Zagazig University

Faculty of Computer and Informatics

2022 – 2023

Project name:

Neurological Disease Diagnostic System Using Artificial Intelligence.

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Abstract

With the spread of artificial intelligence applications and its uses in the medical field and the development of medical devices, we have come up with the creation of a device that helps patients and doctors predict nervous convulsions, especially during coma, by measuring nerve signals first, then predicting using a deep learning model secondly, and there is a mobile application to display a report on the patient's condition If it is normal or abnormal so that the patient sends it to his doctor as soon as possible in the event that the patient is the one using the device.

1. Introduction

In medical terminology, convulsions refer to involuntary, violent, and uncontrolled muscle contractions that can involve the entire body or specific muscle groups. Convulsions are commonly associated with seizures, which are abnormal electrical activities in the brain.

1. Noticeable convulsions: These convulsions are easily recognizable due to their characteristic and prominent physical manifestations. They typically involve visible and dramatic movements, such as jerking, shaking, stiffening, or twitching of the limbs, face, or the entire body. Noticeable convulsions are usually accompanied by other signs of a seizure, such as altered consciousness, loss of awareness, changes in behavior, or other neurological symptoms. Noticeable convulsions are a key feature of conditions like epilepsy and can be witnessed by the person experiencing them or by those nearby.
2. Unnoticed convulsions: Unnoticed convulsions, on the other hand, are convulsive episodes that occur without being easily perceived or detected by the individual experiencing them or by others. These convulsions may be subtle and lack the typical external manifestations of noticeable convulsions. Instead of obvious body movements, unnoticed convulsions might involve more internal sensations or symptoms that are not immediately visible. These can include brief alterations in consciousness, strange sensations, muscle twitches or contractions that are not apparent to others, or a sense of disconnection. Unnoticed convulsions can be associated with certain types of seizures, such as absence seizures or focal seizures without motor symptoms.

It's crucial to note that convulsions are a serious medical concern, and if you suspect you or someone else is experiencing convulsions, it's important to seek immediate medical attention. A healthcare professional can assess the situation, diagnose the underlying cause, and recommend appropriate treatment or management options.

Many patients in a coma suffer from the presence of nervous convulsions in the brain, and these convulsions are of the type of unnoticed convulsions, and these convulsions cannot be recognized by the doctor manually. Therefore, we created a device that measures the nerve signals of the brain and the rest of the body parts supported by a deep learning model to predict the presence of convulsions. When the patient is in a state of convulsion, the device makes an alarm sound to alert the doctor that the patient is in a state of convulsion, and the doctor rescues the patient immediately.

We trained our deep learning model on real data set that we collected from hospitalized patients.

1.1 Objectives

- Measurement of nerve signals

The device measures nerve signals from any part of the human body, according to the location of the electrodes.

- Prediction of nervous convulsions, especially during coma

The device is connected to a mobile application so that the device sends the readings of the neural signal and takes a screenshot of the signal and sends it to the deep learning model, So that he predicts the occurrence of convulsions or not.

- Communication between the patient and the doctor

The mobile application makes a report on the patient's condition, whether it is normal or abnormal, then the patient sends the report to his doctor to provide advice to the patient.

- Remote treatment

Thus, we have achieved the vision of Egypt 2030, as it is one of the goals of the health axis, "developing the health information system, evaluation and follow-up systems, establishing a national health map of disease and health services, and using telemedicine applications.

1.2 Summary of the project

In order to categorize the patient's state, we are interested in analyzing nerve impulses to determine what they convey and quantifying the rate at which they occur. As a result, we have developed a neural signal measurement tool that is distinguished by:

- The capacity to accurately detect nerve impulses in less than 30 seconds.
- The device's diminutive dimensions were made possible by Internet of Things technology.
- Ease of use without the need to be an expert or medical.
- Technology based on artificial intelligence has been used and abused. A mobile application that uses artificial intelligence is linked to the device. It can classify the patient's condition after analyzing the results, predict strokes before they happen, and create a report on the patient's condition that can be used to track the patient's condition over time and determine how well he responded to a protocol treatment.
- The device demonstrated its capability to identify nervous twitches in a state of coma during the trial run of the device in the hospital under the watch of specialized physicians, making it the first device to be able to do so.
- The success of the first device was taken advantage of in the development and use of a second, smaller device that the athlete can wear on the field to monitor the level of his nervous effort and the degree of his recovery from an injury, preventing any negative effects from the exercise by monitoring the results on the desktop application.

Some devices, such as the EEG device, actually measure the nerve signal, but the difference between the EEG device and our device is that our device predicts convulsions and not only measures nerve signals, in addition to that it is very cheap compared to the EEG device and the regular nerve mapping device, and anyone can use it, not just doctors, it is easy to use and its price Within the reach of low-income people.

This device enables it to solve the problem of size, time and cost.

We hope that this device will be available in all hospitals in Egypt, as well as health units in villages, as it saves the disease travel time, effort and cost.

In the future, we hope that such a pressure device will be available in homes, as it is compatible with it in its small size and ease of use.

The stored data about each patient's condition is used as statistics in research and development.

this device is useful for:

- Patients with nerves and strokes.
- Physiotherapy and rehabilitation centers.
- Hospitals and outpatient clinics.
- the elderly+65.
- Average annual income +80,000 EPG.

2. LITERATURE SURVEY

2.1 Importance of technology in medical field:

The use of new technologies and methods to enhance patient care, diagnose and treat patients more effectively, and perform procedures more accurately and efficiently has transformed medicine in many ways. The following are some of the main advantages and significance of technology in the medical field:

1- Greater accuracy in disease detection and diagnosis as well as more effective treatment options are made possible by modern medical technologies like imaging systems, laboratory apparatus, and diagnostic instruments. Treatments become quicker and more efficient as a result, perhaps improving patient outcomes.

2- Improving Patient Care: State-of-the-art telemedicine, electronic health records, and mobile health applications advance patient care by making it easier for patients to access healthcare resources and services. This makes it possible for patients to receive care faster and more comfortably, which improves patient happiness and outcomes.

3- Increased efficiency: The efficiency of medical processes has grown, and the risk of human error has decreased, thanks to technology like automated systems, robotics, and AI-powered instruments. As a result, medical care is now delivered more quickly, precisely, and affordably.

4- Medical research has been significantly advanced by technology, allowing researchers to collect and analyze data more efficiently and accurately. This has resulted in the discovery of new insights and knowledge that can enhance patient outcomes and further advance medical knowledge.

5- Improved communication: Communication technology has facilitated communication between healthcare professionals, patients, and caregivers, leading to better-coordinated care and improved patient outcomes.

6- Remote processing is used in medical research, allowing researchers to analyze large amounts of data remotely and in real-time. This can lead to faster and more accurate research findings, which can lead to the development of new treatments and therapies.

7- The use of remote processing technology has the potential to completely transform how healthcare is provided, improving patient care while lowering costs.

8- Remote processing technology has the capability to provide healthcare providers with virtual training and education programs, allowing them to acquire new skills and knowledge without the need to travel to a specific location.

In conclusion, technological advancements in the medical have enhanced patient care, diagnosis, and treatment, increased productivity, and the expansion of medical knowledge. In order to improve patient outcomes and overall healthcare quality.

Neuroscience requires a high degree of precision and attention to detail.
Doctors seek to understand how the nervous system works to diagnose and treat conditions. Devices play an important role in neuroscience research, allowing doctors to measure and manipulate neural activity in the body. This includes techniques such as electroencephalography (EEG), which records the electrical activity of the brain, and electromyography (EMG), which records the electrical activity of muscles.

The purpose of this section is to discuss EMG device and EEG device) How the device works Test results and challenges(

2.2 EMG (Electromyography) :

Definition:

Electromyography (EMG) is a diagnostic procedure to assess the health of muscles and the nerve cells that control them (motor neurons). EMG results can reveal nerve dysfunction, muscle dysfunction or problems with nerve-to-muscle signal transmission.

How it works:

An EMG (electromyography) test is a medical test that is usually performed by a neurologist. electrodes are placed on the surface of the skin and a small electrical impulse is delivered to the nerves to record their response. In an EMG test, the neurologist will locate specific muscles they want to test and insert a small needle with an electrode through the skin and into the muscle. The patient may feel slight discomfort or pain when the needles are inserted.

The neurologist will then ask the patient to relax and use the muscles in certain ways, such as lifting or flexing a limb, while a machine measures and displays the electrical activity of the muscle. This process is repeated for each muscle being tested. The duration of the examination for each muscle generally takes one to two minutes. Once enough data has been recorded from the muscle, the needle is removed, and the same process is repeated for the next muscle until the test is concluded. The duration of an EMG (electromyogram) test is usually 60 to 90 minutes, depending on the number of muscles to be tested.[1] As figure (1).

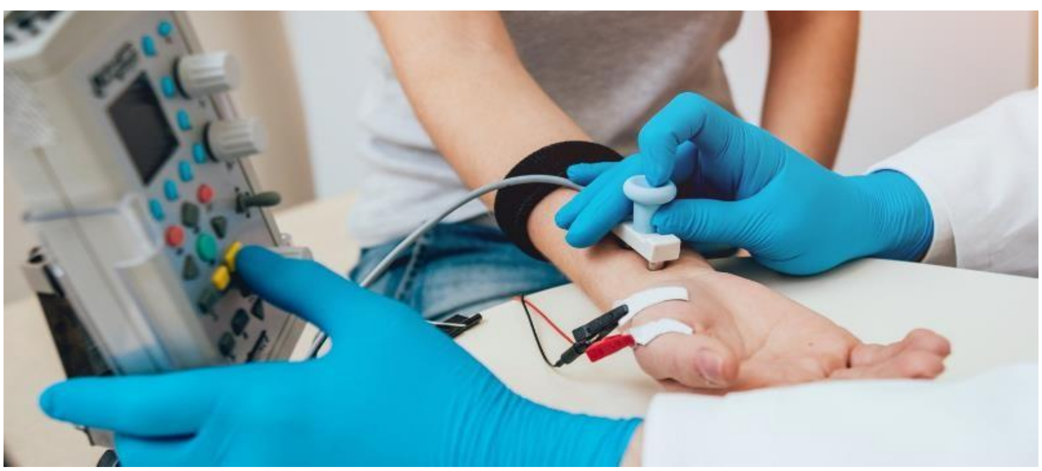


figure (1)

Results of EMG device

Normal:

During an EMG (electromyography) test, a muscle at rest will not display any electrical activity on the recording. However, when the muscle contracts, it will show electrical activity in the form of a wave line or action potential. The size and shape of the action potential provide the doctor with information about the muscle's ability to respond to the nerve that controls it. A normal muscle will show a smooth action potential in a standard EMG. The action potentials are recorded using the electrodes that are inserted into the muscle during the test.

Myopathy:

EMG results can be abnormal in two ways: the muscle may show electrical activity at rest, or it may show abnormal electrical activity during contraction. Abnormal EMG results are characterized by changes in the size or shape of the wave, indicating an abnormal action potential pattern. These results may indicate muscle damage or issues with the nerves that control the muscle. EMG testing is an essential diagnostic tool in identifying and treating neuromuscular disorders. [2]

Typical EMG data patterns for various categories. (a) Normal. (b) Myopathy. (c) ALS. (Amyotrophic Lateral Sclerosis)
As figure (2).

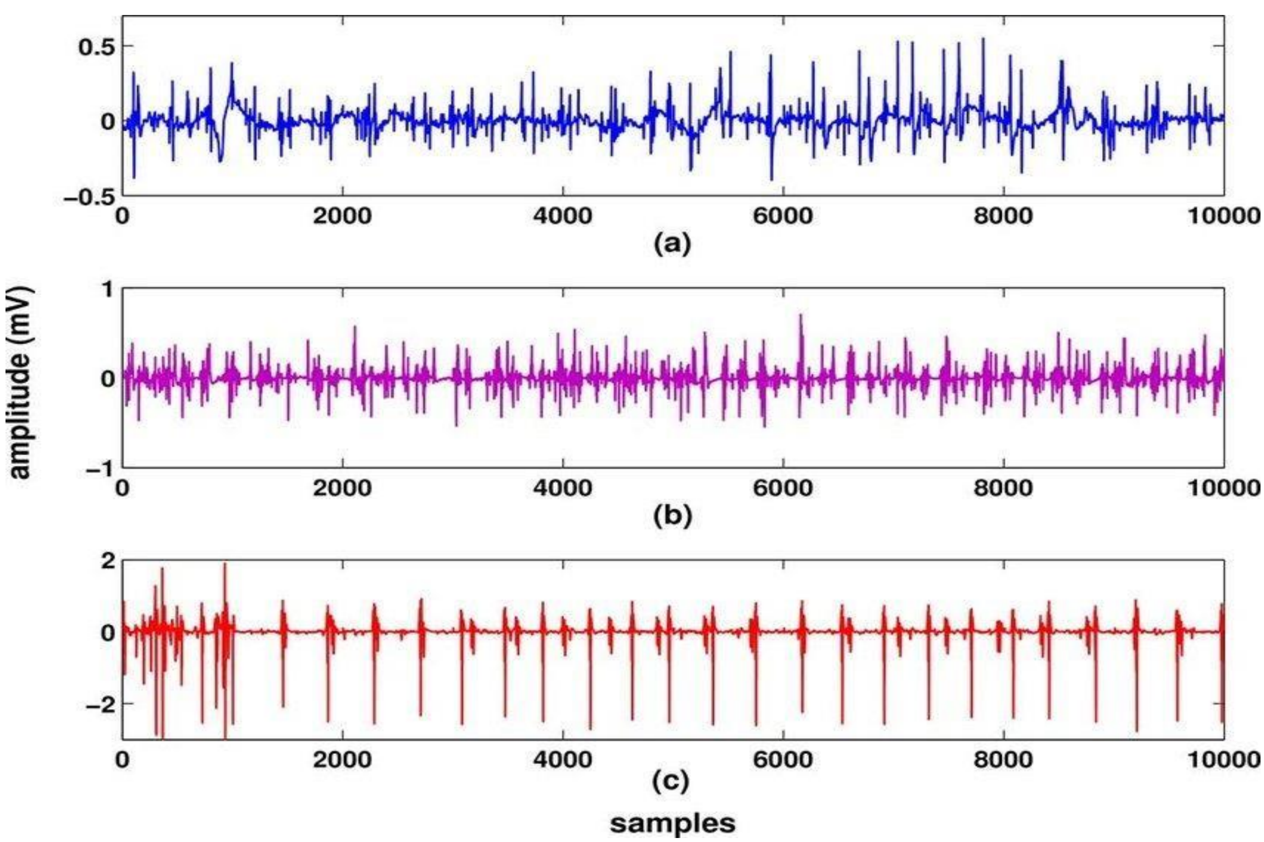


figure (2)

2.3 The challenges of EMG

There are several challenges associated with EMG (electromyography) devices, including:

User discomfort:
EMG testing involves inserting small needles with electrodes into muscles, which can cause discomfort or pain for some patients. This can make the testing process uncomfortable.

Limited availability:
EMG devices can be costly and may not be available at all healthcare facilities. This can limit access to the testing for some patients.

Technical limitations:
EMG devices require proper placement of electrodes and needles to obtain accurate recordings, which can be challenging for some healthcare providers. Additionally, external factors such as electrical interference or muscle movement during the test can affect the quality of the recordings.

Interpretation of results:
EMG recordings require interpretation by a trained medical professional, such as a neurologist or physical therapist. The interpretation of the results can be complex and requires a high level of expertise.

Overall, EMG devices are valuable diagnostic tools for a variety of neuromuscular disorders, but their use can be challenging due to technical limitations, discomfort, and interpretation of the results. Ongoing research and development are necessary to address these challenges and improve the accuracy and accessibility of EMG testing. [1]

2.4 EEG (electroencephalography)

Definition:
An electroencephalography (EEG) sensor is an electronic device that can measure electrical signals of the brain using electrodes placed on the scalp. The electrodes are able to detect the electrical signals produced by the neurons in the brain as they communicate with each other.

How it works:
The patient is usually lying down or sitting with their eyes closed during an EEG recording, and conductive paste or gel is used to adhere the electrodes to their scalp. The electrical impulses from the electrodes are amplified by the amplifier before being sent to a computer for analysis.

The EEG recording produces a pattern of brain waves that can be used to diagnose various neurological conditions, such as seizures, sleep disorders, and brain injuries. The brain waves are classified into different frequency bands, such as delta, theta, alpha, beta, and gamma, which correspond to different states of consciousness and different types of brain activity.

The recording often lasts 20 to 40 minutes, during which the patient may be asked to perform certain tasks or try different forms of stimulation in order to elicit certain brain responses. In some circumstances, such as during a polysomnography or to track brain activity during a seizure, the EEG recording may need to be taken for a longer period of time. [3] As figure (3)

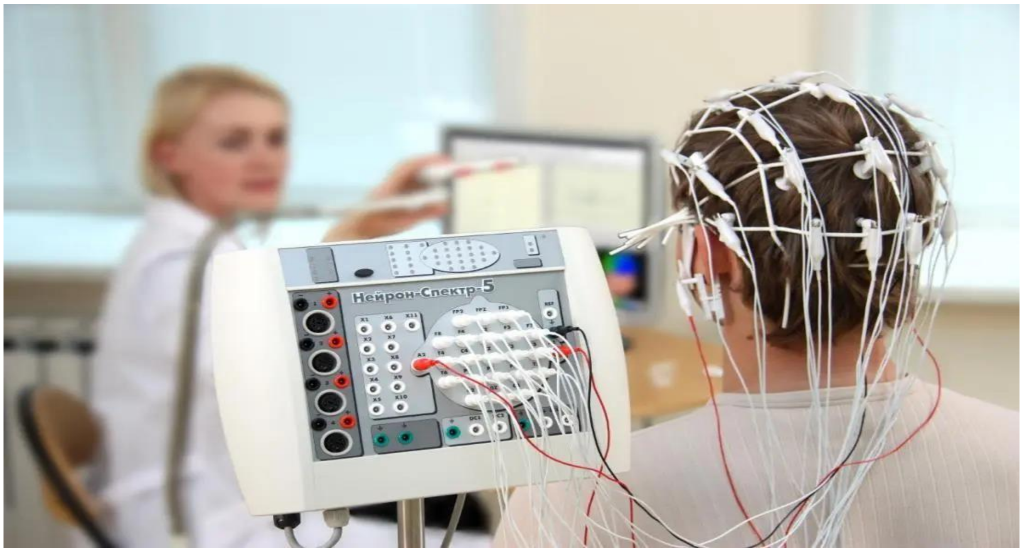


figure (3)

Once the EEG recording is done, the electrodes are removed, and the patient can return to their usual activities. The EEG results are analyzed by a qualified medical expert, such as a neurologist, who can interpret the brain activity patterns and provide a diagnosis or treatment plan if required.

The method used to place the electrodes:
In 1957, at the IV International EEG Congress in Brussels, Herbert Jasper unveiled the 10-20 method. The system was designed to make EEG insertion procedures uniform. The numerals 10 and 20 represent the distance between neighbouring electrodes, which is 10% or 20% of the entire distance from the front to the back or from the right to the left of the skull, respectively. The two preauricular points on the scalp—the nasion and inion for the front and back directions, and the two preauricular points for the right and left—are used to calculate the overall distance [4]. As figure (4)

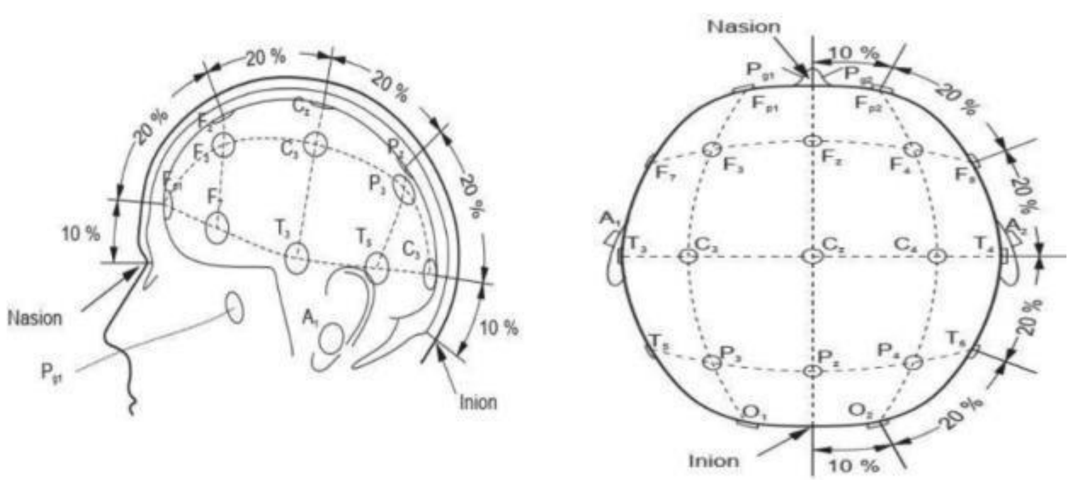


figure (4)

Results of EEG device:

EEG charts show a series of wavy lines that represent the fluctuating voltages within different groups of neurons. These waves are commonly known as "brain waves" and are measured in hertz, which is the number of cycles per second. Brain waves are classified based on their frequency, and the categories include delta (0.5-4 hz), alpha (8-12 hz), beta (12-35 hz), theta (4-8 hz), and gamma (32-100 hz) waves. By analyzing the appearance of these wave types and their locations in the brain, researchers and physicians can gain valuable insights into brain function.

Doctors use information from an EEG to gain insight into brain activity.

- Alpha waves are associated with relaxation and attention and are present when someone is awake with their eyes closed. These waves typically disappear when the person opens their eyes and becomes attentive to something. The frequency of alpha waves is between 8-12 hertz.

- Beta waves are a common occurrence in people who are awake, regardless of whether their eyes are open or closed. These waves are susceptible to the effects of certain drugs, such as sedatives. Beta waves have a frequency range of 12-35 hertz.

- Theta waves are associated with sleep and are slow waves that are normal for all age groups during sleep. They are typically not visible when adults are awake. Theta waves have a frequency range of 4-8 hertz.

- Delta waves are associated with sleep and are normal in adults who are in deep sleep as well as in young children. The frequency range of delta waves is 0.5-4 hertz.

Other brain waves and EEG patterns give doctors information about sleep stages, how easily you can be roused from sleep, and problems with the structure of the brain. As figure (5)

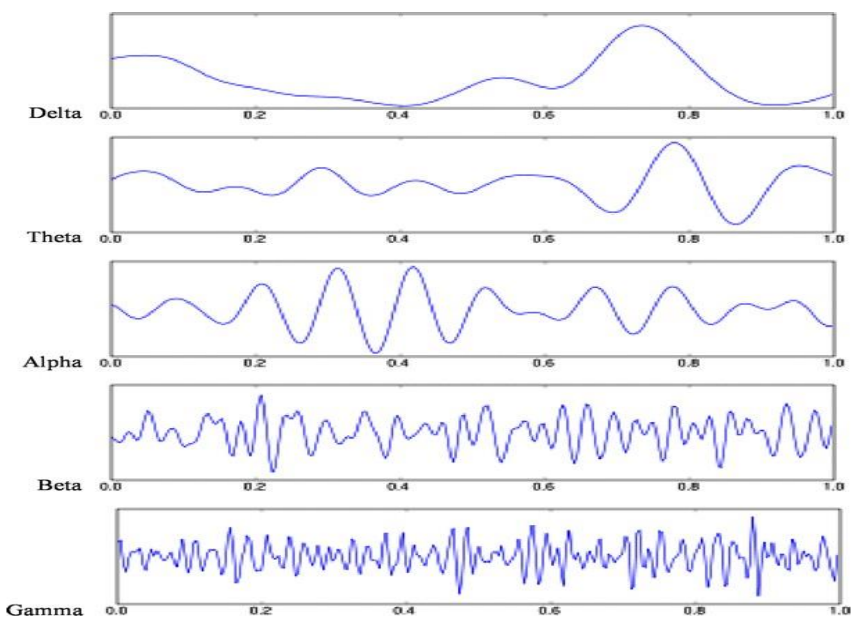


figure (5)

Abnormal EEG results are represented by irregular patterns of brain wave activity that deviate from the typical pattern for the patient's age and health status. The abnormal patterns may include sudden spikes, sharp waves, or prolonged discharges, which can indicate various neurological conditions such as epilepsy, brain tumors, or brain injuries. The abnormal EEG results may also show a lack of brain wave activity in certain regions of the brain, which can indicate a loss of function or damage to the brain tissue. The representation of abnormal EEG results can vary depending on the specific condition and the severity of the abnormality.

Interpretation of EEG results requires the expertise of a trained medical professional, such as a neurologist, who can take into account the patient's medical history, symptoms, and other diagnostic tests. [5]

The challenges of EEG

- Interpretation challenges: Interpreting EEG recordings requires specialized training and expertise, and results can be influenced by factors such as the patient's age, medication use, and overall health. This can make it challenging to diagnose some neurological conditions based solely on EEG results.

- Discomfort for the patient: EEG recordings typically require the patient to sit or lie still for an extended period of time, which can be uncomfortable or anxiety-provoking for some individuals.

- Cost: The price of EEG equipment may prevent some healthcare facilities from using them. EEG recordings frequently need specialised training and knowledge, which can raise the entire cost of the procedure in addition to equipment costs.

- The size of the EEG (electroencephalogram) device can be a challenge in certain situations. Traditional EEG devices can be relatively large and bulky, which can limit their portability and make them challenging to use in certain settings.

3. PROBLEM SPECIFICATION

According to World Health Organization:
The global burden of neurological disorders is estimated to be around 1 billion people, or one in six of the world's population, and is projected to rise to 1.5 billion by 2050. As figure (6)

Neurological disorders (NDs) are heterogeneous diseases that affect the body's autonomic, peripheral and central nervous system. The non-communicable neurological disorders include migraines, non-migraine headaches, multiple sclerosis, Alzheimer's disease and other dementias, Parkinson's disease, epilepsy, and other neurological disorders.

The burden of deaths and disability caused by neurological disorders is increasingly being recognized as a global public health challenge, and its burden is set to rise during the next few decades as a result of the population aging. [6]

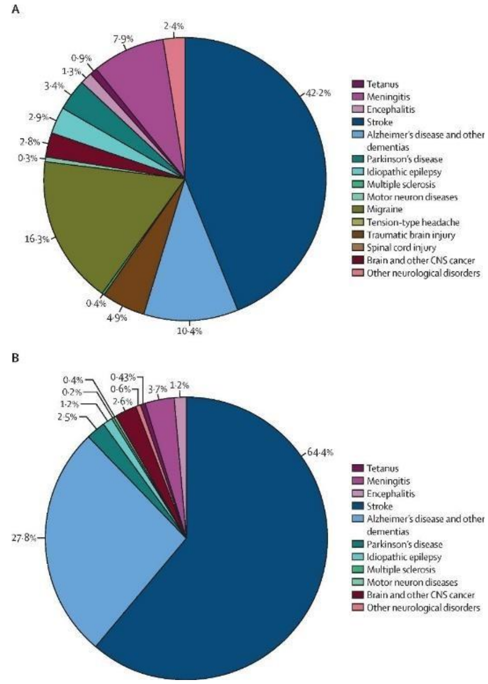


figure (6)

While using the nerve mapping device, we discovered a very big problem, which is the physical harm that the patient feels during the session due to the needle being implanted in his body, which causes deformation in his body (User discomfort).

There is a Discomfort for the patient in EEG recordings typically require the patient to sit or lie still for an extended period of time, which can be uncomfortable or anxiety-provoking for some individuals.

And we started to work on this problem and manufacture a device in which the nerve signals of the human body are measured through a sensor, which makes the patient in a state of psychological calm and without forming any harm in his body.

Among the problems that we also discovered is the lack of speed in diagnosis, as other devices in the market take a very long time to diagnose the condition, which leads to the death of the patient sometimes because there are some critical cases in which the diagnosis must be made in the shortest possible time.

When using our device, the condition is diagnosed in less than 30 seconds with ease.

And there is one of the most important problems and defects in the medical market, which is EMG devices can be costly and may not be available at all healthcare facilities. This can limit access to the testing for some patients. Because of the high price of these devices, which amounts to more than 250,000 EGP, in addition to not being available in some countries, which makes it difficult to purchase them directly.

The most important thing that distinguishes our device is its presence in all medical stores and pharmacies and the ease of purchasing it, as the price was up to 5000 EGP, so it can be bought like a diabetes and blood pressure device.

There are a technical limitations in EMG devices require proper placement of electrodes and needles to obtain accurate recordings, which can be challenging for some healthcare providers. Additionally, external factors such as electrical interference or muscle movement during the test can affect the quality of the recordings. Since the device must be used in certain places in the body, and any change in places causes problems in the results.
We solved this problem in our device by placing electrodes in any infected place in the body, and very correct results are obtained.

One of the most important problems that exist in the EMG device is Interpretation of results that EMG recordings require interpretation by a trained medical professional, such as a neurologist or physical therapist. The interpretation of the results can be complex and requires a high level of expertise.
The solution to this problem is found in our device, whereby any person can measure the nerve signal for himself, and then the device displays the result for him.

And when using the EEG device, we had to put a lot of electrodes on the head to get the best result, and any movement of the head showed incorrect results. As figure (7)

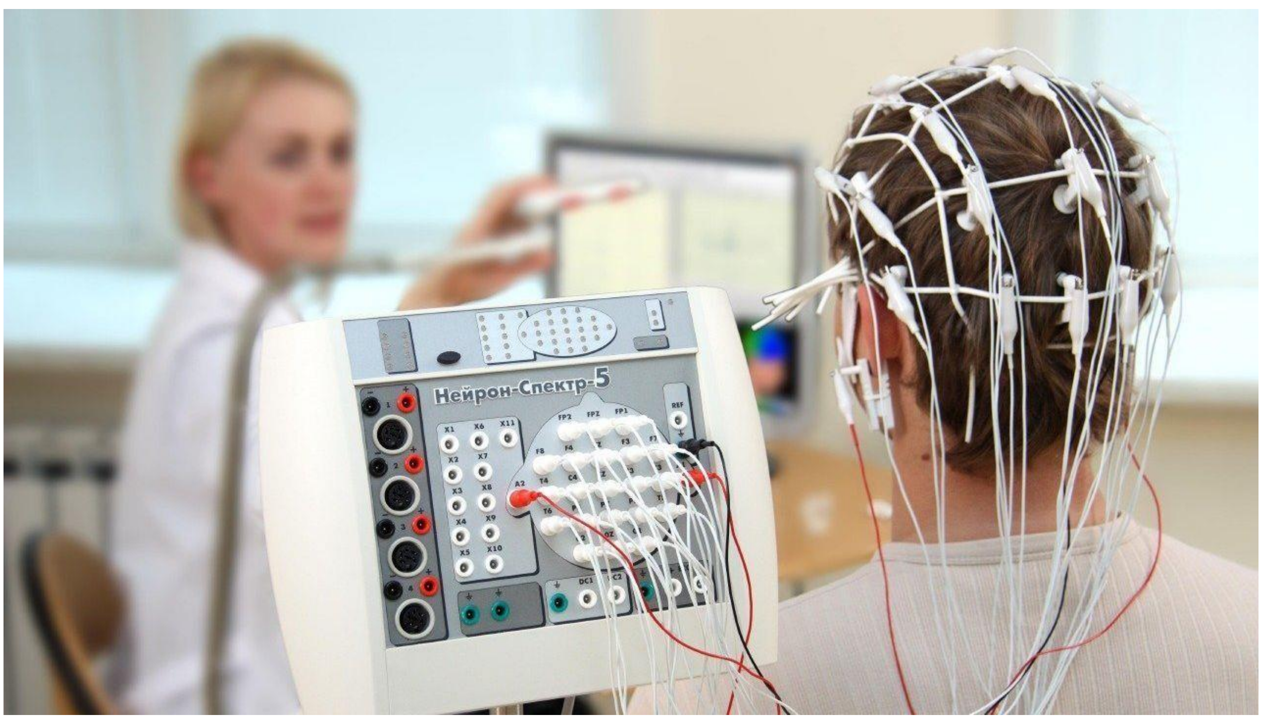


figure (7)

We got rid of this problem by using 6 electrodes that are placed on the affected part only to get the best results.

The size of the EEG (electroencephalogram) device can be a challenge in certain situations. Traditional EEG devices can be relatively large and bulky, which can limit their portability and make them challenging to use in certain settings. As figure (8)

Because of its large size, it is difficult to move the device from one place to another, and it is difficult to use it in homes.

So we developed our device until we made it the size of a mobile phone and it can be hung on the shoulder for use in playgrounds and gymnasiums.

figure (8)

One of the most important problems that our device was able to solve is the lack of a device worldwide that predicts the presence of convulsions for the patient during the state of coma, and because this process is very difficult because the patient does not feel anything during the coma, and it can be detected manually by moving the affected organ in the body, but this method It wasn't very effective.

But with our device, you can predict the presence of convulsions during coma or not by connecting the device to the patient and following up on his condition by constantly measuring his nerve signal.

4. IMPLEMENTATION

4.1 Embedded Systems:

It is a system that performs a specific process to execute a specific order at the same moment It enters into many life matters in many technological systems.

4.2 The Internet of things:

It is a system that connects the systems with some clouds through a mobile application and a website Even being recognized and controlled remotely.

And these are the two types of technology that I will talk about:-

The following tools were used in the project.

Raspberry Pi was used, which is an Embedded system Linux, so that it works on a lot of things in the project, and the most important of them is the speed of absorption and data transfer,

And a link to a display screen to show the reading and the percentage of convulsions in the patient.

An Emg sensor was used, which is a very important sensor for me to transmit my human nerve signal.

figure (9)

figure (10)

These picture are after connecting the device to the patient to measure the nerve signal for him in figure (9) , (10)

And the power to absorb that sensor is too high to take a reading. It was connected using an esp8266 until it was placed with the Raspberry Pi using a technique called I2C to transfer data from Net Analog and convert it into digital. and 12 electrodes are placed on the person, and a reading is taken through them.

How To Know The Output Reading from The Device:

When the emg is delivered to the injured part of the patient, a reading is given, and at this reading the type of disease is determined, whether it was a stroke or nervous spasms.

The device displays the result and sends it to the mobile application, then it takes it to the deep learning model, Give me the score by my own patient.

Firebase receives the reading from esp8266 until it transfers it to the mobile application using Realtime Firebase. Until the reading is transmitted instantaneously, the Arduino firebase library was used with the esp8266 firebase library.

when convulsions occur, the device alerts me using the implant sensor so that doctors and facilities are alerted to the patient. This alert is a result of giving a condition when the patient reached the normal limit in the nerve signal.

4.3 AI & Deep Learning:

To keep pace with our current age and make our project more sophisticated and efficient, we had to use artificial intelligence. Artificial intelligence has many fields, including deep learning that we used in our project. Deep learning has many advantages in various fields, so we used it, Since we are making a classification of a group of images, we used convolutional neural network (CNN). [7]

We collected data from six private hospitals at Zagazig University, and we collected more than 4,000 abnormal cases and more than 3,000 normal cases.
Now let's go to the implementation. In the beginning, what do we want to do? We want to take a screenshot of the neural signal that was received from the device through the mobile application, to enter it into the model to predict if the neural signal is normal or abnormal. [8]

4.3.1 Load dataset:

First we have downloaded the libraries that we are going to use shown in Figure (11).

```
In [1]: import tensorflow as tf
        from tensorflow import keras
        import pathlib
        import PIL
        import cv2
        import os
        import numpy as np
        import tensorflow as tf
        from tensorflow import keras
        from sklearn.model_selection import train_test_split
        from tensorflow.keras import layers
        from tensorflow.keras.models import Sequential
        import matplotlib.pyplot as plt
```

figure (11)

At first we use TensorFlow and keras because TensorFlow is an open-sourced end-to-end platform, a library for multiple machine learning tasks, while Keras is a high-level neural network library that runs on top of TensorFlow. Both provide high-level APIs used for easily building and training models, but

Keras is more user-friendly because it's built-in Python.

After that, we loaded the data into the model to be trained on it by using pathlib library.

4.3.2 Read images from disk into numpy array using opencv:

To read image from disk into numpy array, we made two dictionaries, one for the image and the other for the value of the image, so that the image was normal, we put the value in zero, and if it was abnormal, we put the value in one.

To get the most efficient, we had to give the images one size, To get the most efficient, we had to give the images one size, so we made for loop to loop on our images and give them one size, which we selected, and then we appended the images in two lists, one for the image and the other for the value, and then we converted the list to numpy array, as shown in the figure (12).

```
In [19]: x, y = [], []
         for data_name , images in data_image_dict.items():
             for image in images:
                 img = cv2.imread(str(image))
                 resized_img = cv2.resize(img,(180,180))
                 x.append(resized_img)
                 y.append(data_labels_dict[data_name])

In [20]: x=np.array(x)
         y=np.array(y)
```

figure (12)

4.3.3 Train test split:

After that, we divided the data and divided it as follows: a group for training and a group for testing 75% : 25%, where 75% is for training and 25% is for testing, as shown in the figure(13).

```
In [21]: x_train, x_test, y_train, y_test = train_test_split(x, y, random_state=0)

In [22]: print(f'X_train shape  is {x_train.shape}')
         print(f'y_train shape  is {y_train.shape}')
         print(f'X_test shape  is {x_test.shape}')
         print(f'y_test shape  is {y_test.shape}')

         X_train shape  is (3438, 180, 180, 3)
         y_train shape  is (3438,)
         X_test shape  is (1147, 180, 180, 3)
         y_test shape  is (1147,)
```

figure (13)

4.3.4 Preprocessing: scale images

In order to also make the model more efficient and perform training easily and in a short time, we made the value of each pixel in the image range between zero and one by dividing it by 255, as shown in the figure(14).

```
In [25]: x_train_scaled = x_train / 255
         x_test_scaled = x_test / 255
```

figure (14)

4.3.5 Build convolutional neural network and train it:

After all that, we became ready to build the model and because we used the network, we say a CNN consists of multiple back to back layers connected in a feed forward manner. The main layers are including convolutional layer, pooling layer, and fully connected layer. Three first layers are responsible for extracting features, while fully connected layers are in charge of classification , as shown in the figure(15).

```
In [27]: num_classes = 1

         model = Sequential([
           layers.Conv2D(16, 3, padding='same', activation='relu',input_shape=[180, 180, 3]),
           layers.MaxPooling2D(),
           layers.Conv2D(32, 3, padding='same', activation='relu'),
           layers.MaxPooling2D(),
           layers.Conv2D(64, 3, padding='same', activation='relu'),
           layers.MaxPooling2D(),
           layers.Flatten(),
           layers.Dense(128, activation='relu'),
           layers.Dense(num_classes,activation='sigmoid')
         ])

         model.compile(optimizer='adam',
                       loss='binary_crossentropy',
                       metrics=['accuracy'])
```

figure (15)

the activation function in output layer is sigmoid function because it is binary classification ,So we used too for the loss function binary cross-entropy ,and we choose the optimizer Adam because he achieved the highest accuracy ,as shown in the figure (15).

After that, we trained the model using the fit function and also made an evaluation to find out the efficiency of the model on test data.

- We noticed that the accuracy on the training data reached 99.83% and on the test data 99.56%.
- This means that there is very little overfitting.

4.3.6 Save the model and convert it:

Thus, the model is ready to be linked to the application, and to be linked to the application, we converted it to the tflite format as shown in the figure (16).

```
In [38]: model.save("model")

In [39]: export_dir = r'model/'

In [ ]:  converter = tf.lite.TFLiteConverter.from_saved_model(export_dir)
         tflite_model = converter.convert()
         tflite_model_file = 'converted_model.tflite'

         with open(tflite_model_file, "wb") as f:
           f.write(tflite_model)
```

figure (16)

4.4 Mobile Application:

In the modern age of Information and communication system, people are habituated to use computer and computer application. But Mobile Application uses and development is a new and rapidly growing sector. There is a global positive impact of mobile application. Using mobile application developed country are becoming facilitate and people, society of developing country are upgrading themselves and making a new type of IT infrastructure.
The mobile application run in a mobile environment which usability depends on several factors such as: Screen resolution, Hardware limitations, Expensive Data Usage, Connectivity issues, Limited Interaction possibilities. Last few years the mobile companies are trying to develop mobile device with more screen resolution, more storage, better connectivity which provide better environment for modern mobile application. [9]

4.5 Firebase overview:

Firebase is considered as web application platform. It helps developers‟ builds high-quality apps. It stores the data in JavaScript Object Notation (JSON) format which doesn’t use query for inserting, updating, deleting or adding data to it. It is the backend of a system that is used as a database for storing data.
The services available are : (Firebase Analytics - Firebase Cloud Messaging - Firebase Auth - Real-time Database - Firebase Storage - Firebase Notifications).The most services that are used in our application are:) Firebase Auth - Real-time Database - Firebase Storage). [10]

4.6 About our app:

We designed our application to make it easier for the patient to communicate with doctors, as it is easy to use, and among the advantages of the application is that it guarantees the patient’s privacy, as it is not possible to view personal information except by the user.
Now we will talk about how the application works. The first things that the users see when they launch the application is Onboarding Screens. It's sometimes known as first user experience (FUX). It is usually used to demonstrate some facts about the application such as how to use it, the application features, and how the application can help the users as figure (17).

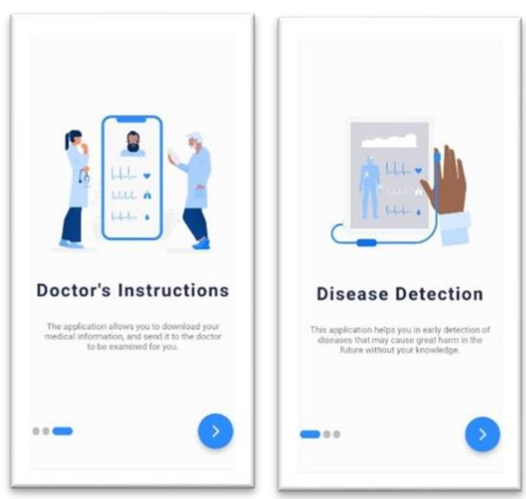


figure (17)

After that, the user can register in the application. At this stage, the user can specify the type of entry, either a trainee or a patient, and record all the data related to him, such as name, age, and phone number. Also, he can set a password to ensure that no other user enters and sees his private data, and thus guarantees the user's privacy.

When the user completes the registration, he goes to the home page, and there the nerve signals that are measured by the device appear, and then he sends them to the application through a service from Firebase called Realtime Firebase, and this service ensures accuracy in the measurement as shown in figure (18).

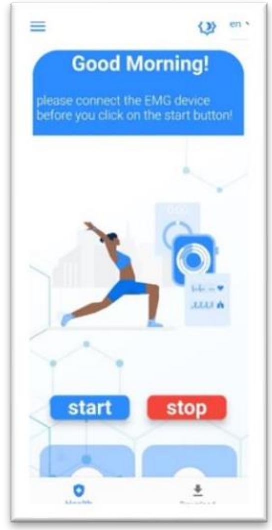


figure (18)

A screen shot of these neural signals sent from the device to the application can be taken and entered into the deep learning model so that the model performs several operations on an image that contains the neural signals and then shows the result of the process by classifying the signals into (normal or abnormal) as shown in figure (19).

The user can also share all his data, as he can download it in the form of a PDF and send it to the attending physician. The PDF contains all the user's data, including personal data and data on the result of the examination carried out by the Deep Learning model as shown in figure (20).

Among the advantages of the application is that it allows the user to control the language of the application, as the application contains both Arabic and English, and we also provide the user with control over the theme of the application, as he can choose the dark or light feature according to his convenience. Also, the user can communicate with us while he has inquired about anything inside the application, through the links of our social networking sites, and these links are found within the application on the contact us page.

figure (19)

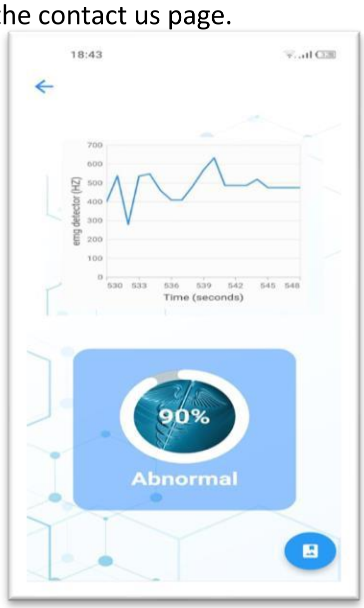
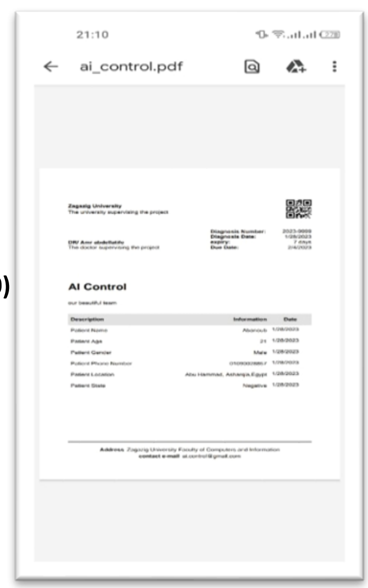


figure (20)



4.7 Result Analysis:

We know that the devices for measuring nerve signals in hospitals is facing challenges:

- More than 20% of people over the age of 60 suffer from a neurological Diseases.
- It was difficult to use the nerve imaging device because it was causing physical harm to the patient.
- An EEG machine rarely causes seizures in patients with a seizure disorder.
- It was difficult to predict any patient's condition.

And where there is a challenge there is also an opportunity:

- The project is a device that measures the nerve signals of the brain and the rest of the body, and the use of artificial intelligence to predict the occurrence of convulsions during a coma and linking it to a mobile application that allows the user to communicate with the doctor remotely, as one of the goals of the health axis in Egypt Vision 2030.

- The device is used during physiotherapy sessions for stroke patients to know the rate of their improvement and the extent to which they are affected by physiotherapy.

- Reducing the death rate from convulsions during coma, as the device predicts the presence of convulsions during coma.

- Our device can predict thepatient's condition during a coma with an accuracy of up to 97%.

- Reduces time and cost compared to other similar devices.

- Ease of use for anyone who does not have to be a doctor or specialist.

CONCLUSION

In this work we introduce a solution to solve the problem of diagnosing neurological diseases in the whole world. We use significant machine learning algorithms (Deep learning networks) which proves a notable success in medical community to deal with the tackle. The deep network that we use CNN. We evaluated the deep network on recent our dataset That we collected from hospitals. The findings show that deep learning gives reliable results to classify the Diagnosis of convulsions by images with recognition rate is 99% in 7500 samples of people. We made a mobile application to find out the percentage of disease in the human body, So that the doctor and the patient can communicate and the treatment is done remotely. Our future work make our device predict all neurological diseases

REFERENCES

	reference
[1]	Marras, W. S. (1990). Industrial electromyography (EMG). *International Journal of Industrial Ergonomics*, *6*(1), 89-93.
[2]	Medically Reviewed By William C. Lloyd III, MD, FACS — Written By Sarah Lewis,PharmD Updated on August 3, 2020.
[3]	Moeller J, et al. Electroencephalography (EEG) in the diagnosis of seizures and epilepsy. Accessed April 15, 2022.
[4]	Oostenveld R, Praamstra P. The five percent electrode system for high-resolution EEG and ERP measurements. Clin Neurophysiol. 2001;112(4):713-719.
[5]	Medically Reviewed By William C. Lloyd III, MD, FACS — Written By Sarah Lewis,PharmD Updated on August 3, 2020.
[6]	World Health Organization
[7]	Wang, X., Zhao, Y., & Pourpanah, F. (2020). Recent advances in deep learning. International Journal of Machine Learning and Cybernetics, 11, 747-750.
[8]	Craik, A., He, Y., & Contreras-Vidal, J. L. (2019). Deep learning for electroencephalogram (EEG) classification tasks: a review. *Journal of neural engineering*, *16*(3), 031001.
[9]	Bin Yang, Yang-Yang Hao, Jie Wang, Zhi-Hua Hu “Flexible service architecture for maritime business promotion based on mobile technology ” 978-0-7695-4011-5/10 $26.00 © 2010 IEEE DOI 10.1109/NSWCTC.2010.269.
[10]	"Firebase Realtime Database". Firebase, Inc dated 18/3/17.

APPENDIX

Hardware code:

```
//#include <ESP8266Firebase.h>
#include <ESP8266WiFi.h>
#include <Firebase_ESP_Client.h>
#include <addons/RTDBHelper.h>



//firebse objects
FirebaseData fbdo;
FirebaseAuth auth;
FirebaseConfig config;

// Hostname
#define DATABASE_URL "noro-14113-default-rtdb.firebaseio.com"//

// wifi settings
#define WIFI_SSID "SADAT"
#define WIFI_PASSWORD "hemal62200111"

int sensor_data=0;
int myString;
#define sensor_pin A0
#define buzz 5//buzer
```

```
void setup() {
  // initialize the serial communication:
  Serial.begin(9600);
  pinMode(sensor_pin ,INPUT);
 pinMode(D0,OUTPUT);
 pinMode(buzz, OUTPUT);//buzer output pin

  /*Serial.println("nerve.txt");
  Serial.println("CLEARSHEET");
  Serial.println("LABEL,DATA,TIME.SENSOR DATA");*/

  WiFi.begin(WIFI_SSID, WIFI_PASSWORD);
  Serial.print("connecting");
  while (WiFi.status() != WL_CONNECTED)
      {
    Serial.print(".");
    delay(500);
      }
  Serial.println();
  Serial.print("connected: ");
  Serial.println(WiFi.localIP());

  /* Assign the database URL(required) */
```

```
void loop() {


  if((digitalRead(10) == 1)||(digitalRead(11) == 1)){
    Serial.println('!');
  }
  else{
    // send the value of analog input 0:
    sensor_data= analogRead(sensor_pin);
    //Serial.println("DATA, DATA, TIME, "+String(sensor_data/1000.0));
    myString = int(sensor_data);
    Serial.println(myString);
    Serial.printf("Send Data: ....%s\n",Firebase.RTDB.setInt(&fbdo,"/Signals",myString)? "OK" : fbdo.errorReason().c_
  }
  //Wait for a bit to keep serial data from saturating
  delay(80);

if(myString>1000){
   Serial.printf("Send Data: ....%s\n",Firebase.RTDB.setString(&fbdo,"/The Ratio","95% Eplipce")? "OK" : fbdo.errorRe
```

```
if(myString>1000){
   Serial.printf("Send Data: ....%s\n",Firebase.RTDB.setString(&fbdo,"/The Ratio","95% Eplipce")? "OK" : fbdo.errorRea

    }
 else if(myString>800){
   Serial.printf("Send Data: ....%s\n",Firebase.RTDB.setString(&fbdo,"/The Ratio","90% Eplipce")? "OK" : fbdo.errorRea

  }

 else if(myString>700){

  Serial.printf("Send Data: ....%s\n",Firebase.RTDB.setString(&fbdo,"/The Ratio","80% Eplipce")? "OK" : fbdo.errorReas
  }
     else {
   // send the value of analog input 0:
   int val = analogRead(sensor_pin);
   //Serial.println(val);
   if (val > 700) {
     tone(buzz, 3000);
     delay(2000);
     noTone(buzz);
     delay(1000);
   }
```

Deep learning code:

```
In [27]: num_classes = 1

         model = Sequential([
           layers.Conv2D(16, 3, padding='same', activation='relu',input_shape=[180, 180, 3]),
           layers.MaxPooling2D(),
           layers.Conv2D(32, 3, padding='same', activation='relu'),
           layers.MaxPooling2D(),
           layers.Conv2D(64, 3, padding='same', activation='relu'),
           layers.MaxPooling2D(),
           layers.Flatten(),
           layers.Dense(128, activation='relu'),
           layers.Dense(num_classes,activation='sigmoid')
         ])

         model.compile(optimizer='adam',
                       loss='binary_crossentropy',
                       metrics=['accuracy'])
```

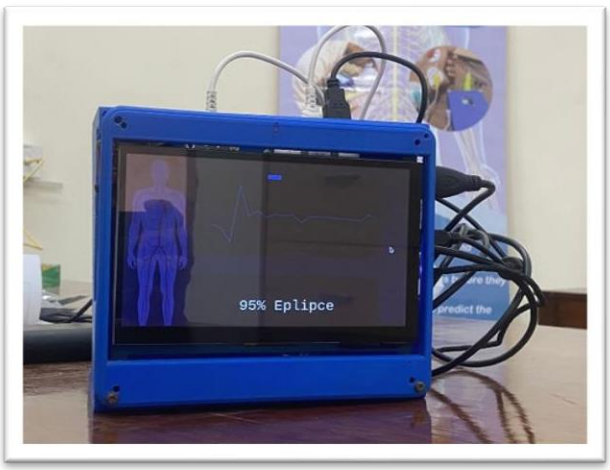
Mobile application code:

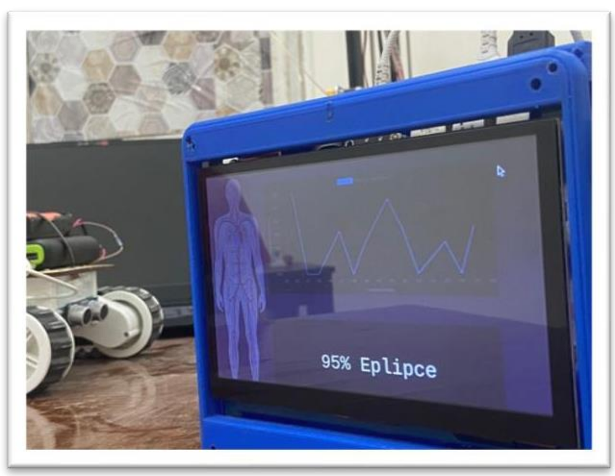
```
@override
Widget build(BuildContext context) {
  return Scaffold(
    body: BlocProvider(
      create: (BuildContext context) => RegisterCubit(),
      child: BlocConsumer<RegisterCubit, RegisterStates>(
        listener: (BuildContext context, Object? state) {
          if (state is RegisterCreateUserSuccessStates) {
            if (typeMember == 'Patient') {
              cachHelper.saveData(key: 'uId', value: state.uId);
                 cachHelper.saveData(key: 'Newtype', value: 'Patient');
              Navigator.pushAndRemoveUntil(
                  context,
                  MaterialPageRoute(builder: (context) => Home()),
                  (route) => false);

              SocialCubit.get(context).getUserData();
            } else {
               cachHelper.saveData(key: 'Newtype', value: 'Athlete');
              cachHelper.saveData(key: 'uId', value: state.uId);
              Navigator.pushAndRemoveUntil(
                  context,
                  MaterialPageRoute(builder: (context) => HomeAthlete()),
                  (route) => false);

              SocialCubit.get(context).getUserData();
            }
          }
        },
```

```dart
Future<void> updateDataSource(Timer timer) async {
  chartData.add(LiveData(time++, _displayText));
  chartData.removeAt(0);
  _chartSeriesController.updateDataSource(
      addedDataIndex: chartData.length - 1, removedDataIndex: 0);
}

List<LiveData> getChartData() {
  return <LiveData>[
    LiveData(0, 0),
    LiveData(1, 0),
    LiveData(2, 0),
    LiveData(3, 0),
    LiveData(4, 0),
    LiveData(5, 0),
    LiveData(6, 0),
    LiveData(7, 0),
    LiveData(8, 0),
    LiveData(9, 0),
    LiveData(10, 0),
    LiveData(11, 0),
    LiveData(12, 0),
    LiveData(13, 0),
    LiveData(14, 0),
    LiveData(15, 0),
    LiveData(16, 0),
    LiveData(17, 0),
    LiveData(18, 0)
  ];
```

```dart
import 'dart:typed_data';
import 'package:tflite_flutter/tflite_flutter.dart';
import 'package:flutter/material.dart';
import 'package:image_picker/image_picker.dart';
import 'dart:ui' as ui;
import 'dart:io' as io;
import 'package:image/image.dart' as img;

class Classifier {
  Classifier(); // Empty init/constructor

  classifyImage(PickedFile image) async {

    var _file = io.File(image.path);
    img.Image? imageTemp = img.decodeImage(_file.readAsBytesSync());
    img.Image resizedImg = img.copyResize(imageTemp!,
        height: 180, width: 180);
    var imgBytes = resizedImg.getBytes();
    var imgAsList = imgBytes.buffer.asUint8List();


    return getPred(imgAsList);
  }
```

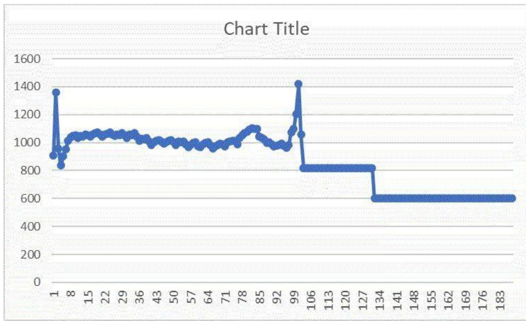
Device picture:

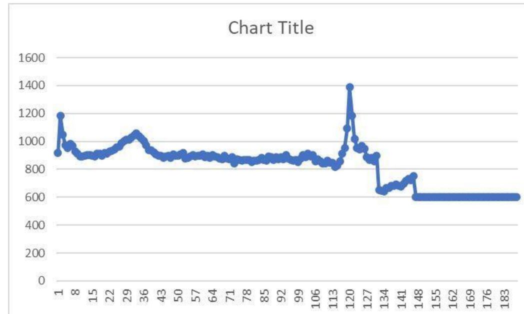


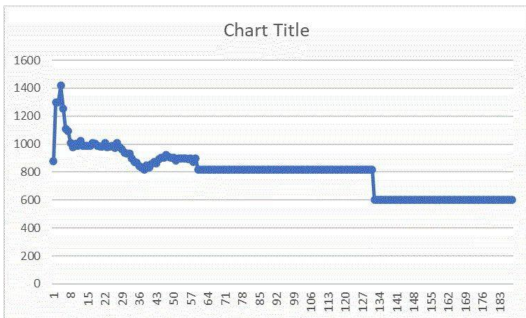


Dataset samples:

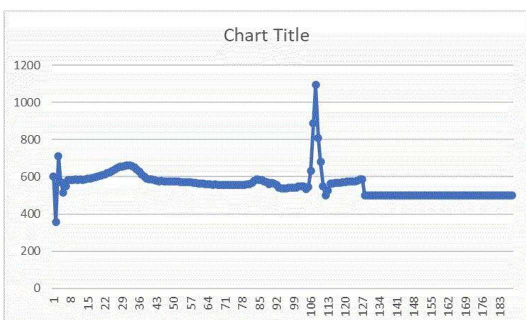
Abnormal

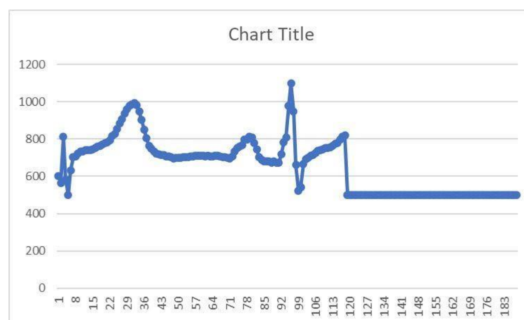


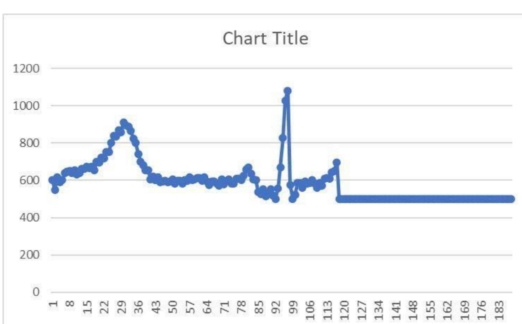


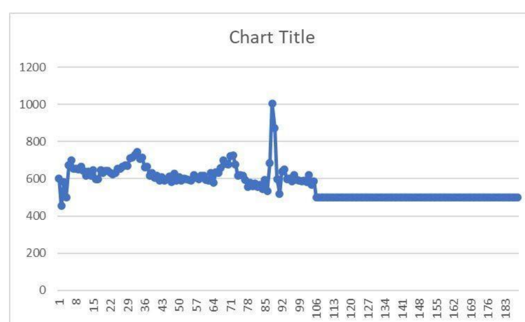


Normal



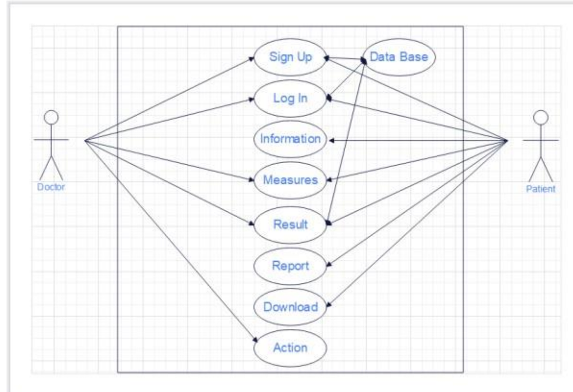






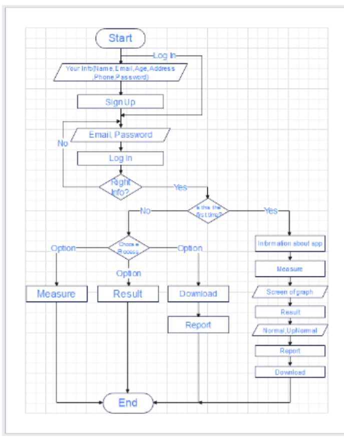
Flow Chart for project:

Use Case Diagram:

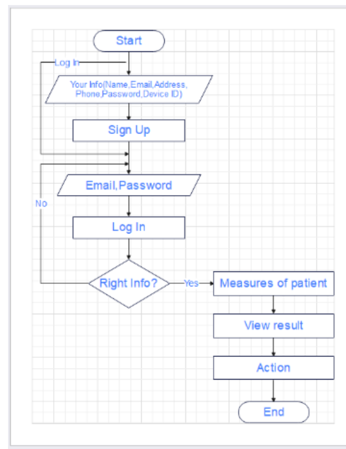


Flow Chart Diagrams:

Patient

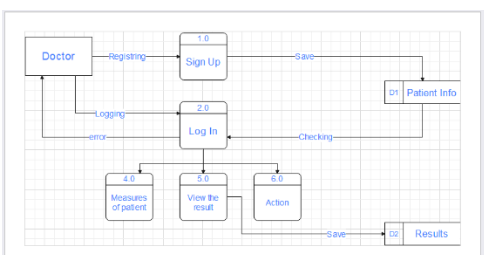


Doctor

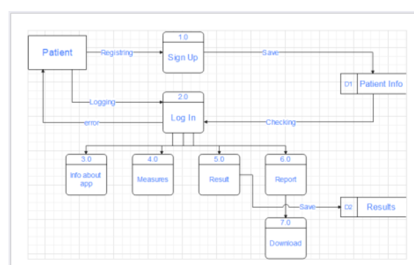


Data flow Diagrams (level 0):

Patient

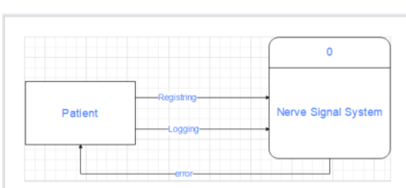


Doctor



Context Diagram (level 1):

Patient



Doctor