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Topic

Classification of vocal cough for COVID-19 detection by Spectrogram images using deep learning

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Abstract

This work, which we present in our master thesis, is to develop a diagnostic support system that enables the detection of COVID-19 disease using human voice images. Since an accurate diagnosis of COVID-19 disease is a difficult task that requires a series of clinical examinations and tests to verify the signs and symptoms of the disease.

The objective of this project is to design an automated diagnostic system for the early detection of COVID-19 disease using schematic images of acoustic signals. The main goal is to differentiate between COVID-19 patients and healthy individuals.

The proposed system is based on two main steps: (1) feature extraction from the spectrograph and (2) classification by deep learning. The discriminative features we selected include two parameters: (1) the feature extraction process and (2) the neural network model parameters. The classification process is based on six deep learning classifiers and models: (1) (Alex Net), (Res Net5), (VGG 16), (VGG 19), and (ANN).

Feature extraction is performed by simulation software: MATLAB Mathworks, in addition to the classification process performed in simulation by SPYDER software.

The COVID-19 disease database we were able to obtain after manual structuring against a previous database was used in our experiments. The performance measures used in this study are: Accuracy, the loss curve and the Accuracy curve. The results obtained are different..

Keywords — : COVID-19 disease, early detection, feature extraction, deep learning, convolutional networks, classification.

ملخص

هذا العمل ، الذي نقدمه في أطروحة الماستر لدينا ، هو تطوير نظام دعم تشخيصي يمكّن من اكتشاف مرض COVID-19 باستخدام صور صوت الإنسان. نظرًا لأن التشخيص الدقيق لمرض COVID-19 يعد مهمة صعبة تتطلب سلسلة من الفحوصات والاختبارات السريرية للتحقق من علامات وأعراض المرض.

الهدف من هذا المشروع هو تصميم نظام تشخيص آلي للكشف المبكر عن مرض COVID-19 باستخدام صور تخطيطية للإشارات الصوتية. الهدف الرئيسي هو التفريق بين مرضى كوفيد -19 والأفراد الأصحاء.

يعتمد النظام المقترح على خطوتين رئيسيتين: (1) استخلاص الميزة من مقياس الطيف و (2) التصنيف بالتعلم العميق. تتضمن الميزات التمييزية التي اخترناها معلمتين: (1) عملية استخراج الميزات و (2) معلمات نموذج الشبكة العصبية. تعتمد عملية التصنيف على ستة نماذج ونماذج للتعلم العميق: (1) (Alex (1) (Net و Res) (Net5 و VGG) 16) و VGG) 19) و .(ANN) يتم استخراج الميزات بواسطة برنامج محاكاة: Mathworks MATLAB ، بالإضافة إلى عملية التصنيف التي يتم إجراؤها في المحاكاة بواسطة برنامج .SPYDER تم استخدام قاعدة بيانات مرض COVID-19 التي تمكنا من الحصول عليها بعد الهيكلة اليدوية على واحدة سابقة في تجاربنا. مقاييس الأداء المستخدمة في هذه الدراسة هي: الدقة ، منحنى الخسارة ومنحنى الدقة . النتائج التي تم الحصول عليها كانت مختلفة.

الكلمات المفتاحية--- امرض كوفيد -19 ، الكشف المبكر ، استخراج الميزات ، التعلم العميق ، الشبكات التلافيفية ، التصنيف.

Resume

Ce travail, que nous présentons dans notre mémoire de master , vise à développer un système d'aide au diagnostic qui permet de détecter la maladie COVID-19 à partir d'images de voix humaines. Un diagnostic précis de la maladie de COVID-19 étant une tâche difficile qui nécessite une série d'examens cliniques et de tests pour vérifier les signes et les symptômes de la maladie, l'objectif de ce projet est de concevoir un système de diagnostic automatisé pour la détection précoce de la maladie de COVID-19.

L'objectif de ce projet est de concevoir un système de diagnostic automatisé pour la détection précoce de la maladie de COVID-19 à l'aide d'images schématiques de signaux acoustiques. Le but principal est de différencier les patients atteints de COVID-19 des individus sains.

Le système proposé est basé sur deux étapes principales : (1) l'extraction de caractéristiques à partir du spectrographe et (2) la classification par apprentissage profond. Les caractéristiques discriminantes que nous avons sélectionnées comprennent deux paramètres : (1) le processus d'extraction des caractéristiques et (2) les paramètres du modèle de réseau neuronal. Le processus de classification est basé sur six classificateurs et modèles d'apprentissage profond : (1) (Alex Net), (Res Net5), (VGG 16), (VGG 19) et (ANN).

L'extraction des caractéristiques est réalisée à l'aide d'un logiciel de simulation : MATLAB Mathworks, en plus du processus de classification effectué en simulation par le logiciel SPYDER. La base de données de maladies COVID-19 que nous avons pu obtenir après une structuration manuelle par rapport à une base de données précédente a été utilisée dans nos expériences. Les mesures de performance utilisées dans cette étude sont : Accuracy, la courbe de perte et la courbe de Accuracy. Les résultats obtenus sont différents.

- Mots-clés: Maladie COVID-19, détection précoce, extraction de caractéristiques, apprentissage profond, réseaux convolutifs, classification.

ACKNOWLEDGMENTS

First of all, we thank **ALLAH**
who helped us and provided us with patience and courage during these years of study.

I would like to thank my distinguished Dr. **KHALED BENSID**
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my sincere thanks to dr. **ELMOUNDHER HEDJAIDJI**
for his patience, his efforts and his contribution to the development of this research and achieve good results in our study, as well as the success of this great academic year .

We would like to thank the members of the jury, Dr. Lati and Dr. Sami, for agreeing to review and evaluate our modest work. We would also like to express our sincere thanks to Dr. Hosni Mohamed Fouad and his colleagues Mohamed El-Eid and Ibrahim Ghawar for accompanying and guiding us, and to all my teachers for all their advice during these academic years. We would also like to take this opportunity to express our gratitude to all our teachers for their cooperation, availability, and empathy while teaching.

DEDICATIONS

We dedicate this modest work as a testimony of affectation, of admiration :

To My Family

With pleasure, with an open heart, and with great joy, I dedicate my work to my dear father and mother: ”He gave me life, tenderness, and the courage to succeed. All I can give you cannot express the love And my gratitude to you. In my testimony, I offer you this humble thanks for your work The sacrifices and passion with which it has always surrounded me. I dedicate this work to: my dear brothers Abd al-Rahman, Taha, and Zakaria, and to the star of the house, my dear sister, and to all my cousins, without exception. And my family is in Tunisia My dedications also go to my colleagues, companions, dear brothers and sisters, Yahya and chaker.

Dear friends

Who helped me build ideas and correct my many mistakes, motivating me by sharing words, advice, and constant encouragement with the perfect blend of insight and humor throughout my years of study and throughout the process of researching and writing this successful and enjoyable treatise. To all my friends who have accompanied me in my life. And my friends, Al-Moataz Allah, Ahmed, Abdel Kader, Mustafa, Massoud, Abdullah, and Abdul Razzak, all those who have passed through my life.

Ahmed

DEDICATIONS

We dedicate this modest work as a testimony of affectation, of admiration :

To My Familly

To my loving family. My dad who has been my constant support and source of inspiration throughout this journey. Mom, your love and encouragement has been the driving force behind my success And My very dear brothers ahmed and Shaker.

Dear friend

To my dear friends, who have been my pillars of strength and have stood by me through thick and thin. Your unwavering support and encouragement have been a constant source of motivation for me.
Thank you for believing in me, cheering me on, and always being there. I could not have done it without you.

yahya

DEDICATIONS

We dedicate this modest work as a testimony of affectation, of admiration :

To My Familly

I dedicate this graduation to the one who taught me life's lessons and I desperately await this day, and to the one whose name I proudly bear "my father", and to my angel in life, and the one whose supplication was the secret of my success "my beloved mother". And my dear brothers:walid and issam, azzaoui and Muhammad chafik, and my two precious sisters. And to all my beloved family I dedicate my diploma to my colleagues and brothers Ahmed and Yahya.

Dear friend

To my friends who were like brothers Abd al-Karim, Reda, Ayman, Abd alkader, Moluki,Hakim,ahmed zaidi and ahmed elzain and all my friends. And a special thanks to My friends from Aoulef .

chaker

List of abbreviation

SARS − COV2:	severe acute respiratory syndrome coronavirus 2
RT − PCR:	reverse transcription-polymerase chain reaction
WHO:	World Health Organization
AI:	Artificial Intelligence
DL:	Deep learning
ML:	Machine learning
ANN:	Artificial Neural Network
CNN:	Convolution neural networks
RNNs:	Recurrent neural networks
STFT:	Short-Time Fourier Transform
VGG NET :	Visual Geometry Group
Res Net :	Residual Network
MDVR-KCL:	Mobile Device Voice Recordings at King's College London
Train:	Training
val:	valition
TP:	True Positive
TN:	True Negative
FP:	False positive
FN:	False negative

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General Introduction

Introduction

In 2019, the world witnessed the emergence of a strange, fast-spreading, and contagious virus, and the emergence of several cases of pneumonia of unknown origin in China, Wuhan, led to the emergence of a new virus called $Covid-19$ virus [1]
. And that $Covid-19$ has greatly affected human life in various fields of science and health [2]. It also led to changes that forced most of the world's businesses to move to the digital world and speed up their work [3]
. The rapid and terrifying spread of $theCovid-19$ virus, in the form of severe acute syndrome ($SARS-COV2$), led to the spread of the crown around the world [4], and scientists and doctors sought to find solutions and methods to diagnose the virus, and that early diagnosis using rapid and advanced technologies to reduce De the spread of COVID-19, ($RT-PCR$) test considered a great and gold standard for early detection of Corona and limiting its spread [5], And the Real-time reverse transcription polymerase chain reaction test ($RT-PCR$) is the method recommended by doctors and scientific experts to detect COVID-19 and limit its spread ($SAR-COV2$) [6]
. And $Covid-19$ affects human life in all respects, so we know that the coronavirus mainly targets the respiratory system, which leads to disturbances and changes in Voice, because many different voice problems have been reported that may be associated with chronic cough and can affect our daily life and its quality [7].it can be associated with chronic diseases. cough and can affect life Voice disorders are part of the general health problems that affect our lives, and their prevalence rate in the world is 30% among the ordinary population, and a significant percentage among professional voice users, as a result of the $Covid-19$ virus [8]. And that this virus greatly affected the quality of the human voice by conducting an audio analysis of 64 corona patients and 70 healthy speakers, which led to a significant difference in the results and the appearance of symptoms and voice disorders[9]
. Artificial intelligence also played a major and important role in the diagnosis of coronavirus symptoms, automatically analyzing patient data. The deep learning model showed similar performance to radiologists, and will significantly improve the efficiency of radiologists in medical practice[10]
.

Contribution

We are contributing to the design of a diagnostic aid system that enables early detection of COVID-19, and more specifically, in this work we have undertaken, we are interested in distinguishing between healthy and infected patients exposed to COVID-19 using cough sound spectrogram images. The approach we have proposed is based on two main steps: extraction and conversion of cough sounds into spectrograms, and classification. by extracting features. Our classification process is based on five classifiers powered by convolutional deep learning networks (CNNs): - (Resnet) - (VGG16) - (VGG19) - (Alexnet) - (ANN). . Sounds are converted to spectrograms and features are extracted by simulation software: MATLAB from MathWorks. . Classification is performed by simulation software: SPAYDER from spyder-ide.org. . A database of specification jobs is used in our experiments. The performance measures used in this study are accuracy (loss curve)and (Accuracy curve).

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Memory organization

Our work is organized as follows :

The first chapter: In this chapter, we introduce sound, explain its structures and characteristics, discuss various types of disorders that occur in the voice, and discuss and explain the COVID-19 virus.

The second chapter: is dedicated to the proposed method.

The third chapter: is dedicated to the experimental results and discussion.

Conclusion and perspectives.

Voice and Vocal Tract Generalities

I.1 introduction

Sound is an important part of our daily life, as it allows us to explain and Communicate with others. Therefore, the human body contains a structural and structural that helps to produce this sound, thanks to the presence of a vocal tract that contains the larynx, pharynx, nasal and oral cavities, so that these basic elements of the vocal system play their role effectively, which leads to the production of different sounds or speech
. And that this sound is related to the elements of its production, because one of its basic production elements can be damaged, which leads to voice disturbance, such as cough diseases and $Covid-19$
. The vibration of the vocal cords is the main source of sound production. Most people with $Covid-19$ have symptoms in the respiratory system. With moderate to severe and significant impairment of the respiratory system associated with the vocal system[11]
.
In this chapter, we present in the first part the anatomy of the vocal tract and voice production and its characteristics. then the definition of voice. The second part.

I.2 Definition of The voice

It is a set of sound waveforms resulting from the recording of the occurrence of a sound or the speech process of a person or any sound
. A waveform is a kind of graph proportional to time on the X-axis and amplitude on the Y-axis. Waveforms are very useful for conveying basic information about the composition of a sound recording by displaying all the high and low bits of that recording, as well as other information.
To define voice disorders, the voice and the anatomy of the human voice should be defined first:

1. Definition and Anatomy of the vocal Tract

The vocal tract consists of a set of parts that interact with each other to produce Sound and a set of these parts must work together to perform the specific function of producing sound. The first is the respirator, which acts like a compressor: it compresses the air in

the lungs

. The second is a pair of vocal cords, which act as a sound generator: using vibrations, and the third is the larynx and pharynx, passing through the oral cavity and pharynx, which works to formulate the sound or bring out the sound [12], and these elements are responsible for the production of sound, and each component is made up of this components[13]

. The four are smaller components inside, allowing it to carry out its task from this process, so we need all of these essential elements. as shown in Figure:

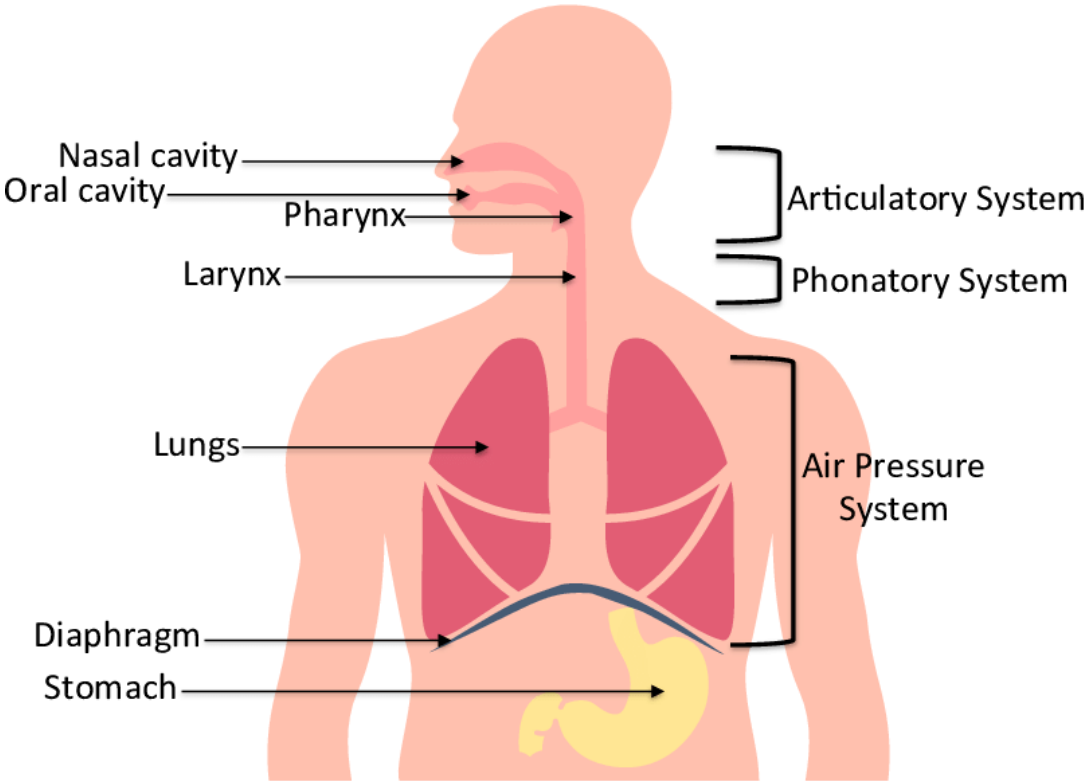

Figure 1: anatomy of the vocal tract.

I.2.a The Pharynx:

The pharynx is a cavity that connects the nasal and oral cavities to the larynx, and it is these parts that we will discuss after the pharynx. It is the larynx that produces the sound, which is a form of vibration, and the pharynx plays an important role in this sound because it amplifies or resonates with this sound. The shape of the throat, mouth, and nose is also a qualitative element because it transforms the vibrating sound produced by the larynx into different understandable sound

. The larynx is divided into two parts:

- The esophagus which connects to the stomach.
- The trachea which connects to the lungs.

The pharynx plays an important role in the physiological process of swallowing safely and transporting food into the esophagus through its various muscles [14].

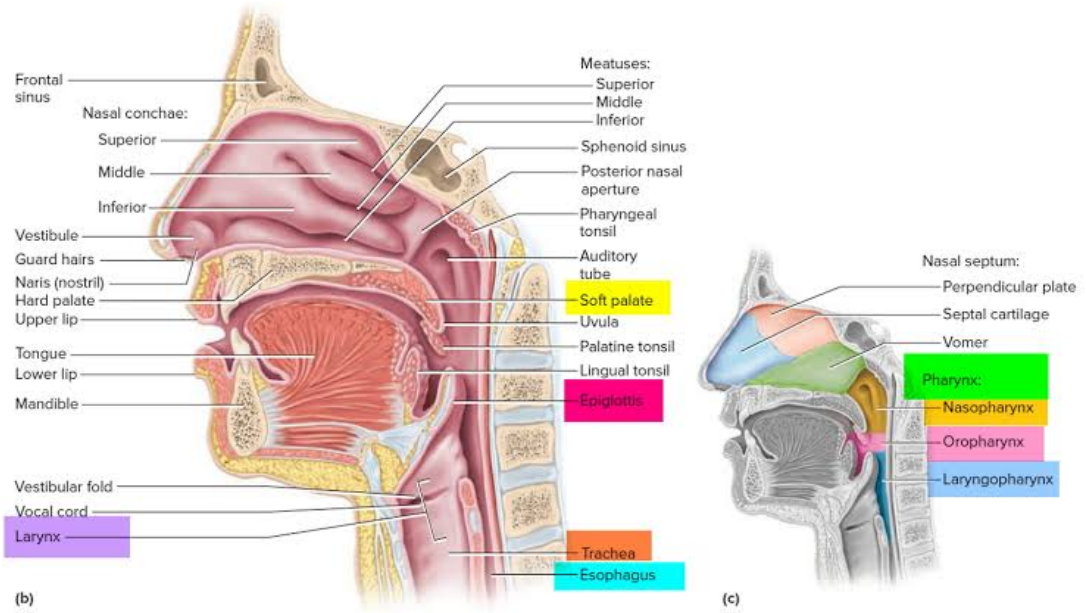

Figure 2: Anatomy of the pharynx

I.2.b The Larynx:

The larynx is called the voice box because it is the organ that contains the vocal Cords, and it is also called the vocal cords because of its folded shape. The larynx Consists of nine cartilages connected by ligaments and muscles. It measures 4 cm to 5 cm in length and diameter and is generally smaller in women than in men. Air flows Through the larynx to and from the lungs. As this air passes through the closed vocal Cords, it causes

them to vibrate against each other and produce the sound that Eventually becomes a tone. As a result of all the words we speak, the larynx provides a tight vocal system that allows vocal and articulatory communication with the pharynx, oral cavity, and nose [15]

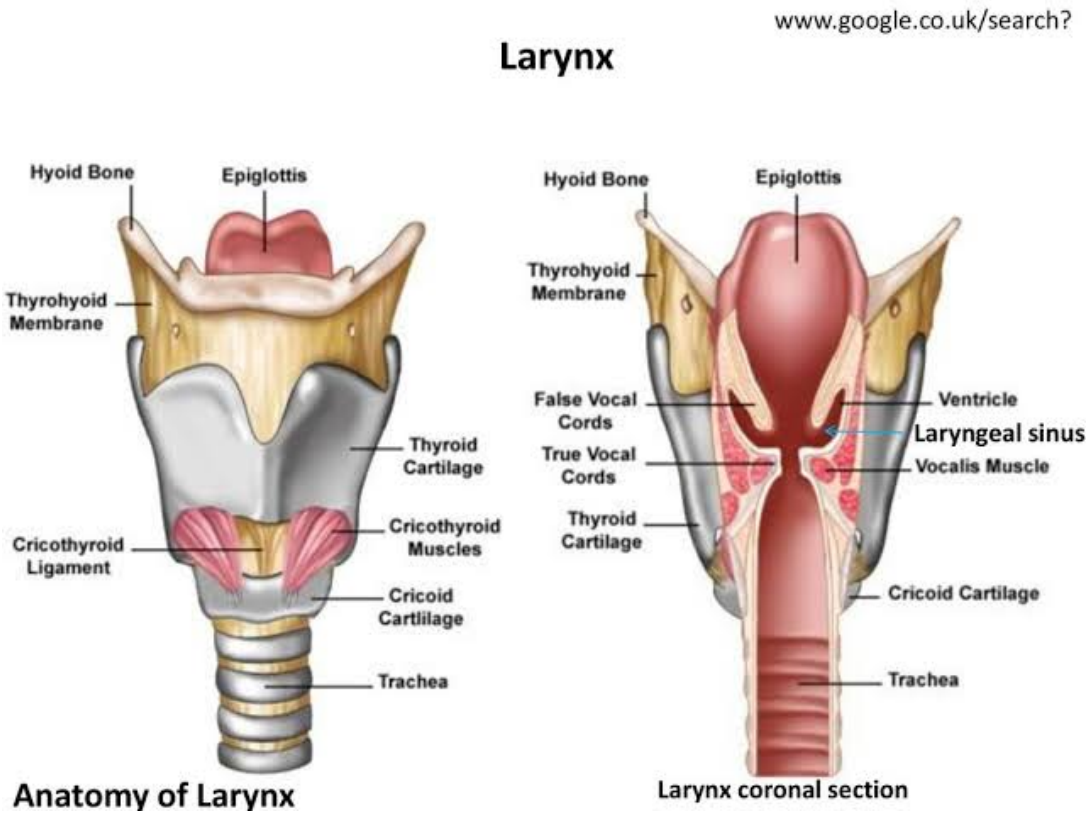

Figure 3: Anatomy of the Larynx

1.3 The oral cavity:

The oral cavity is part of the vocal system and consists of the tongue, teeth, and Lips. The oral cavity and oropharynx consist of the upper part of the digestive system. These two areas are distinct from each other[16]. All of these elements of the larynx Help shape the air in the vocal tract to create the different types of speech sounds we make, regardless of their effect. Type, sing, shout, or speak normally

. The hard surface of the oral cavity is called the hard palate, which is the softest part of the palate, and at the end is the uvula, which is the soft part. All these structures in the oral cavity work together to produce a variety of sounds

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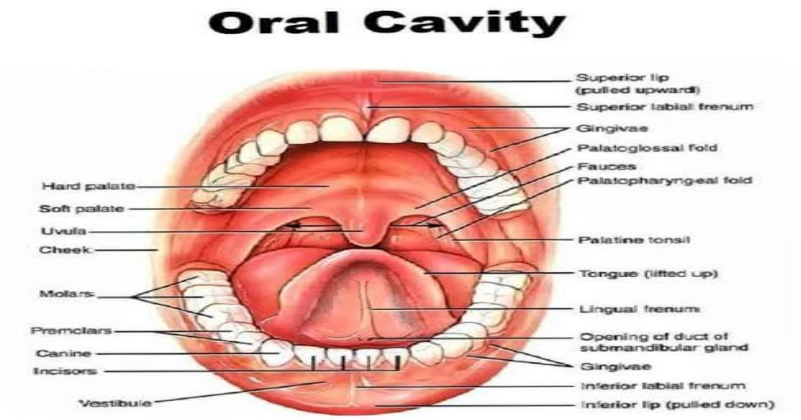

Figure 4: Anatomy of the Oral cavity.

1.3 The Nasal cavity:

The nasal cavity is important for the respiratory system because it warms and Hydrates the air we breathe, and the cavity of the mouth and its bony components Form the upper and lower jaw, the nasal cavity and sinuses that we are now talking about the most of the parts of the face [17]. And that the latter plays a role in speech there are sounds called nasal sounds.

These sounds are produced when air comes out through the nasal cavity rather than the oral cavity or mouth.

In addition to the role of the nasal cavity in the vocal tract, there is also an area responsible for the sense of smell that sends information about the smell we smell to the brain.

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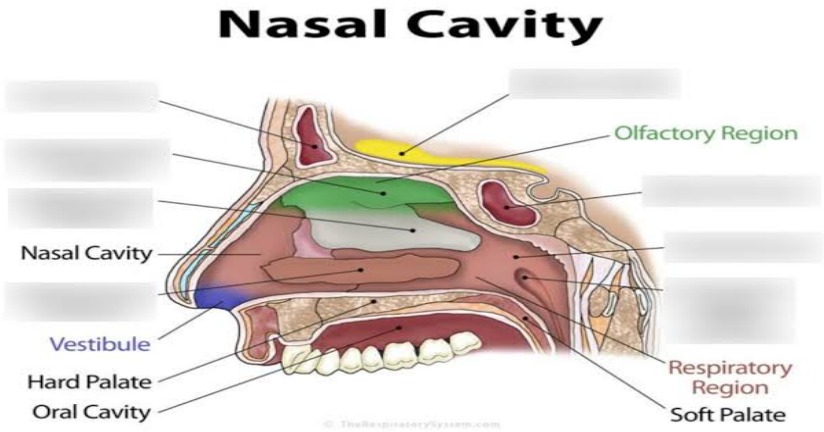

Figure 5: Anatomy of the Nasal cavity..

2. The voice parameters:

Sound is characterized by a number of important characteristics namely:

2.1 Wavelength:

This sound characteristic refers to the minimum distance over which a sound wave repeats.

2.2 Wave velocity:

It is the distance traveled by the sound wave in one second. The wave velocity is measured in meters per second.

2.3 Intensity:

It is the maximum displacement of the particles in the medium through which the sound passes, that is to say, the intensity that the sound passes through which it passes. It is measured or expressed in decibels, and in low tones the sound is Controlled the controlled by the control of the oboe, while the opposite is done in the high voice [18].

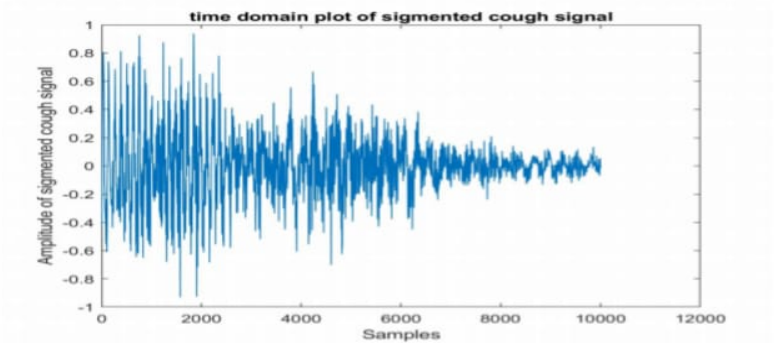

Figure 6: Intensity of the voice.

2.4 Time period:

It is the period of time it takes to emit a sound wave, a complete sound cycle, or the time it takes for the sound to vibrate until it ends.

2.5Frequency (pitch):

This is the frequency of the number of sound waves or the number of cycles that occur in one second, and the frequency of waves is measured in hertz(HZ). The classification of sounds differs according to the different types of frequencies, tones, and slopes of the sound spectrum. The difference in frequencies has been observed between men and women, and this may be due to the different lengths of the mouth, pharynx, etc.[19].

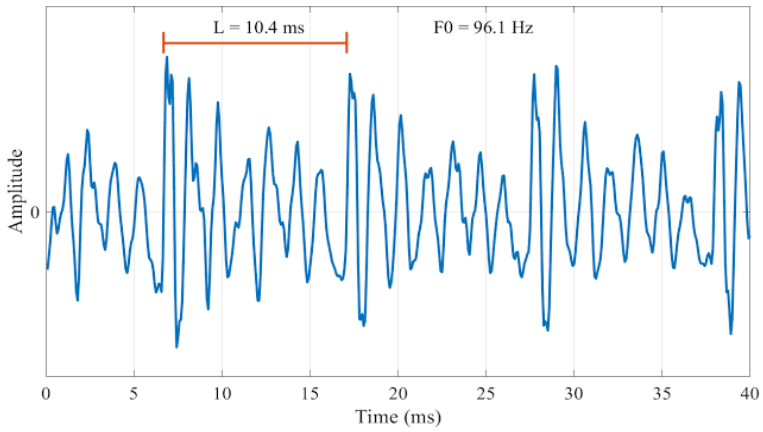

Figure 7: pitch of the voice.

3. Voice Disorders and its changes:

As we have already mentioned, the voice is a very important thing in our life and it is what allows us to do all our actions of all kinds, which is the result of a structural process that occurs in the vocal tract of different kinds

. Components that contribute to the production of speech, one of these components can develop a defect or disease in our body. It prevents it from performing its function, resulting in a change or disturbance of the voice. Voice disorders generally fall into one of the following categories, but they may overlap: The structures that produce sound are the larynx and vocal cords. Functional disorders of the vocal tract usually result from the inability to use the vocal cord muscles or vocal cords. A defect in the vocal cord as a result of diseases that affect this part of the body such as coughing and wheezing failure of vocal therapy is often associated with the persistence of smoking, non-compliance with treatment, or early discontinuation of treatment

3.1 Functional:

The structures that produce sound are the larynx and vocal cords. Functional disorders of the vocal tract usually result from the inability to use the vocal cord muscles or vocal cords. A defect in the vocal cord as a result of diseases that affect this part of the body such as coughing and wheezing failure of vocal therapy is often associated with the persistence of smoking, non-compliance with treatment, or early discontinuation of treatment [20]. These skeletal disorders can also result from:

- Dystopia.
- Pharyngeal contraction.
- Curvature of the vocal cords.

3.2 Organic:

The voice is exposed to many changes that occur to it, the most important of which we are organic problems, which are the occurrence of organic problems in the natural structure of the larynx or vocal cords, or a defect in the lungs and are divided into two parts

.

3.2.a Structural:

Which are problems related to the strutting in the organic structure including:

- Laryngitis.
- Output..
- $Covid-19$.
- Abnormal growths in the larynx (malformations).

3.2.b Nervous:

This refers to the occurrence of neurological problems in the brain-related nerves of the voice or disorders in the nerves that affect the larynx, including:

- partial paralysis..
- Parkinson's disease..
- spasmodic dysarthrie (laryngeal tension).

Is a common voice disorder that is usually simple to manage Most people suffer from hoarseness with upper respiratory tract infection, which is treated gradually over time, avoiding hoarseness and other irritants such as smoking and others[21]

.

3.3 Psychological:

These are disorders and problems related to the human psyche, and despite their rarity, some voice disorders develop due to emtins stress or trauma. This can be the result of anxiety depression, crying, and so on

. And the psychological effects of voices lot, are deep and wide-ranging in the context of a book called "Psychology of voice disorders " was written by specialists and doctors, and it is the first book that provides an honest and clear vision of patients who suffer from voice disorders as a result of various psychological changes and this book included 3 chapters that included3 what is related to our topic [22].

4.COVID-19:

Several western, dangerous and unknown infections were recorded in China in 2019, and this virus was the dangerous and contagious $Covid-19$ virus caused by the virus $(SARS-COV-2)$, which led to a wide spread of the Corona pandemic, which leads to the emergence of thousands of infections and deaths worldwide[23]

. $Covid-19$ virus is a corona virus, which is caused by severe acute respiratory syndrome, and with a high-throughput structural analysis of the virus $(SARS-COV-2)$, we analyzed the structure of the non-skeletal protein, and that protein encoded by $ORF1$ a which has no specific function, but it can This is the cause of viral RNA production and synthesis, and the structure of the protein is clarified [24], $SARS-COV$, $MERS-COV$ and $SARS-COV-2$ are still unknown because 96.2% of the SARS class is similar to the bat genome COV_2 and therefore The natural source of this virus is considered to be bats, and this is called the transformation from bat to human $(SARS-COV-2)$

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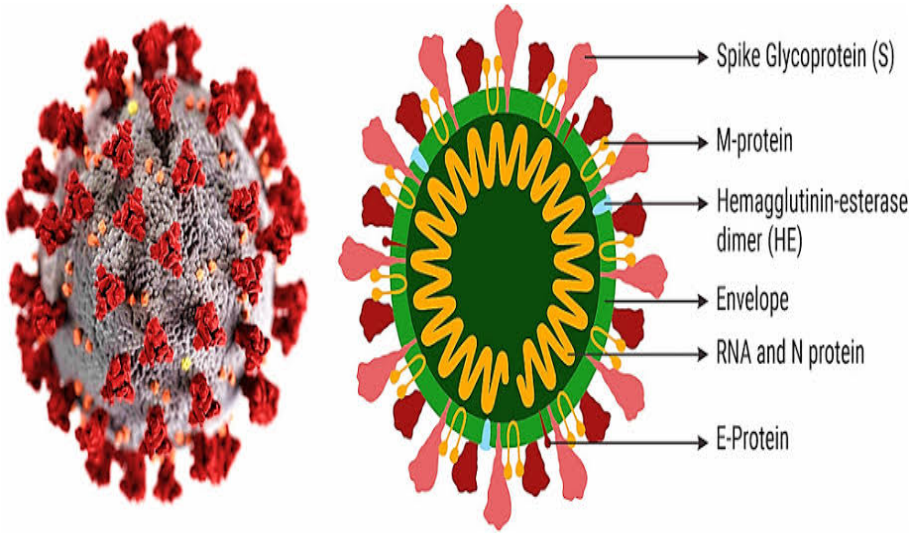

Figure 8: The structure of the corona virus
[25]

$Covid-19$ the virus is an infectious and fast-spreading virus, because several months after its appearance in China, the virus was able to spread to almost all parts of the world, due to its easy spread, so that the World Health Organization (WHO) declared $Covid-19$ is a global pandemic because on June 3, 2020, the coronavirus caused more than 6,500,000 detected cases of infection in 210 countries and regions and about 383,000 confirmed deaths pared through respiratory droplets that are spread during the speech [26]

. $Covid-19$ or $SARS-COV-2$ virus is thought to be widely and extensively spread by respiratory droplets that are spread during coughing and sneezing of a person with $Covid-19$, and this included that $Covid-19$ virus is transmitted in two ways, directly and indirectly, and includes the direct case (1) which is the transmission through aerosols formed by surgical and dental procedures, body fluids and secretions such as:(stool, saliva, urine..) And indirectly from tools or surfaces such as :(furniture and accessories) in the immediate environment of the infected patient and objects used on the infected person such as (a stethoscope or thermometer) [27] [28].

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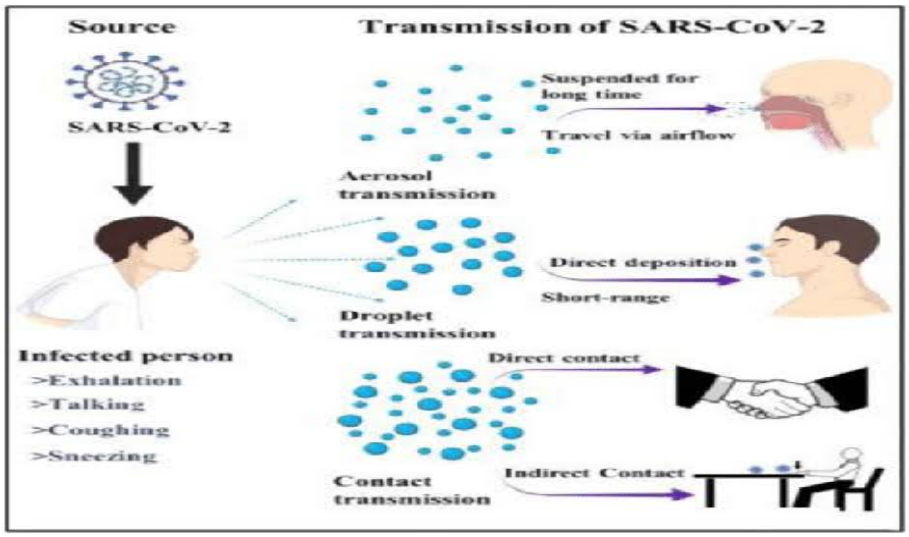


Figure 9: The schematic of ways of transmission of covid-19.
[29] [30]

The World Health Organization (WHO) reported that the Coronavirus has significantly decreased in October 2022 compared to last winter, due to the significant decrease in the number of deaths and the number of recorded cases, and doctors and experts around the world have recommended that certain measures and methods should be followed to prevent and avoid the spread of $Covid-19$, through pharmaceutical and non-pharmacological interventions. Coronavirus prevention includes social distancing, the use of face masks, environmental hygiene, and hand washing. Pharmaceutical interventions for the prevention of the virus are different vaccines, and reuse of fixed drugs for short-term prevention is a more urgent option, as some have done Researchers promote *chloroquine* and *hydroxychloroquine* for the treatment and prevention of various diseases, including $(hydroxychloroquine-2)$ [27].

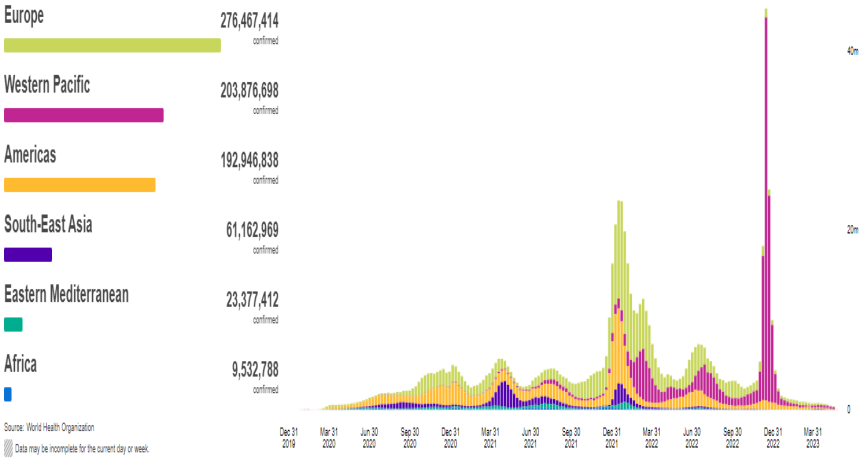


Figure 10: The schematic of Daily confirmed cases of $covid-19$ by world [31]

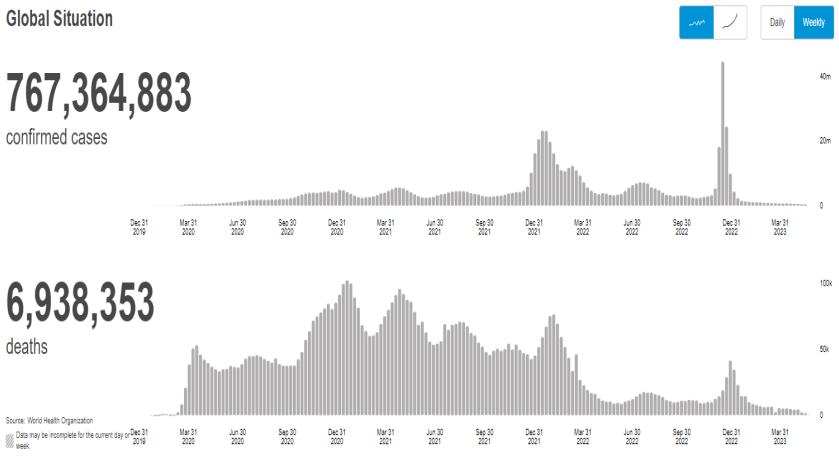


Figure 11: The schematic of Global Situation confirmed cases And deaths [31]

IV. Conclusion

Since the emergence of the corona epidemic and its spread around the world, many studies and different techniques have been carried out in order to detect the infection by the $covid-19$ virus to reduce its spread, using medical techniques or other modern technologies such as AI (artificial intelligence) and others

. In this chapter of our work, we have defined and explained the vocal tract with all its basic components we have to know the voice and the disturbances that occur in the voice of all kinds, and the features that make up the sound have been discussed and explained, and we have discussed the coronavirus, its composition the modes of transmission between individuals, And the Data on the cases of infection with the virus in the world

. In the next chapter, we will discuss deep learning, feature extraction, classifiers, and spectrogram ways to use sound images in $covid-19$ detection, and present our system and how to use it.

Artificial Intelligence, Machine learning And Deep Learning Features Extraction and Classification.

II. Introduction

In recent years, scientists and doctors have tried many new and rapid ways Methods and mechanisms of the process of detecting diseases of all kinds, but With the advent of artificial intelligence, the latter has revolutionized the medical Field, thanks to its use of rapid detection and diagnosis of diseases. And compare the results of disease diagnosis between doctors and Artificial Intelligence Recent advances in image analysis, particularly the application of artificial intelligence (AI), have the potential to automate these processes and support more accurate and rapid diagnoses. [32] These technologies are preferred for use in medical detection systems because of their speed and reliability. As a result, there has been a growing interest among healthcare professionals and scientists to explore the potential of AI algorithms in disease detection, so proper clinical evaluation of AI algorithms before their adoption in practice is essential. The clinical evaluation aims to confirm acceptable AI performance through appropriate external testing and to confirm the benefits of AI-assisted care over conventional care through appropriately designed and conducted studies, for which prospective studies are desirable.[33] These findings underscore the growing importance of AI in the medical field and its potential to transform disease detection and diagnosis.

II-1 Artificial intelligence

In recent years, artificial intelligence (AI) has become an integral part of our daily lives, as machines equipped with AI capabilities have proven capable of performing various tasks, such as playing chess and recognizing handwriting, as human. The field of artificial intelligence involves the development of machines capable of performing tasks that normally require human-level intelligence and cognitive abilities. The term ”artificial intelligence” was first coined in 1956. Artificial intelligence is a branch of computer science capable of analyzing complex medical data. Their ability to exploit a meaningful relationship with the dataset can be used in diagnosis, treatment and prediction of outcomes in a multitude of clinical scenarios[34]. AI objects differ from natural intelligence in that they are artifacts that possess special properties not normally possessed by artifacts. They are therefore things that have a certain property (intelligence) as a result of a certain process (because they were created, designed, or manufactured in this way). [35].

AI is comprised of a set of systems and algorithms that enable machines and devices to simulate human intelligence and cognitive processes, thereby allowing them to perform tasks that are similar to those performed by humans. These capabilities are achieved through specific processes, as machines are designed and manufactured in a manner that enables them to emulate human intelligence [35].

II-1-1deep Learning

Deep learning is a simulation process in which digital devices such as computers process data in a way that mimics the processing of a human brain. Deep learning involves computer models consisting of multiple layers of abstraction and has been enhanced with various technologies such as speech recognition and visualizations. Deep learning is a branch of machine learning that attempts to model high-level abstract data using multiple layers of neurons composed of complex structures or nonlinear transformations. As the amount of data and computing power increases.[36]. Artificial neural networks (ANN) are used to simulate the human mind and its intelligence, and these networks consist of multiple neural layers. Deep learning relies on hidden and subtle neural layers, which makes it different from traditional neural networks.

Different types of deep neural networks are used for different tasks. Convolutional neural networks (CNN) are specialized in image recognition, image processing, and face recognition. Recurrent neural networks (RNNs) are specialized in understanding and processing sequential data.

There are different types of deep neural networks, and they differ in their tasks and functions. Neural networks have been widely used in many applications, such as image classification and understanding, language processing, and control of autonomous systems. These networks work by mapping inputs to outputs through a series of layers. In each layer, the input to that layer undergoes an affine transformation followed by a simple nonlinear transformation before being passed to the next layer .[37]

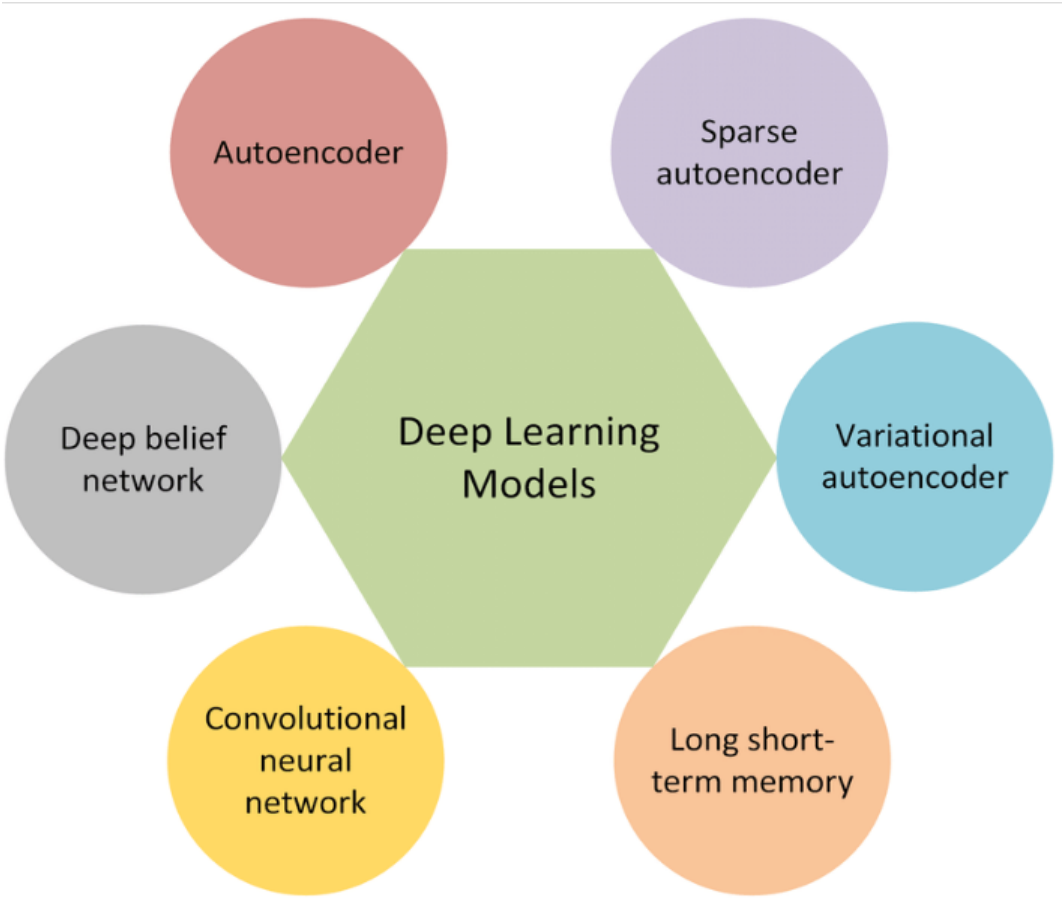


Figure 12: deep Learning types.

II-1-2 Difference Between Deep learning And Machine learning:

Machine learning and deep learning are fundamental components of artificial intelligence, as they are used extensively in data science with complex and powerful applications. Deep learning employs a set of algorithms, similar to neural networks, to simulate human intelligence. In contrast, machine learning selects variables that aid in the prediction process to extract and identify features. The primary difference between machine learning (ML) and deep learning (DL) is that ML can handle structured data by performing the process of extracting and classifying features, whereas DL can handle both structured and unstructured data such as sounds and images.

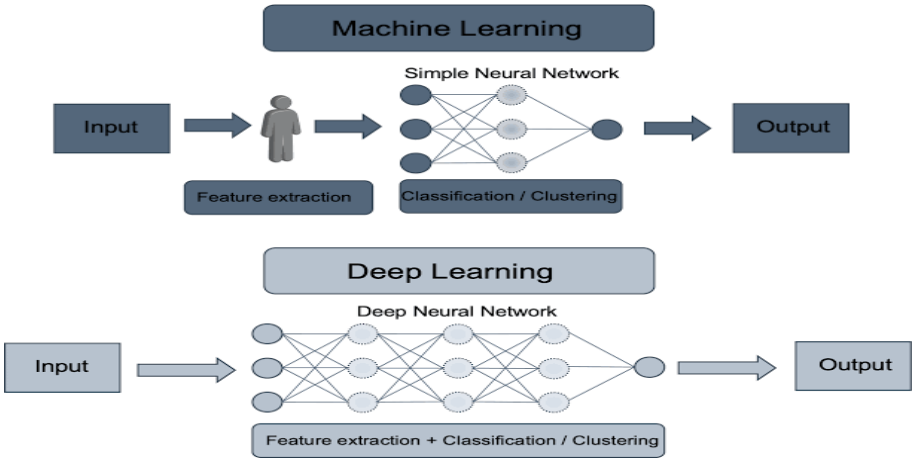


Figure 13: schematic of Different Between Deep learning And Machine learning.

II-1-3 : Feature Extraction :

Feature extraction is a crucial component of the dimensionality reduction and scaling process. It involves identifying the most significant data and features from raw data without compromising crucial information. Feature extraction also aids in data control by grouping them and then selecting variables to merge into features, thereby obtaining the best outcomes from the data groups and reducing duplicate data within the group. Feature extraction is an essential part of building machine models, and it helps generalize, process data, and increase speed while reducing errors. Various AI applications, such as audio and image processing, rely on feature extraction to classify the characteristics of data. For example, one study found that feature extraction is central to diagnosis, classification, clustering, recognition, and detection. It may be of interest to many researchers to choose appropriate features that are used in applications.[38]

1-4 Spectogram:

Sound is produced by the human vocal tract in the form of sound waves that vary in intensity and duration. Spectrograms provide a graphical representation of these sound waves and contain information about the frequency, strength, pitch, and time of the sound. However, the process of obtaining accurate representations of sound remains controversial due to the different methods used.

A spectrogram is a visual representation of the spectrum of signal frequencies synchronized in time. Spectrographs are sometimes called echocardiograms, sound fingerprints, or sonograms. Spectral maps are widely used in the fields of music, radar, speech pro-

cessing, seismology, etc. Phonograms can be used to identify phonetically pronounced words and to analyze the calls of various animals.

Another method is the short-range Fourier transform (STFT), which analyzes a small part of the waveform to obtain the spectral graph of the sound. A study has been carried out with the main purpose of this paper being to present a method that allows the extraction of vibrational components from a high-resolution spectroscopy based on the STFT evaluated as an image to support transient analysis on rotating machinery.[39]

- This graph represents the energy of sound as a function of time and frequency and can be obtained using the formula $S(\omega) = |X(m, \omega_k)|^2$ Spectral maps can be useful in various applications, such as studying recorded seismic signals, distinguishing between different types of signals, and identifying their differences.

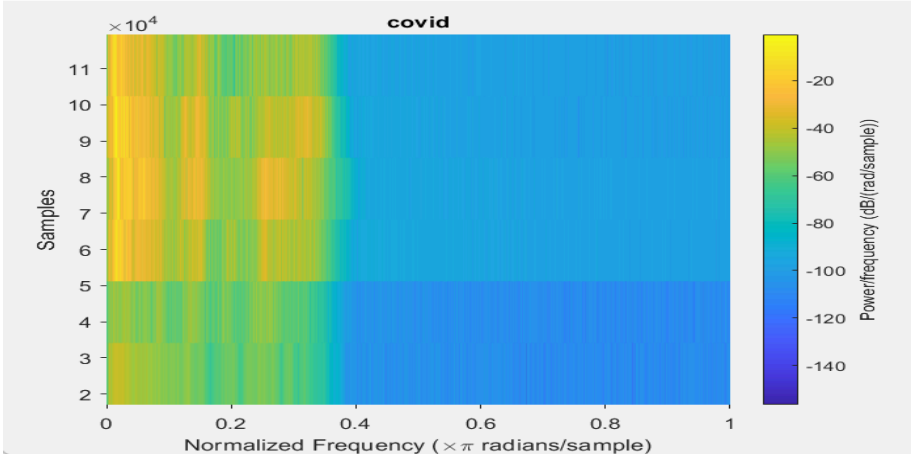


Figure 14: Spectrograms of Cough Covid-19.

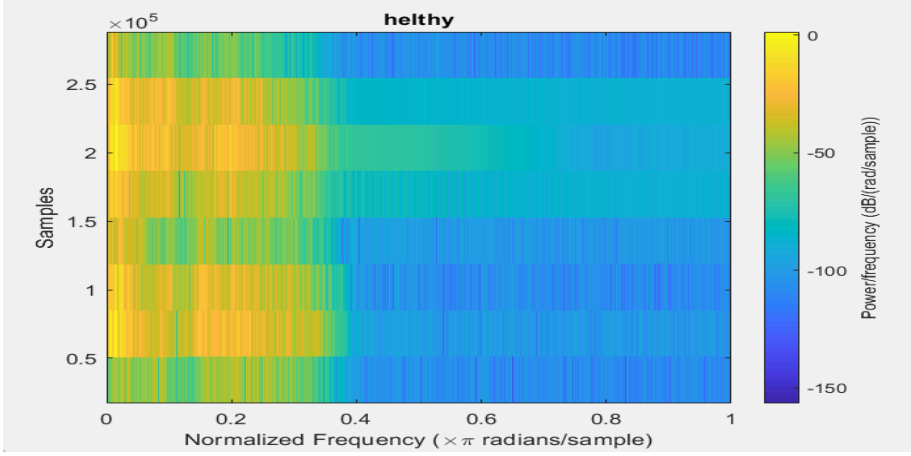


Figure 15: Spectrograms of Cough Covid-19 helthy.

II-2 Artificiel Neural Network

Artificial neural network (ANN), is an artificial neuron cell designed to mimic the structure of a biological neuron. ANNs are used to train computers to perform various tasks, such as data processing, by processing information similarly to the human brain. ANNs can also be used as a component of deep learning algorithms to process complex data for computers or machines to understand. While neural networks simulate aspects of information processing in the brain, they do so in a simplified manner. It is worth noting that ANNs are implemented using computers, which allows for the processing of vast amounts of information simultaneously. Additionally, neural networks aim to bring computers closer to emulating the capabilities of the brain by simulating certain aspects of information processing in the brain [40]. The fundamental concept underlying an ANN is its ability to process large amounts of information in parallel and provide an accurate output, much like the human brain [40].

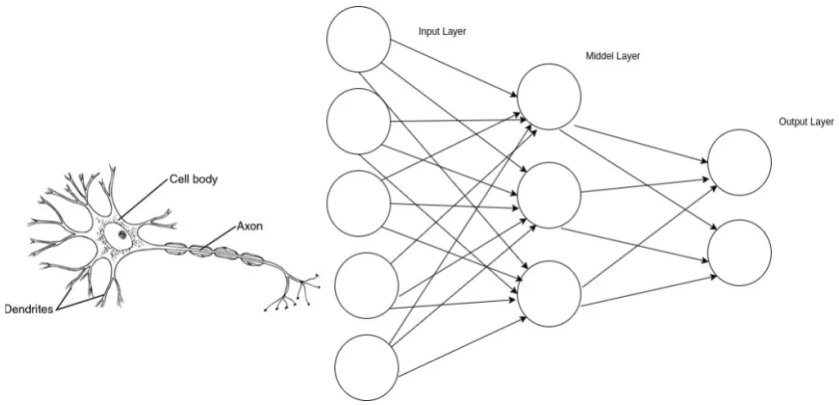


Figure 16: structure of artificial Neuron model.

The neural network serves the purpose of generating or modifying an output pattern corresponding to a given input pattern that it has been trained on. This can be achieved through the process of classifying the input pattern and describing it in detail, wherein the patterns are sorted into a single group or multiple groups. The different types and algorithms of neural networks make them widely used, particularly in overcoming existing obstacles in the realm of artificial intelligence. Neural networks can be applied in various fields such as speech recognition, image classification, medical diagnosis, and driving.

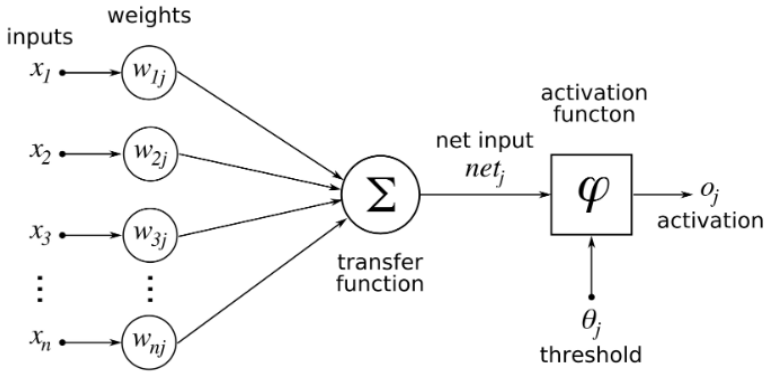


Figure 17: The internal structure of a neuron in mathematical terms.

As previously mentioned, neural networks are composed of artificial neurons or nodes, which are stacked together in three different layers:

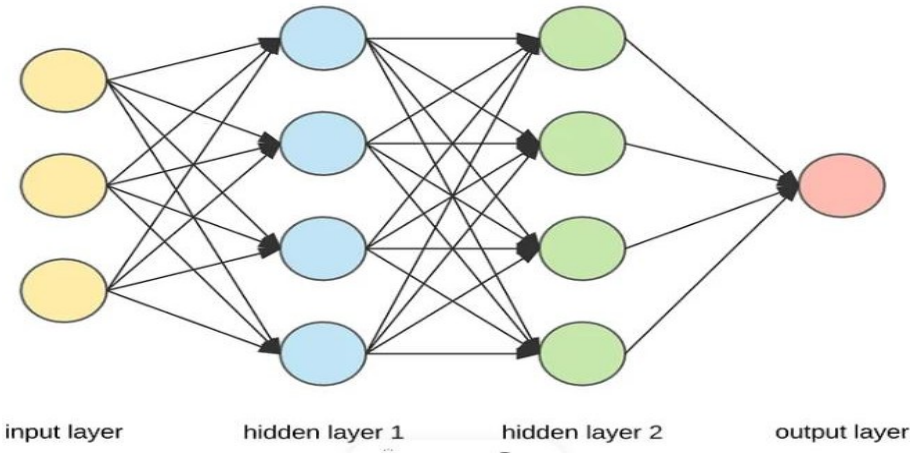


Figure 18: structure of the Node (ANN)

There are Artificial Neural Network (ANN) models that are designed to recognize patterns, predict and compress data. These models consist of input nodes that receive input data, which is then multiplied by assigned weights. These weights represent the flow of information within the network and are mathematically calculated to limit the neuron's activation or last function. The output of the artificial neurons is then calculated, sometimes based on a certain threshold, and is a summary of its inputs. Since each neuron has only one input, the output is simply the input multiplied by the weight [41].

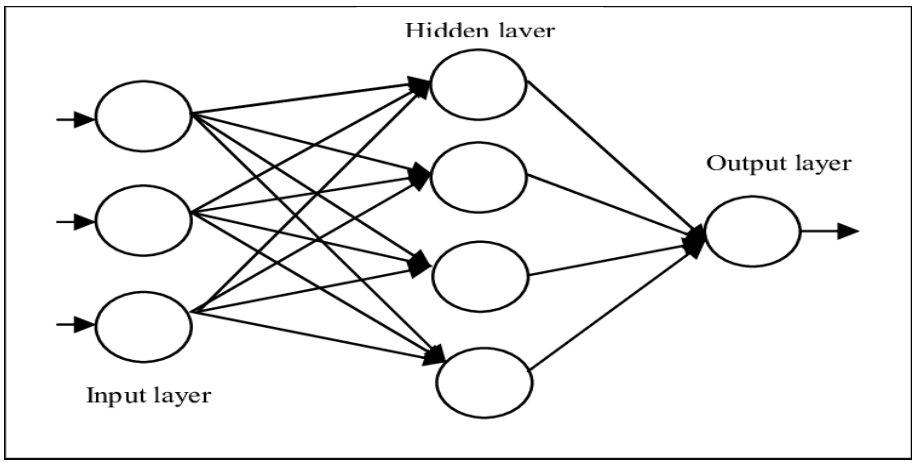


Figure 19: Architecture OF Artificiel Neureul Network

II-2-a Input layer :

In this layer, input data is received and passed on to the masked layers for processing, so that each node in the input layer represents a feature or characteristic of the input data or a feature that symbolizes the input data.

II-2-b Hidden layer or Hidden layers :

Artificial neural networks (ANNs) are used for a variety of purposes such as pattern recognition, prediction, and voice and data recognition throughout the training process. In the scaling process, the equation y = ax + b is commonly used, where a is the x-independent coefficient and b are denoted by the slope[41]. The main function of this layer is network computation and feature extraction; it also provides nodes with a fixed value that can be trained using inputs sent by the network. Right-to-left activation can be used to

analytically train ANNs and, when used as a classifier, can match input/output (I/O) features to I/O features. Networks have been very successful in facilitating classification and learning by training on data, mimicking human brain structure, and generally applying correct methods. ANNs have been widely used in a variety of fields, including weather forecasting, climate change, agriculture, and more.

II-2-c Output Layer :

The output layer in which the final output of the network is output, so the number of nodes in the output layer depends on the management of the work to be done or the management of the type of problem to be solved. There are many types of algorithms dedicated to deep learning, including:

- Convolution neural networks (CNN).
- long-term memory networks) LSTMs)
- recurrent neural networks (RNNs)
- Generative adversarial networks (GANs)
- Radial-based function networks (RBFNs)
- Deep belief networks (DBNs)
- multilayer receivers (MLPs)
- BOLTZMANN Braking Machines (RBMs)
- A utomatic encoders(Autoem coder).

II-2-e Pre-trained ANN :

In the field of deep learning, Artificial Neural Networks (ANN) are commonly used for pattern recognition and classification of various types of data. The learning process in these networks involves modifications to the layers within. It is important to differentiate between ANN models, which are the network arrangements, and the algorithms that produce the network outputs. ANN models aim to simulate the way the biological brain processes data [42]. The structure of ANN is comprised of a series of artificial neurons arranged in layers, which includes an input layer that receives various types of data and a hidden layer, where sensitive processes such as feature extraction and data preprocessing are performed. This is achieved through the activation functions that stimulate the layers,

initiating the forward propagation process towards the output layer.

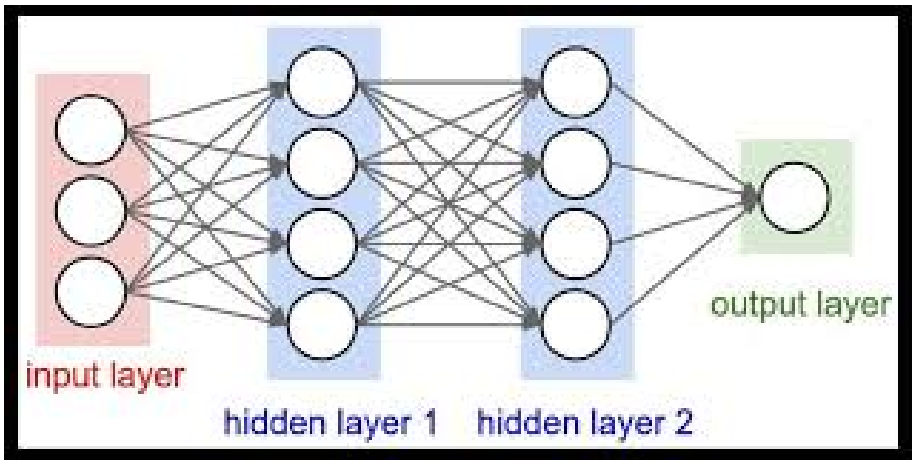


Figure 20: architecture of ANN.

II-3 Convolution neural networks

The Convolutional Neural Network (CNN), also referred to as CNN Net, is a deep learning algorithm used to identify images by processing them as inputs and extracting features, learnable weights, and other features from the images. The CNN is designed to automatically learn and adapt spatial hierarchies of features using backpropagation through multiple blocks, such as sublayers, convolutional spectra, pooling layers, and fully connected layers [43]. This algorithm consists of three types of layers, namely convolution, aggregation, and fully connected layers, and is constructed mathematically. The convolution and aggregation layers extract features, while the fully connected layer maps the extracted features to the final output, similar to the classification process [43]. The CNN environment includes various building blocks, such as convolution layers, aggregation layers, and fully connected layers, and the CNN architecture involves stacking several convolution and aggregation layers connected to one or more fully connected layers[43]. CNN networks have achieved great success in different applications, including their ability to classify, learn, and recognize patterns and shapes through data, and their unique structures in work, training, and prediction that allow them to handle simple and complex tasks. Moreover, CNN networks can overcome learning constraints and obstacles to reducing the network's workload, which scientists are continuously exploring to improve the performance of CNNs [43].

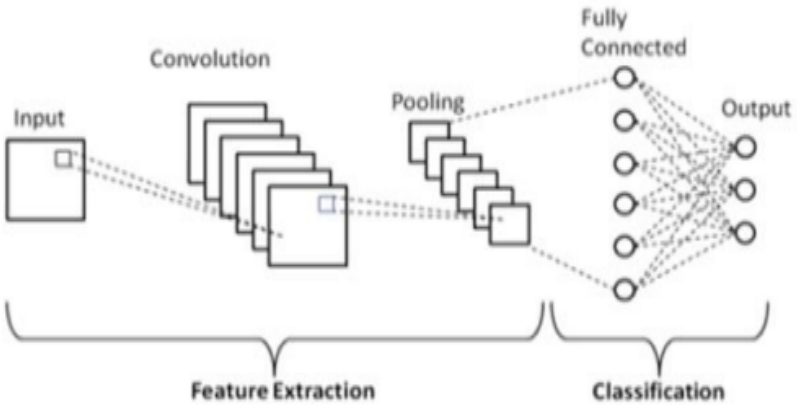


Figure 21: Architecture of Convolutional Neural Network.

II-3-1 Convolutional Layers:

convolutional layers are the core component of a CNN. This layer applies a set of learning filters (also called kernels) to the input data and extracts local features through convolutions. Each filter is associated with the input data, resulting in a feature map that represents the presence of specific features in the input. convolution layer is a fundamental component of convolutional neural networks that performs mathematical operations to merge two sets of information.

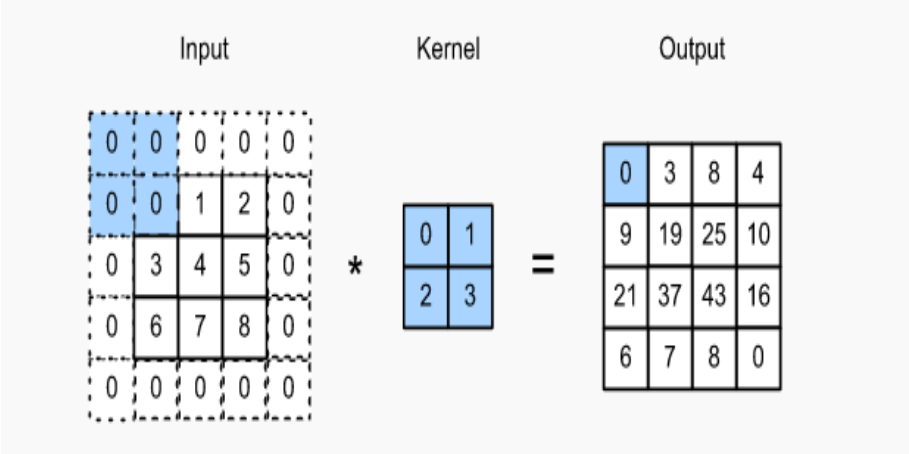


Figure 22: representation of a convolutional layer.

II-3-2 Pooling layer:

Clustering is an important operation in convolutional neural networks (CNNs), which involves reducing the spatial size or the volume occupied by the input entity. This is accomplished through the use of a clustering layer, which is responsible for this task,

and helps to reduce the computational power required to process the data by decreasing its dimensions and sizes. There are two main types of clustering methods: maximum and average clustering. In the maximum clustering process, the maximum pixel value is located, and the dimensions of the input entity are reduced to the maximum size required. On the other hand, the average clustering process reduces the dimensions to control computation and noise in the image. In general, maximum pooling is considered better than average pooling due to its ability to locate the most important features in the input entity.

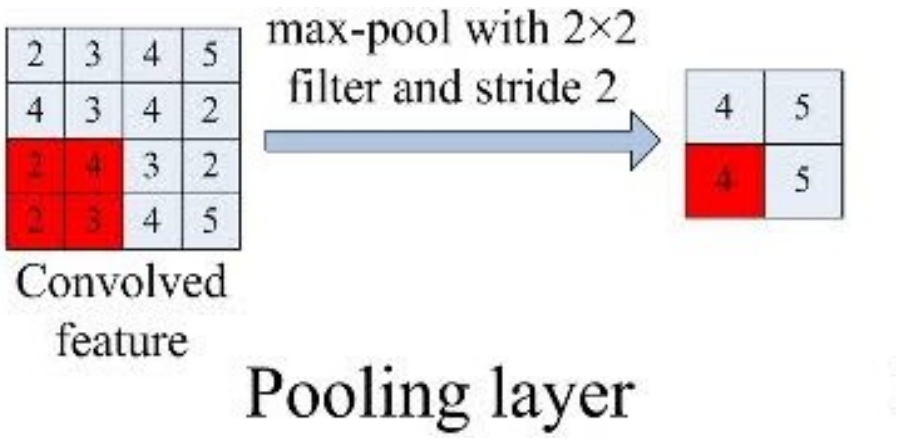


Figure 23: Example of pooling layer (max pooling).

II-3-3 Fully connected layer :

A fully connected layer is an additional layer that is commonly added to convolutional neural networks for learning from non-linear, structured collections of higher-level properties. This layer consists of a set of artificial neurons that are connected to all neurons in the previous layer. It functions as a nonlinear transformation in the learning process, enabling the network to learn complex representations of the input data. There are numerous algorithms and techniques available for use as a learning layer in convolutional neural networks, including: Alex Net VGG NET 16 ,VGG NET 19 Res Net ANN

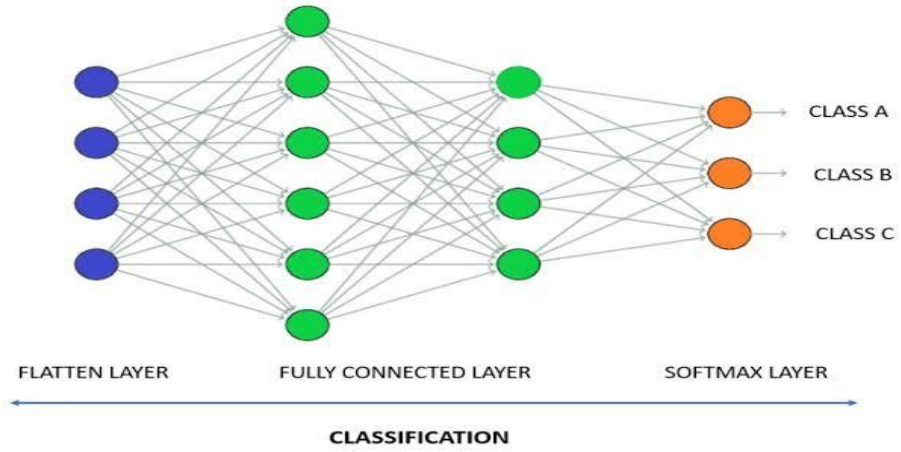


Figure 24: schematic of Fully connected network.

II-3-4 Output Layer :

The output layer in a convolutional network is the last layer of the network and is responsible for producing the final results for the desired task. The output layer depends on the type of problem being solved using the convolutional network, and the output layer depends on the task required, whether it's a binary or multiple classifications, a predictive problem, image synthesis, and so on. An appropriate transition function is used to generate final results that meet the needs of the specific problem.

II-3-5 Activation functions :

Activation functions play a significant role in neural networks by computing the weighted sum of inputs and biases to decide if a neuron can fire. The activation layer applies an activation function to obtain the output of a neural network. This resulting value is determined by the type of activation function used and is typically between 0 and 1 or 1 and -1 [44]. The primary function of activation functions is to improve the learning rate and automate the feature discovery process, leading to better pattern recognition and predictions [45]. It introduces non-linear activation functions into CNN, enabling it to model complex relationships in data. Activation functions commonly used in CNN include Rectified Linear Unit (ReLU), which sets negative values to zero and keeps positive values unchanged, and variables such as Leaky ReLU and Parametric ReLU.

I-3-5-a Type Activation functions:

Type Activation functions : There are many activation functions with different tasks that work on the same basis, which is the activation of neural networks, and we mention them:

5-a-1 Sigmoid Activation function

The sigmoid function is considered one of the most popular and widely used activation functions due to its non-linear nature. It converts the input value to a range between 0 and 1 and is defined as follows:

$$F(x) = 1/(1 + e^{(} - x))$$

The sigmoid function is differentiable and its derivative is defined as follows:

$$F'(x) = F(x) * (1 - F(x))$$

However, the sigmoid function is not symmetric, which results in all output values being the same in the neurons. This problem can be solved by scaling the sigmoid function and modifying its elements to correct the defect. [44]

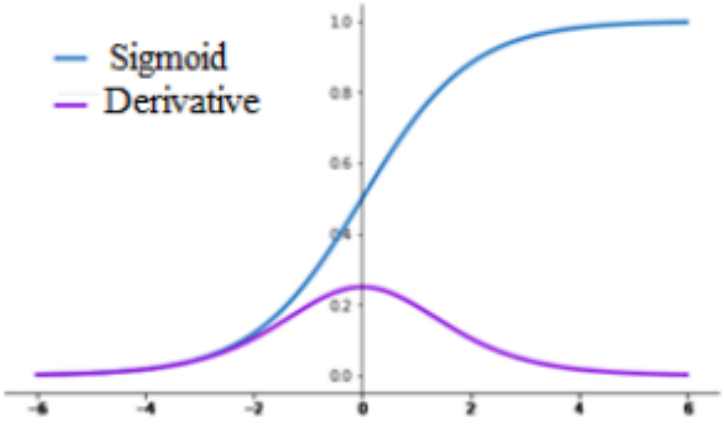


Figure 25: Sigmoid Activation function.

5-a-2 RELU Activation function:

This is one of the most prominent activation functions and is widely used in the neural network activation process. Rectified Linear Unit (ReLU) is a non-linear activation func-

tion that operates on the premise of selectively activating neurons. Specifically, ReLU deactivates neurons for which the output of the linear transformation is zero. This is expressed mathematically as follows:

$$F(x) = max(0, x)$$

. Additionally, derivatives in the linear function can be defined as

$$F'(x) = max(0, 1)$$

. ReLU is considered one of the most efficient activation functions as it selectively activates neurons. Conversely, sometimes it deactivates all neurons, leading to the gradient value of 0. The reason for this is that weights and biases are not updated during the backpropagation stage of the neural network training and learning process[45] .

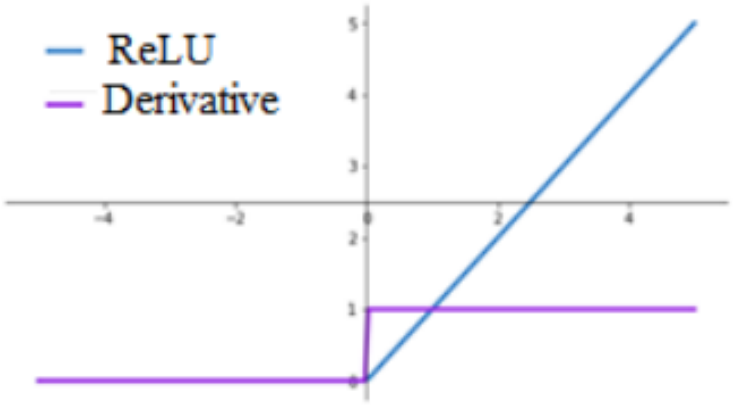


Figure 26: Relu Activation function.

5-a-3 softmax Activation function:

The softmax activation function is a function that converts the vector of real K values into a vector of real K values whose sum is 1. Input values can be positive, negative, zero, or greater than one, but Softmax converts them to values between 0 and 1. The softmax function is used in the output layer of the neural network for multiclass classification problems. It normalizes the output into a probability distribution, where the sum of all output values is equal to. The softmax formula is as follows:

$$softmax(z_i) = exp(z_i)/sum(exp(z_j))forj = 1toN$$

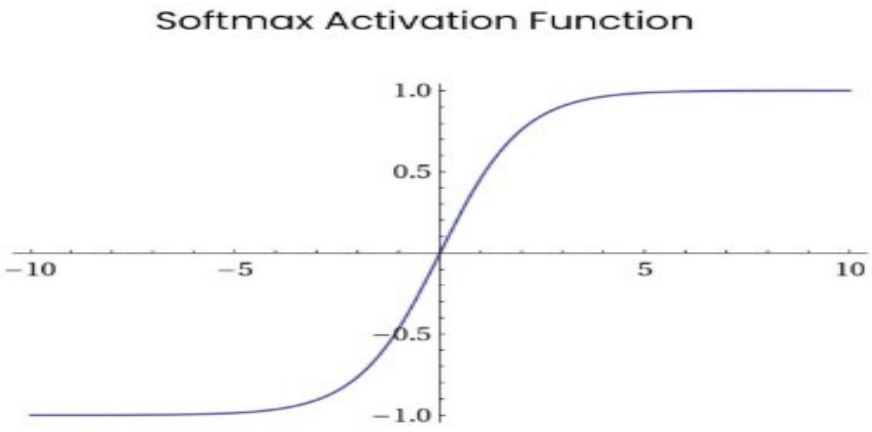


Figure 27: softmax Activation function.

II-4 Transfer Learning :

Transfer learning refers to the process of improving learning in a new task by transferring knowledge from a related task that has been learned and trained before. This approach is commonly utilized in image detection, discrimination, and other applications. Transfer learning involves training a fast and accurate CNN by importing weights from a pre-trained CNN that has been trained on a larger dataset, rather than initializing the weights from scratch. This method can be helpful in addressing the issue of insufficient training data and improving performance in the target task [46].

The transfer learning process in neural networks employs various algorithms, such as classification algorithms and inference algorithms, to transfer knowledge from one task to another. Besides, Bayesian networks and logical Markov networks can be used for this purpose. Ongoing research aims to develop algorithms that facilitate the transfer learning process. This research focuses on improving performance and reducing the time required for the transfer process while enhancing the level of performance. Transfer learning is a method by which a model is applied to a machine learning task so that it is adapted and applied to another task, the training task b, the learning transformation can help solve the problem of insufficient training data and improve performance on the desired goal or task.

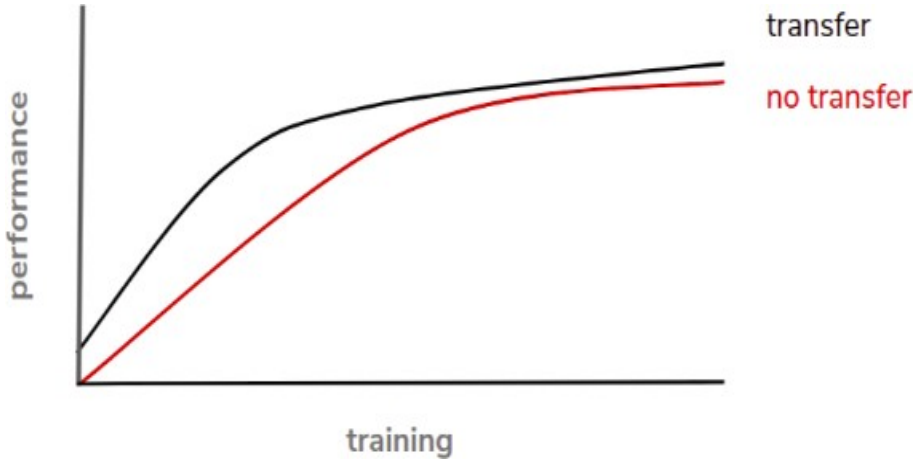


Figure 28: Representation of Transfer learning Relu Activation function.

II-5 Pre-trained Convolutions neural networks And Classification methods:

We have implemented a sound disturbance detection system in our study, utilizing the sound spectrogram to extract features from the recorded sound as a preliminary step. Various techniques and digital processes were then used to extract and classify representative images of the sound recordings. In this study, we discuss commonly used techniques for image feature extraction, detection, and classification, and classify the algorithms used in training and classification.

One such technique is Convolutions Neural Networks (CNN), a type of neural network in artificial intelligence designed to perform specific tasks. CNN contains a group of networks compatible with its structure to perform tasks required in the learning and training process, such as extraction and classification of features. Some of these networks include: .

5-1 Alex Net :

Convolutions Neural Networks (CNNs) are designed to recognize images and patterns. Alexnet, which was first introduced in the Image net Challenge in 2012, is considered to be the first successful CNN network, achieving an accuracy rate of 84.60 [46]. The Alexnet architecture consists of approximately 6 million parameters, with 5 convolutional layers and 3 dense layers. Unlike previous networks that used the relative activation function, Alexnet uses the ReLU (Rectified Linear Unit) function to activate its layers.. AlexNet is commonly used as a pre-trained network for image classification, and it has been demonstrated that the features extracted by the network outperform those that are manually designed. The Rectified Linear Unit (ReLU) activation function is utilized by AlexNet to facilitate the training process through various parameter configuration methods. One significant drawback of this network is that it involves a large number of parameters, which can negatively affect the efficiency and speed of training.

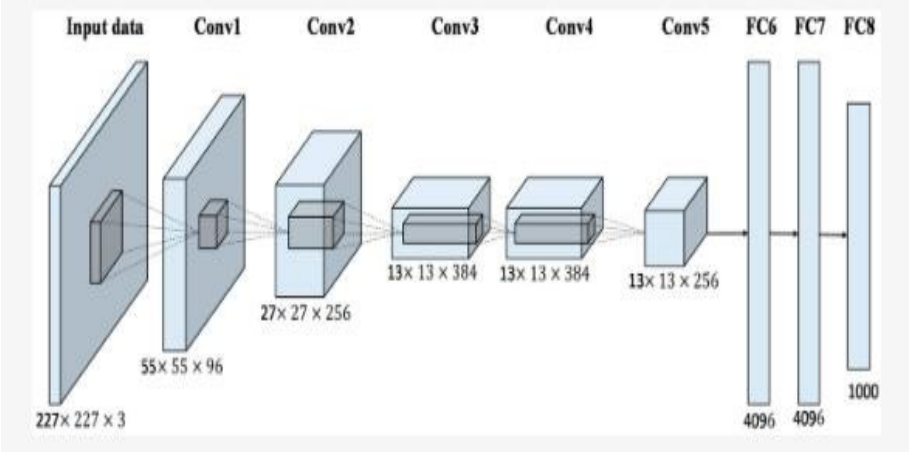


Figure 29: architecture of Alex Net.

5-2 VGG16-VGG19 :

In the field of face recognition and image classification, the VGG16 model is a popular deep learning model. It achieved an accuracy rate of 91.90 in the ImageNet competition in 2014 and consists of 138 million parameters, five convolutional blocks, and three fully connected layers [46]. VGG19, another model of the VGG family, contains 19 layers including 16 convolutional layers, three fully connected layers, five Max-Pooling layers, and one Softmax layer. It has 193 million parameters, which is higher than VGG16, due to an increased number of filters and classes. The additional layers in VGG19 increase the model's capacity to learn more complex structures [45].

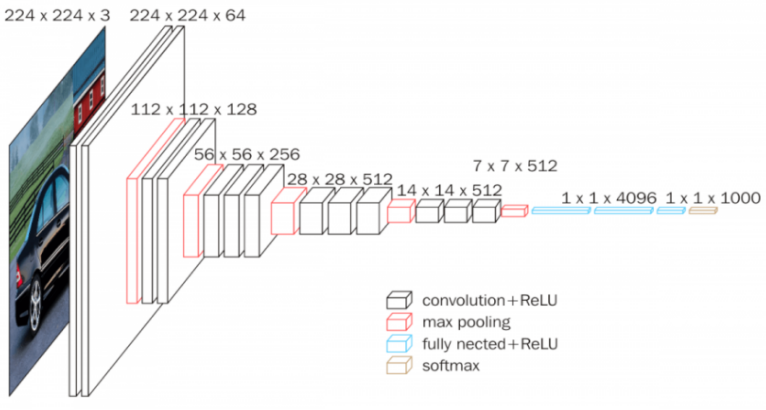


Figure 30: architecture of VGG

5-3 ResNet-50:

ResNet-50 is one of the Residual Neural Network (ResNet) models used in the field of pattern recognition, which achieved first place in the ImageNet competition in 2015 with an impressive accuracy rate of 92.29, which was five times higher than its nearest competitor. ResNet-50 is composed of 25 million parameters [46]. Other ResNet models include ResNet-101, ResNet-152, and ResNet, which differ mainly in the number of layers used in their architecture. ResNet-50 contains 48 convolutional layers along with a Max-Pool layer and an intermediate layer-Pool[46]. However, one of the main drawbacks of this network is the residual block correction, which leads to filters of similar sizes. ResNet-50 requires a well-trained dataset for optimal performance[47].

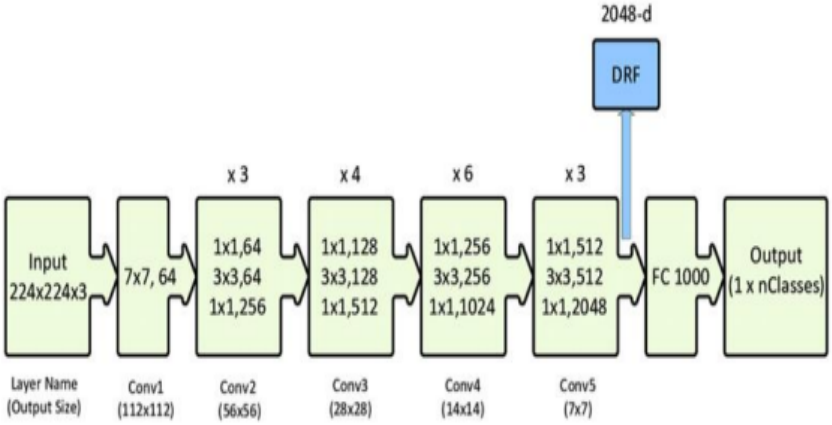


Figure 31: architecture of ResNet50.

IV. Conclusion

In this chapter, we have provided a definition and explanation of artificial intelligence, along with a discussion of its various branches. We also explained the process of feature extraction in sound to obtain the sound spectrogram and its associated characteristics. Furthermore, we focused on the branch of deep learning and deep neural networks, including their various components, functions, and activation methods, which are essential for machine learning and training. In particular, we discussed the AlexNet model, Res Net and Vgg16 Vgg19, and ANN, which we will employ in our system. In the following chapter, we will present similar works and systems to ours, and provide detailed explanations and illustrations.

Experimentation, Results and Interpretation

III.1 Introduction

In this study, we propose a system for diagnosing COVID-19 patients using cough sounds and spectral analysis. Our system is able to detect the virus in mild symptoms Patients and a phenomenon such as coughing, thus reducing the risk of transmission and facilitating early treatment. the The proposed approach is used. The method extracts features from the cough sound signal, Which is then fed to a neural network trained for classification. In this paper, we will describe in detail the computer simulations that have been performed In the detection of COVID-19 through the use of the specification database used In the detection of COVID-19 through the spectral patterns of cough sounds extracted from Cough sound features from MATLAB. We will also discuss the feature extraction process, Training the neural network model and evaluating the proposed system. Accuracy, sensitivity, and the F1 score will be used to evaluate the performance of our system. finally, We will present and discuss the results obtained from our experiments.

III.2 State of the Art about Covid-19 detection using spectogram

In the context of the COVID-19 pandemic, the lack of a vaccine and effective means to detect the virus has led to an urgent need for advanced solutions to limit its spread and isolate symptomatic individuals. To this end, we propose an intelligent system that leverages mobile applications to enable disease detection without the need for medical devices or appliances. The proposed system involves extracting cough sounds using the extraction function to generate a spectrogram, which is then classified by algorithms in the application. The use of this method is cost-effective and widely accessible, enabling large-scale disease detection and prevention through self-discovery using trained networks that identify different diseases. By enabling safe and automatic detection of COVID-19, this approach has the potential to significantly reduce the spread of the virus.

In this study, we present a novel deep learning method for automated COVID-19 detection using cough sound spectrograms. Our proposed system is based on an approach similar to a set of proposed solutions for COVID-19 detection, which uses signal processing techniques to classify cough sound acoustic signals for COVID-19. The following study

provides similar details on the operation and method of our approach.

CR rodriguez and Angeles.D.2020

The MDVR-KCL dataset was recorded at King's College London (KCL) Hospital, Denmark Hill, Brixton, London SE5 9RS. This dataset is freely available online and can be easily downloaded.

For the recording procedure, a Motorola Moto G4 Smartphone is used as a recording device. Due to the fact, that they directly record the microphone signal, they end up with high-quality recordings with a sample rate of 44.1 kHz and a bit depth of 16 Bits (audio CD quality). The speech was saved. WAV formats.

In this dataset they tend to Ask the participant to read out a specific text or tend to start a spontaneous dialogue with him, the test executor starts asking random questions about places of interest, local traffic, or personal interests if acceptable [48].

The voice recordings are labeled with; first, IDNN, with $N \in [0, 9]$ which refers to the subject identification. Next to it is the health status label (hc or pd accordingly).

The provided dataset has a total of 42 healthy control (21 Reading Text,21 Spontaneous Dialogue) and 31 PD (16 Reading Text, 15 Spontaneous Dialogue).

ALI. M and N. ALOTAIBI, 2022

In their 2022 study, Aly, M., and Alotaibi, N.S. presented their proposed system for detecting COVID-19 using two main steps. The first step involves converting the questioned voice into spectrograph images, which is enhanced using a slope-scale spectrogram approach. The second step involves extracting features and classifying them using nine deep learning models, including RESNET 18/34/50/100/101, Google Net, SqueezeNet, Mobile Net v2, and Net Mobile. The study utilized a dataset comprising information from approximately 1600 individuals, including 1185 males and 415 females from various regions of the world. The system studied the indicators of coughing and breathing based on the CCN algorithms, utilizing spectral charts of coughing sounds and the SGD optimizer. The results showed that the RESNET 50 model achieved the highest accuracy of 92.2 using the SGD optimizer, with a sensitivity of 98.3 and a specificity of 97.8 [49].

R GUPTA 2022

A study was conducted by R Gupta to detect COVID-19 from coughing sounds and their spectral coverage. The study utilized the open-source Coughvid dataset and employed CNN models including VGG16 and MobileNet ResNet50, with improved audio and network sequencing. The system achieved an accuracy of 77.5 in detecting COVID-19 using CNN handcrafted features, 72.5 using VGG16 and a spectrogram, and 81.23 using ResNet50, which demonstrated the best performance among the models. [50].

Rahman,T 2022:

Researcher Rahman T. conducted a study on the detection of COVID-19 by utilizing cough samples and breath sounds from a research group at the University of Cambridge, consisting of 582 healthy individuals and 821 patients with COVID-19. The study employed spectral charts generated through the "Qu Cough Scope" web application. The research focused on the structure and characteristics of CNN networks, achieving an accuracy rate of 96.5 using coughing sound spectrometry and an accuracy rate of 91.3 for images of the breathing sound chart[51].

III.3 System Design

In the presented study that proposes the utilization of dish chart images for Covid-19 detection, the methodology is described as follows. Firstly, the coughing sound characteristics are extracted from a database and reorganized. Then, these sounds are converted into spectrum charts through a mock structure using Matlab in the first stage. In the second stage, these extracted charts are put into a new database, and the CNN network along with some of its pre-generated models (resnet50, vgg16, vgg19, Alex Net
And ANN) are prepared for the data selection process.
In the third stage, classifiers are employed to select the data, where each of the CNN models performs a method in the image classification process. The spectrum diagram is then applied to two categories, which are Covid-19 (-) and other than Covid-19 (+).

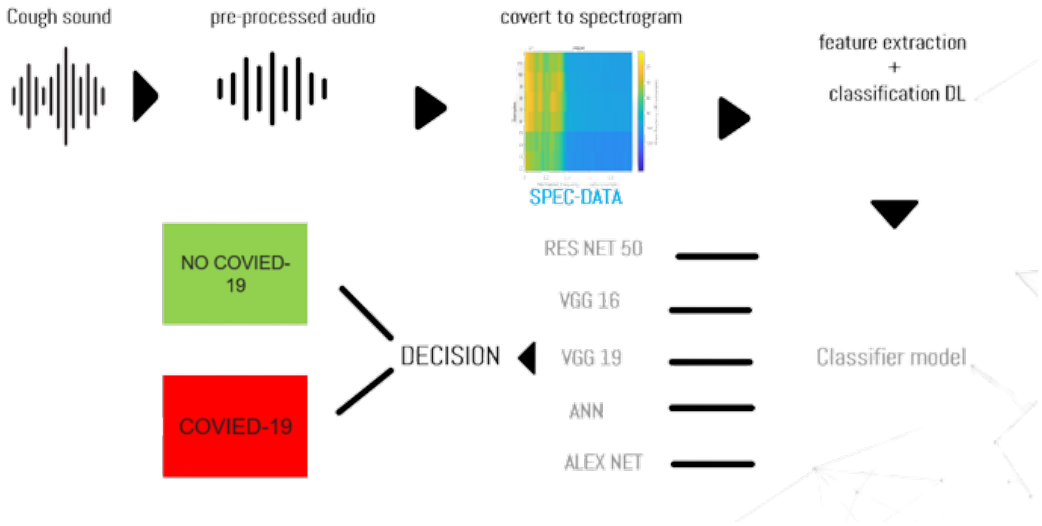


Figure 32: System design

III.4 Experimental data bass covid-19

This study is a database test point reagent system to detect Covid-19 by cough sounds. Using a kaagle internet database named coswara sepparated specs (CSS) and a previous database obtained, it extracted cough sounds and consisted of 2771 audio files. I photographed an extract application on an extract application. Each spectrogram looks like a signal. In the coswara sepparated specs database, we selected 37 cases from the specification dataset, of which 431 were described as colocalized for Covid-19 and 37 were negative. Then we divided it into two files: the training file, which consisted of 29 negative cases and 344 cases, and the file, which consisted of 29 negative cases and 87 cases. These files were used in the data selection process in our good approach.

Matlab2021:

Matlab is a widely-used software tool in engineering and mathematical operations, which is employed for analyzing data, creating mathematical models, developing algorithms, and processing and analyzing images. It is compatible with various platforms, including Mac OS, Windows, and Linux, and is available in both 32-bit and 64-bit versions, which can be downloaded from the Internet. In our research, we utilized Matlab software for converting the cough signal into spectrogram images.

Experimental SETUP:

DEVELOPMENT HARDURE:

We executed our detection system using the Spyder program, which runs on a demo board terminal, similar to a PC gaming platform. The operating system used was Microsoft Windows 10 64bit. The system was equipped with an

- **CPU:** Ppocessor AMD Ryzen 5-3600 processor with 6 cores and a processing speed of 3.6 GHz.
- **RAM:** 16 GB.

DEVELOPMENT SOFTWARE:

- **the program used:** Phyton spyder.

Spyder is an open-source integrated development environment (IDE) for scientific programming in the Python language. It is a highly sophisticated and platform-independent IDE used for data analysis. It is one of the most widely used programming tools, particularly for the development and manipulation of data, as well as for model creation.

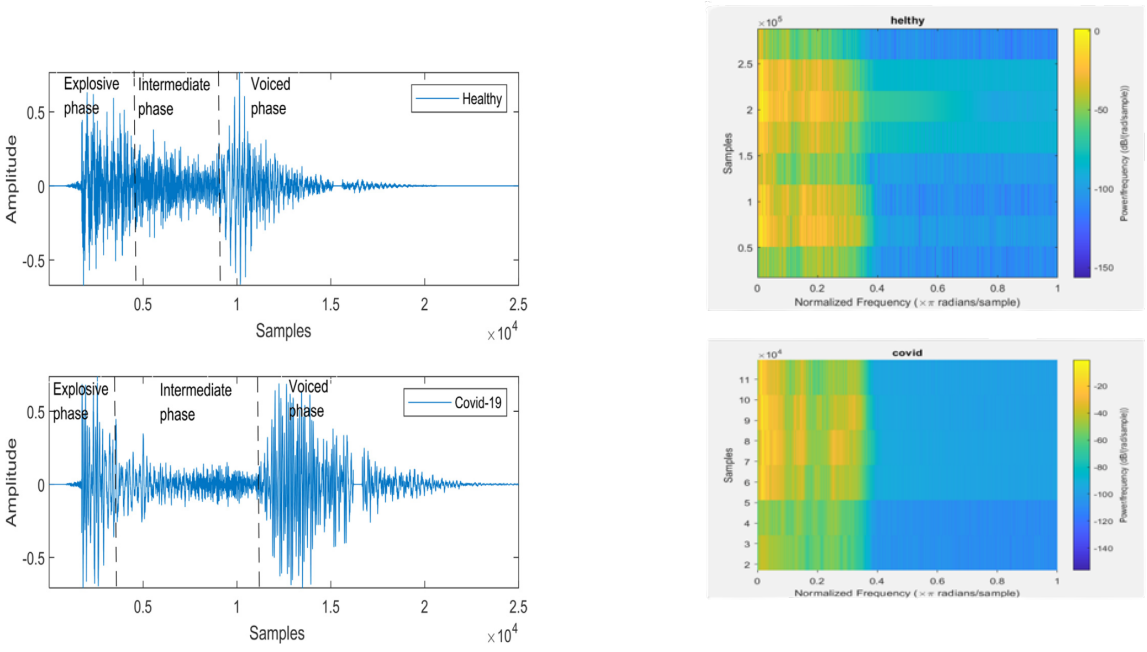
METHOD SETUP:

Data Split

In order to prepare the data for use in the proposed detection system, the first step involved organizing and categorizing it into six distinct categories, consisting of both negative and positive samples. These categories were further divided into two sets, namely the ”Train” and ”Val” sets, which also contained both negative and positive samples.

Data Segmentation

In this stage, we will extract a sample from the spectrogram of different cough sounds, located between the spectrogram of a negative person for Covid-19 (healthy) and that of a person infected with Covid-19 disease.



cough sound covid-19 spectogram covid-19

Figure 33: figure to Data segmentation

III.5 Classification methods:

In our proposed system, the classification process represents the final stage, where in each CNN model is chosen based on its individual coefficient and classification methodology. Specifically, we employed the following models: resnet50, vgg16, vgg19, ANN, and alxnet.

- **Res Net 50:**For the resnet50 model, we utilized a pre-trained version and modified the ”epoch” and ”batch size” parameters for building our classification model.
- **VGG16,VGG19:**we employed pre-trained vgg16 and vgg19 models for image classification while modifying the same parameters.
- **ANN:**For the ANN network, we used a pre-existing model that had been trained on the same system and altered the ”epoch” and ”batch size” parameters.
- **Alex Net:**alxnet, a CNN network model with a unique structure, was employed, with modifications made to the ”epoch” and ”batch size” parameters. After selecting a model from the aforementioned trained models, each model created its network structure and classified images as negative or positive (healthy or Covid).

III.6 Experimental metrics:

The developed system aimed to detect Covid-19 disease using spectrogram charts. The performance of the model was evaluated using the SPEC-DATA dataset, as previously mentioned. Results from the proposed classifiers or classification models were compared and displayed.

- **Accuracy:** was used as the primary performance measure to evaluate the effectiveness and responsiveness of the medical decision system. Other performance measures used included:

$$\text{Accuracy}(\%) = \frac{TP + TN}{TP + TN + FP + FN} \times 100 \tag{1}$$

- **Sensitivity:** The probability of diagnosing abnormal samples as positive, expressed as follows:

$$\text{Sensitivity } (\%) = \frac{TP}{TP + FN} \times 100 \tag{2}$$

- **Specificity:** The probability of correctly selecting normal samples, expressed as follows:

$$\text{Specificity}(\%) = \frac{TN}{TN + FP} \times 100 \tag{3}$$

Where TP,TN,FP and FN are :

- **True positive (TP):** the pathogenic nature of the speech sample is indicated by the signal.
- **True negative (TN):** refers to the sound sample being normal and being correctly identified as such.
- **False positive (FP):**refers to a normal sound sample being incorrectly identified as pathogenic.
- **False negative (FN):** refers to a pathogenic vocal process being identified as healthy.
- **F1 Score:** The degree of F1 expresses the accuracy of the model in a binary classification system, where the samples are classified as positive or negative.

$$F1 \text{ Score } = 2 \times \frac{\text{Precision } \times \text{ sensitivity}}{\text{precision } + \text{ sensitivity}} [\textbf{?}]. \tag{4}$$

where the Precision is given by :

$$\text{Precision} = \frac{TP}{TP + FP} \tag{5}$$

.

III.7 Results and discussions

The proposed system was utilized for the classification of Covid-19 patients using spectrum images from the aforementioned SPE-DATA dataset, aiming to determine the most accurate and optimal model for this task. Comparative analyses with five pre-trained network models, namely RESNET50, VGG16, VGG19, ALEXNET, and ANN, were conducted and their performance was evaluated. In the first phase, the pre-trained models were selected from the convolutional neural network (CNN) family, each model characterized by its unique features. To achieve this, DL compilers were independently implemented for each model, with individual settings utilized for each.

- We had a 80% from the dataset as a training data.
- while 20% was reserved for testing purposes.
- The EPOCH settings ranged between 10 and 100, and BATCHSIZE ranged between 16 and 256 for all CNN models.

Finally, we present the performance results of the five CNN models employed in our proposed system, namely RESNET50, VGG16, VGG19, ALEXNET, and ANN. The models were evaluated using the EPOCH and BATCHSIZE parameters and the metrics used to measure their classification accuracy are presented in the following table.

-Results of Alex Net:

Batch-size/epoch	10	20	30	40	50	60	70	80	90	100
16	93.75	93.75	90.62	92.19	92.19	93.75	92.19	93.75	92.19	93.75
32	92.19	93.75	92.19	92.19	92.19	93.75	93.75	90.62	92.19	93.75
64	92.19	93.75	92.19	95.31	90.62	93.75	95.31	93.75	92.19	96.88
128	90.62	90.62	92.19	93.75	92.19	92.19	89.06	92.19	93.75	92.19
256	93.75	92.19	92.19	93.75	92.19	92.19	95.31	92.19	92.19	93.75

The table above shows the results of the proposed Covid detection system and its

effectiveness, as we achieved the best detection accuracy by the Alex Net selection algorithm, where infected individuals were detected with 95.31% accuracy using Epoch is 40 and Batch-Size is 64.

This doesn't mean that we can't rely on another classifier for detection, as our experience with our proposed system has produced similar and better results, which we'll present.

-Results of Res Net 50:

Batch-size/epoch	10	20	30	40	50	60	70	80	90	100
16	91.58	66.32	64.21	91.58	91.58	92.63	91.58	92.63	78.95	85.26
32	91.58	91.58	92.63	82.11	91.58	91.58	92.63	92.63	92.63	89.44
64	91.58	91.58	91.58	91.58	91.58	91.58	91.58	81.05	92.63	91.58
128	91.58	91.58	91.58	91.58	91.58	91.58	81.05	92.63	91.58	91.58
256	91.58	91.58	91.58	91.58	91.58	91.58	81.05	92.63	91.58	92.63

The table above shows the results of the proposed Covid detection system and its effectiveness, as we achieved the best detection accuracy by the Res Net50 selection algorithm, where infected individuals were detected with 92.63% accuracy using Epoch is 60 and Batch-Size is 16. And we've achieved the same accuracy using different batch sizes and eras.

-Results of ANN:

Batch-size/epoch	10	20	30	40	50	60	70	80	90	100
16	97.87	93.62	97.87	95.74	97.16	94.33	95.04	94.33	99.29	97.16
32	96.45	97.16	97.16	96.45	95.74	97.87	95.74	97.87	95.04	95.74
64	93.62	95.04	96.45	95.74	97.16	94.33	97.87	97.87	95.74	97.87
128	95.04	95.04	96.45	97.87	95.74	95.74	94.33	97.16	95.74	97.87
256	97.94	93.62	97.16	97.49	93.62	97.87	97.16	96.45	93.62	95.04

The table above shows the results of the proposed Covid detection system and its efficiency, where we obtained the best detection accuracy by the ANN selection algorithm, where infected individuals were detected and the best result in the system was 97.87% accuracy using Epoch is 10 and batch size is 16.

-Results of VGG 16:

Batch-size/epoch	10	20	30	40	50	60	70	80	90	100
16	92.63	92.63	92.63	91.58	91.58	91.58	91.58	91.58	91.58	91.58
32	92.63	92.63	91.58	92.63	91.58	91.58	91.58	91.58	91.58	91.58
64	92.63	92.63	92.63	91.58	91.58	91.58	91.58	91.58	91.58	91.58
128	92.63	92.63	92.63	92.63	92.63	91.58	91.58	91.58	91.58	91.58
256	89.47	92.63	92.63	92.63	92.63	92.63	/	/	/	/

The table above shows the results of the proposed Covid detection system and its efficiency, where we achieved a detection accuracy by the VGG16 selection algorithm of 92.63% using epoch 10 and batch size 16.

-Results of VGG 19:

Batch-size/epoch	10	20	30	40	50	60	70	80	90	100
16	91.58	92.63	93.68	92.63	92.63	92.63	92.63	92.63	92.63	92.63
32	92.63	92.63	93.68	93.68	92.63	92.63	92.63	92.63	92.63	92.63
64	91.58	92.63	93.68	93.68	92.63	92.63	92.63	92.63	92.63	92.63
128	92.63	92.63	92.63	92.63	92.63	92.63	92.63	92.63	92.63	92.63
256	91.58	92.63	92.63	92.63	92.63	92.63	92.63	92.63	92.63	92.63

The table above shows the results of the proposed Covid detection system and its efficiency, where we achieved a detection accuracy by the VGG19 selection algorithm of 93.68% using epoch 30 and batch size 16.

-The best results in all the binders we've used:

Table 1: Results of The best results in all the binders we've used

Classifier	Epoch	Batch-Size	Accuracy%
ANN	10	16	97.87
Alex Net	40	64	95.31
Res Net 50	60	16	92.63
VGG 16	10	16	92.63
VGG 19	30	16	93.86

The table above shows the best results of the proposed Covid detection system and its efficiency, as we achieved the best detection accuracy by the algorithm determining ANN, as infected individuals were detected with an accuracy of 97.87%.

This doesn't mean that we can't rely on another classifier for detection, as our experiment with our proposed system gave similar results, where Alex Net can detect with an accuracy of 95.31%.

We also achieved good results in the rest of our work.

-The model's best result :

Table 2: The model's best result ANN

Classifier	Epoch	Batch-Size	Accuracy%
ANN	10	16	97.87
Alex Net	40	64	95.31

We note in the following table study of the best result and the best model, where the ANN classifier obtained the best accuracy of 97.87% in our system compared to the other classifiers.

III.8 accuracy And loss comparison

III.8- 1 accuracy curve

Accuracy is a common measure for evaluating the performance of a neural network model and its ability to understand data. The accuracy curve in deep learning also refers to the percentage of correct responses that the model was able to predict during the training process. The accuracy curve is usually represented as a graph where the accuracy value is plotted on the y-axis and the time gradient or epochs on the x-axis. The accuracy curve is monitored throughout the training process to keep an eye on the model's performance and to understand whether it is improving in scores or encountering problems.

III.8-2 Loss curve

The loss curve is a process in which the loss is calculated between the expected values and the values predicted by the model and reflects the model's ability to adapt and learn from the data. The main aim of the loss curve is to reduce loss during the testing process by adjusting and updating weights and parameters in the neural network. A loss curve is a graph in which the loss value is plotted on the interval axis (y) and the temporal gradient or epochs on the horizon axis (x). In the loss curve, it is always noticeable at the start of training that the loss value is high and gradually decreases as the training process progresses and the model improves.

III.8.c accuracy curve Alex Net

In the accuracy curve of the Alex Net model, as shown in Figure 35. An increase in the training curve indicates the model's success in giving the right answers during the training process. And our model showed a response in training, as it was previously trained on the Image Net model, which is a multi-ranking model. While in the validation accuracy curve, we note a stability of accuracy between 92% and 95.31%.

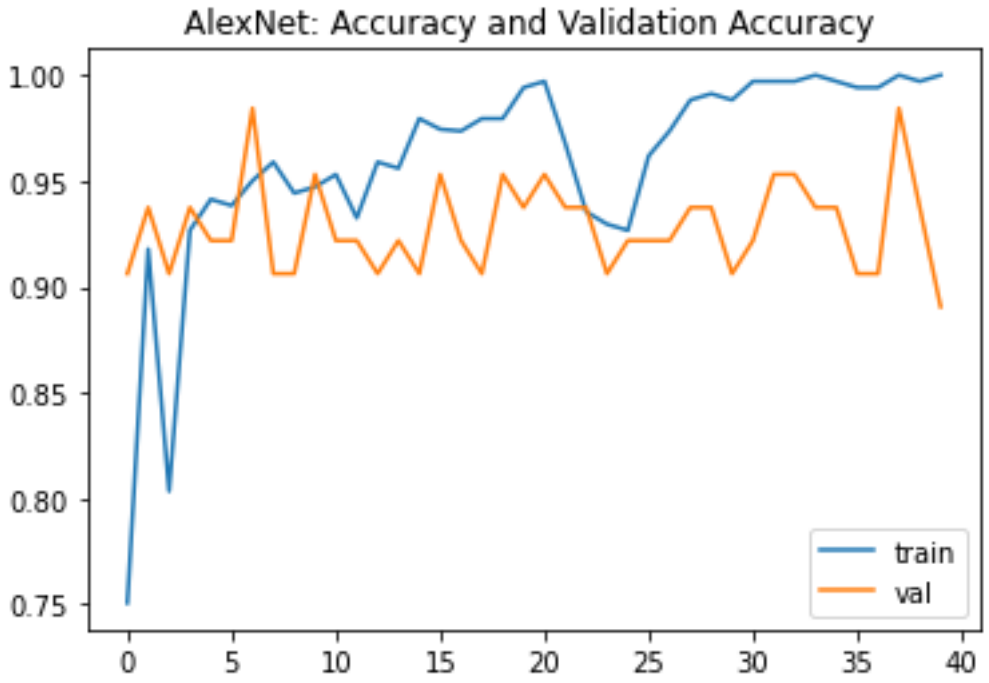


Figure 34: Accuracy curve to Alex Net

III.8.d Loss curve Alex Net

In Alex Net's loss curve, we notice a proportionality in each of the test curves and the precision curve achieved, where the percentage was high at the start of training and reached 78. And then we notice a decrease in this percentage, i.e. a decrease in the percentage of loss, which is shown in the following figure, so that we notice stability of the percentage of loss at around 0, and stability until the end of the training process.

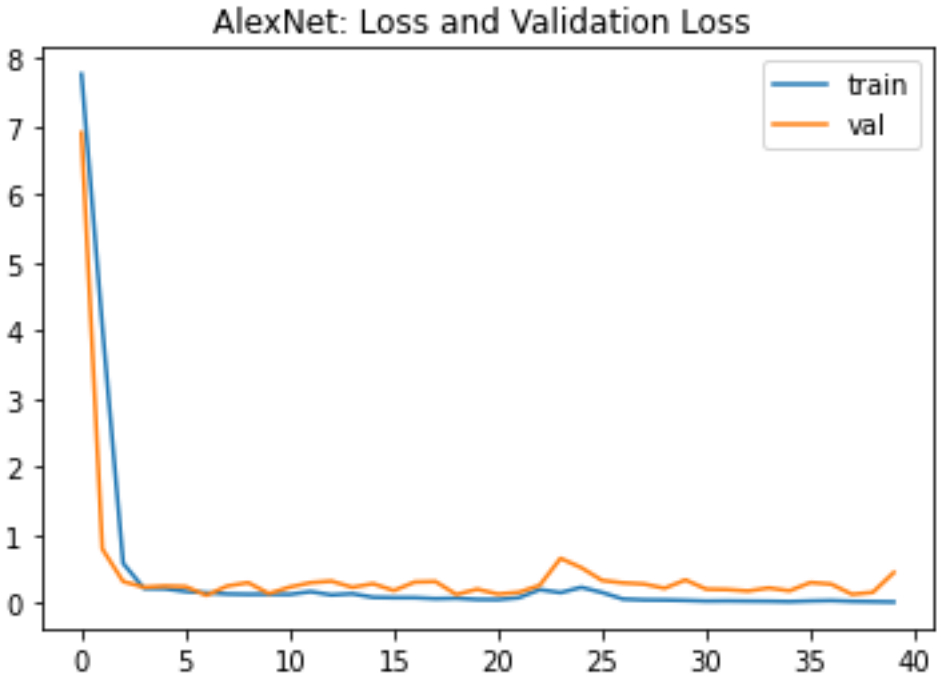


Figure 35: Loss curve to Alex Net

III.8.e accuracy curve Resent50

In the accuracy curve of the Resent50 model, as shown in Figure 37, an increase in the learning curve indicates the model's success in providing the right answers during the learning process. And the proportional stability of the test curve with a significant decrease of some EPOCH to values close to 0. And our model showed a response to training, where while you're in the validation accuracy curve, we notice accuracy stability between 92.63% and values slightly above that.

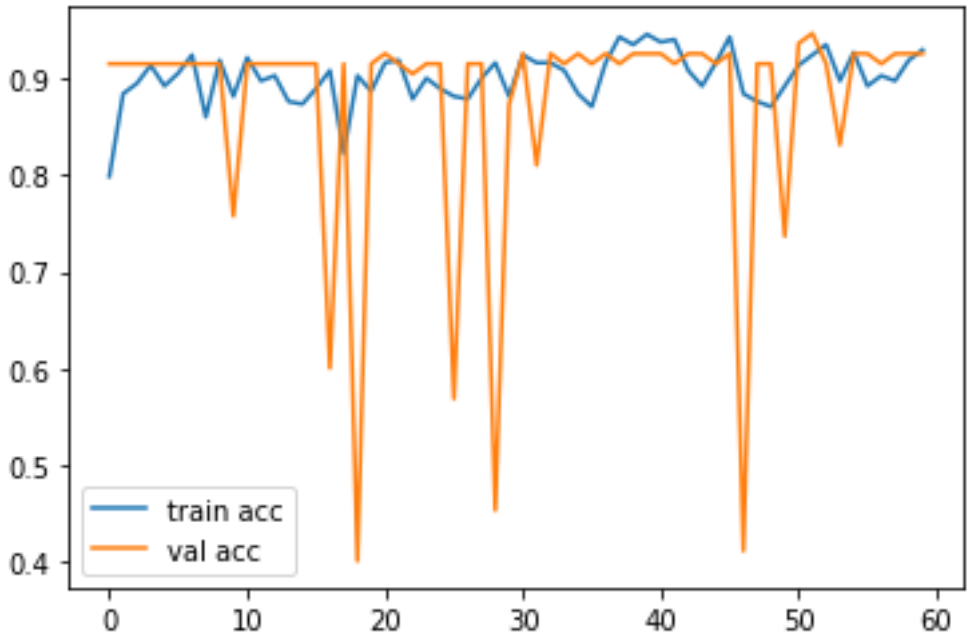


Figure 36: Accuracy curve to Res NET 50

III.8.f Loss curve Res Net 50

In the Res Net 50 loss curve, we note a proportionality in each of the test curves and the precision curve achieved, as we notice a decrease in both curves. Then, we notice a significant increase in the test loss curve sometimes and its decrease sometimes, while in the training loss curve, it experienced a small fluctuation and stability in smaller values between 2% and 10% as shown in the following figure 38, so we note the stability of the training curve loss rate at around 0 and the test curve loss rate at 50% at the end of the training process.

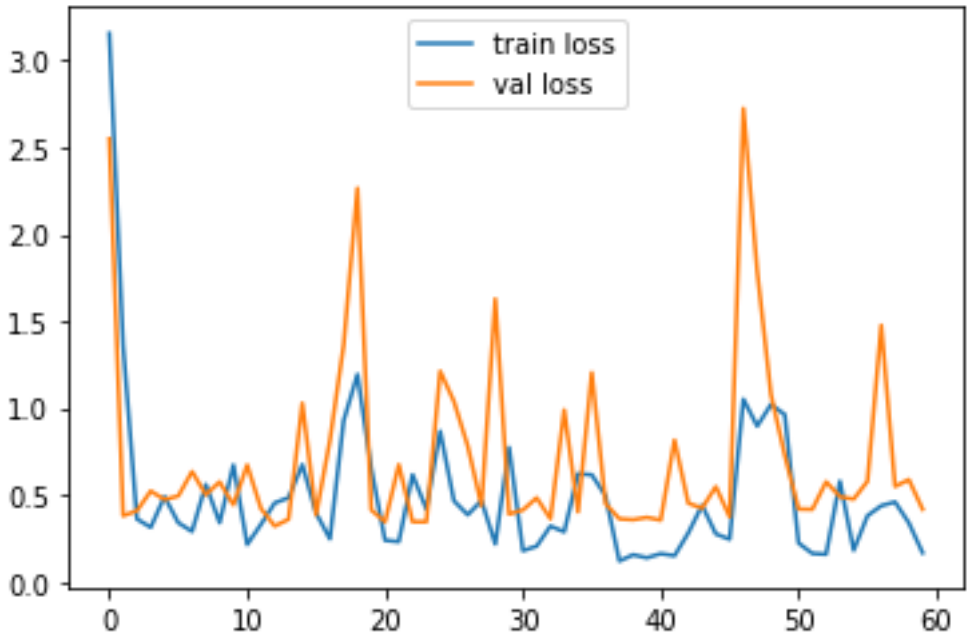


Figure 37: Loss curve to Res NET 50

III.8.g accuracy curve VGG 16

in the accuracy curve of the VGG 16 model, as shown in Figure 39. An increase in the training curve indicates the success of the model in providing the correct responses during the training process. Our model showed a response in training, as the training accuracy curve achieved a significant increase, reaching 97%. While we note that the test curve achieved good accuracy, ranging between 90% and 93% , which means that the model was successful in the training process, and this was apparent in the test process.

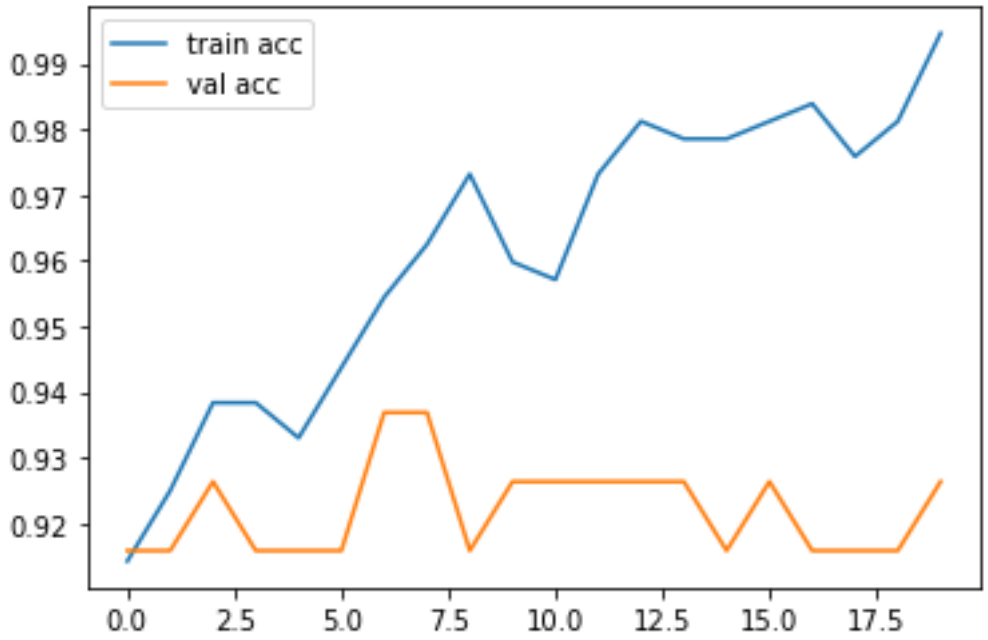


Figure 38: Accuracy curve to VGG 16

III.8.h Loss curve VGG 16

In the VGG 16 loss curve, there is a gradual decrease in the learning process loss curve, indicating that the model is being trained correctly, and the loss has continued until it reaches 0 at the end of learning. While the test loss curve shows an increase from 30% to 40%, the test loss value remains stable between 20 % and 30% and remains stable until the end of training.

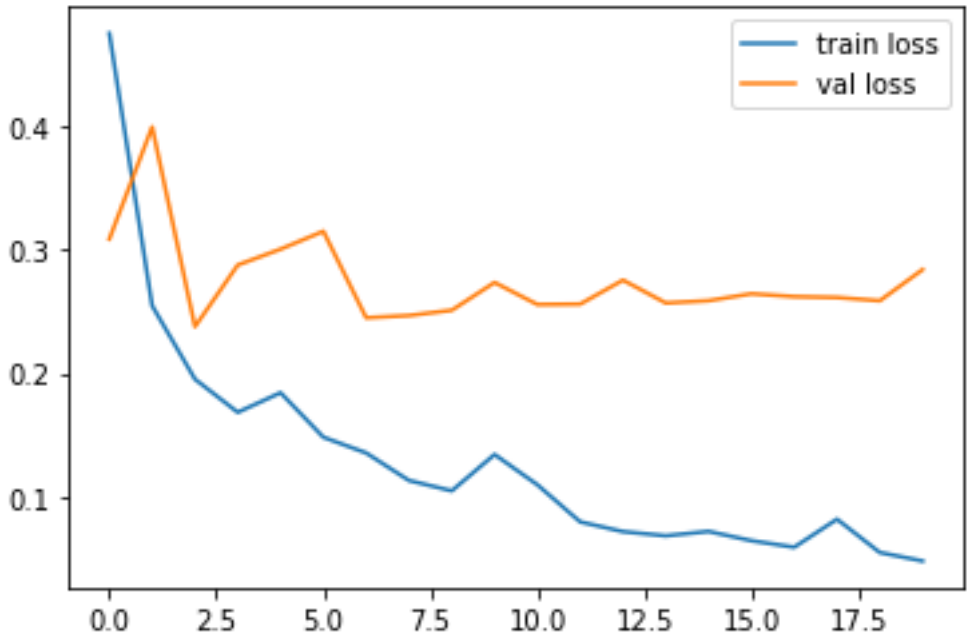


Figure 39: Loss curve to VGG 16

III.8.I accuracy curve VGG 19

in the accuracy curve of the VGG 19 model, as shown in Figure 41. An increase in the training curve indicates the success of the model in providing the correct responses during the training process. Our model showed a response to training, as the percentage of accuracy in the training curve was 99%. The test curve, on the other hand, showed a constant accuracy between 92% and 93%, i.e. passing the test.

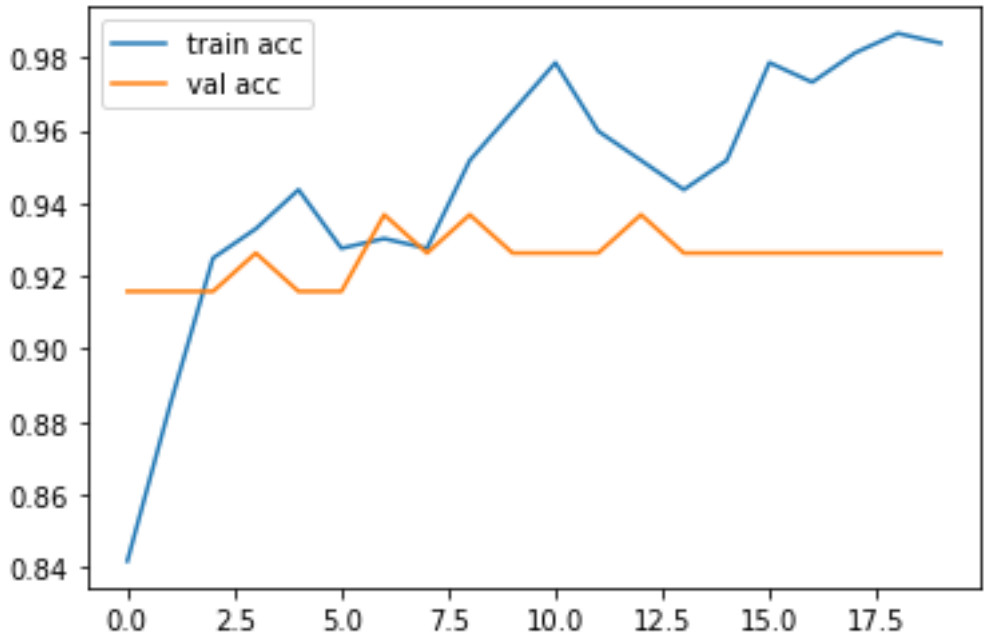


Figure 40: Accuracy curve to VGG 19

III.8.j Loss curve VGG 19

In the VGG 19 loss curve, we note a proportionality in both the test curves and the achieved accuracy curve, as the ratio was high at the start of training and reached 13%. We then see a decrease in this ratio, i.e. a decrease in the loss ratio shown in the following Figure 42, so that we notice the stability of the loss ratio in the test curve at around 1% and close to zero, and its stability until the end of the training process. However, in the test loss curve, we note the stability of the accuracy between 4% and 2%, a low percentage of loss in the model.

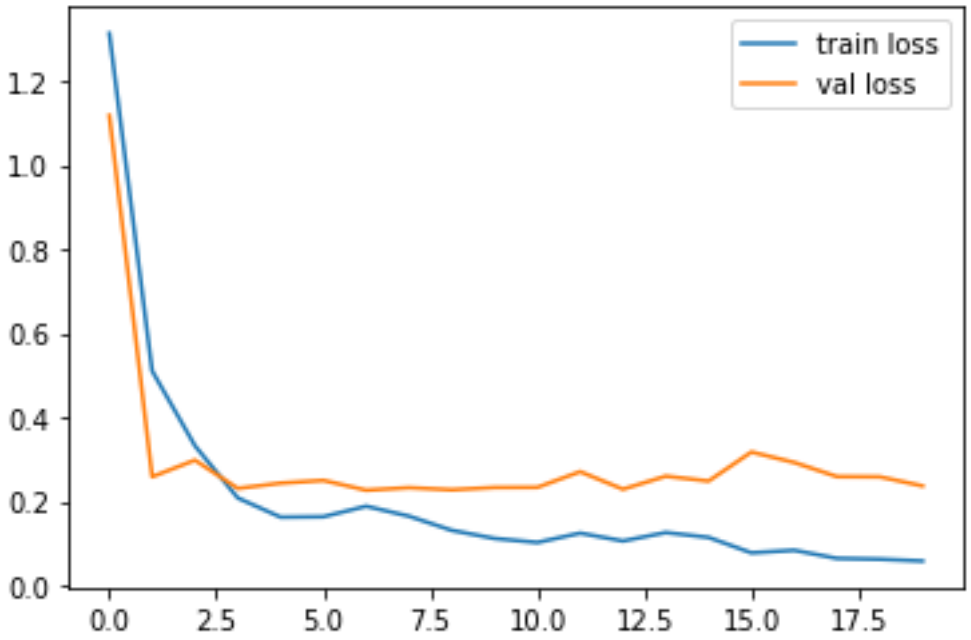


Figure 41: Loss curve to VGG 19

III.9 Comparison

In Figures 35, 37, 39, and 41, we notice a difference in the accuracy curve, as the accuracy curve in the AlexNet Train model is higher than the accuracy curve in other models such as ResNet50, and VGG16. Where AlexNet achieved a training accuracy close to 100%, and a test accuracy of 97.87%. Which is considered the best.

In addition to the loss curve, as shown in the following figures: 36, 38, 40, and 42, there is a difference in the loss curve, as the loss curve in Train for the AlexNet model was the best of all the models, as we notice a small percentage loss and it's the best of them all. As for the test loss curve, AlexNet was also one of the best models.

So when the results are close to 100% in accuracy and 0% in loss, the results are perfect. We can say that the higher the accuracy of the system and the lower the loss rate, the better the Accuracy curve and the better the loss curve.

III.10 Conclusion:

In our system, we proposed a method to classify cough signal spectrogram images for COVID-19 detection based on the feature extraction process and convolutional network classifiers in deep learning. In this work, we use SPEC-DATA datasets to evaluate the performance of 4 CNN models And ANN Models by changing the parameters. In most of the tested models, the results were obtained with high accuracy, and the model was the best, as it obtained an estimated accuracy of ...., followed by a model with an accuracy of... In our proposed work, we used evidence that may not be sufficient to obtain better results than this. The use of new and good evidence always leads to improving the accuracy and performance of the efficiency of our system or similar systems, and better results can be obtained.

General Conclusion

In the past few years that have passed, I have witnessed that the Covid-19 virus was one of the most dangerous and widespread viruses, as it led to the death of many people around the world, and after that, scientists and doctors have tried to discover ways and solutions for early diagnosis of the disease to limit its spread. In light of the search for efficient and effective methods for early detection of Covid-19, modern technologies have tended to use artificial intelligence, especially deep learning, convolutional networks, and images, to detect Covid-19, due to its efficiency in detection. and accuracy. In this work, we proposed to use a database containing spectrum diagrams extracted from cough sound signals and trained them on CNN models. Our study was as follows:

- We tried to propose a detection system for Covid through a spectrum diagram and trained CNN models (Res Net50, VGG 16, VGG19, ANN, Alex Net).
- A database was used to work on it, obtaining images of spectral diagrams of Covid-19 cough sounds, and we used the type of deep learning and convolutional networks. We compared the classifiers (Res Net50, VGG 16, VGG19, ANN, and Alex Net).
- A set of results were obtained in this work, which proves the accuracy and excellent performance of this system.

Finally, the experimental results were projected onto our system, and results in terms of accuracy and curves were obtained for our models. CNN is ideal for handling image classification and achieves better classification results because it has a special structure for its models. Where the Alex Net model achieved an accuracy of 95.31% it is considered the best The ANN model is considered the best model because it achieves 97.87% accuracy. Epoch, batch size, and number of layers can all play an important role in the results.

- In this study we have obtained these good results that prove the effectiveness of our system, which can be a major incentive to work with them or other successful studies

in medical decision systems and work, to try to obtain efficient, fast results and more accurate detection systems.

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الجمهورية الجزائرية الديمقراطية الشعبية

وزارة التعليم العالي و البحث العلمي

جامعة قاصدي مرباح ورقلة

عنوان المشروع:

تطبيق للكشف عن كوفيد – 19 باستخدام المخططات الطيفية و التعلم العميق

مشروع لنيل شهادة مؤسسة ناشئة في اطار القرار الوزاري 1275

الاسم التجاري	**صورة العلامة التجارية**

MXP TAIBECHE

بطاقة معلومات:

حول فريق الاشراف وفريق العمل

1- فريق الاشراف:

فريق الاشراف	
(01): المشرف الرئيسي د. بن الصيد خالد	**:**التخصص الكترونيك و اتصالات

2- فريق العمل:

فريق المشروع	التخصص	الكلية
الطالب: العولقي يحيى	الكترونيك الانظمة المدمجة	كلية الالكترونيك والاتصالات و التكنولوجيات الحديثة
الطالب: ضفيرات شاكر عبد الغني	الكترونيك الانظمة المدمجة	كلية الالكترونيك والاتصالات و التكنولوجيات الحديثة
الطالب: بن طالب احمد	الكترونيك الانظمة المدمجة	كلية الالكترونيك والاتصالات و التكنولوجيات الحديثة

1 كرة المشروع (الحل المقترح)

مشروع الذي سنقوم بأنجازه هو عبارة عن انجاز تطبيق الكتروني حديث يقوم بالكشف عن كوفيد-19 باستخدام المخططات الطيفية لاصوات السعال و التعلم العميق. وبدأت فكرة انشاء هذا تطبيق من جراء النقص في انظمة القرارات الطبية و التكاليف التي تتطلبها الكشوفات السريرية ن وقت وتكاليف باهضة , فمن خلال هذا تطلعنا الى تطوير هذا التطبيق الذي سيكون بمثابة حل وهري لعملية التشخيص السريعة و الغير مكلفة .

سنقوم مع زملائي والدكتور خالد بن الصيد بعملية نمذجة المعلومات والدراسة التي اجريناها الى تطبيق الكتروني فعال استنادا الى الذكاء الاصطناعي و سيتم ذلك في الجامعة.

2. القيم المقترحة

يمكن أن تنشأ القيم المقترحة أو المقدمة للزبائن من خلال العناصر التالية:

- الحداثة: تلبية احتياجات موجودة في السابق لكن لم يتم صياغتها الى مشروع مماثل , رغم وجود دراسات مماثلة في السابق.
- الأداء: سوف نحرص على أن يكون أداء المنتج أو الخدمة أعلى أو مساوي لتوقعات العميل.
- التكييف: سيتم التكييف او التعامل مع اي طلب للعميل و العملاء بالتغيير حسب احتياجاتهم مع الحفاظ على المبدا الاساسي للتطبيق.
- إنجاز المهمة: مساعدة العميل على انجاز مهمة الكشف بنفسه من خلال التطبيق.
- التصميم: الحرص على جعل التصاميم تتوافق مع رغبات وظروف العميل.من خلال تصميم مسجل للصوت و ادراجه داخل التطبيق و اتخاذ القرار الالي و السريع .
- خفض التكاليف: مساعدة العملاء على خفض تكاليفهم.من خلال تنزيل التطبيق من المتجر الالكتروني دون الحاجة الى تكاليف مادية باهضة.
- الحد من المخاطر: تقليص احتمال تعرض العملاء للمخاطر لدى شرائهم المنتجات أو الخدمات بتقديم ضمانات. وذلك بتقديم النظام كجهاز الكتروني طبي او تطبيق الكتروني في الهاتف المحمول.
- سهولة الوصول: جعل المنتجات متاحة للعملاء الذين لم يكن بإمكانهم من قبل الوصول إليها.بتوفيرها عبر اجهزة الهواتف المحمولة.
- الملاءمة/سهولة الاستخدام: جعل التطبيق سهل و بسيط الاستخدام لكل الفئات العمرية .
- فريق العمل

3. فريق العمل :

هنا تتحدث عن فريق العمل على المشروع من خلال :

- فريق العمل يتكون من ثلاث طلبة جامعيين متحصلين على شهادة ليسانس تخصص الكترونيك ويشرفون على نيل شهادة ماجستير في الانظمة المضمنة و دكتور جامعي .
- يتمثل التنظيم في توزيع العمل لانجاز التطبيق بين اعضاء الفريق وذلك كلا حسب مهاراته , بحيث يتحلى كل طالب بروح المسؤلية وحل المشاكل التي تواجهه و التواصل مع الدكتور لاخذ التوجيهات.
- تكون طريقة التواصل والتفاعل بين اعضاء الفريق بواسطة التواصل الالكتروني او الالتقاء .

4. أهداف المشروع

- استغلال اصوات السعال في اجراء الكشف عن المرض.
- استخدام الذكاء الاصطناعي في نمذجة التطبيق الالكتروني .
- ابتكار طريقة فعالة وسهلة للكشف عن المرض بتوفير التطبيق في الهاتف .

5. جدول زمني لتحقيق المشروع :

- كيفية تقسيم الهدف النهائي لبراءة الاختراع إلى مهام فردية.
- تحديد الوقت اللازم لكل مهمة.
- تحديد النتائج الرئيسية لكل مهمة.

الشهر

	البحث في قواعد البيانات الخاصة ببراءات الاختراع وجمع المعلومات	✓	✓					
	الشروع في الاختبارات المخبرية لإعداد النموذج الأولي		✓	✓				
	تجريب النموذج الأولي		✓	✓	✓			
	تجربة النموذج الأولي خارج المخابر			✓	✓	✓		
	تسجيل براءة الاختراع من اجل الحصول على رقم الإيداع والحماية الصناعية							
	متابعة عملية الحصول على براءة الاختراع وتصحيح ملاحظات الممتحنين من **inapi**							

الأعمال

6. عرض القطاع السوقي :

- السوق المحتمل هو كل الافراد سواءا الحاملين للمرض او الاصحاء لكثرة احتياجات الافراد الى تطبيقات مماثلة تسهل الخدمات للعميل و تشبع رغباته.
- السوق المستهدف (الشريحة): السوق المستهدف هو كل الافراد الذين يحتاجون التطبيق أو المؤسسات كالمستشفيات او المخابر الطبية .

- تم اختيار هذا السوق المستهدف وذلك لسهولة الحصول على التطبيق و توفره , و تسهيل العمل على المستشفيات او المخابر من خلال الكشف السريع دون اجراءات سريرية معقدة.
- إمكانية ابرام عقود شراء مع بعض الزبائن المهمين كالمستشفيات او المخابر ببيع التطبيق بصيغ مخالفة و حسب طلبات الزبائن.

7. قياس شدة المنافسة :

- حدد من هم منافسوك المباشرين والغير مباشرين.
- المنافسين المباشرين هم الذين يملكون تطبيقات مماثلة او المنافسين غير المباشرين كالذين ينجزون جهاز الكتروني مماثل لعمل التطبيق.

- لم يتم التعرف على اعداد المنافسين و حصصهم في السوق.
- تتمثل نقاط قوتهم في بيئة العمل و المناخ المناسب لعمل التطبيق كسرعة الانترنيت و الترويج عبر الاشهارات لمنتجاتهم. اما نقاط ضعفهم فتتمثل في عدم تلاءم التطبيق مع احتياجات العملاء في بعض الاحيان او صعوبة الوصول الى المنتج في بعض الاماكن.

8. التكاليف والأعباء :

- تتمثل تكاليف في المشروع في التكاليف الثابتة و هي عبارة عن انجاز النموذج الاولي للتطبيق من طرف مصممين تطبيقات الكترونية , و التكاليف المتغيرة في عملية اضفاء تعديلات على التطبيق .

9. رقم الاعمال :

- لم يتم الحصول على مبيعات على النشطات المخققة , وذلك في ظل استمرارية العمل على اكمال انجاز التطبيق .

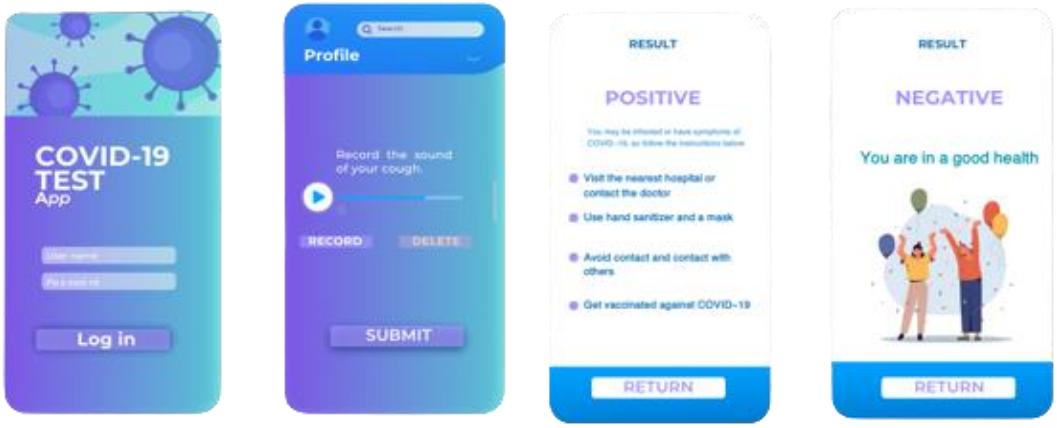
10. النموذج الاولي التجريبي

النموذج الأولي التجريبي هو نسخة أولية تم صنعها من المنتج أو الخدمة والتي تستخدم كأساس في التطوير للوصول الى المنتج النهائي الذي سيطبق في السوق رسميا.

- في هذا الجانب يقدم صاحب المشروع نموذج اولي ملموس (يقدم للجنة)، كما يمكنه تصوير مقطع فيديو أو مجموعة من الصور تثبت وصوله إلى إتمام النموذج الأولي .
- مواصلة العمل على انجاز النموذج الاولي للتطبيق و تقديمه للجنة .
- كما يمكنه تقديم شرح للمراحل الأساسية المتبعة للوصول الى النموذج الأولي.
- شرح المراحل الاساسية لانجاز التطبيق و المتمثلة في :
  - تجريب النظام للحصول على دقة جيدة لاداء التطبيق .
  - تحويل النظام المنجز الى تطبيق الكتروني عن طريق انجاز واجهة التطبيق و العمل على انشاء خلفية جيدة و تتلاءم مع التطبيق .
  - نشر التطبيق في المتاجر الاكتروني لكي يصبح متاح وسهل الوصول .

يمكن لأصحاب مشاريع التطبيقات والمنصات الرقمية عرض نموذج أولي للتطبيق الكترونيا

عنوان المشروع : تطبيق للكشف عن كوفيد – 19 باستخدام المخططات الطيفية و التعلم العميق



Covid-19 Test Application Form

الملحق رقم 04: نموذج العمل التجاري