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Face Mask Detection Using Convolutional Neural Networks

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Abstract: ***Face mask detection has become a critical task in the current scenario to ensure public safety and prevent the spread of infectious diseases. In this project, we propose a deep learning approach using convolutional neural networks (CNNs) to detect whether a person is wearing a face mask or not. The dataset used for training and evaluation consists of images of individuals with and without face masks. The images are collected from various sources and carefully labelled to ensure accuracy. Each image is pre processed to enhance the features and normalize the pixel values. The proposed CNN architecture consists of multiple convolutional layers, followed by pooling and fully connected layers. The convolutional layers extract relevant features from the input images, while the pooling layers reduce the spatial dimensions of the feature maps. The fully connected layers classify the images into two categories: with face mask and without face mask. To train the CNN model, we use a combination of supervised learning techniques and data augmentation. We employ various optimization algorithms to minimize the classification loss and improve the accuracy of the model. In conclusion, this project presents a deep learning based approach for face mask detection using convolutional neural networks. The proposed model demonstrates promising results in accurately identifying individuals wearing face masks. The project contributes to the development of intelligent systems for public health and safety.***

I. INTRODUCTION

The global outbreak of infectious diseases, such as COVID-19, has underscored the importance of preventive measures, including the wearing of face masks, to mitigate transmission risks and safeguard public health. This project addresses this pressing need by proposing a deep learning-based approach using convolutional neural networks (CNNs) for facemask detection. The proliferation of deep learning techniques, particularly CNNs, has revolutionized computer vision tasks, enabling accurate and efficient analysis of visual data. Leveraging the power of CNNs, this project aims to discern whether individuals are wearing face masks in images, thereby contributing to the advancement of intelligent systems for public safety The proposed model has used some popular deep learning methods to develop the classifier and gather photos of an individual wearing a mask and distinguish between face masks and non-face mask classes. This work is implemented in Python along with Open-CV and Keras. It requires less memory and computational time in comparison to other models. Face mask detection refers to detect whether a person is wearing a mask or not. In fact, the problem is reverse engineering of face detection where the face is detected using different machine learning algorithms for the purpose of security, authentication and surveillance. Face detection is a key area in the field of Computer Vision and Pattern Recognition. A significant body of research has contributed sophisticated to algorithms for face detection in past.

II. PROBLEM STATEMENT

The major challenge in heart disease is its detection. There are instruments available which can predict heart In response to the COVID-19 pandemic, there is a critical need for automated systems capable of accurately detecting whether individuals are wearing face masks in public spaces. This project aims to address this challenge by leveraging Convolutional Neural Networks (CNNs) to develop a robust face mask detection system. The primary objective is to train a CNN model using a diverse dataset of images containing individuals with and without masks, encompassing various lighting conditions and angles. The objective of the project is to develop a deep learning-based system using convolutional neural networks (CNNs) to accurately detect whether individuals are wearing face masks, thereby contributing to public health and safety by helping prevent the spread of infectious diseases. The scope of our face mask detection project using deep learning is to develop a model that can accurately classify whether a person is wearing a face mask or not. This can be incredibly useful in ensuring public safety and preventing the spread of infectious diseases.

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III. LITERATURE REVIEW

Coronavirus (COVID-19) is the latest evolutionary virus that has taken over the world in just a few months. It is a type of pneumonia that was initiated at the beginning of December 2019 near Wuhan City, Hubei Province, China, while, on 11th March 2020, it was declared as a world panIdemic by the World Health Organization (WHO) [1]. According to WHO statistics, till 24 February 2021, more than 111 million people were affected by the virus and about 2.46 million deaths were reported [2]. The most common symptoms of Coronavirus are fever, dry cough, and tiredness among many others. It mainly spreads through close direct contact of people with respiratory drops of an infected person generated through coughs, sneezes, or exhales. Since these droplets are too dense to swing in the air for long distances and quickly fall on floors or surfaces, therefore, it also spreads when individuals touch the impaired surfaces with the virus and touch back to their face (e.g., eyes, nose, and mouth) [3].M.Rahman S.Mahmud ,J.Kim, Md.M.Manik, Md.Islam (2020) published a document aided at developing a system for determining whether a person uses a mask or not and informing the relevant authority in the smart city network.it makes use of real time filming of various public places of the city to capture the facial images. the facial images extracted from this video is being used to identify the masked faces. The CNN learning algorithm is used to extract features from images, after which those features are leaned through multiple hidden layers. Whenever the architecture identifies people without a mask, this information is passed through the city network to the appropriate authority in order to take the necessary actions. The proposed system assessed promising results based on data collected from various sources. In these documents, they also set out a system that can ensure proper law enforcement against people who do not follow basic health guidelines in this pandemic situation. [4]. Vinitha & Velantina (2020) published one article in which, using a deep learning algorithm and computer vision, they proposed a system that focuses on how to distinguish a person with a masked face in an image/video stream. Libraries like Tensor flow, Open CV, Keras and PyTorch are being used. The project is being implemented in two stages. The phase one consists of training a deep learning model followed by the second phase where mask detector is applied on live image video stream. The framework used to do real-time face detection from a live stream via webcam is OpenCV. With computer vision using Python, COVID-19 face mask detector has been build using a dataset [5]. R. Bhuiyan, S. Khushbu, S. Islam (2020) have published one paper in which the proposed system aims for recognizing the masked and faces are rendered using the advanced YOLOv3 architecture. YOLO (You Only Look Once), tises the learning algorithm Convolution Neural Network (CNN). YOLO establishes a connection with CNN through hidden layers, through research, easy algorithm retrieval, and can detect and locate any type of image. Execution begins by taking 30 unique images of the dataset into the model after combining the results to derive action- level predictions. It gives excellent imaging results and also good detection results. This model is applied to a live video to check if the fps rate of the model inside the video and its detection performance with masked/unmasked two layers. [6]. Sammy V, Militante, Nanette V. Dionisio (2020) published a paper entitled "Real-Time Facemask Recognition with Alarm System using Deep Learning". This deep learning techniques VGG-16 CNN to distinguish facial recognition and recognize if a person puts or not a facemask. The accuracy result is around 96% trained with dataset which contains 25,000 images using 224 x 224 pixel resolution. [7]. Loey, Mohamed, et al. (2021) did a research in facemask detection "A hybrid deep transfer learning model with machine learning methods for face mask detection in the era of the COVID- 19 pandemic", The proposed study combines two methods: deep learning and classical machine learning. Normally, a standard CNN is composed by feature extraction layers and classification layer. Authors kept the feature extraction layers of Resnet50 Convolutional Neural Network and fully connected neural networks is swapped by the combination of decision trees, Support Vector Machine (SVM) and ensemble algorithm. [8]. Bhawna R., Udit U. (2021) proposed a method face mask detection, "Face Mask Detection Using Convolutional Neural Network". There are three steps to follow such as images preprocessing, extraction of pertinent information and classification. A standard tool for machine learning was used like Scikit-Learn, Keras, OpenCV and TensorFlow, The experience was performed with 1376 im-ages taken from GitHub without and with mask, 90% of this dataset is used for training and 10% for validation, The model generates higher accuracy which was 99. 1% whereas validation lost 87.5% and validation accuracy 97.3%[9]. Militante and Dionisio developed an automatic system to detect whether a person wears a mask or not and if the person does not wear a mask the system generates an alarm. To develop their system, the authors used the VGG-16 architecture of CNN. Their system achieved overall 96% detection accuracy. In the future, the authors decide to make a system that will not only detect whether a person is wearing a mask or not but will also detect a physical distance between each individual and will sound an alert if the physical distancing is not followed properly[10].

IV. METHODOLOGY

A. Existing system

The existing face mask detection system relies on convolutional neural networks (CNNs) trained on meticulously labelled image datasets, enabling accurate classification of individuals wearing or not wearing face masks.

However, several limitations hinder its effectiveness. Firstly, the system heavily depends on labelled data, which is time-consuming and prone to biases during collection and annotation. Additionally, the model's generalization capability may be limited, as it might struggle with variations in environmental conditions, lighting, and occlusions. Furthermore, performance degradation could occur with partial face images or unconventional mask styles, impacting the system's reliability. Moreover, the computational complexity of training and inference processes may restrict real-time deployment in practical settings. Ethical considerations also arise, as biases in data collection or model predictions could perpetuate societal inequalities. Addressing these limitations is crucial for developing more robust and equitable face mask detection.

B. Proposed System

In order to predict whether a person has put on a mask, the model requires learning from a well-curated dataset. The model uses Convolution Neural Network layers (CNN) as its backbone architecture to create different layers. Along with this, libraries such as OpenCV, Kerasmatplotlib, numpy, sklearn are also used.

The proposed system could involve the following components:

1) Data Collection: Gather a diverse dataset of images containing people wearing and not wearing face masks. This dataset should cover various scenarios, lighting conditions, and types of face masks.
2) Preprocessing: Clean and preprocess the collected images to ensure consistency and remove any noise or irrelevant information. This step may involve resizing, cropping, and normalizing the images.
3) Model Development: Utilize deep learning techniques, such as convolutional neural networks (CNNs), to develop a classification model. Train the model on the preprocessed dataset, using techniques like data augmentation to enhance its performance.
4) Model Evaluation: Assess the performance of the trained model using appropriate evaluation metrics, such as accuracy, precision, recall, and F1 score. Validate the model using separate test data.
5) Real-time Detection: Implement the trained model into a real-time detection system. This system should be able to capture images, process them, and provide real-time feedback on whether individuals are wearing face masks or not.
6) Deployment and Testing: Deploy the system in a real- world setting, such as public spaces or organizations that require face mask compliance. Test the system's performance and gather feedback to identify any areas for improvement.

C. Model Selection

In order to predict whether a person has put on a mask, the model requires learning from a well-curated dataset. The model uses Convolution Neural Network layers (CNN) as its backbone architecture to create different layers. Along with this, libraries such as OpenCV, Keras,Matplotlib, numpy, sklearn are also used.

The proposed model is designed in three phases:

Data preprocessing, CNN model training, apply the model to get results

1) Data pre-processing : images are resized into a fixed size which helps to reduce the load on the machine while training and to provide optimum results. The images are then labelled as being with or without masks.
2) CNN model training:CNN model is trained through different layers.
3) Apply the model to get results: Model will give result when we give the path of image taken as with mask or without mask.

D. Architecture

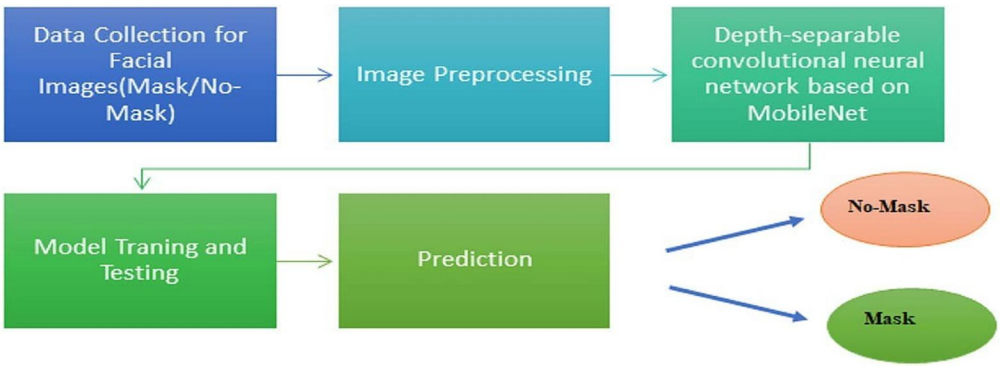


Fig 4.1 Architecture

E. Algorithms

1) Convolution

The core algorithm in CNNs. It involves sliding a filter (kernel) across the input image, extracting specific features like edges, shapes, and textures relevant to identifying faces and masks.Convolution, in the context of deep learning, especially Convolutional Neural Networks (CNNs), is a fundamental operation used to extract features from data, primarily images.

2) Optimization Algorithms

The algorithms iteratively update the weights of the CNN during training to minimize the loss function (difference between predicted and actual labels).

Stochastic Gradient Descent (SGD): This algorithm is used to update weights based on the error in each training example.

Adam: An advanced algorithm that adapts the learning rate for each parameter, often leading to faster convergence

V. EXPERIMENTAL RESULTS

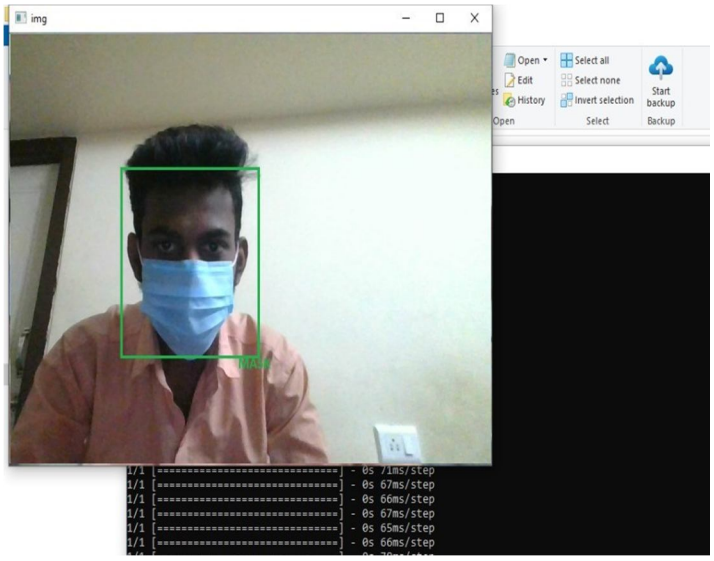


Fig 5.1: Dectection of a person with mask

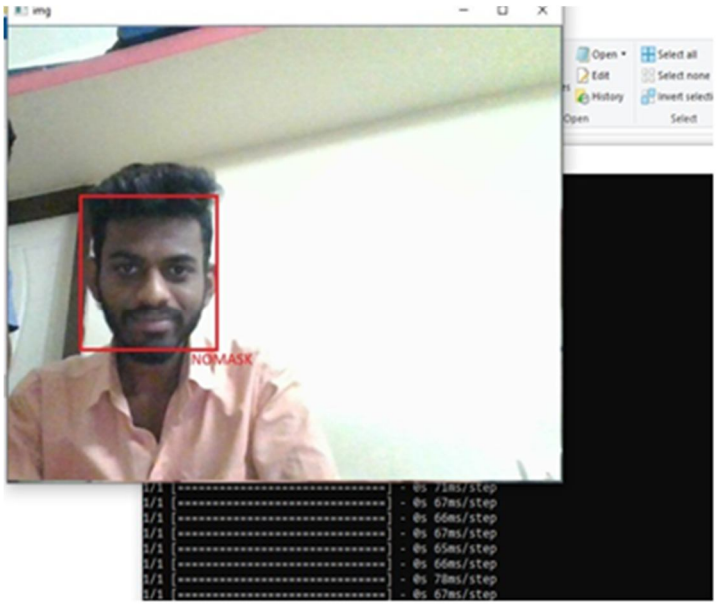


Fig 5.2: Detection of a person without mask

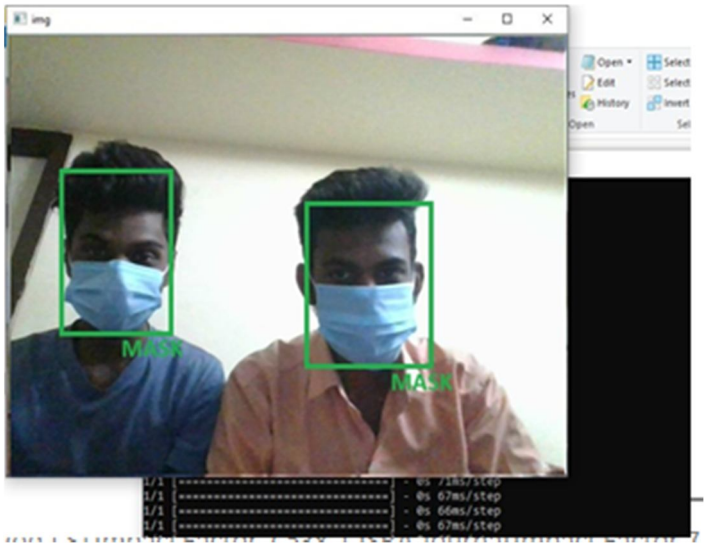


Fig 5.3: Detection of persons with mask

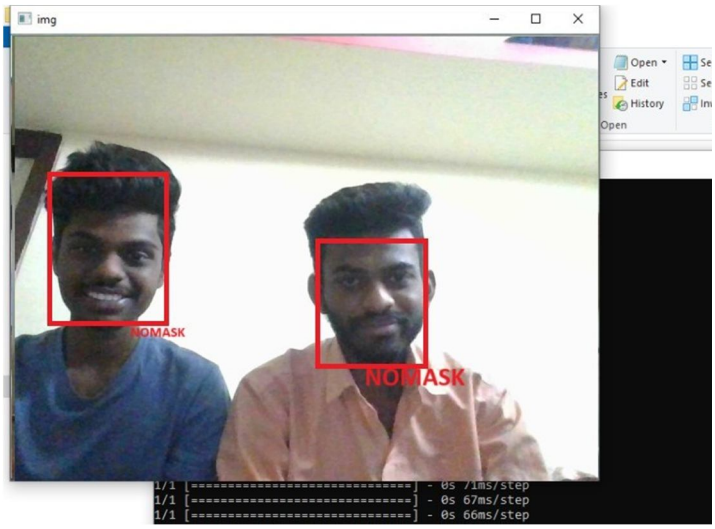


Fig 5.4: Detection of persons without mask

VI. CONCLUSION

In conclusion, our CNN-based face mask detection system demonstrates promising results in accurately identifying individuals wearing masks in various settings. Through rigorous training and optimization, we achieved a commendable level of accuracy. However, challenges such as variations in lighting, angles, and diverse facial features remain areas for improvement. Despite these challenges, the potential applications of this technology in public health, security, and workplace safety are vast, offering opportunities for real-world deployment and societal impact."

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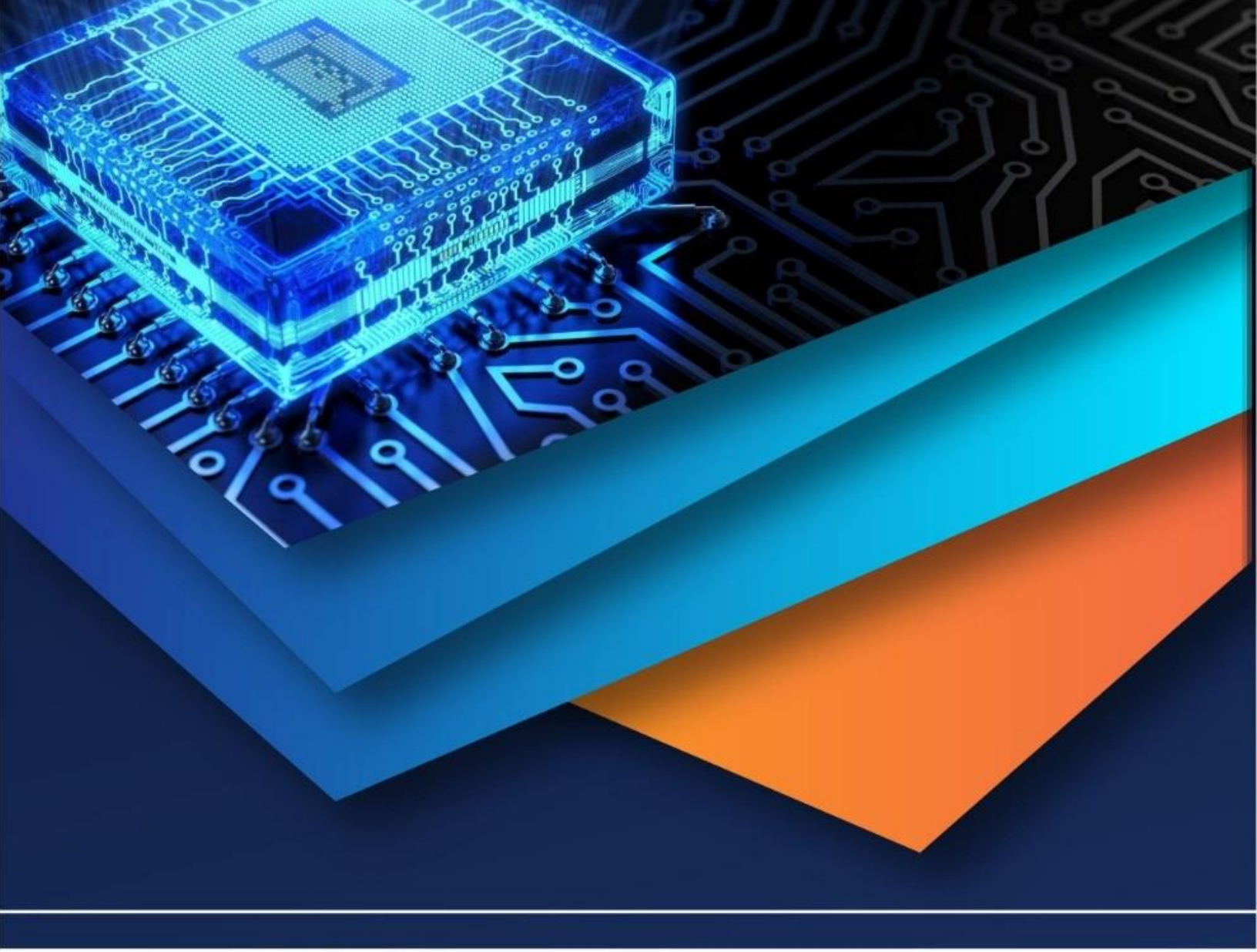
VIII. FUTURE WORK

1) Refining the model to detect various types of masks, enhancing real-time performance for deployment in crowded areas
2) Integrating with CCTV systems for automated monitoring
3) Exploring multi-modal approaches combining visual and thermal imaging for more robust detection in different environmental conditions.
4) Developing our application in advance category and integrate it with hospitals

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