Istanbul Medipol University

School of Engineering and Natural Sciences

Graduation Project

2022-2023

PROJECT TITLE
Social Distancing and Face Mask Detector
FACULTY ADVISOR
Prof. Dr. Reda ALHAJJ
TEAM MEMBERS
Didem GÜRLER Mehmet Alp SARIDAYI

Project Code

Istanbul Medipol University
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Project Title: Social Distance and Face Mask Detector
Faculty Advisor: Prof. Dr. Reda ALHAJJ
Project Team Members: Didem GÜRLER and Mehmet Alp SARIDAYI
Sponsor Company (if any):

BUDGET (TL)	PROPOSED	CONSENTED
IMU FUNDING	25.000TL	22.000TL
SPONSOR COMPANY FUNDING	30.000TL	22.000TL
TOTAL	55.000TL	44.000TL

PROJECT PLAN	PROPOSED	CONSENTED
PROJECT PLAN	04.03.2022	11.03.2022
STARTING DATE	05.03.2022	11.03.2022

Project Code

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ADVISOR	DEPARTMENT CHAIR
Name: Prof. Dr. Reda ALHAJJ	**Name:** Assoc. Prof. Mehmet Kemal ÖZDEMİR
Contact Information: Tel: - E-mail: ralhajj@medipol.edu.tr	**Contact Information:** Tel: +90 (216) 681 5626 E-mail: mkozdemir@medipol.edu.tr
Signature:	**Signature:**

TEAM MEMBER	TEAM MEMBER
Name: Didem GÜRLER	**Name:** Mehmet Alp SARIDAYI
Contact Information: Tel: +90 538 767 5223 E-mail: dgurler@std.medipol.edu.tr	**Contact Information:** Tel: +90 535 645 5640 E-mail: mehmet.saridayi@std.medipol.edu.tr
Signature:	**Signature:**

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PROJECT OVERVIEW/SUMMARY/ABSTRACT

Because of the Covid-19 pandemic observed in the globe and in our country for the last two years, many rules and prohibitions have been introduced. These rules are the mask, social distancing, and hygiene rule. In this project, persons who contravene the mask and observe the rule of social distancing and oppose these rules was be identified. Our goal in the project is to detect violations committed by Computer Vision and monitoring in real time using Deep Learning techniques such as MobileNetV2, ResNet50 and YOLOv5 to see the spread of this virus and whether people comply with social distancing and wear face masks as part of this pandemic.

In this research, we created a system that makes use of CCTV and thermal cameras to estimate social distance and identify face masks. For object detection, we've integrated the TensorFlow framework, OpenCV, and the YOLO (You Only Look Once) method. The YOLO algorithm is used to identify the people in the image after it has been taken by the thermal camera, processed by OpenCV to identify them, and measured the distance between them. To ensure precise recognition of people, mask use, and social distance, we tested the system after training the model with a thermal picture dataset. We worked independently on three different topics to come to this conclusion.

Firstly, we completed our work on Mask detection and we can summarize our steps as follows.

1) Faces that were both masked and unmasked in an image dataset were gathered.
2) Using the coordinates of the bounding boxes around the faces and labels indicating whether a mask is present, a YOLO model was trained on the annotated dataset.
3) Identify faces in fresh photos and extract the bounding box coordinates and accompanying mask labels using the trained YOLO model.

4) The output was processed to produce the final detection finding and visualization.

Secondly, we completed the social distance detection in our project and followed it with the following steps.,

1) Yolov4 was our model of choice for people detection in images, and we trained it with TensorFlow and Mobile Net V2 on the COCO dataset.
2) The most important factor for us in determining distance was calibrating the cameras at different angles, and we did this assuming the camera position was fixed and the background was stable, the front We decided to position the four corner points (a road or ground) on the ground in the processing stage, and then after the selected corner points were taken, their coordinates were ordered, then the transformation matrix (M) was obtained using OpenCV's getPerspectiveTransform() function.

3) According to our research, humans are typically between 152 and 182 cm tall. As a result, the pixel equivalent of this circumstance is roughly 80 pixels, hence 80 px was chosen as the minimum distance.
4) Finally, the social distance between the people was measured by calculating the Euclidean distance between the defined people using the fast and advanced python modules numpy and scipy.

The project's last step involved utilizing Yolov4 to train the datasets we had gathered for social distance estimation on the thermal images and getting our model to the point where it could also identify in the thermal image.

Keywords: social distancing rule, masks, detector, Deep Learning, OpenCV, MobileNetV2, ResNet50, YOLOv5, CNN

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BUDGET PROPOSED– (TL)

	ITEMS				
	PEOPLE	MACHINE-INSTRUMENT	MATERIALS	SERVICE	TRAVEL
IMU FUND	22.000 TL	5.000TL	500TL	1.500TL	-
SPONSOR COMPANY FUND	22.000 TL	5.000TL	500TL	2.000TL	-
TOTAL	44.000 TL	10.000TL	1.000TL	3.500TL	-

BUDGET APPROVED– (TL)

	ITEMS				
	PEOPLE	MACHINE-INSTRUMENT*	MATERIALS*	SERVICE	TRAVEL
IMU FUND	21.000 TL	5.000TL	500TL	1.500TL	-
SPONSOR COMPANY FUND	21.000 TL	5.000TL	500TL	2.000TL	-
TOTAL	42.000 TL	10.000TL	1.000TL	3.500TL	-

Within the project period (4 months), the required budget for the two-person fee and materials provided

1. OBJECTIVE OF THE PROJECT:

Nowadays, approximately over six million people have died and continue to lose their lives due to the corona virus in the world and in our country. However, the fast expand of this virus all over the globe has led to a health crisis in all countries. The World Health Organization and much more have found that serious recommendations on wearing a face mask at home with a curfew and quarantine in many countries are placed in crowded environments together, which slow down and reduce social distance to avoid the fast expand of this virus. Although, there is a vaccine against this virus today, we should still pay attention to masks and social distancing to avoid contracting this virus and protect public health. Our goal in this project is to detect the spread of this virus and the violations committed by tracking in real time whether people comply with social distancing and wear a face pack within the scope of this pandemic using Computer Vision and Deep Learning techniques such as MobileNetV2, ResNet50 and YOLOv5.

2. LITERATURE REVIEW:

This article describes the measures taken against social distance and face mask violation during the COVID-19. According to the article, a Dual Shot Face Detector (DSFD) and a MobileNetV2 based dual classifier were used for contact detection, mask detection, and distance measurement. The system should be evaluated using a video dataset labeling method. [1]

In this article, the researcher focused on the corona virus in the world and the aim of this article is detecting the social distance and face mask with using YOLO and CNN algorithms with using CCTV footages.[2]

The general problem mentioned in this article is to record the data formed by measuring the close between two and more individuals with cameras, forgetting the rule of social distancing that people have formed due to the Covid-19 virus. This article describes a system that, in general, deciphers the neglected distance between deep learning and people, detects it with cameras and records the measured data.[3]

Wearing masks and maintaining a social distance of at least two meters are some of the precautions attempted to prevent the Corona virus from spreading. According to the article, a system has been developed that can perform snapshot analysis during the neglect of these rules. It is a system that sends alerts to the relevant centers when there are parties, concerts, meetings when it is out of the rule.[4]

The aim of this study was to indicate how a real-time system for human detection, monitoring, and substantiation works. To achieve their goal, the system combines various computer vision algorithms, such as a human detection algorithm, an object following method, and a motion analysis method, to deliver a solid performance. [5]

Researchers provide an overview of object detection frameworks based on deep learning, and their review provides us with very useful information about the history and representative tool of deep learning, namely Convolutional Neural Network.[6]

In this article researcher's main aim is making a social distance and mask detector that can be applied in various areas and, also the technique used which is CNN models training with ResNet-50 and MobileNet. And for the dataset they used present dataset which contains 3835 images with 1916 wearing mask and 1919 not wearing mask.[7]

A sequantial classifier and a pre-trained CNN including two layers of 2D convolution coupled to thick layers of neurons are offered by researchers working on the project. For the dataset part they tested whether there was a mask only from the front view and that a standard mask was used as a mask type. Out of 1,376 images of 1,690 people, it was seen that only 686 people were not wearing masks. In the second data set, on the other hand, it takes a face view from all angles and the display of other types of masks has been tested.853 images have been studied.[8]

In this article we can clearly see the different techniques that is InceptionV3.The researchers uses the MobileNetV2 for the main model for person detection and, also with calculating Euclidean distance between persons and they used the InceptionV3, trained and tested with dataset which name Simulated Masked Face Dataset. With this algorithm they achieved the accuracy up to %99,9 when they are training model.[9]

When we check another research at this topic which is the detection of the face masks with using the Deep Learning methods and some Computer Vision methods. The researcher used OpenCV for image processing and for the deep learning TensorFlow, Keras and PyTorch were used to train MobileNetV2. The certainty of the mask and without mask testing was between %87 and %95.[10]

In this project, the suggestion of researcher is a feature pyramid network-based single-stage detector. A comparison of Resnet and MobileNet was also presented in the article. The training precision of ResNet with ImageNet pre-train was found to be much more than 10% of MobileNet in both face and mask detection.[11]

In this article, YOLO which is trained in deep learning, was used in mask detection. As a result of the experiments used here, people were used as subjects. Thanks to the experiments with YOLO, accurate and fast results were obtained. As a result of this experiment and article, it was determined that the application will be used in many fields.[12]

In the project mentioned in this article, human faces are detected using TensorFlow and OpenCV methods and these faces are taken into the bounding box to see if the face is masked. When the detected faces are stored in the database, it then gives an alarm with the person's name when they are not using the mask properly. This application can be used in schools at work.[13]

This article, we talked about how to determine gender when using a face mask. There are two main problems with the inability to determine gender when using masks. One of them is the inadequacy of the dataset, the other is the lack of facial cues from masked areas. In this article, ResNet50 and GoogLeNet, which are deep learning networks, are pre-trained with big data.[14]

In this article, we proposed MaskHunter, a high-performance face mask detector optimized specifically for the night environment, based on the YOLOv4 model. Using MaskHunter's powerful detection capability, fast, good, and real-time detection can be performed on videos. MaskHunter has been found to perform better compared to other models. The night mask detection resolution is more.[15]

This article, research has been carried out on a face mask detection detector with a thermal imager. During the experiments, it was tested on multiple deep learning models, but the best result was obtained from the YOLOV3 model. With YOLOV3, data was obtained faster and with less error rate. It is necessary to have thermal camera images for the data set. It can also be used in thermal camera images of models that we have trained with photos taken in visible light.[16]

As a result of the research, a report on the measurement of social distance using a thermal imager was presented. Deep learning model which is the YOLOV4 model is trained. It has been mentioned that more efficient results are obtained when combining YOLOV4 with a thermal imager. It has been observed that it is easier to measure the distance to inanimate objects with a thermal imager. Here, results were obtained with a bird's-eye view, and the experiments detected pedestrians who followed the distance rules indoors and outdoors.[17]

Batagelj, B, and his colleagues proposed ways to test the model by incorporating a dataset for mask identification in their research. They also gave a comparison of previous studies and suggested various design techniques that may be applied to improve the model's performance.[18]

The study looked at various attempting to use deep learning techniques that could increase the model's accuracy and precision, as well as aid the mask detection process by employing bounding boxes to identify whether a face is masked or not in real time. [19]

A run-time facial mask detection system was proposed by the researcher using CNN which Convolutional Neural Networks and Computer Vision techniques. In the cause of a Covid-19 epidemic, face masks are essential. The suggested model converts an RGB image to a grayscale image by image pre-processing. The CNN deep learning construction is used to determine whether individuals are wearing masks. As a result, the training accuracy is 98.7%, and the testing accuracy is 0.98 units. This method assisted in dealing with the pre-processing component of model training. However, there is room for improvement in terms of improving the photos used in the training phase. Normalization, edge detectors, and sharpening are some of the methods that can be used. [20].

In this article, he describes that he compares influential object detectors based on deep learning, in the last of which, Deciphering people in public spaces and measuring the distance between them, the YOLO V4 model achieves faster and clearer results than other models. [21].

Researchers revealed effective methods for social distance monitoring using deep learning techniques in the article we just read. Additionally, researchers developed a system for identifying and tracking people using the YOLOv3 with Deep sort algorithm; they used an Open Image Data set repertory. The researchers also looked at outcomes from different deep learning methods.[22].

3. ORIGINALITY:

In this project, school, classroom, office, etc. We also planned to find the person who violated the rules in certain areas, such as. We have developed a system that we can use on different cameras as well. With this system we have produced, people who break the rules can also be seen in open areas. Warnings can be sent to the relevant police stations for a more crowded environment.

4. SCOPE OF THE PROJECT AND EXPERIMENTS/METHODS:

In this project, a face mask and a social distance tracking device have been developed to prevent the spread of coronavirus or any kind of epidemic. It is a program that processes the video or live broadcast according to the rules of social distancing and face mask and gives a signal to the observer.

- First of all, we needed data to determine social distancing and face mask rules. Datasets were used throughout the Kaggle and datasets obtained from our own images were used.
- YOLO or OpenCV face recognition and person detection feature were used.
- To detect the masks on the face, different algorithms were used to Decipher the distance between different people, the biggest point that makes these algorithms different is the accuracy rate.
- Secondly, the work done on the data we receive is divided into two, and these are Face recognition and person detection.
- Then the necessary algorithms were used to make these determinations, for example, YOLO or OpenCV face detection and person detection.
- After detecting the Face and the Person, they are Deconstructed among themselves from these steps.

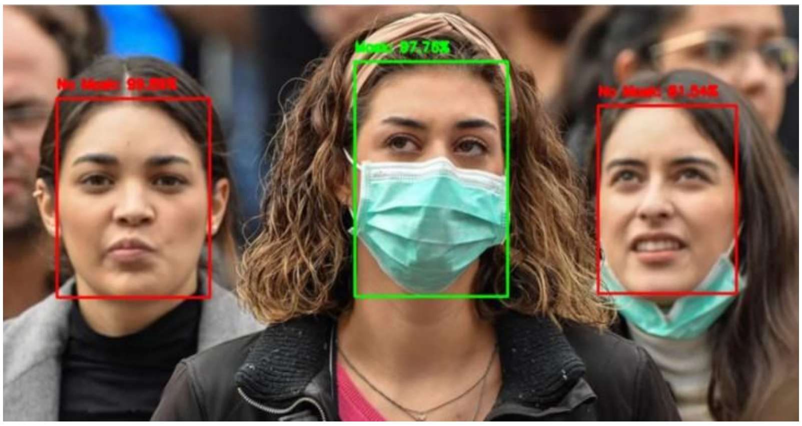


Figure 1: Face masks detection

The system we planned in our project, all visual documents, for example live camera images, were transferred to evaluate the videos recorded at the beginning. Then, if the inputs are suitable for the system, you can activate the YOLOv3 or YOLOv5 system, and the bounding boxes for people and faces have been created. After all, different algorithms are used to Decipher the face and determine the social distance between people. Thus, if the people at the entrance wore masks and maintained social distance, they were seen in a green box on the screen, if they did not comply with these conditions, images of people were obtained in a red box on the screen *(Figure 1)*

As we have seen in our research so far, a Convolutional Neural Network (CNN) has been used for face detection. This is due to the fact that CNN can work with high accuracy even at low resolution. This is also a plus compared to other models. We have also added the Mobile Net V2 model to our system to achieve higher accuracy. We can take the output we obtained into the face limiter box, then we have successfully performed the face detection, we will send this output to the model we will use for mask detection.

Figure 2: Detection for Social Distancing

We thought of using a Single-Shot Multi-Box Detector (SSD) included in the Mobile Net V2 architecture for face mask detection. With the help of Mobile Net V2, we have obtained a fast and highly accurate model for mask detection. In addition, our research has a higher accuracy rate compared to the R-CNN and YOLOv 3 models.

Although we have determined some models according to the researches we have done so far, these models may differ according to the results of the tests we have done. *(Figure2)*

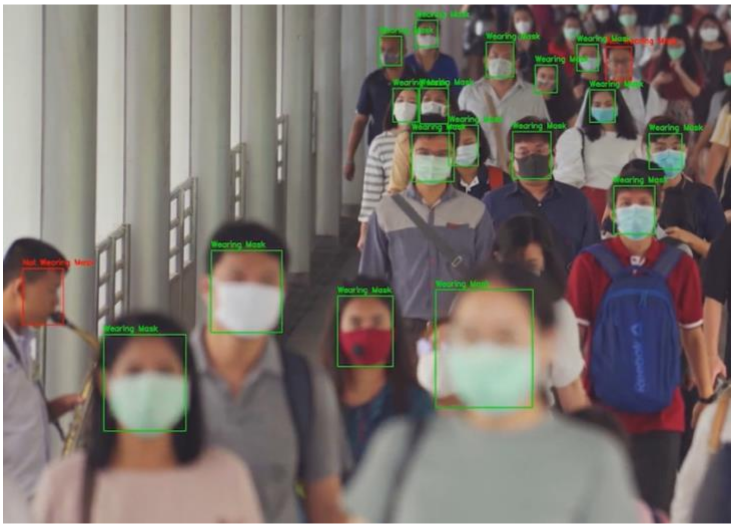


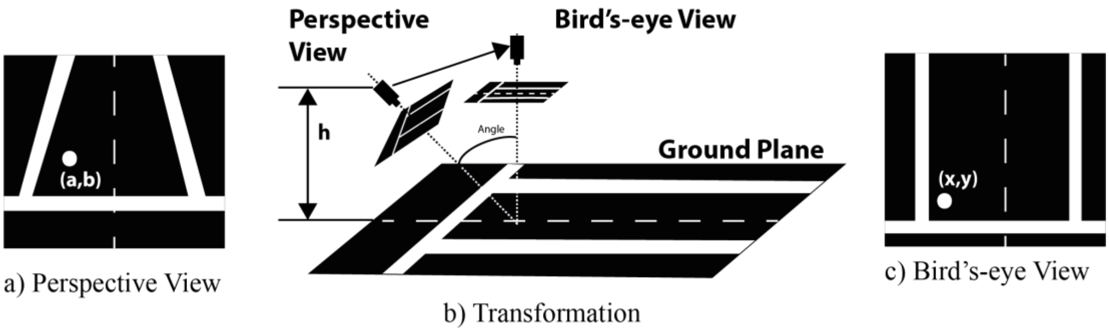
Figure 3: Mask detection in a crowded environment

In the part of our project so far, we have worked on 3 important topics and these topics are Real time pedestrian detection, calibration and determining social distance violation, respectively.

- **Real Time Pedestrian Detection**

We have previously discussed various algorithms for detecting people, such as YOLO, R-CNN and SSD. At the moment we have chosen yolov4 and used the COCO dataset to train our model using TensorFlow and Mobile Net V2. To increase the processing speed in the future, we thought about implementing MobileNet, which uses the TensorFlow framework and includes MobileNetV3 and SSD.

- **Calibration**



The right coordinates of a quadrilateral, onto which the picture frame is warped, can be chosen to transform the image frame from viewpoint to a top-down (or bird's eye) view. Street ways, the floor, or the ground are possible targets for this. The only factor used for calibration is the background of an image. As a result, if the background view transforms, the quad-points also change, which causes the calibration transformation matrix to change.

The simplest method is to locate four corner-points (of a road or floor) on the ground in the pre-processing stage, supposing that the camera location is fixed and that the background is as well.

Figure 4: The only factor used for calibration is the background of an image.

The primary calibration factor is the conversion matrix. After taking the selected corner points, their coordinates were sorted, then the getPerspectiveTransform () function of OpenCV was used to obtain the transformation matrix (M). Used the mapping function to distort the entire image frame:

$$dst(x,y) = src(\frac{M_{11}x + M_{12}y + M_{13}}{M_{31}x + M_{32}y + M_{33}}, \frac{M_{21}x + M_{22}y + M_{23}}{M_{31}x + M_{32}y + M_{33}})$$

Figure 5: The primary calibration factor is the transformation matrix (x, y) is references for the image coordinates

The positions of the identified people were calibrated according to their corresponding positions in the distorted image or in the "bird's eye view grid" using the transformation matrix. MIN_ DIST is used to calculate the minimum required social distance. The height of a person Decays from 152.4 to 182 cm. In addition, we must maintain a social distance of 150 cm. By subtracting the median height of the individuals from the output of the pedestrian detector, this height was defined as MIN_DIST. However, when used for distance violation detection, this height was calibrated.

- **Determining Social Distance Violation**

The brute force method involves calculating all possible pairs' Euclidean distances and identifying any that exceed the limit. The quick and sophisticated python modules numpy and scipy can be used to accomplish this with easily.

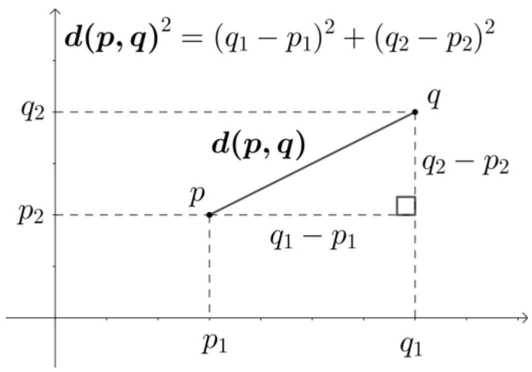


Figure 6: Euclidian Distance

5. PROJECT TARGETS AND SUCCESS CRITERIA:

For the project we needed a dataset to train our model, so it is important and contributed 5 percent to our project. Secondly, we needed to process our data to get better accuracy in the training model, he contributed 15 percent to the project. We were able to choose the DL and CV Methods to use and implement them in our code, contributing 15% to the project. Measuring the performance of our algorithm is one of the most important components of the project, accounting for 15% of the total. The most important aspect of the project is to train and test our model before the result is obtained; its contribution to the project was 20%. Finally, with our project we are able to detect social distancing and face mask violation, thus we have achieved a 25% contribution.

Work packages	*Overall, Success*
Literature Review	%5
Getting dataset	%5
Data Processing	%15
Determine the CV and DL Methods to be used	%15
Measuring the Performance of Algorithm	%15
Testing and training the model	%25
Detect the violations	%25

6. RISKS AND B PLANS:

We have such a risk in the project and we think some solutions to eliminate this risks and we applied into our project. Firstly obtaining a sufficiently large and diversified dataset that accurately depicts the real-world scenario is one of the biggest dangers in data collection. We came up with a solution to this problem by collecting as much data as possible, including data from various places and all kinds of people. Second risk is to overfit the model to the training data, which can lead to poor performance on new data. The solution to this risk would be to use techniques such as cross validation and regularization to avoid overfitting. Also the model may be biased if the data is not diverse enough, leading to poor performance on certain groups of people. The solution to this risk would be to ensure that the data is diverse and representative of the population. It is crucial to take into account the model's ethical implications and potential for misuse. Making sure the model is used for its intended purpose and limiting access to the model will both mitigate this risk.Lastly our model may not perform well in real-world scenarios because it has not been tested in a variety of different conditions. The solution to this risk would be to test the model in different lighting conditions and environments.

7. FINANCIAL EVALUATION:

Two people are working on the face mask and Social Distancing Detector project. For this reason, materials such as two laptops, chargers, two mice, cameras, connection cables, thermal imagers are required. Consequently, the required budget is about 22.000TL.

8. RESULTS:

Before creating a deep learning model for Mask Detection, we applied data preprocessing, which is a data set divided into two sequences, masked and unmasked. After that, using Tensorflow, we loaded the images from the directory and set the target size as a resolution of 224x224 pixels, better accuracy was achieved in the model. After uploading the image, we converted the images into array forms with the target size, then added these data and tags to the arrays. After processing the images, we sent this to the images to the MobileNet layer. After that, we have images sent to the maximum pool layer, fully connected layer and output. MobileNet is much faster than CNN, so we used Mobilenet to compile our model. We also used Open-Cv's subnet called FaceNet for facial recognition.

The proposed model underwent 20 iterative rounds of training with Spyder in a Python environment. Additionally, it had accuracy ratings of 96.67% on the validation set and 99.04% on the training set. The suggested model was evaluated on a test set as well, and the results showed 98.30% accuracy with 0.122 loss. Figure 7 also depicts how the model behaved after being trained using the validation set. Additionally, Figure 7's accuracy-period graph demonstrates that accuracy rises with age. As a result, it can be said that the model both does well on different datasets and performs effectively while learning from training data.

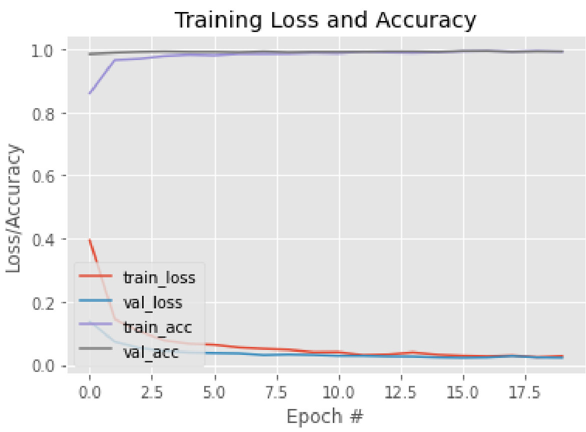


Figure 7: Training Loss and Accuracy of the model

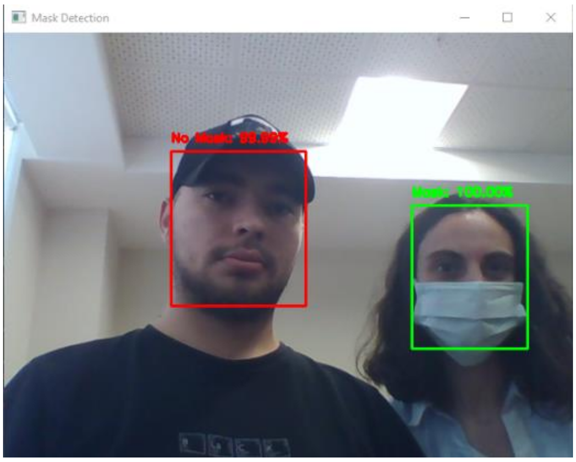


Figure 8: Face Mask Detection Output

Also, we added another functionality our project which is gender detector. We also applied similar steps as a face mask detector. Thus, we can see the results of the training and the preliminary result of the gender detection.

Figure 9: Training Loss and Accuracy of the model

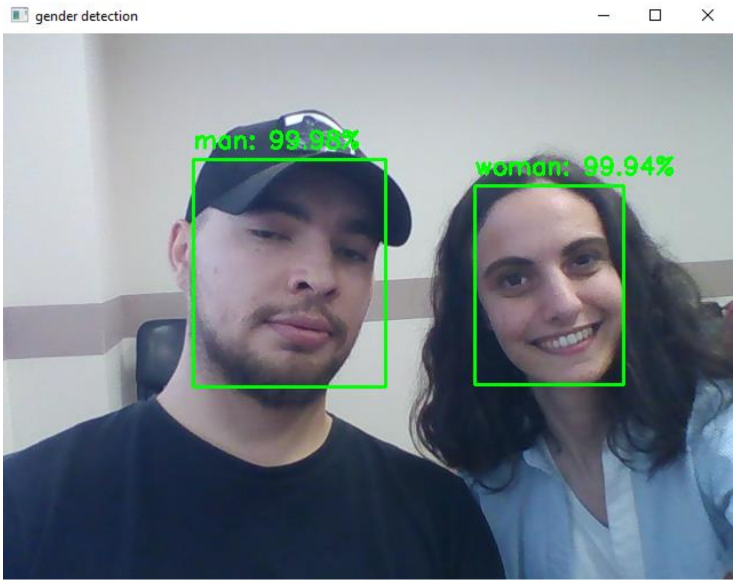


Figure 10: Gender Detection Output

As a result, research has been conducted in the literature mainly related to the mask detector and the social distance detector. In our preliminary studies, MobileNet, a mask-sensing deep learning model, was trained. As a result of the trained model, Figure 5 was obtained. Since we have encountered a gender-detection model in the articles we have researched, our studies on the gender-detection model have been created and we had output successfully. *(Figure 10).*

For the second part of this project, we completed our first attempt with using the methods which we explained on the Methodology part and in here we can see the results of some test which is done by us.

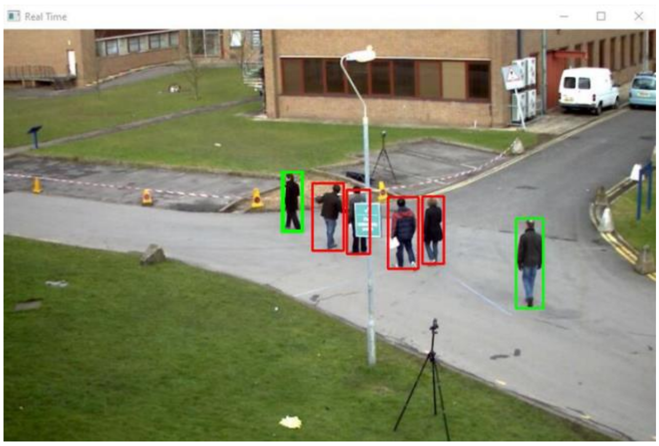


Figure 11: Social Distance Monitoring

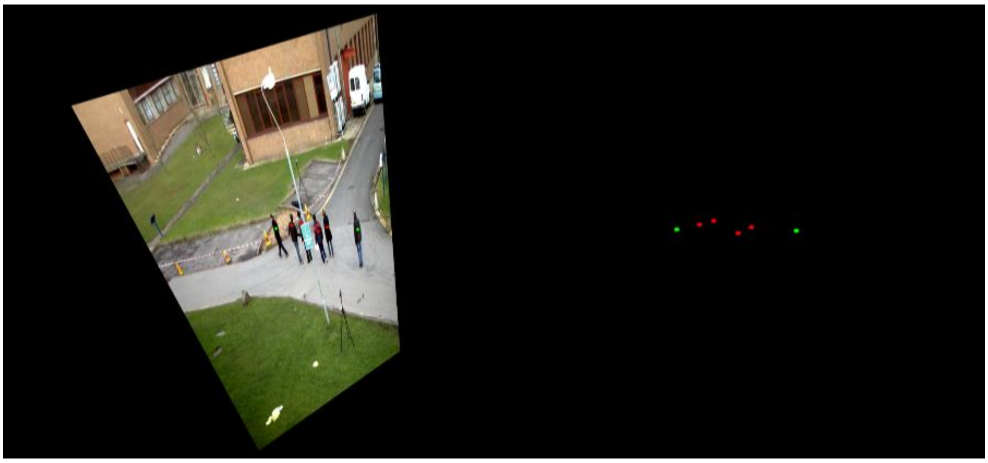


Figure 12: Warped frames and locating peoples in bird's-eye view

In the picture of the top, we can see the visualization of the deterministic of social distance, at the left side there is a warped frame from the calibrated data and at the right side we can find people in a bird's eye perspective and add them as dots points in a black box using calibrated data. Red dots represent the violations and green dots mean is safe distance from the other pedestrians.

Figure 13: Distance Detection on Thermal Images

In the remaining portion of our project, we completed training the model for our project using a thermal image dataset and YOLO V5. However, we were unable to test the model on real time images as we did not have access to a thermal camera. The detection process can be seen in the figures of thermal images of people. *(Figure 13 and Figure14).*

Figure 14: Distance Detection on Thermal Images

9. DISCUSSION:

The expected outcome of our project, which includes a face mask detector and a social distance detector, is a model that can identify individuals who are not following mask- wearing regulations and measure the distance between people to ensure it is at least two meters. We were successful in achieving this goal for our face mask detection and social distance measurement. Additionally, we were able to perform thermal image processing and detection of people using a thermal camera. However, we noticed that the gender detection and mask detection, which we aimed to include in our project, had insufficient resolution at long distances and resulted in errors when used in conjunction with distance measurement. We believe this is since it is easier to detect the entire body rather than just the face, as the human face appears small in comparison to the body when viewed from a distance. As a result, our system is unable to detect faces at a far distance.

10. CONCLUSION:

The subject of our project is a Face Mask and Social Distance Detector. Through research and experimentation, we have completed our project. We developed this detector by training a MobileNet deep learning model using the TensorFlow, Keras and YOLO framework. The system can identify individuals who are wear masks and maintain proper social distancing, and display them in a green frame, while individuals who do not wear masks and violate social distancing are shown in a red frame. Additionally, we trained a model to work with thermal images and instant thermal camera images using a thermal image dataset, however, this model has not yet been fully tested with live imaging as we do not have access to a thermal camera. We have only been able to test this using stock video footage. As a result, we attempted to detect masks in the snapshots at the same time, but as we have discussed in the discussion section, we did not achieve optimal results due to quality of the snapshots and the distance of the individuals from the camera. In the future, we anticipate that our project will achieve better performance with the advancements in artificial intelligence and image processing. Furthermore, our frame per second (FPS) rate was low when processing images in real-time with the current computer power we have, but we expect that by using GPU processing, we can significantly increase these values. Ultimately, this project has the potential to be developed into a model that can be used in various public settings such as streets, parks, schools, workplaces, shopping malls, and concert halls.

11. PLAN FOR FUTURE STUDIES

To continue researching this topic, one possible next step would be to improve the performance of the model by incorporating more data and fine-tuning the model for different environments. Another approach could be to compare the performance of the thermal and normal cameras under different lighting conditions, and determining which camera provides better results in different scenarios. Additionally, studying the impact of different environmental factors (e.g. lighting, camera angle, etc.) on the model's accuracy could be beneficial. Additionally, expanding the model to detect other safety measures, such as the use of gloves or hand sanitizer could be explored. Finally, exploring other similar models that could be used to detect social distancing, such as ultrasonic sensors or lidar could be interesting.

12. REFERENCES

[1] Rujula Singh R, Nikhil Nayak, Sahana Srinivasan, Ruchita R Biradar, “COVID-19 Monitoring System using Social Distancing and Face Mask Detection on Surveillance video datasets”, Department of Computer Science and Engineering R.V. College of Engineering,2020, https://arxiv.org/pdf/2110.03905.pdf

[2] G. V. Shalini, M Kavitha Margret, M J Sufiya Niraimathi and S Subashree, “Social Distancing Analyzer Using Computer Vision and Deep Learning” *Published under licence by IOP Publishing Ltd, Phys.: Conf. Ser.* 1916 012039, 2021, https://iopscience.iop.org/article/10.1088/1742-6596/1916/1/012039

[3] Yew Cheong Hou, Mohd Zafri Baharuddin, Salman Yussof, Sumayyah Dzulkifly “Social Distancing Detection with Deep Learning Model”, 2020 8th International Conference on Information Technology Abd Multimedia (ICIMU), 20152567, 2020, https://ieeexplore.ieee.org/abstract/document/9243478

[4] Shashi Yadav, "Deep Learning based Safe Social Distancing and Face Mask Detection in Public Areas for COVID-19 Safety Guidelines Adherence", *covid-19 safety*, 10.22214/ijraset.2020.30560,2020, https://www.researchgate.net/publication/343346690_Deep_Learning_based_Safe_Social_Distancing_and_Face_Mask_Detection_in_Public_Areas_for_COVID-19_Safety_Guidelines_Adherence

[5] Mohammed E. Hussein, W. Abd-Almageed, Yang Ran, Larry S. Davis "Real-Time Human Detection, Tracking, and Verification in Uncontrolled Camera Motion Environments", *Computer Vision Systems*, 2006 ICVS '06. IEEE International Conference on, https://www.researchgate.net/publication/4215591_RealTime_Human_Detection_Tracking_and_Verification_in_Uncontrolled_Camera_Motion_Environments

[6] Hidefumi Takahashi, Shintaro Ishiwata, Ryuji Okazaki, Yukio Yasui, Ichiro Terasaki, "Enhanced thermopower via spin-state modification", PACS numbers: 75.30.-m, 72.20. Pa, 74.62.F,2018. https://arxiv.org/pdf/1807.0551

[7] Safa Teboulbi, Seifeddine Messaoud, Mohammed Ali Hajjaji, Abdellatif Mtibaa, "Real-Time Implementation of AI-Based Face Mask Detection and Social Distancing Measuring System for COVID-19 Prevention", Scientific Programming, vol.2021, Article ID 8340779,21 pages,2021. http://doi.org/10.1155/2021/8340779

[8] A. Das, M. Wasif Ansari and R. Basak, "Covid-19 Face Mask Detection Using TensorFlow, Keras and OpenCV," *2020 IEEE 17th India Council International Conference (INDICON)*, 2020, pp. 1-5, doi: 10.1109/INDICON49873.2020.9342585. https://ieeexplore.ieee.org/document/9342585

[9] K S Pavan Krishna, Harshita S, Nayan Deep, Gautham M G, "Social Distancing and Face Mask Detection Using Deep Learning". International Journal of Innovative Science and Research Technology, Volume 6, Issue 6, June – 2021 https://ijisrt.com/assets/upload/files/IJISRT21JUN471.pdf

[10] Vinitha V. "COVID-19 Facemask Detection with Deep Learning and Computer Vision." International Research Journal of Engineering and Technology. Volume: 07 Issue: 08 Aug 2020 https://www.irjet.net/archives/V7/i8/IRJET-V7I8530.pdf.

[11] Jiang M, Fan X. "RetinaFaceMask: A Single Stage Face Mask Detector for Assisting Control of the COVID-19 Pandemic" Computer Vision and Pattern Recognition (cs.CV), IEEE SMC 2021, https://arxiv.org/abs/2005.03950

[12] K. Bhambani, T. Jain and K. A. Sultanpure, "Real-time Face Mask and Social Distancing Violation Detection System using YOLO," *2020 IEEE Bangalore Humanitarian Technology Conference (B-HTC)*, 2020, pp. 1-6, doi: 10.1109/B-HTC50970.2020.9297902. https://ieeexplore.ieee.org/abstract/document/9297902

[13] H. Adusumalli, D. Kalyani, R. K. Sri, M. Pratapteja and P. V. R. D. P. Rao, "Face Mask Detection Using OpenCV," *2021 Third International Conference on Intelligent Communication Technologies and Virtual Mobile Networks (ICICV)*, 2021, pp. 1304-1309, doi: 10.1109/ICICV50876.2021.9388375.

[14] Md. Mahbubul Islam, Nusrat Tasmim and Joong-Hwan Baek, "Gender Prediction from Masked Face Images using Deep Learning towards Smart Store Customer Management", *Department of Electronics and Information Engineering, Korea Aerospace University, Goyang 10540, Korea.* https://www.researchgate.net/publication/350106387_Gender_Prediction_from_Masked_Face_Images_using_Deep_Learning_towards_Smart_Store_Customer_Management

[15] Zhihao Cao, Mingfeng Shao, Li Xu, Shaomin Mu, Hongchun Qu, "MaskHunter: Real-time Object Detection of Face Masks During the COVID-19 Pandemic", 23 February 2021 http://doi.org/10.1049/iet-ipr.2020.1119

[16] Natalia Glowacka, Jacek Ruminski, "Face with Mask Detection in Thermal Images Using Deep Neural Networks", *Department of Biomedical Engineering, Faculty of Electronics, Telecommunications and Informatics, Gdansk University of Technology, Narutowicza 11/12, 80-233 Gdansk, Poland*, 21 September 2021, https://www.mdpi.com/1424-8220/21/19/6387/htm

[17] Saponara, S., Elhanashi, A. & Zheng, Q. "Developing a Real Time Social Distancing Detection System Based on YOLOv4 tiny and Bird-eye view for COVID-19". *J Real-Time Image Proc* 19, 551–563 (2022). https://doi.org/10.1007/s11554-022-01203-5

[18] Batagelj B, Peer P, Štruc V, Dobrišek S. "How to Correctly Detect Face-Masks for COVID-19 from Visual Information?", Applied Sciences. 2021;11(5):2070. https://dx.doi.org/10.3390/app11052070.

[19] Singh S, Ahuja U, Kumar M, Kumar K, "Face mask detection using YOLOv3 and faster R-CNN models: COVID-19 Environment.", Multimedia Tools and Applications. 2021;80(13):19753–19768. https://dx.doi.org/10.1007/s11042-021-10711-8.

[20] M. M. Rahman, M. M. H. Manik, M. M. Islam, S. Mahmud, and J.-H. Kim, "An Automated System to Limit COVID-19 Using Facial Mask Detection in Smart City Network," *2020 IEEE International IOT, Electronics and Mechatronics Conference (IEMTRONICS)*, 2020, pp. 1-5, doi: 10.1109/IEMTRONICS51293.2020.9216386. https://ieeexplore.ieee.org/document/9216386

[21] Sangeeta Yadav, Preeti Gulia, Nasib Singh Gill, and Jyotir Moy Chatterjee, "A Real-Time Crowd Monitoring and Management System for Social Distance Classification and Healthcare Using Deep Learning", *Volume 2022 | Article ID 2130172 | https://doi.org/10.1155/2022/2130172*

[22] Narinder Singh Punn, Sanjay Kumar Sonbhadra, Sonali Agarwal, Gaurav Rai, "Monitoring COVID-19 social distancing with person detection and tracking via fine-tuned YOLO v3 and Deepsort techniques", *[Submitted on 4 May 2020, last revised 27 Apr 2021 (this version, v4)], https://arxiv.org/abs/2005.01385*

Istanbul Medipol University

School of Engineering and Natural Sciences

Graduation Project

2022-2023

PROJECT ACTIVITIES AND WORK PLAN

Work and Activity	**Responsible Group Member**	**Timeline**													
		1. Week	2. Week	3. Week	4. Week	5. Week	6. Week	7. Week	8. Week	9. Week	10. Week	11. Week	12. Week	13. Week	14. Week
1.Literature Review	Didem M. Alp			X	X	X	X	X							
2.Identifying the basic the CV and DL	Didem M. Alp					X	X	X							
3.Getting Dataset	Didem M. Alp								X	X	X	X	X		
4. Data Processing	Didem M. Alp								X	X	X	X	X		
5. Measuring the Performance of Algorithm	Didem M. Alp								X	X	X	X	X		
6. Testing and Training the model	Didem M. Alp										X	X	X	X	X
7.Detect Violations	Didem M. Alp													X	X

Figure 15: For Project 1 Project Activities and Work Plan Table

Istanbul Medipol University

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Graduation Project

2022-2023

PROJECT ACTIVITIES AND WORK PLAN

Work and Activity	**Responsible Group Member**	**Timeline**													
		1. Week	2. Week	3. Week	4. Week	5. Week	6. Week	7. Week	8. Week	9. Week	10. Week	11. Week	12. Week	13. Week	14. Week
1.Literature Review	Didem M. Alp		X	X											
2.Identifying the basic the CV and DL	Didem M. Alp		X	X	X										
3.Getting Dataset	Didem M. Alp			X	X										
4. Data Processing	Didem M. Alp			X	X	X	X	X	X	X	X	X	X	X	X
5. Measuring the Performance of Algorithm	Didem M. Alp			X	X	X	X	X	X	X	X	X	X	X	X
6. Testing and Training the model	Didem M. Alp			X	X	X	X	X	X	X	X	X	X	X	X
7.Detect Violations	Didem M. Alp			X	X	X	X	X	X	X	X	X	X	X	X

Figure 16: For Project 2 Project Activities and Work Plan Table

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LIST OF WORK PACKAGES

WP No	Detailed Definition of Work and Activity
1	Literature Review
2	Getting dataset
3	Data Processing
4	Determine the CV and DL Methods to be used
5	Measuring the Performance of Algorithm
6	Testing and training the model
7	Detect the violations

Work package	Target	Measurable outcome	Contribution to overall success (%)
1	Literature Review		%5
2	Getting dataset		%5
3	Data Processing		%10
4	Determine the CV and DL Methods to be used		%15
5	Measuring the Performance of Algorithm		%15
6	Testing and training the model		%25
7	Detect the violations		%25
			Total:100

WORK PACKAGE DISTRIBUTION							
Project Member	WP1	WP2	WP3	WP4	WP5	WP6	WP7
Didem	50	50	50	50	50	50	50
M. Alp	50	50	50	50	50	50	50
Total	100	100	100	100	100	100	100