

# FACE MASK DETECTION

Using Machine Learning and Deep Learning



Affiliated to GGSIP University, New Delhi  
Approved by AICTE & Council of Architecture

## Project Report

### Submitted By

Name	Enrollment No
Saiyam Jain	41218002717
Mayank Goyal	35118002717
Deepak Singh	42918002717
Abhishek Aswal	43318002717

### Under the guidance of

Ms. Upasna Joshi

Assistant Professor

Department of Computer Science & Engineering

Delhi Technical Campus

## **Declaration By the Students**

We student(s) of B.Tech in Computer Science & Engineering branch of Delhi Technical Campus hereby declare that the project entitled **“Face Mask Detection using Machine Learning and Deep Learning”** which is submitted by us to Department of computer science and engineering, delhi technical campus, Greater Noida, in partial fulfillment of requirement for the award of the degree of Bachelor of Technology in Computer Science And Engineering, has not been previously formed the basis for the award of any degree, diploma or other similar title or recognition.

The Authors attest that permission has been obtained for the use of any copy righted material appearing in the Dissertation / Project report other than brief excerpts requiring only proper acknowledgement in scholarly writing and all such use is acknowledged.

### **Name of the Student(s)**

Saiyam Jain

Mayank Goyal

Deepak Singh

Abhishek Aswal

Place – **Greater Noida**

Date – **08-June-2021**

## **CERTIFICATE OF ORIGINALITY**

On the basis of declaration submitted by **Saiyam Jain, Mayank Goyal, Deepak Singh, Abhishek Aswal**, student(s) of B.Tech(CSE), I hereby certify that the project titled “**Face Mask Detection using Machine Learning and Deep Learning**” which is submitted to, DELHI TECHNICAL CAMPUS, Noida, in partial fulfillment of the requirement for the award of the degree of Bachelor of Technology in Computer Science and Engineering, is an original contribution with existing knowledge and faithful record of work carried out by him/them under my guidance and supervision.

To the best of my knowledge this work has not been submitted in part or full for any Degree or Diploma to this University or elsewhere.

Date: 08-June-2021

Ms. Upasna Joshi

(Name and Signature of Guide)

Department of Computer Science & Engineering

Delhi Technical Campus, Greater Noida

## ACKNOWLEDGEMENT

Firstly, we would like to express our special thanks of gratitude to our teacher and guide Ms. Upasna Joshi who gave us the golden opportunity to do this wonderful project on the topic "Face Mask Detection using Machine Learning and Deep Learning ", which also helped us in doing a lot of Research and gain knowledge about many new things. She encouraged us to work on this project and we are really thankful to her. We are also grateful to our college for giving us the opportunity to work with them and providing us the necessary resources for the project. We are immensely grateful to all involved in this project as without their inspiration and valuable suggestion it would not have been possible to develop the project within the prescribed time.

## **CONSENT FORM**

This is to certify that we Saiyam Jain, Mayank Goyal, Deepak Singh and Abhishek Aswal, students of B. Tech CSE of 2017-2021 presently in the VIII Semester at DELHI TECHNICAL CAMPUS, Greater Noida give our consent to include all our personal details, for all accreditation purposes.

Saiyam Jain - 41218002717

Mayank Goyal - 35118002717

Deepak Singh - 42918002717

Abhishek Aswal - 43318002717

Place – **New Delhi**

Date – **08-June-2021**

### **DECLARATION FORM (Health, Safety & Plagiarism)**

We, students of B. Saiyam Jain, Mayank Goyal, Deepak Singh and Abhishek Aswal, batch 2017-2021, Department of Computer Science and Engineering, Delhi Technical Campus, GGSIP University, New Delhi, hereby declare that we have gone through project guidelines including policy on health and safety, policy on plagiarism etc.

Date: 8Th June'2021

Name and Signatures of the Students

Saiyam Jain

Mayank Goyal

Deepak Singh

Abhishek Aswal

## **TABLE OF CONTENT**

Sr. No.	Content	Page No.
1	INTRODUCTION	8
2	LITERATURE SURVEY	9
3	BACKGROUND STUDY	11
4	METHODOLOGY	14
5	RESULTS	16
6	TEST OUTPUTS	18
7	LIMITATION & FUTURE WORK	19
8	CONCLUSION	20
9	REFERENCES	21

## **INTRODUCTION**

Corona Virus was originated in Wuhan, China at the end of 2019. Since then, it has been spreading like a wild fire in a forest. Millions have been affected and around 37,96,473 have unfortunately passed away as on 08th of June 2021, almost a year since this virus came to existence. People who have this illness can take up to 2 weeks to cure, with the risk of having to suffer additional medical problems caused by it. Children and old people have proved to be at the highest risk to contract the disease, which may even result in death. Hence, it has been made a priority to contain the virus than to cure it. The virus spreads through the air, transmitted by one person to another not only by touch, but also by speaking and coughing. The concern was put forward to WHO(World Health Organization) which suggested that face masks and social distancing is the answer to it, until a cure is invented. Putting a face mask on can reduce the risk of getting infected by a great extent, not only to the one wearing it but also to the others that he comes in contact with. Wearing masks every time we go out is something we can do with little effort that can effectively save lives, and that is precisely why it is in so much demand at this point of time.

We propose a Face Mask Detection project that consists of 2 phases, namely training and deployment. The first stage detects human faces, while the second stage uses deep learning to firstly, identify the ROI(Region Of Interest) being the person's face and secondly identify the faces detected in the first stage as either 'With Mask' or 'Without Mask' and draws boundary of colors either green or red, depending on the output. The project takes JPG and PNG files as inputs, but it has also been tested on videos. The project can give accurate results if set up with a CCTV camera to track people without masks to ensure the safety and wellbeing of others, thus help controlling the spread of the virus.



## **LITERATURE SURVEY**

Object detection is one of the trending topics in the field of image processing and computer vision. Ranging from small scale personal applications to large scale industrial applications, object detection and recognition is employed in a wide range of industries. Some examples include image retrieval, security and intelligence, OCR, medical imaging and agricultural monitoring. In object detection, an image is read and one or more objects in that image are categorized. The location of those objects is also specified by a boundary called the bounding box. Traditionally, researchers used pattern recognition to predict faces based on prior face models. A breakthrough face detection technology then was developed named as Viola Jones detector that was an optimized technique of using Haar, digital image features used in object recognition. However, it failed because it did not perform well on faces in dark areas and non-frontal faces. Since then, researchers are eager to develop new algorithms based on deep learning to improve the models. Deep learning allows us to learn features with end to end manner and removing the need to use prior knowledge for forming feature extractors.

Like object detection, face detection adopts the same architectures as one-stage and two-stage detectors, but in order to improve face detection accuracy, more face-like features are being added. However, there is occasional research focusing on face mask detection. Some already existing face mask detectors have been modeled using OpenCV, Pytorch Lightning, MobileNet, RetinaNet and Support Vector Machines.

In this project, embedded devices are used for deployment that could reduce the cost of manufacturing. MobileNetV2 architecture is used as it is a highly efficient architecture to apply on embedded devices with limited computational capacity such as Google Coral, NVIDIA Jetson Nano. This project performed well, however, if a large portion of the face is occluded by the mask, this model could not detect whether a person is wearing a mask or not. The dataset used to train the

face detector did not have images of people wearing face masks as a result, if the large portion of faces is occluded, the face detector would probably fail to detect properly. To get rid of this problem, they should gather actual images of people wearing masks rather than artificially generated images.

## **BACKGROUND STUDY**

### **Machine Learning**

Machine Learning or ML is a study of computer algorithms that learns and enhance automatically through experience. It seems to be a subset of artificial intelligence. A machine learning algorithm builds a mathematical model based on "training data", in order to make decisions or predictions without being explicitly programmed to do so.

Machine learning algorithms are used in a variety of applications from email filtering to computer recognition, where it is difficult or impossible to develop general skills to perform the required tasks. These studies are closely related to computer statistics, which focus on computer-generated domain. The data prediction and mining is a coherent field of study, focusing on the analysis of experimental data by unsupervised learning. In its application to business problems, machine learning is also called predictive analytics.

### **Deep Learning**

Deep learning methods aim to learn feature hierarchies with a high-level hierarchy which is structured by the construction of lower-level features. Automated learning at multiple levels of extraction allows a system to learn complex tasks to do input mapping directly from data to output, without relying entirely on man-made features. Deep learning algorithms capture unspecified structure inside the input distribution to find better characterization frequently at multiple levels, with high-level learning features in the context of low-level features.

Inputs and outputs are in-depth study of the analog Excel problem domain. Meaning, they are not some size in table format, but they are pixel data, text data documents or data from audio files. Deep learning empower logical and

mathematical models to find representations of data with numerous levels of abstraction, multiple processing layers.

## **OpenCV**

OpenCV is a library which is used to develop computer based real-time applications. It majorly focuses on analysis including features like image processing, video capture and object detection and face detection.

We use the OpenCV library to execute infinite loops using our webcam, which detects faces using cascade classifications. The library has over 2000 optimized and advanced algorithms for computer vision based machine learning. These algorithms can be used for face detection and recognition, object detection, classifying human movements in video, tracking camera actions, tracking objects, taking 3D objects, adaptive thresholding and assembling together to produce high resolution image. It can also be useful in finding similar images from the database, removal of red eyes from photos taken with flash, follow the facial movements, and add tags to transition with advanced reality. It is continuously adding new modules to the latest algorithms from machine learning.

## **Tensorflow**

Tensor Flow is a standalone and open-source software library for Dataflow for a variety of tasks and a wide variety of programming. It is also used for machine learning applications such as the Symbolic Mathematics Library, and Neural Networks. TensorFlow is a great system for handling all aspects of a machine learning system. However, this class focuses on using the unique Tensor Flow API to train and deploy machine learning models.

We used TensorFlow and Keras to train the classifier to automatically identify if a person is wearing a mask. Since reference implementation runs on single devices, TensorFlow is able to run on multiple Processing Units and GPUs having extensions regarding general use.

## **Keras**

Keras is an API for high level neural networking. It follows best practices to reduce the major burden and provides consistent and flexible APIs that reduce the number of user actions required for normal usage situations and provide clear and actionable error messages. It is written in Python programming language and has a large developer community and support.

Keras includes several implementations of commonly used neural-network architecture, such as hosting devices to simplify the coding required to write layers, targets, optimizers, activation tasks, and an intensive neural network. It make easy to work with image and text data. The Keras models are easily deployable among various platforms.

## **MobileNet V2**

MobileNet is a Convolution Neural Network architecture model for various categorical classification and object detection work. This architecture is easily executable on mobile devices with a high rate of accuracy when compare to other light weighted CNN architectures. Also, it is ideal for mobile devices that do not have GPUs and highly embedded computational efficiency. It is significantly faster and accurate on results. It is also well suited for web or browsers as the browser has limitations on computing, graphic processing and storage.

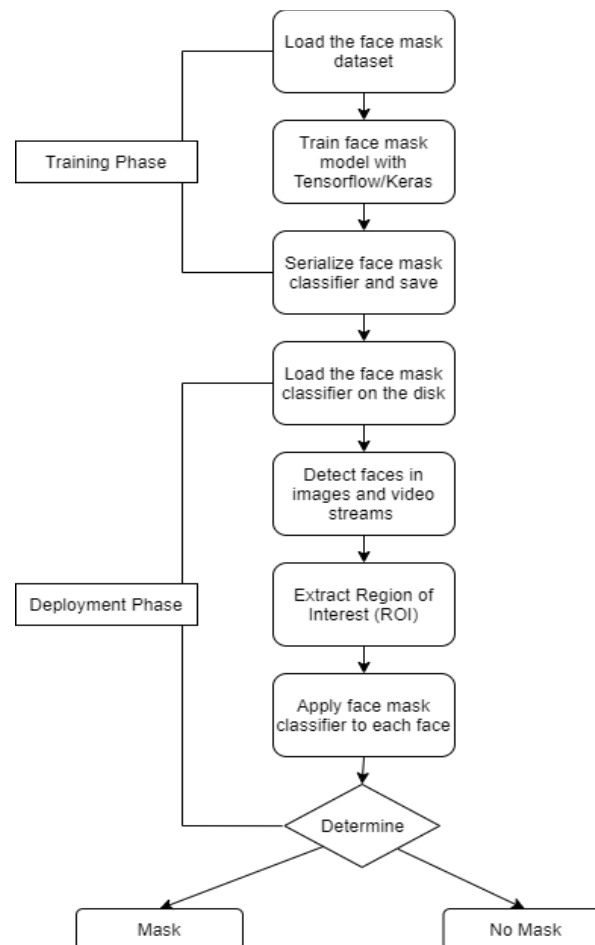
We have used the MobileNetV2 architecture, for it computational efficiency, making it easy to set up models for embedded systems (Raspberry Pi, Google Corel, Jetson, Nano, etc.).

# METHODOLOGY

This proposed model focuses on identifying face mask in a person through an image or video stream with the help of Deep Learning and Machine Learning using Keras, TensorFlow, OpenCV and the Scikit-Learn library. We have designed our model in two phases:

**1. Training** (Training the model on the dataset using Tensorflow & Keras)

**2. Deployment** (Loading the trained model and applying detector over images/live video stream)



Flowchart showing the training and deployment phase.

The above figure depicts the training and deployment phases of our face detection model.

The dataset is loaded first in the training phase. Training and modeling are streamlined during the training phase. After serializing face mask classifier to the disk, model is loaded to detect the face mask on the images or real-time video.

The model will calculate the ROI (Region of Interest) for the determination. We then compute bounding box value for a particular face and ensure that the box falls within the boundaries of the image. We then determine the class label based on predictions returned by the mask detector model and colors are assigned for interpretation. The “Green” will be for with mask and “Red” will be for without mask. Once all detection is executed we will display the output.

We have used MobileNetV2 architecture which is accurate and efficient and can be applied to embedded devices. We have specified the constants i.e. Initial Learning rate to be  $1e-4$ , batch size to be 32 and no of epochs to train the model as 20. After preprocessing, the input images are resized as 224 x 224 x 3 pixels and then compiled and evaluated on the test set. Face detection is similar to what was discussed earlier. A special frame is held in place by a stream and re-shaped. Then the face mask detection is processed. The results are displayed on the screen after post processing.

## **RESULTS**

We tried using three different base models for detecting ‘mask’ or ‘no mask’. The exercise was done to find the best fit model in our scenario. The evaluation process consists of first looking at the classification report which gives us insight towards precision, recall and F1 score. The equations of these three metrics are as follows:

**Precision** = True Positives / Positives + False Positives

**Recall** = True Positives / Positives + False Negatives

**Accuracy** = True Positives + True Negatives / Positives + Negatives

Using these three metrics, we can conclude which model is performing most efficiently. The second part consists of plotting the train loss, validation loss, train accuracy and validation accuracy which also proves helpful in choosing a final model.

### **MobileNet V2 Loss Function**

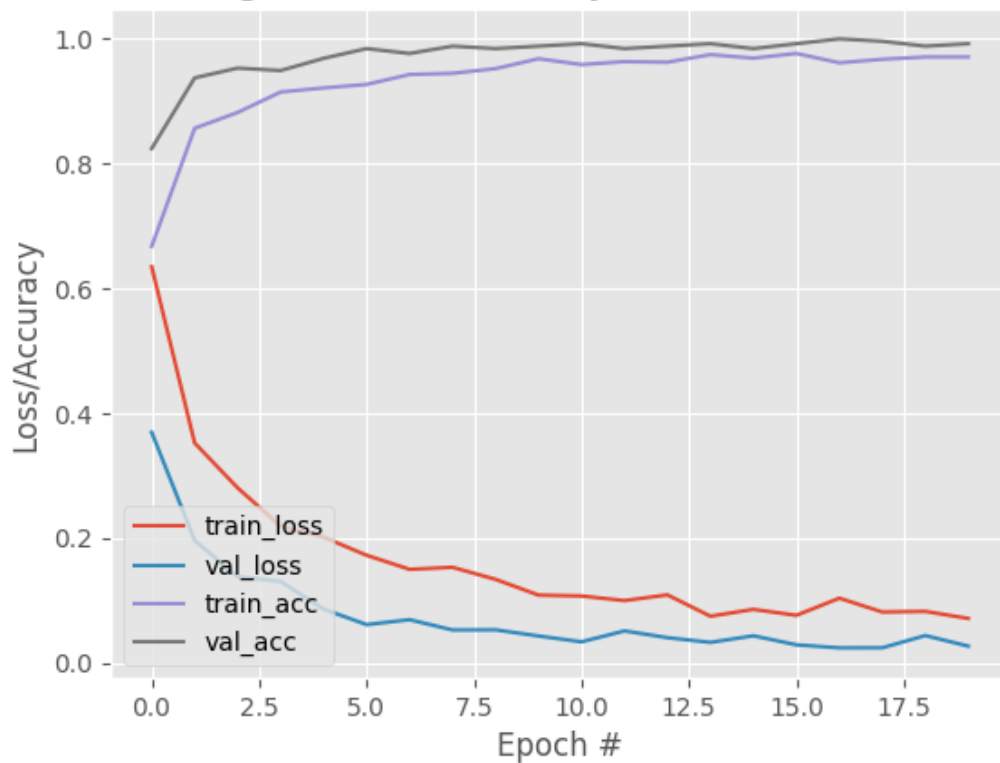
MobileNetV2 is an architecture of bottleneck depth-separable convolution building of basic blocks with residuals. It has two types of blocks. The first one is a residual block with stride of 1. Second one is also residual block with stride 2 and it is for downsizing.



**Evaluation Table for Trained Model**

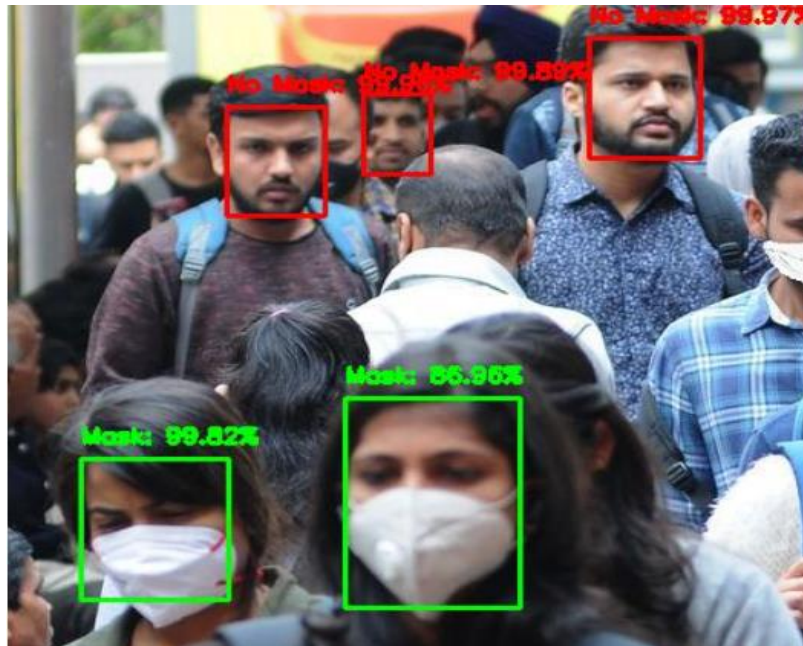
	Precision	Recall	F1-Score	Support
With mask	0.99	0.93	0.94	134
Without mask	0.99	0.96	0.94	134
Accuracy			0.98	274
Macro Avg.	0.98	0.98	0.98	274
Weighted Avg	0.98	0.08	0.98	274

**Training Loss and Accuracy on COVID-19 Dataset**

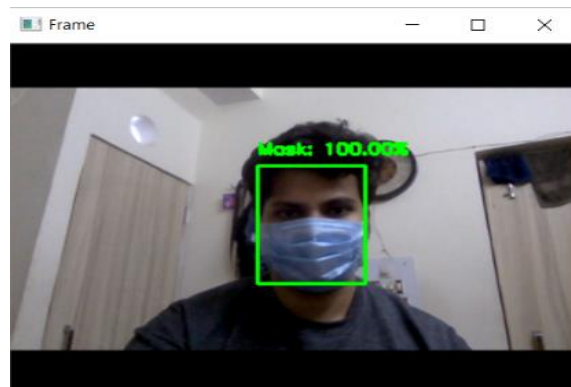
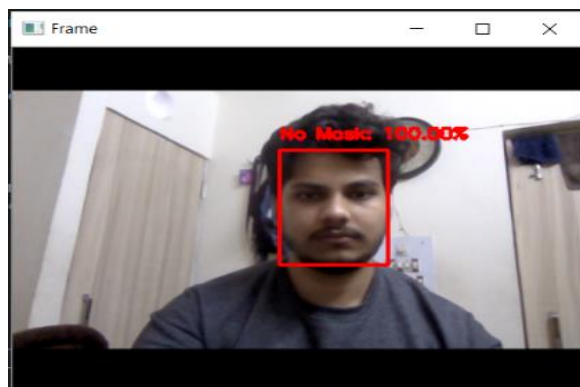


## TEST OUTPUTS

As we can see the accuracy obtained by our trained face mask detector model is ~98%. We have got the following output from our model



Output of Face Mask Detector in Uploaded Image



Output of Face Mask Detector in Real time video stream

## **LIMITATION & FUTURE WORK**

There were not many challenges faced but the two problems that were time consuming and made the tasks tedious are discussed as follows. One was the excessive data loading time in Google Colab Notebook while loading the dataset into it. Since the runtime restarting refreshes all the cells, the cell for dataset loading took most of the time while running. Secondly, the access problem in Google Colab Notebook: it did not allow the access of webcam which posed a hurdle in testing images and live video stream through Google Colab Notebook. Therefore, we had to run the code locally on the computer through which we tested the code on the live video stream.

More than fifty countries around the world have recently initiated wearing face masks compulsory. People have to cover their faces in public, supermarkets, public transports, offices, and stores. Retail companies often use software to count the number of people entering their stores. They may also like to measure impressions on digital displays and promotional screens. We are planning to improve our Face Mask Detection tool and release it as an open-source project. Our software can be equated to any existing USB, IP cameras, and CCTV cameras to detect people without a mask. This detection live video feed can be implemented in web and desktop applications so that the operator can see notice messages. Software operators can also get an image in case someone is not wearing a mask.

Furthermore, an alarm system can also be implemented to sound a beep when someone without a mask enters the area. This software can also be connected to the entrance gates and only people wearing face masks can come in.

## **CONCLUSION**

We created a face mask detector using Deep Learning, Keras, Tensorflow and OpenCV. We trained it to distinguish between people wearing mask and people not wearing a mask We have used MobileNet V2 classifier with the ADAM optimizer for the best result.

The model is tested with photos and real-time video streams. It detected the face from the images/videos and extracts each individual's face and apply the face mask classifier to it.

Since, we have used the MobileNet V2 architecture we can easily deploy our model to the embedded systems such as Raspberry Pi, Jetson, Google Coral, Nano etc. This can help be very helpful for the society and can possibly contribute to the public healthcare

## REFERENCES

- [1] D. Chiang., “Detect faces and determine whether people are wearing mask, 2020.
- [2] G. Jignesh Chowdary, Narinder Singh Pun, Sanjay Kumar Sonbhadra, Sonali Agarwal “Face Mask Detection using Transfer Learning of InceptionV3”,2020
- [2] P. Khandelwal, A. Khandelwal, S. Agarwal,” Using computer vision to enhance safety of workforce in manufacturing in a post covid world” 2020
- [3] Z. Wang, G. Wang, B. Huang, Z. Xiong, Q. Hong, H. Wu, P. Yi, K. Jiang, N. Wang, Y. Peiet al., “Masked face recognition dataset and application” arXiv preprint arXiv:2003.09093, 2020.
- [4] Z.-Q. Zhao, P. Zheng, S.-t. Xu, and X. Wu, “Object detection with deep learning: A review”, IEEE transactions on neural networks and learning systems, vol. 30, no. 11, pp. 3212–3232, 2019.
- [5] Kumar, A. Kaur, and M. Kumar, “Face detection techniques: a review,”Artificial Intelligence Review, vol. 52, no. 2, pp. 927–948, 2019.D.-H. Lee, K.-L. Chen, K.-H. Liou, C.-L. Liu, and J.-L. Liu, “Deep learning and control algorithms of direct perception for autonomous driving, 2019.
- [6] Qin B. and Li D. , Identifying face mask wearing condition using image super-resolution with classification network to prevent COVID-19.doi: 10.21203/rs.3.rs-28668/v1
- [7] Erhan, D., Szegedy, C., Toshev, A., and Anguelov, D. (2014). “Scalable object detection using deep neural networks,” in Computer Vision and Pattern Recognition Frontiers in Robotics and AI
- [8] R. Girshick, J. Donahue, T. Darrell, and J. Malik, “Rich feature hierarchies for accurate object detection and semantic segmentation,” in Proceedings of the IEEE conference on computer vision and pattern recognition, 2014.
- [9] <https://www.worldometers.info/coronavirus/coronavirus-death-toll/> for the statistics related to the Corona virus.

