



FUTURISTIC FACE RECOGNITION BASED COVID NON-VACCINATION POPULATION FINDER AND ALERT SYSTEM

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ABSTRACT

Vaccinations are an important and effective cornerstone of preventive medical care with significant health benefits. Vaccination is crucial to limit the pandemic spread of SARS-CoV-2/COVID-19. The government has started vaccination to prevent the continuous spread of corona infection in India. Therefore, besides the development and supply of vaccines, it is essential that sufficient individuals are willing to get vaccinated, but concerning proportions of populations worldwide show vaccine hesitancy. However, it soon became clear that to end the pandemic, we would have to address another ubiquitous problem: the widespread hesitancy toward or downright rejection of vaccination. To achieve population immunity first we have to find the non-vaccinated population to this end, this project proposed an Aadhaar-based facial recognition system is used to find non-vaccination citizen and alert them using Artificial Intelligence. Deep learning in the form of Convolutional Neural Networks (CNNs) to perform the face recognition and seems to be an adequate method to carry out face recognition due to its high accuracy. A CNN is a type of Deep Neural Network (DNN) that is optimized for complex tasks such as image processing, which is required for facial recognition. CNNs consist of multiple layers of connected neurons: there is an input layer, an output layer, and multiple layers between these two. In the context of the corona virus disease (COVID-19) pandemic, a face recognition-based person's current vaccination status to protect against COVID-19 can then be used for continuity of care or as proof of vaccination for purposes other than health care. Facial recognition technology (FRT) along with the Aadhaar to authenticate people before entering into any kinds of service. This project provides COVID-19 vaccination status using their face and attest that an individual has received a vaccine or not and alert them to get vaccinated.

Keywords: DCNN,FRT,CNN

1. INTRODUCTION

A vaccine can confer active immunity against a specific harmful agent by stimulating the immune system to attack the agent. Once stimulated by a vaccine, the antibody-producing cells, called B cells (or B lymphocytes), remain sensitized and ready to respond to the agent should it ever gain entry to the body. A vaccine may also confer passive immunity by providing antibodies or lymphocytes already made by an animal or human donor. Vaccines are usually administered by injection (parenteral administration), but some are given orally or even nasally (in the case of flu vaccine). Vaccines applied to mucosal surfaces, such as those lining the gut or nasal passages, seem to stimulate a greater antibody response and may be the most effective route of administration. (For further information, see immunization.).

The first vaccines

The first vaccine was introduced by British physician Edward Jenner, who in 1796 used the cowpox virus (vaccinia) to confer protection against smallpox, a related virus, in humans. Prior to that use, however, the principle of vaccination was applied by Asian physicians who gave children dried crusts from the lesions of people suffering from smallpox to protect against the disease. While some developed immunity, others developed the disease. Jenner's contribution was to use a substance similar to, but safer than, smallpox to confer immunity. He thus exploited the relatively rare situation in which immunity to one virus confers protection against another viral disease. In 1881 French microbiologist Louis Pasteur demonstrated immunization against anthrax by injecting sheep with a preparation containing attenuated forms of the bacillus that causes the disease. Four years later he developed a protective suspension against rabies.

Vaccine effectiveness

After Pasteur's time, a widespread and intensive search for new vaccines was conducted, and vaccines against both bacteria and viruses were produced, as well as vaccines against venoms and other toxins. Through vaccination, smallpox was eradicated worldwide by 1980, and polio cases declined by 99 percent. Other examples of diseases for which vaccines have been developed include mumps, measles, typhoid fever, cholera, plague, tuberculosis, tularemia, pneumococcal infection, tetanus, influenza, yellow fever, hepatitis A, hepatitis B, some types of encephalitis, and typhus—although some of those vaccines are less than 100 percent effective or are used only in populations at high risk. Vaccines against viruses provide especially important immune protection, since, unlike bacterial infections, viral infections do not respond to antibiotics.

Vaccine types

The challenge in vaccine development consists in devising a vaccine strong enough to ward off infection without making the individual seriously ill. To that end, researchers have devised different types of vaccines. Weakened, or attenuated, vaccines consist of microorganisms that have lost the ability to cause serious illness but retain the ability to stimulate immunity. They may produce a mild or subclinical form of the disease. Attenuated vaccines include those for measles, mumps, polio (the Sabin vaccine), rubella, and tuberculosis. Inactivated vaccines are those that contain organisms that have been killed or inactivated with heat or chemicals. Inactivated vaccines elicit an immune response, but the response often is less complete than with attenuated vaccines. Because inactivated vaccines are not as effective at fighting infection as those made from attenuated microorganisms, greater quantities of inactivated vaccines are administered. Vaccines against rabies, polio (the Salk vaccine), some forms of influenza, and cholera are made from inactivated microorganisms. Another type of vaccine is a subunit vaccine, which is made from proteins found on the surface of infectious agents. Vaccines for influenza and hepatitis B are of that type. When toxins, the metabolic by-products of infectious organisms, are inactivated to form toxoids, they can be used to stimulate immunity against tetanus, diphtheria, and whooping cough (pertussis).

In the late 20th century, advances in laboratory techniques allowed approaches to vaccine development to be refined. Medical researchers could identify the genes of a pathogen (disease-causing microorganism) that encode the protein or proteins that stimulate the immune response to that organism. That allowed the immunity-stimulating proteins (called antigens) to be mass-produced and used in vaccines. It also made it possible to alter pathogens genetically and produce weakened strains of viruses. In that way, harmful proteins from pathogens can be deleted or modified, thus providing a safer and more-effective method by which to manufacture attenuated vaccines.

Recombinant DNA technology has also proven useful in developing vaccines to viruses that cannot be grown successfully or that are inherently dangerous. Genetic material that codes for a desired antigen is inserted into the attenuated form of a large virus, such as the vaccinia virus, which carries the foreign genes "piggyback." The altered virus is injected into an individual to stimulate antibody production to the foreign proteins and thus confer immunity. The approach potentially enables the vaccinia virus to function as a live vaccine against several diseases, once it has received genes derived from the relevant disease-causing microorganisms. A similar procedure can be followed using a modified bacterium, such as *Salmonella typhimurium*, as the carrier of a foreign gene.

Vaccines against human papillomavirus (HPV) are made from viruslike particles (VLPs), which are prepared via recombinant technology. The vaccines do not contain live HPV biological or genetic material and therefore are incapable of causing infection. Two types of HPV vaccines have been developed, including a bivalent HPV vaccine, made using VLPs of HPV types 16 and 18, and a tetravalent vaccine, made with VLPs of HPV types 6, 11, 16, and 18.

Another approach, called naked DNA therapy, involves injecting DNA that encodes a foreign protein into muscle cells. The cells produce the foreign antigen, which stimulates an immune response.

Vaccines based on RNA have been of particular interest as a means of preventing diseases such as influenza, cytomegalovirus infection, and rabies. Messenger RNA (mRNA) vaccines are advantageous because the way in which they are made allows them to be developed more quickly than vaccines made via other methods. In addition, their production can be standardized, enabling rapid scale-up for the manufacture of large quantities of vaccine. Novel mRNA vaccines are safe and effective; they do not contain live virus, nor does the RNA interact with human DNA.

Table of vaccine-preventable diseases

Vaccine-preventable diseases in the India, presented by the year of vaccine development or licensure.

Disease	Year
*Vaccine recommended for universal use in U.S. children. For smallpox, routine vaccination was ended in 1971.	
**Vaccine developed (i.e., first published results of vaccine usage).	
***Vaccine licensed for use in United States.	
smallpox*	1798**
Rabies	1885**
Typhoid	1896**
Cholera	1896**
Plague	1897**
diphtheria*	1923**
pertussis*	1926**
tetanus*	1927**
Tuberculosis	1927**
Influenza	1945***
yellow fever	1953***
poliomyelitis*	1955***
measles*	1963***
mumps*	1967***
rubella*	1969***
Anthrax	1970***
Meningitis	1975***
Pneumonia	1977***
Adenovirus	1980***
hepatitis B*	1981***
Haemophilus influenzae type b*	1985***
Japanese encephalitis	1992***
hepatitis A	1995***
<u>varicella*</u>	1995***
<u>Lyme disease</u>	1998***

Disease	Year
rotavirus*	1998***
human papillomavirus	2006
<u>dengue fever</u>	2019

Covid 19

At the end of 2019, a novel coronavirus now known as severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) was identified as the cause of a cluster of pneumonia cases in Wuhan, a city in the Hubei Province of China. It rapidly spread, resulting in a global pandemic. In February 2020, the World Health Organization named the disease COVID-19, which stands for coronavirus disease 2019. The world is in the midst of a COVID-19 pandemic. As WHO and partners work together on the response -- tracking the pandemic, advising on critical interventions, distributing vital medical supplies to those in need--- they are racing to develop and deploy safe and effective vaccines.

Vaccines save millions of lives each year. Vaccines work by training and preparing the body's natural defenses – the immune system – to recognize and fight off the viruses and bacteria they target. After vaccination, if the body is later exposed to those disease-causing germs, the body is immediately ready to destroy them, preventing illness.

There are several safe and effective vaccines that prevent people from getting seriously ill or dying from COVID-19. This is one part of managing COVID-19, in addition to the main preventive measures of staying at least 1 metre away from others, covering a cough or sneeze in your elbow, frequently cleaning your hands, wearing a mask and avoiding poorly ventilated rooms or opening a window.

As of 15 November 2021, WHO has evaluated that the following vaccines against COVID-19 have met the necessary criteria for safety and efficacy:

- AstraZeneca/Oxford vaccine
- Johnson and Johnson
- Moderna
- Pfizer/BionTech
- Sinopharm
- Sinovac
- COVAXIN

Covid19 Vaccination in India

COVID-19 vaccines in India and elsewhere are mostly two shot vaccines. High efficiency requires both doses of COVID-19 vaccines to be administered that can provide protection against fatal infection. As the second wave of COVID-19 infection picked up, India saw a high rate of COVID infection and deaths among the elderly people and people with comorbidities. Elderly and the people with comorbidities were the ones who were at high risk of COVID-19 infection, and hence they were prioritized to receive COVID-19 vaccine shots relative to others in the phase wise vaccine rollout. Many among them who were vaccinated with the first dose contracted COVID-19 infection and some of them died as the first dose alone was not meant to build sufficient immunity to fight severe COVID infection. However, the myth developed particularly in the rural areas that covid vaccines were causing deaths and illness. This too likely contributed to vaccine hesitancy during the third and the fourth phase of the vaccination drive.

1.1. Problem Identified

From the beginning of this COVID-19 pandemic, it has been witnessed that very less attention has been paid on risk communication, leading to social isolation and discrimination of COVID patients, community resistance toward testing, etc., It is of utmost importance to carry out intensive risk communication and advisory activities to make people aware who actually require it and how much protection it can give. In due course of time, the demand of vaccine might keep on decreasing. Further, acceptability of vaccine for the general population is also questionable. History revealed poor utilization of flu vaccine introduced after H1N1 pandemic. Hence, a pre-introduction acceptability survey among the general population is recommended. Although vaccination against COVID19 is voluntary, generating a certificate after vaccination may point to a purported design to force people to adopt vaccines as it may be mandated for travel and other businesses. Underutilized vaccines may create an economic burden for the society. COVID-19 digital certificate to show proof of only COVID-19 vaccinations in India.

However, in the context of vaccination certificates, it is necessary to examine the risks that have been repeatedly highlighted by the Indian and global communities, namely the growing market for counterfeit certificates of various kinds. Europol, for example, has also warned in its reports of the risks of misuse – in particular of test certificates. False certificates can pose a significant risk to public health. The authorities of one Member State must be sure that the information contained in a certificate issued in another Member State is reliable, that it has not been falsified, that it belongs to the person presenting it and that anyone verifying the information has access to only the minimum amount of information necessary. To achieve population immunity first we have to find the non-vaccinated population to this end, this project proposed an Aadhaar-based facial recognition system is used to find non-vaccination citizen and alert them using Artificial Intelligence.

1.2. Artificial Intelligence

Artificial Intelligence (AI) is the field of computer science dedicated to solving cognitive problems commonly associated with human intelligence, such as learning, problem solving, and pattern recognition. Artificial Intelligence, often abbreviated as "AI", may connote robotics or futuristic scenes, AI goes well beyond the automatons of science fiction, into the non-fiction of modern-

day advanced computer science. Professor Pedro Domingos, a prominent researcher in this field, describes “five tribes” of machine learning, comprised of symbolists, with origins in logic and philosophy; connectionists, stemming from neuroscience; evolutionaries, relating to evolutionary biology; Bayesians, engaged with statistics and probability; and analogizers with origins in psychology. Recently, advances in the efficiency of statistical computation have led to Bayesians being successful at furthering the field in a number of areas, under the name “machine learning”. Similarly, advances in network computation have led to connectionists furthering a subfield under the name “deep learning”. Machine learning (ML) and deep learning (DL) are both computer science fields derived from the discipline of Artificial Intelligence.

Broadly, these techniques are separated into “supervised” and “unsupervised” learning techniques, where “supervised” uses training data that includes the desired output, and “unsupervised” uses training data without the desired output.

AI becomes “smarter” and learns faster with more data, and every day, businesses are generating this fuel for running machine learning and deep learning solutions, whether collected and extracted from a data warehouse like Amazon Redshift, ground-truthed through the power of “the crowd” with Mechanical Turk, or dynamically mined through Kinesis Streams. Further, with the advent of IoT, sensor technology exponentially adds to the amount of data to be analyzed -- data from sources and places and objects and events that have previously been nearly untouched.

1.2.1. History of AI

The history of artificial intelligence goes as far back as ancient Greece. However, it’s the rise of electronic computing that made AI a real possibility. Note that what is considered AI has changed as the technology evolves. For example, a few decades ago, machines that could perform optimal character recognition (OCR) or simple arithmetic were categorized as AI. Today, OCR and basic calculations are not considered AI but rather an elementary function of a computer system.

- 1950s – Alan Turing, a man famous for breaking the WWII ENIGMA code used by the Nazis, publishes the Computing Machinery and Intelligence paper in the Mind. He attempts to answer the question of whether machines can think. He outlines the Turing Test that determines whether a computer shows the same intelligence as a human. The test holds that an AI system should have the ability to hold a conversation with a human without the human knowing they are speaking to an AI system. The first ever AI conference is held at Dartmouth College. It’s here that the term artificial intelligence was first used.
- 1960s – The US Department of Defense through DARPA takes great interest in AI and embarks on developing computer programs that mimic human reasoning. Frank Rosenblatt builds the Mark 1 Perceptron computer based on a neural network that learns through experience.
- 1970s – DARPA completes various street mapping projects.
- 1980s – A more complex wave of AI emerges. Neural networks with backpropagation algorithms find widespread application in AI systems.
- 1990s – Exponentially growing volumes of data are produced. Powerful computers process large quantities of data quickly. The Deep Blue supercomputer defeats world chess champion Garry Kasparov twice. The Genome Sequencing project and other similarly complex undertakings generate vast information. Computing advances make it possible for this data to be stored, accessed, and analyzed.
- 2000s – The Internet Revolution drives AI to unprecedented heights. Big data joins corporate lexicon. DARPA rolls out intelligent personal assistants long before Alexa, Siri, Cortana, and Google Assistant become household names. This paves the way for the reasoning and automation that’s a part of present-day personal computers and smartphones. That includes smart search systems and decision support systems that augment and complement human abilities.
- 2010s – China’s search giant Baidu unveils the Minwa supercomputer that relies on a convolutional neural network to identify, analyze, and categorize images with higher accuracy than the average human. The AlphaGo deep neural network program from DeepMind beats Go world champion Lee Sodol in a five-game match. Go is an ancient Chinese game that’s considerably more complex than chess.

1.2.2. AI in everyday life

Below are some AI applications that you may not realize are AI-powered:

Online shopping and advertising

Artificial intelligence is widely used to provide personalized recommendations to people, based for example on their previous searches and purchases or other online behavior. AI is hugely important in commerce: optimizing products, planning inventory, logistics etc.

Web search

Search engines learn from the vast input of data, provided by their users to provide relevant search results.

Digital personal assistants

Smartphones use AI to provide services that are as relevant and personalized as possible. It providing recommendations and helping organize daily routines have become ubiquitous.

Machine translations

Language translation software, either based on written or spoken text, relies on artificial intelligence to provide and improve translations. This also applies to functions such as automated subtitles.

Smart homes, cities and infrastructure

Smart thermostats learn from our behavior to save energy, while developers of smart cities hope to regulate traffic to improve connectivity and reduce traffic jams.

Cars

While self-driving vehicles are not yet standard, cars already use AI-powered safety functions. The EU has for example helped to fund VI-DAS, automated sensors that detect possible dangerous situations and accidents.

Navigation is largely AI-powered.

Cybersecurity

AI systems can help recognize and fight cyberattacks and other cyber threats based on the continuous input of data, recognizing patterns and backtracking the attacks.

Artificial intelligence against Covid-19

In the case of Covid-19, AI has been used in thermal imaging in airports and elsewhere. In medicine it can help recognize infection from computerized tomography lung scans. It has also been used to provide data to track the spread of the disease.

Fighting disinformation

Certain AI applications can detect fake news and disinformation by mining social media information, looking for words that are sensational or alarming and identifying which online sources are deemed authoritative.

1.2.3. Deep Learning

Deep Learning is a branch of machine learning that involves layering algorithms in an effort to gain greater understanding of the data. The algorithms are no longer limited to create an explainable set of relationships as would a more basic regression. Instead, deep learning relies on these layers of non-linear algorithms to create distributed representations that interact based on a series of factors. Given large sets of training data, deep learning algorithms begin to be able to identify the relationships between elements. These relationships may be between shapes, colors, words, and more. From this, the system can then be used to create predictions. Within machine learning and artificial intelligence, the power of deep learning stems from the system being able to identify more relationships than humans could practically code in software, or relationships that humans may not even be able to perceive. After sufficient training, this allows the network of algorithms to begin to make predictions or interpretations of very complex data.

Image and Video Classification, Segmentation

Convolutional Neural Networks out-perform humans on many vision tasks including object classification. Given millions of labeled pictures, the system of algorithms is able to begin identifying the subject of the image. Many photo-storage services include facial recognition, driven by Deep Learning.

1.3. Project Scope

India is looking at adding Aadhaar-based facial recognition in an effort to make its COVID-19 vaccination procedure contactless. To test the efficacy of the facial recognition system, which is based on data obtained from the Aadhaar database. Aadhaar is already the “preferred” mode of identity verification and for vaccination certificates. Using facial recognition at vaccine centers risks further marginalizing vulnerable people who may be misidentified and refused the vaccine, and raises fears the controversial technology could become the norm at all centers.

1.4. Objective of the project

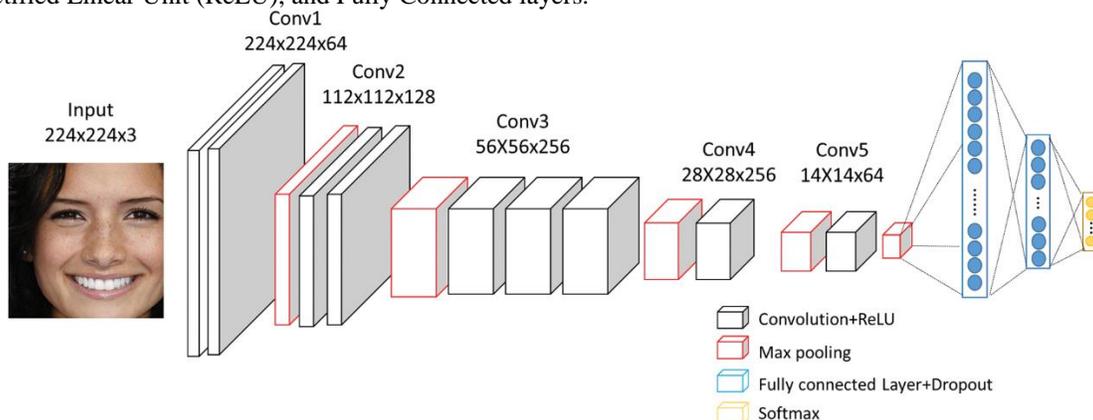
The main objective of the project is to develop an “Aadhaar-based facial recognition system could soon replace biometric fingerprint or iris scan machines at COVID-19 vaccination finder across the country in order to avoid non-vaccination,”

Proposed System

- This project provides COVID-19 vaccination status using their face and attest that an individual has received a vaccine or not and alert them to get vaccinated. Proposed an Aadhaar-based facial recognition system is used to find non-vaccination citizen and alert them using Artificial Intelligence.
- Deep learning in the form of Convolutional Neural Networks (CNNs) to perform the face recognition.

DCNN

CNNs are a category of Neural Networks that have proven very effective in areas such as image recognition and classification. CNNs are a type of feed-forward neural networks made up of many layers. CNNs consist of filters or kernels or neurons that have learnable weights or parameters and biases. Each filter takes some inputs, performs convolution and optionally follows it with a non-linearity. A typical CNN architecture can be seen as shown in Fig.1. The structure of CNN contains Convolutional, pooling, Rectified Linear Unit (ReLU), and Fully Connected layers.



A. Convolutional Layer: Convolutional layer performs the core building block of a Convolutional Network that does most of the computational heavy lifting. The primary purpose of Convolution layer is to extract features from the input data which is an image. Convolution preserves the spatial relationship between pixels by learning image features using small squares of input image. The input image is convoluted by employing a set of learnable neurons. This produces a feature map or activation map in the output image and after that the feature maps are fed as input data to the next convolutional layer.

B. Pooling Layer: Pooling layer reduces the dimensionality of each activation map but continues to have the most important information. The input images are divided into a set of non-overlapping rectangles. Each region is down-sampled by a non-linear operation such as average or maximum. This layer achieves better generalization, faster convergence, robust to translation and distortion and is usually placed between convolutional layers.

C. ReLU Layer: ReLU is a non-linear operation and includes units employing the rectifier. It is an element wise operation that means it is applied per pixel and reconstitutes all negative values in the feature map by zero. In order to understand how the ReLU operates, we assume that there is a neuron input given as x and from that the rectifier is defined as $f(x) = \max(0, x)$ in the literature for neural networks.

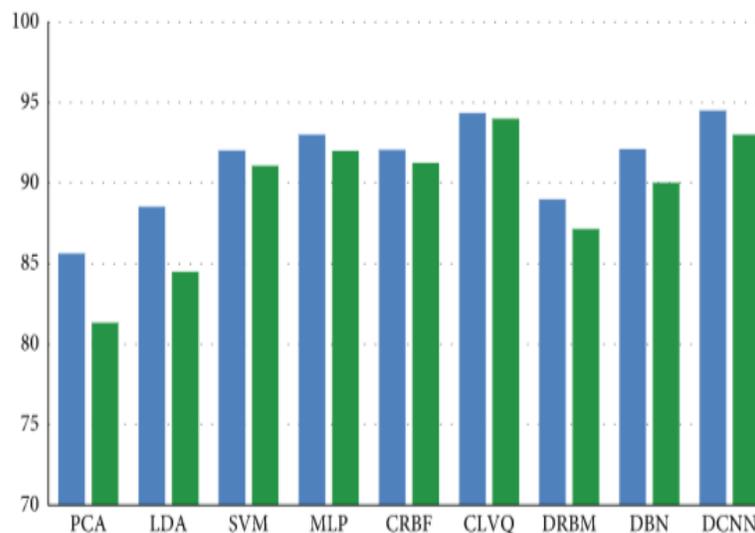
D. Fully Connected Layer: Fully Connected Layer (FCL) term refers to that every filter in the previous layer is connected to every filter in the next layer. The output from the convolutional, pooling, and ReLU layers are embodiments of high-level features of the input image. The goal of employing the FCL is to employ these features for classifying the input image into various classes based on the training dataset. FCL is regarded as final pooling layer feeding the features to a classifier that uses Softmax activation function. The sum of output probabilities from the Fully Connected Layer is 1. This is ensured by using the Softmax as the activation function. The Softmax function takes a vector of arbitrary real-valued scores and squashes it to a vector of values between zero and one that sum to one.

Advantages

- The system stores the faces that are detected and automatically marks vaccinated or not or Dose 1.
- Provide authorized access.
- Multiple face detection.
- Provide methods to maximize the number of extracted faces from an image.
- Ease of use.

RESULT AND DISCUSSION

A comparative evaluation based on the accuracy of the proposed face recognition Deep Convolutional Neural Network (DCNN) system, compared to Support Vector Machine (SVM), Linear Discriminant Analysis (LDA), Principal Component Analysis (PCA), as statistical approach, Multi-Layer Perceptron (MLP), Combined Radial Basis Function (CRBF), as neural network approach, Deep Restricted Boltzmann Machine (DRBM), Deep Belief Neural Nets (DBNN). The results show that the proposed DCNN achieves higher accuracy compared to other approaches.



Face Recognition Accuracy

CONCLUSION

A facial recognition system is a technology capable of matching a human face from a digital image or a video frame against a database of faces, typically employed to authenticate users through ID verification services, works by pinpointing and measuring facial features from a given image. In the context of the coronavirus disease (COVID-19) pandemic, A face recognition-based person's current vaccination status to protect against COVID-19 can then be used for continuity of care or as proof of vaccination for purposes other than health care. Facial recognition technology (FRT) along with the Aadhaar to authenticate people before entering into any kinds of service. This project provides COVID-19 vaccination status using their face and attest that an individual has received a vaccine or not and alert them to get vaccinated. The proposed classifier performance evaluation was presented as a confusion matrix, in terms of sensitivity, specificity, precision, accuracy, and F1 score. Results indicated that the proposed classifier has achieved higher recognition accuracy than ten other classifiers of the state of art.

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