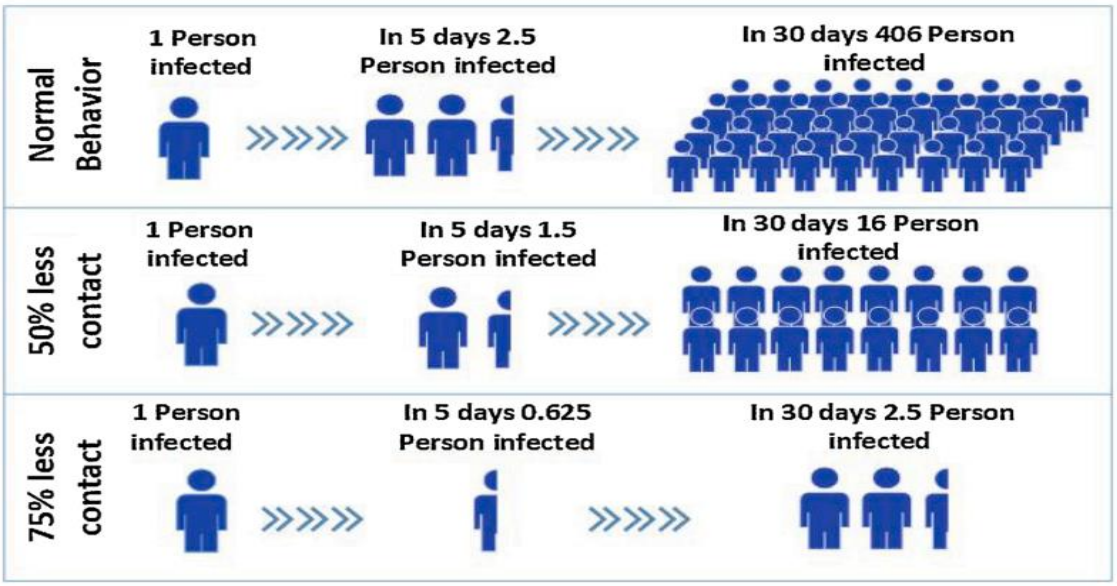
Abstract:- COVID-19 is a rapidly spreading viral disease which has challenged the health services of the world. Social distancing has been recommended as one of the best practice that helps to restrain the curve of COVID-19 virus. The effective measure of Social distancing has helped to decrease the transmission rate of the infectious COVID-19 worldwide.Furthermore, the lack of temporalunderstanding among the people may cause unintentional breach of the social distancing norms. Hence, it is necessary to bring in a vision based concurrent flow that will spot the social distancing violations. Social Distancing limits the physical contact among the people and by doing such, the danger of spreading COVID-19 can be decreased. The main objective of this proposed systemis to create a deep-learning system to detect social distancing to recognize persons in video sequences. The proposed system will employ YOLOv3 object recognition algorithm. The significance of this model is improvised through the transfer learning process. The pre trained algorithm is coupled with the trained layer which uses an additional data that will help in the detection process. The Euclidean distance is used to compute the pairwise distances of objects from the identified bounding box centroid while the bounding box information helps to identify the objects.A social distancing violation threshold will beset to examinewhether the distance value among the people exceeds minimal barrier that has been set for social distance. This work will define a social density value and show that pedestrian-density is heldunder the value defined. Thus thechance of a Social Distancing violation could be prevented.

I. INTRODUCTION

COVID-19 (Coronavirus disease) started from Wuhan, China was declared a pandemic,has spread to over 180 nations, resulting in 232,696,764 confirmed cases and 4,764,064 deaths worldwide as of September 26, 2021. The pandemic of COVID-19 has put a severe strain on the healthcare sector. Because many of the proposed medicines are still in various stages of clinical trials or are only approved for emergency use, clinical management now focuses on prevention, diagnosis, and supportive care for hospitalized patients. The population's vulnerability is exacerbated by the lack of effective treatment drugs and immunity to COVID-19. Due of the limited amount of vaccines available, social distance is one of the most viable strategies for combating the epidemic.

Coronavirus, which was first reported in Wuhan, China is dangerous disease that affects mostly human respiratory system. WHO (World Health Organization) named it as Coronavirus disease 2019, shortly named COVID-19 on February 12, 2020.In comparison to the already known SARS (Severe Acute Respiratory Syndrome) and MERS(Middle East Respiratory Syndrome), the COVID-19 is highly infectious disease. Moreover, it can spread through droplets and be easily transmitted between human beings, even with the minimal contact, and spread through asymptomatic virus carriers.Approximately 27 crore people have been infected by COVID-19 pandemicall around the world. Cough, fever, and lung inflammation are all symptoms of the virus, which potentially leads to acute respiratory distress syndrome.The common symptoms of coronavirus are fever, cough and dyspnea. The condition has the potential to induce deadly consequences in those who are susceptible, particularly the elderly with comorbidities. Early detection of the disease can enable individual patients receive treatment more quickly and allow for more appropriate isolation, which will manage the sick person and prevent the virus spread quickly and prevent infection.



"Fig. 1: Social Distancing Importance"

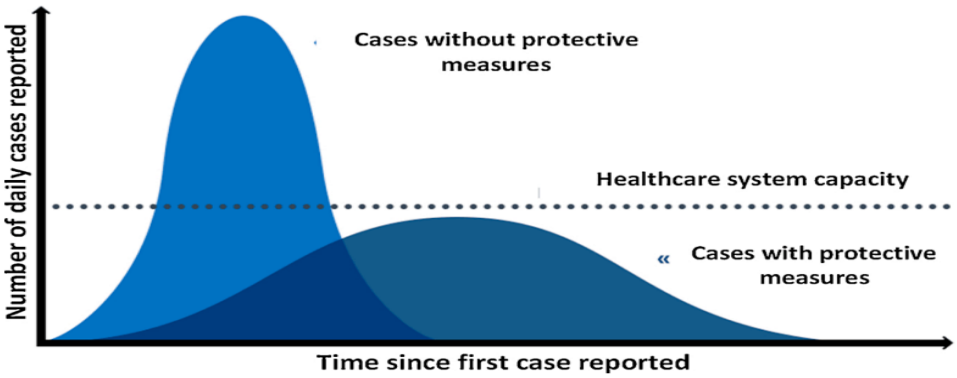


Fig. 2: Social Distancing Outcomes: the curve of COVID-19 cases is declining and being compatible with available health care capacity

The effective measure of Social distancing has helped to decrease the transmission rate of the infectious COVID-19 worldwide. Social distancing involves reducing person-to person contact by enforcing a minimum physical distance among people inpublic places, usually 2 meters and generally reducing public gatherings. When it is implemented, social distance can help to decline the transmission of the COVID-19 and prevent the pandemic disease from reaching its peak. Ultimately, this measure will bring down the death percentage by making sure that the total no.ofactive cases will not surpass the community healthcare system's capabilities.

However, such requirements are contrary to long-practiced human behavior. Hence, automated and non-intrusive solutions that assist in social distancing compliance can be useful in this time. Computer vision, deep learning, and machine learningtechniques have showed promise in a variety of real-world situations during the last few decades. Deep learning has recently improved, making object detection more effective. Computer vision (CV)-based solutions are well-suited for the automated monitoring of social distancing compliance. Technological solutions to monitor social distancing compliance need to satisfy certain criteria to justify the benefits of their implementation.

The distance between people will be determined using clustering and distance-based techniques. Distance calculation between the peoplewith an overhead perspective will result in a superior distance estimate and bigger coverage of the scene if a top-down method is used, i.e. an overhead perspective view approach.

Here, an overhead view will be used to establish asuccessful framework that will monitor the social distance among peoples. The above perspective has a widerarea of view, andremoves occlusion issues, thriving to make it suitable for monitoring social distancing and calculating the distances among people. The objective of this work is to develop system that will help to monitor social distancing based on deep-learning method. A deep learning method named You Only Look Once - YOLOv3 is utilized to recognize people in the crowd. To test the existing model, an overhead data set is used (which has been pre trained on normal/ frontal view data set). Transfer learning algorithm will help in increasing the accuracy of the detection model.

The detection model will detectthe humans and provide theinformation related to bounding box. Using the centroid information of the bounding box that has been detected, the Euclidean distance among every centroid pair is determined following the human being detection.Using pixel to distance assumption, a preset minimum social distance violation criterion will be created. Then, the estimated data will be compared to the violation threshold so that the calculated distance is inside the violation set or not. The bounding box's color will be originally set to green. However, the bounding box's color will change to red if it is in the violation set. To track if someone has crossed the social distance threshold, the centroid tracking approach will be used.

The objectives ofthe proposed systemare given below:

- Provide a deep learning based social distance monitoring framework which will use an overhead view perspective.
- To use a pre trained version of YOLOv3 to recognize humans and compute the bounding box centroid information. Additionally, apply transfer learning method to increase the model's efficiency.
- An overhead data set is used for the additional training, and the layer that has beentrained newly will be added to the method that has previously been trained.
- To track the social distance among the people, the distance among every pair of the centroid of the identified bounding box is approximated using the Euclidean distance. Also, using a pixel to distance calculation, social distance breach threshold will be set.
- To keep track of an individual, a centroid tracking approach will be employed who crosses the social distance requirement.
- Determine how the pre trained YOLOv3 on overhead data set performs. The result from the detection framework would be evaluated in both approach: with and without transfer learning.

This has paved the way for deploying an active monitoring system like this necessitates careful ethical considerations as well as intelligent system design. In this regard, a fully convolutional machine learning system, for example, a deep neural network which is not having any of the feature based input space is far more equitable, with one discretion: have equitable training data distribution.

II. RELATED WORK

Few related deep learning based human detection research has been discussed in this section. The process of localization and categorization of its shape in the video footage, the detection of human being can be considered as object detection process in computer vision field. “Nguyen et al. has provided anin-depth study of the state of the art in current developments and the problems that occurs in the detection of human being [14].”Machine learning techniques,Human descriptors, real-time detection and occlusion are all covered in the survey. On a variety of image recognition benchmark approaches based on deep convolutional neural networks (CNN) have been proven to outperform others [15]. The CNN model, which is most suitedin feature learning approaches and robust in detecting the objects in many situations, was one-off the categories in deep learning for object detection in images.Deep learning have neural network structure that helps to self-construct object descriptors helps in increasing its effectiveness in object recognition and learn high-level properties that aren't directly presented in the dataset.

Even in the near future, it is quite difficult to completely eliminate COVID-19, however an automated system for tracking the infected person and assessing social distancing measures would be extremely beneficial to us. Pedestrian Detection: The pedestrian detection isgenerally considered in two ways: (i) as a sub-task of normal object detection (ii) as a separate task that will be dedicated solely to detect the pedestrians. Here, we will find a thorough examination of 2D object detectors,the datasets as well as the metrics and basics that go with them.YOLO, SSD, and EfficientDet are some of the most popular models. The detectors can be divided into two categories: anchor-based and anchor-free techniques.

The existing state of the art object detectors having deep learning model have itsown benefits and dis benefits in aspect of speed and accuracy. Within an image, the item may have various spatial locations as well as the aspect ratios. Hence as an outcome, the real time object detection algorithm and methods based on the Convolutional Neural Network model, such as YOLO and R-CNN, has been generatedto acknowledge multi-classes in distinct regions of images. With aspect to both speed and accuracy, YOLO is most popular deep CNN based object identification algorithm.

The distance between people will be determined using clustering and distance-based techniques.A deep learning approach named YOLOv3 (You Only Look Once v3) will be used to recognize humans.The detection model will detect the humans and provide us the bounding box information. To determine the Euclidean distance amongall of the recognized centroid pair, detected bounding box and its centroid informationwill be used after thedetection of humans.

III. PROPOSED MODEL

To determine the distance among people and ensure safety among the people, the proposed system is suggested using the deep structured learning technique, and Python Language.The distance among the people will be determined using clustering and distance-based techniques. The overhead perspective distance will result in a proper distance estimate and provide an extensive coverage of the largeview.

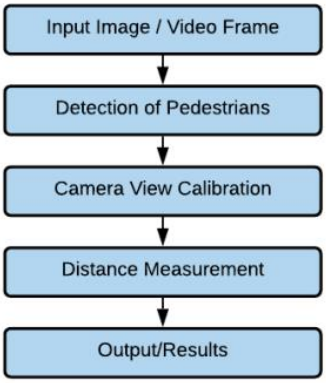


Fig. 3: Workflow of proposed system

This systemis developed using the YOLOv3 model, which is based upon the concept of deep learning techniques, computer visionand convolutional neural networks. The person in the image or frame will be detected using YOLOv3. A deep learning method named YOLOv3 (You Only Look Once) is utilized to recognize humans. To test the already existing model, an overhead data set is used (which has been pre trained on normal/frontal view data set). Transfer learning will be used to increase the accuracy of the detection model, transfer learning is used.The proposed model will detect the humans and provide us the bounding box information. Furthermore, using the centroid information of the bounding box, the Euclidean distance among every centroid pair is determined. Apreset minimum social distance breach criterion would be created using the pixel to distance assumptions. The estimated data will then be compared to the violation threshold that has been set to determine if the calculated distance is inside the violation set or not. The bounding box's color has been originally set to green; however, the bounding box's color will be changed to red if it is in the violation set. The centroid tracking approach will also used to track someone who has crossed the social distance threshold.

IV. MONITORING SOCIAL DISTANCE

This system introduces a deep learning based social distance monitoring framework with an overhead perspective view approach.The collected overhead data set is then split up into two groups: testing and training. Humans in sequences are detected using a deep learning-based detection methodology. “Krizhevsky, Sutskever, and Hinton (2012), Simonyan and Zisserman (2014), Girshick, Donahue, Darrell, and Malik (2014), Szegedy et al. (2015), Girshick (2015), Ren, He, Girshick, and Sun (2015)” are some of the object detection models available (2015). YOLOv3 (Redmon & Farhadi, 2018) will be applied in this work since it has the greatest performance results for general object detection.

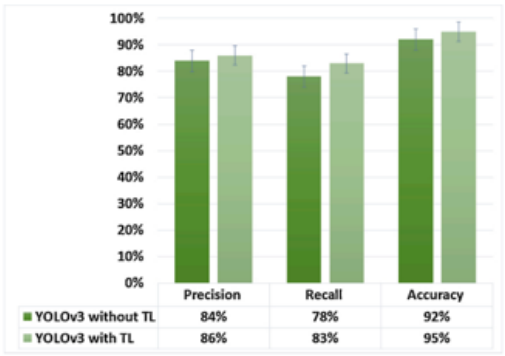


Fig.4: Precision, Recall, & Accuracy of model (YOLOv3) with and without transfer learning

With an overhead perspective, this paper will provide a deep learning based social distance monitoring method. Individuals in sequences are detected using a deep learning-based detection methodology. Object detection models come in a range of shapes and sizes. YOLOv3 is chosen in this study since it has the good performance result for normal object detection. To determine the class probabilities and the bounding boxes, this model will use a single stage network design.

To boost detection model's efficiency, transfer learning will be implemented, and to the existing architecture a new layer of overhead training for overhead view person recognitionwill be added. Each bounding box centroid distance will be calculated utilizing bounding box information, primarily centroid information, after detection.To compute the distance amongevery human bounding box that will been identified, the Euclidean distance will be used. Following the centroid distance calculation, a specified threshold will be used to see if the distance between any of the two bounding box centroids is less or equal to the composedno. of pixels.A centroid tracking technique will be employed for tracking, which will help to identify those who break or violate thethreshold that has been set for social distancing. The resultfrom the proposed system displays total no. of social distancing violations as well as the found persons bounding boxes and centroids.

V. PROPOSED WORK RESULTS AND DISCUSSION

The details of the different experiments that will be carried out using the proposed model and approach to detect the social distance monitoring is mentioned here. To monitor the social distance, a dataset that contains the video frames obtained from overhead view. The collected data will be partitioned into 30% for testing whereas 70% for training. No restriction would be put on the movement of the individuals all around the scene. Humans in the video frames can move freely; however their visual might get effected by the radial distance and camera’s position. The appearance of the individual are not identical as the height, color, pose and the scales of the human keeps on differing in the data set. Open cv will be using for the implementation of the proposed system. Then, the overall result from the experiment will be segmented into two parts: firstly the pre

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trained model testing result will be analyzed and then result of the detection model will be discussed after the application of the transfer learning algorithm on the overhead dataset in the second section.

VI. SOCIAL DISTANCING MONITORING RESULT USING PRE TRAINED MODEL

The testing result of social distancing framework will be visualized using a pre trained model and using the different video sequences, the results of testing will be evaluated. Human in the video can be seen having free movement in the scenes. The visual appearance of individual will not be uniform to the side view or the frontal view. The proposed model in this paper will only consider human class; hence, only those objects which have appearance like human will be identified by the pre trained model in the system. The pre trained model will deliver principled result and detect different size individual bounding boxes.Many individual are entering in the scene and people can move freely in the video. To check if any individual in the video breaches the social distance or not, the distance among every identified bounding box is calculated after the detection of individual.

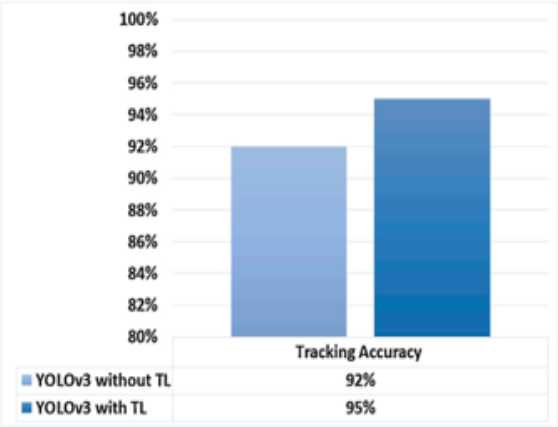

Fig.6: Tracking accuracy with pre-trained and trained YOLOv3 detection model

VII. SOCIAL DISTANCING MONITORING RESULT USING TRANSFER LEARNING ALGORITHM

Transfer Learning Algorithm helps to increase the accuracy and efficiency, hence we will be using the transfer learning algorithm to improvise the efficiency of detection model. Overall result of the experiment shows that transfer learning improves detection outcomes significantly. The model will be detecting individuals at different locations of the scene. Individuals having different characteristics can be identified effectively and the distance among the people can also be computed.All the people entering and walking in the video frames are detected and monitored using the proposed system. Whenever, social distance among the people is violated, the framework will be detecting the violating effectively and will be marking the bounding box as red if the individuals are near to each other.

S. no.	Model	True detection rate	False detection rate
1.	Fast-RCNN (pre-trained)	90%	0.7%
2.	Faster-RCNN (pre-trained)	92%	0.6%
3.	Mask-RCNN (pre-Trained)	92%	0.5%
4.	YOLOv3 (pre-trained)	92%	0.4%
5.	YOLOv3 (trained overhead data set)	95%	0.3%

"Table: Comparison results of YOLOv3 with other deep learning models."

VIII. CONCLUSION

A method for analysis of social distance between the people is put forward in this paper. The system uses the deep learning and computer vision technique. Computer Vision will help to calculate the distance between each person and it will help in monitoring the social distancing. An overhead perspective view approachwill be used to show social distance monitoring methodbased upon deep learning. The pre-trained YOLOv3 paradigm is used for the identification of human. An individual's size, shape, visibility, appearance, scale, and posture varies substantially while viewing from top view. Therefore, the transfer learning process is applied so that it enhances the performance of the pre trained model. After training on an overhead data set, the freshly trained layer is attached to the previous model.

A deep learning based detection paradigm uses the transfer learning algorithm to monitor the social distance. Bounding box information, including centroid coordinates, is provided by the detection model. For the computation of centroid distance in pair, the Euclidean distance is used among the identified bounding boxes.A red bounding box will be displayed if any group of people is deemed to be violating the minimum acceptable threshold value. Alreadyfilmed video of people on a busy street is used in the proposed system.The proposed technology can calculate the distance among the two people. The patterns of social distancing is categorized and identified as: "Safe" and "Unsafe" distance.

REFERENCES

[1.] Yang, D.; Yurtsever, E.;Renganathan, V.; Redmill, K.A.; Özgüner, Ü. "A Vision-Based Social Distancing and Critical Density Detection System for COVID-19".Sensors 2021, 21, 4608. https://doi.org/10.3390/s21134608

[2.] Narinder Singh Punn, Sanjay Kumar Sonbhadra and Sonali Agarwal, "Monitoring COVID-19 social distancing with person detection and tracking via fine-tuned YOLO v3 and Deepsort techniques"

[3.] Sreetama Das, Anirban Nag, DhrubaAdhikary, Ramswaroop Jeevan Ram, Aravind BR, Sujit Kumar Ojha, Guruprasad M Hegde, "Computer Vision-based Social Distancing Surveillance Solution with Optional Automated Camera Calibration for Large Scale Deployment", Corresponding author:

sreetama.d2005@gmail.com ORCID: 0000-0002-4523-8915, * equal contribution

[4.] Cong T. Nguyen, YurisMulyaSaputra, Nguyen Van Huynh, Ngoc-Tan Nguyen, Tran Viet Khoa,Bui Minh Tuan, Diep N. Nguyen, Dinh Thai Hoang, Thang X. Vu, ErykDutkiewicz, SymeonChatzinotas, and Bjorn Ottersten, "A Comprehensive Survey of Enabling and Emerging Technologies for Social Distancing Part I: Fundamentals and Enabling Technologies" DOI: 10.1109/ACCESS.2020.3018140 and "A Comprehensive Survey of Enabling and Emerging Technologies for Social Distancing Part I: Fundamentals and Enabling Technologies" DOI: 10.1109/ACCESS.2020.3018140

[5.] G V Shalini, M Kavitha Margret, M J Sufiya Niraimathi, S Subashree, "Social Distancing Analyzer Using Computer Vision and Deep Learning", To cite this article: G V Shalini et al 2021 J. Phys.: Conf. Ser. 1916 012039

[6.] C. Courtemanche, J. Garuccio, A. Le, J. Pinkston, and A. Yelowitz, "Strong social distancing measures in the united states reduced the covid-19 growth rate: Study evaluates the impact of social distancing measures on the growth rate of confirmed covid-19 cases across the united states." Health Affairs, pp. 10–1377, 2020.

[7.] D.T. Nguyen, W. Li, P.O. Ogunbona, Human detection from images and videos: A survey, Pattern Recognition, 51:148-75

[8.] SafaTeboulbi ,SeifeddineMessaoud ,Mohamed Ali Hajjaji , and AbdellatifMtibaa, "Real-Time Implementation of AI-Based Face Mask Detection and Social Distancing Measuring System for COVID-19 Prevention" Article ID 8340779, https://doi.org/10.1155/2021/8340779

[9.] Mahdi Rezaei, Mohsen Azarmi, "DeepSOCIAL: Social Distancing Monitoring and Infection Risk Assessment in COVID-19 Pandemic" doi: https://doi.org/10.1101/2020.08.27.20183277

[10.] Alexey Bochkovskiy, Chien-Yao Wang, Hong-Yuan Mark Liao, "YOLOv4: Optimal Speed and Accuracy of Object Detection" https://www.researchgate.net/publication/340883401

[11.] Sonali Agarwal, Narinder Singh Punn, Sanjay Kumar Sonbhadra, P. Nagabhusahan, PraveerSaxena, "Unleashing the power of disruptive and emerging technologies amid COVID 2019: A detailed review", https://www.researchgate.net/publication/341639677

[12.] Yew Cheong Hou, Mohd Zafri Baharuddin, Salman Yussof, Sumayyah Dzulkifly, "Social Distancing Detection with Deep Learning Model"

[13.] Yilun Wang, Yuqing Zhang, Kim Bennell, Daniel Kenta White, Jie Wei, Ziying Wu, Hongyi He, Shaohui Liu, Xianghang Luo, "Physical Distancing Measures and Walking Activity in Middle-aged and Older Residents in Changsha, China, During the COVID-19 Epidemic Period: Longitudinal Observational Study" https://www.jmir.org/2020/10/e21632/

[14.] D.T. Nguyen, W. Li, P.O. Ogunbona, "Human detection from images and videos: A survey", Pattern Recognition, 51:148-75, 2016.

[15.] Krizhevsky, I. Sutskever, G.E. Hinton, "Imagenet classification with deep convolutional neural networks", In Advances in neural information processing systems, pp. 1097-1105, 2012.

[16.] S.Amudha, M.Murali, 2020,'Deep Learning based energy efficient novel scheduling algorithms for body-fog-cloud in smart hospital', Journal of Ambient Intelligent Humanized Computing, https://doi.org/10.1007/s12652-020-02421-0

[17.] M.Murali, 2015,' Principal Component Analysis based Feature Vector Extraction', Indian Journal of Science and Technology, 8(35), 1-4

[18.] M.Murali, Shreya Sharma, Neel Nagansure,2020, 'Reader and Object Detector for blind', ICCSP, July 28-30, INDIA

[19.] M.Murali, SimranKourAwal, Kabir Singh Sethi,2020, 'Detection and Classification of white blood cell cancers', International Journal of Advanced Science and Technology, 29(7), 937-943