Section A-Research paper

Disease spreading control in indoors

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ABSTRACT

Infectious diseases will significantly affect every aspect of our life, from work and education to healthcare and entertainment. In order to reduce its spread, safety guidelines both indoors and outdoors have to be followed. In this project, the focus is on scenarios related to indoor safety monitoring. Disease spreading is more severe indoors than outdoors. Particles from an infected person can move throughout an entire room or indoor space. The particles can also linger in the air after someone leaves the room. Preventing the person from entering if his temperature is high or if he does not wear a mask or if the crowd is huge in indoors is essential. This paper relies on intelligent technology: IoT devices, sensors, and computer vision. This paper uses these technologies to control the disease spreading in indoors.

Keywords: social distancing ,YOLOv3, QR Scanning, sensors, computer vision

1. Introduction

In our daily lives, infectious diseases can significantly impact various aspects, including work, education, healthcare, and entertainment. To prevent the spread of these diseases, it is crucial to follow safety protocols for indoor and outdoor settings. During pandemics, public gatherings are often prohibited due to the lack of information, vaccines, and medication. However, long-term lockdowns may not be viable in countries where tourism is a crucial industry.

Indoor environments can provide ideal conditions for spreading certain infectious diseases, particularly those transmitted through respiratory droplets or contact with contaminated surfaces. Poor ventilation, high population density, and shared surfaces can all contribute to the ease of disease propagation in indoor environments.Infectious diseases are often transmitted indirectly through surfaces, and the incubation period can be long. Therefore, governments have implemented, various safety measures such as social distancing, mandatory mask-wearing, quarantine, travel restrictions, self-isolation, and canceling large social events to reduce disease transmission during pandemics of different diseases.

We focus on indoor safety monitoring as disease transmission is typically more severe in indoor spaces. Infected individuals can release particles that can move throughout an entire room or area and linger in the air after they leave. To address this issue, we must consider various aspects relevant to indoor disease prevention,

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such as visitor mask-wearing, body temperature checks, limited indoor capacity, touch-free hand sanitization, and contact tracing.

2. METHODOLOGY

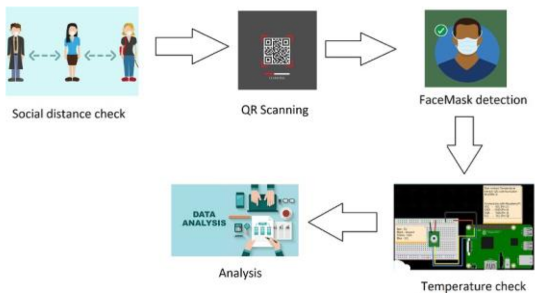


Figure 1. Block Diagram

2.1 Social distancing:

Social distancing refers to a set of non-pharmaceutical interventions taken to prevent the spread of contagious diseases by maintaining a physical distance between people. By reducing the number of close contacts a person has, social distancing helps to slow down the spread of a disease, particularly in the early stages of an outbreak. It also helps to prevent healthcare systems from being overwhelmed by reducing the number of cases requiring medical attention at any given time.

2.1.1 YOLOv3:

YOLOv3 (You Only Look Once version 3) is a popular real-time object detection algorithm. It's a neural network-based algorithm that detects objects in images and videos and is known for its speed and accuracy. The algorithm works by dividing the image into a grid and predicting bounding boxes and class probabilities for each grid cell. It uses anchor boxes to detect multiple objects in a single cell, and non-max suppression to eliminate duplicate detections.The algorithm is trained on large datasets such as COCO (Common Objects in Context) and ImageNet, which contain millions of images with labeled objects. This training allows YOLOv3 to detect a wide range of objects with high accuracy, including people, vehicles, animals, and more.

Steps involved in social distance check:

1. We use YOLOv3 to detect the people in the frame.
2. Once we detect the people we assign a bounding box to each individual.
3. We calculate the distance between the centers of the bounding boxes.
4. If the distance is less than the scaled minimum distance, the people will be indicated in red and the number of violations are shown.
5. If there are violations, the buzzer makes a continuous beep sound.
6. If there are no violations, it will proceed to the next step.

2.2 QR Scanning:A QR code is a two-dimensional barcode containing information in a square-shaped grid of

Figure 2: Sample QR

black and white pixels. It can be easily read by digital devices such as smartphones and is commonly used to track product information in a supply chain or for marketing and advertising purposes. QR codes have also been used recently in contact tracing efforts to help slow the spread of the coronavirus. When a QR code is scanned, a QR reader identifies it based on the three large squares outside the code. Once it recognizes these shapes, it can read the information inside the square.

2.2.1 Mobilenet:

We utilized the Mobilenet package from TensorFlow to preprocess our images to be compatible with the Mobilenet architecture. Mobilenet is a popular pre-trained model for image classification, which means it has been trained using a large dataset of images. Pre-trained models like Mobilenet are advantageous because they eliminate the need for developers to build and train a neural network from scratch, saving valuable development time.With Mobilenet's pre-trained model, we could quickly and easily classify our images for our disease-spreading control project. This allowed us to focus on other essential aspects of the project, such as social distancing, QR scanning, face mask detection, temperature checks, and risk analysis.

2.2.2 Computer vision:

Computer vision is an interdisciplinary field that deals with enabling machines to interpret and understand visual data from the world around us. It involves developing algorithms and techniques that allow computers to analyze, manipulate, and extract useful information from images and videos. Computer vision is the foundation for many applications of Artificial Intelligence. It plays a pivotal role in various fields like self-driving cars, robotics, and even photo editing applications.

2.2.3 OpenCV:

OpenCV is a widely-used open-source library for computer vision, machine learning, and image processing. Its importance in today's systems lies in its ability to perform real-time operations. OpenCV can be used to process images and videos and identify objects, faces, or even human handwriting. When combined with other libraries like NumPy, Python can analyze OpenCV array structures to process them.

To identify image patterns and their various features, OpenCV uses vector space and performs mathematical operations on these features. The library provides various tools for image and video processing, including edge

detection, image filtering, object recognition, and optical flow.
Steps involved in face mask detection:
Images of people with masks and without masks are collected to train a face mask detection model.
1. Data processing, Image reshaping, and image-to-array conversion are done to create a model.
2. The images will be split into training and testing sets and used to train the face detection model using mobilenet.
3. The trained model is used to detect face masks in real The person will be allowed inside only if he has a mask on his face.

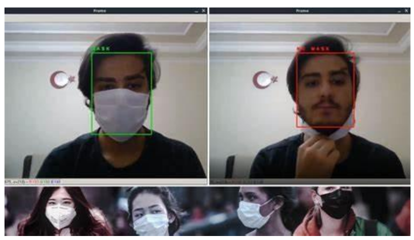


Figure 3. Mask detection

2.2.4 Raspberry Pi Zero w:

Raspberry Pi Zero W is a single-board computer and a smaller version of the Raspberry Pi line of computers. It has a compact form factor, measuring 65mm x 30mm x 5mm, and is equipped with a Broadcom BCM2835 SoC, which includes a 1GHz single-core CPU and 512MB of RAM.It also features built-in Wi-Fi and Bluetooth connectivity, which makes it ideal for IoT and wireless applications. Despite its small size, it has several useful ports, including mini-HDMI, micro-USB, and a 40-pin GPIO header.
Steps involved in risk analysis:

1.We extract the data of each individual from the QR data stored in a CSV file.

2.Each data we collected, like tested or not, test date, test result, and sick frequency are risk factors.

3.We assign a specific score to each risk factor based on the disease.

4.Then we calculate the risk score of each individual.

5.We notify the people with high-risk scores to take necessary measures.

6.We plot the risk score vs the number of people graph for an easy understanding of the disease propagation.

3. Results and Discussion

3.1 Social distancing:


Figure 3.1: Social distancing-No violation   Figure 3.2: Social distancing- Violation

As the distance between the two people is greater than the minimum distance, the bounding boxes are in green color and the number of violations is 0.

As the distance between the people is less than the minimum distance, the bounding boxes are red and the number of violations is more than zero. The violations are 2 indicating 2 people are violating the social distancing.

3.2 QR scanning:

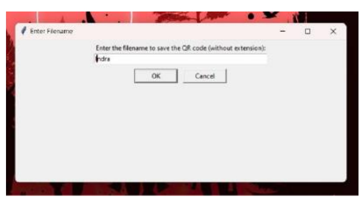
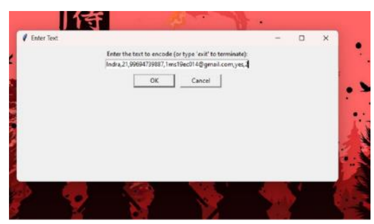



Figure 3.3.QR- text   Figure 3.4. QR-filename

3 .2.1 QR Create:

We made a simple QR generator for people who do not know how to make them. We need to type the data of the person and provide the name of the file with which we will save the image.

3.2.2 QR test result:

Figure 3.5: QR-test result

Results of QR, scanned with online QR scanner

3.2.3 QR final result:

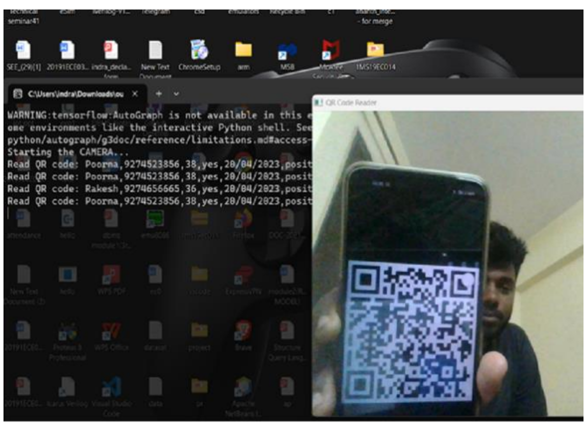


Figure 3.6: QR-final result 2

After passing the social distance check, the individual needs to go through QR scanning. QR contains the info of the individual like name, age, number, tested or not, tested date, test result, mail, living conditions, etc. The individual is not allowed to pass through if he is tested and his test result is positive, if he is not tested and has a high sick frequency, etc. All the scanned data is saved in a CSV file and the file can be sent to the government for further analysis. We use the data for the risk analysis.

3 .3.1 Dataset sample:

Figure 3.7. Dataset sample- with mask   Figure 3.8. Dataset sample - without mask

This is the sample of the data set used for training the model for face mask detection. This dataset consists of 2865 images having masks and 2917 images without masks. We have collected these images from various sources.

3.3.2 Model training results:

We trained our mask detection model up to 16 epochs with a batch size of 37

3.3.3 Performance Metrics:

	precision	recall	f1-score	support
with_mask	0.99	1.00	0.99	573
without_mask	1.00	0.99	0.99	584
accuracy			0.99	1157
macro avg	0.99	0.99	0.99	1157
weighted avg	0.99	0.99	0.99	1157

Figure 3.9. Performance metrics

We got the above performance metrics for the trained model.

3.3.4 Accuracy and loss plots:

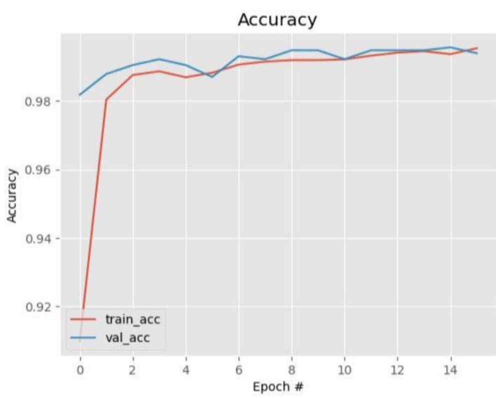


Figure 3.10. Accuracy plot

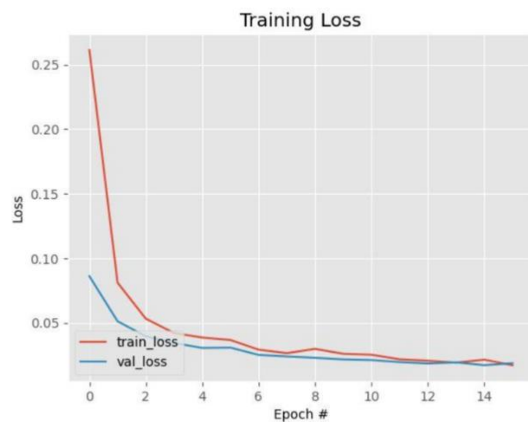


Figure 3.11. Loss plot

3.3.5 Detection results:

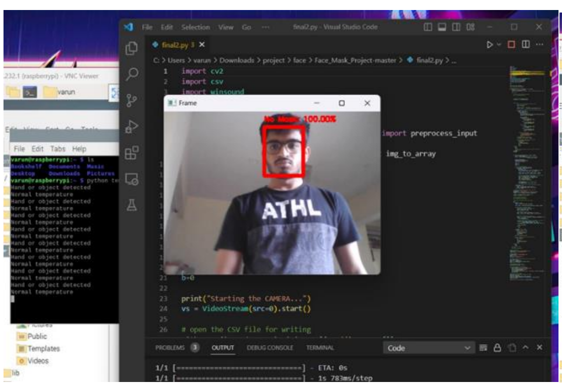


Figure 3.10.Detection - no mask

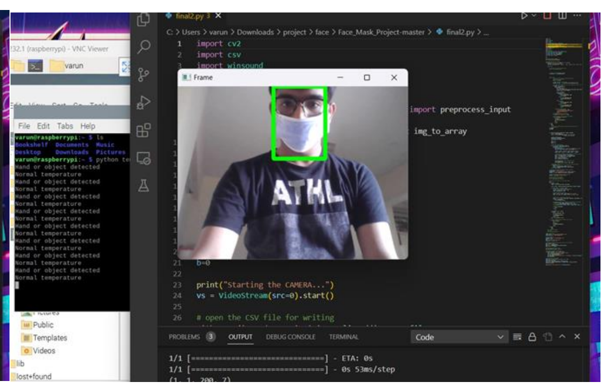


Figure 3.11. Detection - mask

As the mask is not detected it shows no mask in red and beeps continuously as a warning for the person to wear a mask in fig 3.12As the mask is detected it shows a green box around the face with the label 'Mask'. After the mask detection, the individual needs to go through a temperature check in fig 3.13

3.3.5 CSV file: The CSV file contains the scanned QR data of the people. On quitting the program this file will be sent to the specified mail address mentioned in the code automatically

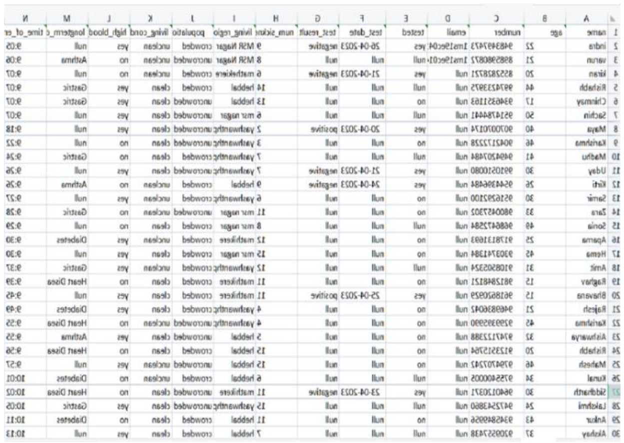
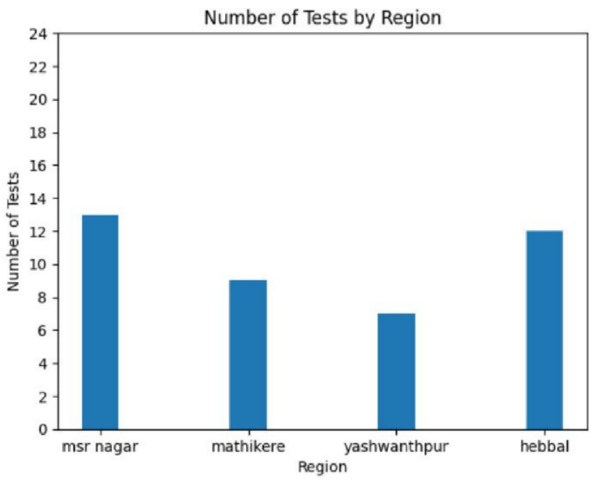
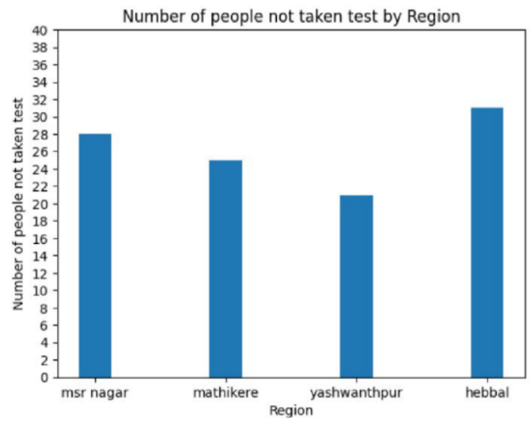


Figure 3.12.CSV file contents

Figure 3.13.Test status and living region of people visited





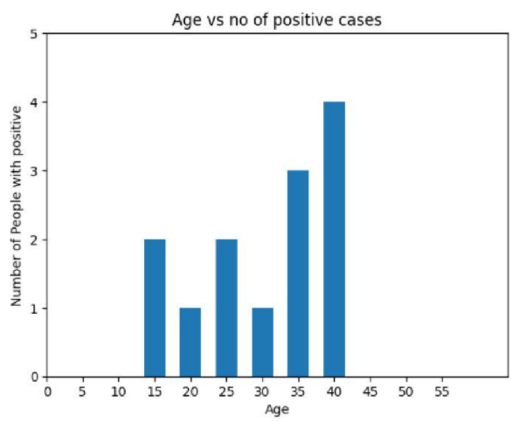


Figure 3.14.Age vs no. of positive cases

4.CONCLUSION

After calculating the individual risk scores of each person. We separate the people with positive cases as they are not in any risky situation but give risky situations to others. The above plot is risk score ranges vs the number of people. A warning notification will be sent to the people with high-risk scores so that they can take the necessary steps. In summary, smart technologies have transformed infectious disease indoor monitoring by enabling early detection, real-time monitoring, data-driven insights, enhanced response capabilities, improved public health planning, remote monitoring and increased public awareness.These advancements contribute to more effective disease surveillance, prevention, and control, ultimately helping to safeguard public health and reduce the impact of infectious diseases.

The use of smart technologies for indoor monitoring can also provide valuable data for epidemiological studies and research, helping to advance our understanding of infectious diseases and how they spread. As for the future scope, the system can be integrated with other IoT devices, such as air quality sensors, to further enhance the safety of indoor environments. For example, the system can monitor air quality and alert users when it's necessary to take action to improve air quality.

In the future, machine learning algorithms can be applied to develop more accurate risk assessment models that can be continuously updated and refined. We can include automated contact tracing by using location data collected from mobile devices. This can help health authorities quickly identify and isolate potential contacts of infected individuals. The system can be further enhanced by integrating with other technologies and adding more advanced features to improve its effectiveness in controlling the spread of diseases in indoor environments.

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