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Home Automation for Disable Person Using Gesture Control and Artificial Intelligence

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Abstract- For an extended time, gestures communique has performed a giant function in conveying information. Before the evolution of human beings, while no verbal mode of communique changed into the present, gesture communique changed into the simplest manner to interact with different human fellows. After evolution, with language improvement, the want of gestures for brief variety communique changed into removed. However, it became nonetheless giant in conveying messages at large distances, i.e., by lightening the hearth place at a far-off place. The modern generation is gaining this mode of communique, and it has correctly translated those gestures into the virtual world. The improvement of augmented truth is an instance of it. With the arrival of deep gaining knowledge of algorithms like Artificial Neural Networks (ANN), Convolutional Neural Networks (CNN) and Recurrent Neural Networks (RNN), the issue in records evaluation and sample recognition has come to be very smooth and robust. In this undertaking, we've advanced a mind gestures (signals) reputation machine that controls home automation home equipment for bodily impaired people.

Keyword: Artificial intelligence, convolutional neural network, recurrent neural network, signals.

I. INTRODUCTION

In a review expected to gather data from patients concerning the helpfulness of mind motions correspondence, the review presumed that 9 to 10 % of patients who utilize electronic contraptions to collaborate with actual climate are the people who can walk, talk and hear positively. The question is shouldn't something be said about those patients who can't talk, walk uninhibitedly or are hard of hearing overall? What are their difficulties, and how would they speak about their current circumstances? The response to the inquiry is to devise something that has the accompanying elements:

We have a three-focused plan now, yet we are unfit to think about how to make it happen because of the neurophysiology and its marvel called EEG that provides us with some insight into where to begin. Starting from the primary point that the gadget ought to be similarly powerful for various patients, it will be exceptionally simple to make an innovation utilizing mind cues that can be similarly successful for a wide range of patients [1]. The second point says that it ought to be hearty; we realize that the advanced AI calculation uniquely with the appearance of profound learning calculation, the power and grouping results have improved to a degree that matches human insight these days. We have enough pre-hand information, so we should think about the principal goals of this venture. The task means to: Foster an implanted framework that can help truly tested individuals (hard of hearing, stupid, visually impaired, faltering) to control actual gadgets through mind cues, for example, turning the ON/OFF fan or light bulb, open or close the entryway, turn ON/OFF TV, enact or deactivate a caution to call somebody. Upgrade the framework's power and diminish remote correspondence dormancy to speak with applications with any mistake or postponement. This venture plans to bring BMI from research facilities and medical clinics to an everyday person limit. By doing the relative examination with financially accessible BMIs, we aim to make it prudent and financially savvy. Decrease the size and volume of the gadget to such an extent that it ought to be helpful for a patient to worry about it with no additional concern. The gadget ought to perform similarly well for a wide range of patients and be client amicable [1].

A. Proposed Arrangement

To find a solid answer to the previously mentioned goals, we will utilize the modern-day supernatural occurrence of science as an "EEG" gadget. In the clinical field, EEG is giving dependable answers for various nervous system science issues like diagnostics and estimations. On the off chance that we see other fields of life to such an extent that control frameworks and gaming, EEG is a consistently separating innovative pattern. As we mentioned before, our primary objective is to make a helping gadget that can help truly debilitated individuals so that we will confine our utilization of EEG to the degree of our venture [2-5]. In any case, the utilization of this gadget can be stretched out from easing up a bulb to messing around on cell phones by utilizing mind cues. Separate a venture into more modest undertakings and sub-methods to effectively achieve it. Our work division to carry out this task is the following:

- The initial step is to choose a decent monetarily accessible EEG sensor.

- The subsequent step is to prepare a profound gaining model on the information obtained from the sensor for various kinds of utilization.
- After effectively preparing the model, interface the sensor and applications with a focal handling unit.
- Import the prepared model to the focal handling unit.
- Train a human cerebrum to utilize sensors to control applications productively.

Fig. 1. EEG headset.

1) Sensor Determination

The most significant and imperative move toward this venture is the choice of an EEG sensor, shown in Figure 1. The characteristics of a decent sensor are the following:

- It ought to unequivocally quantify EEG beat (alpha, beta, gamma, delta, mu waves).
- It ought to have a high increase (40000). This is because our mind cues are extremely low in extent (in the scope of a miniature volt). In this way, we want a high-addition sensor to enhance the caught signal.
- High sign to clamor proportion and inclined to the outer commotion.
- Transfer speed of 100 Hz (0-100Hz) to gauge EEG musicality.
- Less expensive cost and simple to use with a worked-in Bluetooth module for remote correspondence.

We involved Neurosky Mind Wave headgear in our undertaking since it fulfills all of the above conditions [6-11]. However, it is somewhat costly, yet its highlights are incomparable, and no other sensor gives a similar exhibition. It is a four-channel sensor with 100Hz transmission capacity. It accompanies an underlying Bluetooth module and preparing applications that empower the client to prepare his psyche handily. Besides, it unequivocally records EEG cadence with an increase of 45000 furthermore, extremely high SNR [12-15].

2) Model schooling

After choosing an amazing sensor, it's time to educate a deep getting-to-know version of the usage of the uncooked data from the sensor as functions and the range of programs as labels. We used "Keras" as a deep getting-to-know framework for constructing a neural community version. Python is getting used as a programming language. Our version 5 consisted of 1400 enter nodes, two hidden layers with 500 nodes in line with the layer and 5 output nodes. We used the squared mistakes loss technique to educate our community. The version became skilled on 500 samples with a general schooling time of five mins and 10 seconds. The total range of epochs had been 50. The executed accuracy changed to 85.43%. [16]

3) Interfacing with CPU

After schooling the version, we stored a .csv report of our version for destiny use. Now it's time to interface the sensor and all domestic automation programs with a principal processing unit. In our case, we used Arduino as a processing device. The first step is to interface Arduino with the top sensor. For this purpose, first we want to interface a Bluetooth module with Arduino. We used HC-06 as a Bluetooth module with Arduino. The subsequent step is to attach all programs to Arduino. For this purpose, we used virtual pins on the Arduino board to attach all programs.

4) Import deep learning model.

After putting the complete circuit in place and interfacing the sensor with Arduino, it's time to import our pre-skilled deep getting-to-know version. We coded a feed-ahead neural community with a backpropagation set of rules in Arduino IDE. This set of rules has equal functions because the preceding version is skilled in Keras. For weight values inside the community, we imported that .csv report we saved in advance and assigned values to every weight department of the community. Now the entirety is finished, and the final step is to educate the human mind. The schooling element is vital because our complete machine depends upon the enter acquired from the mind. The head sensor data 3 styles of indicators from the mind, meditation sign, interest sign and blink sign. The human mind has to find out how to manipulate those three indicators to ship the best fee as an entry [17].

5) Brain Action

The human body contains nerves that send upgrades from the outer climate to the human mind. The mind is generally eluded as a focal sensory system (CNS)[2]. The cells that make up the CNS are called nerve cells or glial cells. The CNS contains a great many neurons that have 6 interaction data and produce a result. Every neuron comprises axons, dendrites, soma and neurotransmitter. As displayed in Figure 2 underneath, an axon is a long branch between two cell bodies/soma of neurons. Axon linkage comprises many Schwann cells covered with myelin sheath (a lipid, unsaturated fat). The joint between two cells is called the hub of ranvier. The axon can convey activity potential from one neuron to the next. The root-like construction joined to every phone body is called dendrites. It capabilities as expected authority for soma. The connection between two neurons is called a neurotransmitter, while the fundamental cell body is called soma.

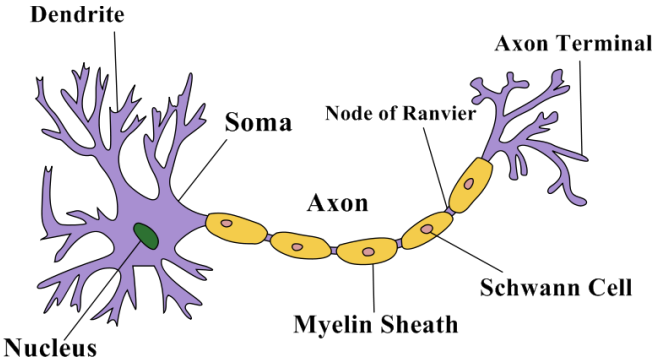

Fig. 2. structure of a biological neuron

The event through which one neuron transmits it signal to another neuron is called synaptic activity. There are two types of synaptic activities:

- Chemical Synapse.
- Electrical Synapse.

One thing that should be realized is that two types of neurons exist before a synapse activity. The neuron which is

going to send the signal is called pre-synapse neuron and the neuron that is going to receive the signal is called post-synapse neuron. In an electrical synapse, the axon's two ends act as a wire's terminals. The pre-synaptic neuron generates a signal transmitted over the axon and reaches the post-synaptic neuron. 7 Electrical synapse is quicker than a chemical synapse. The size of an electrical neural connection goes from - 70mV to 60-70mV, which is expected to exist under soma (cell layer). The capability of each synaptic action relies on the kind of synaptic action. There are two kinds of synaptic exercises: an excitatory neural connection and an inhibitory neurotransmitter. We should consider two pre-synaptic neurons with axons prompting a typical post-synaptic neuron. Assuming that the activity capability of both presynaptic neurons builds the likelihood of post-synaptic neuron to create an activity potential, such synaptic movement is called excitatory synaptic action and activity potential produced by post-synaptic neuron is called excitatory post-synaptic potential (EPSP). Then again, if both pre-synaptic neurons repress the age of activity potential in post-synaptic neurons, such movement is called an inhibitory neurotransmitter, and the activity potential is called inhibitory post-synaptic potential (IPSP). The various results of synaptic activities are shown in Figure 3 - 8.

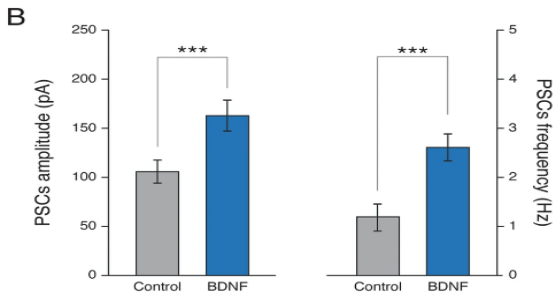

Fig. 3. Synaptict Activities result 1

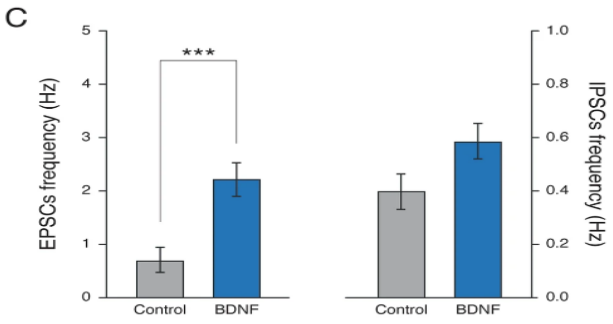

Fig. 4. Synaptic Activities result 2

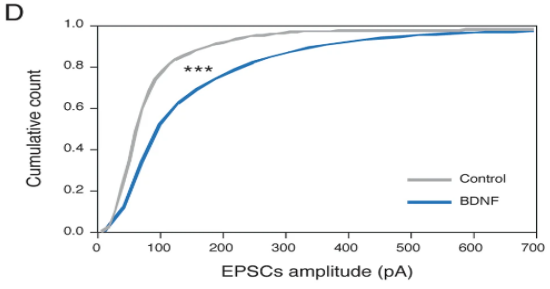

Fig. 5. Synaptic wave result 1

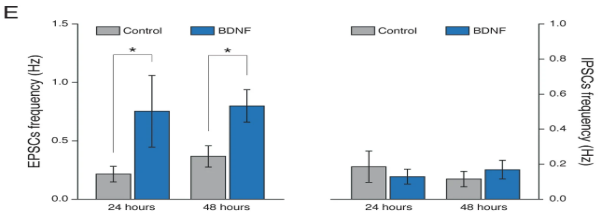

Fig. 6. Synaptic Activities Result 3

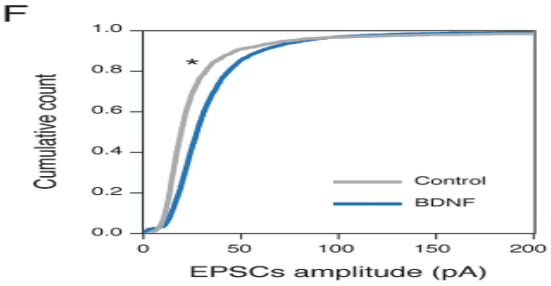

Fig. 7. Synaptic wave 2 result

6) Action Potentials

Action ability is sincerely a sign this is transmitted with the aid of using a neuron because of synapse activity. The records transmitted with the aid of using a nerve is known as a motion ability (AP). APs are resulting from an alternate of ions throughout the neuron membrane and an AP is a brief alternate with inside the membrane ability this is transmitted alongside the axon. It is normally initiated with inside the mobileular frame and normally travels in a single direction. The membrane ability depolarizes (will become greater positive), producing a spike. After the height of the spike the membrane repolarizes (will become greater bad). The ability will become greater bad than the resting ability after which returns to normal. The motion Potentials of maximum nerves final among five and 10 milliseconds. Figure 9 suggests an instance AP. The conduction pace of movement potentials lies among 1 and one hundred m/s. APs are initiated with the aid of using many exclusive varieties of stimuli; sensory nerves reply to many varieties of stimuli, consisting of chemical, light, electricity, pressure, touch, and stretching. On the opposite hand, the nerves in the CNS (brain and spinal cord) are often inspired with the aid of using chemical pastime at synapses. A stimulus should be above a threshold degree to spark off an AP. Very vulnerable stimuli purpose a small nearby electric disturbance, but do now no longer produce a transmitted AP. As quickly 9 because the stimulus electricity is going above the threshold, an movement capability seems and travels down the nerve [3].

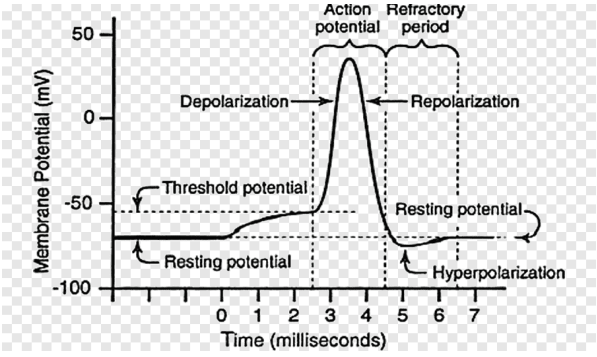

Fig. 8. Action potential plot

II. METHODOLOGY

The project operation steps are also shown in block diagram i.e Figure 10.
This project's operation is broken down into three steps [4]:

A. *Step 1:*

The initial step is to record brain signals and send the unprocessed data to the classification unit for processing. The NeuroSky mind wave headgear collects the attention signal, meditation signal, and blink signal in the form of binary data in the first step of the process and transmits it to the Arduino through Bluetooth module HC-05. The Bluetooth module's baud rate is 9600 bps, while the headgear's default baud rate is 115200 bps. To match the data rates of both devices, we will adjust the baud rate of our Bluetooth module. To accomplish this, open the Arduino IDE's serial communication window and modify the baud rate from 9600 to 115200 bps.

B. *Step 2*

Receiving raw data and classifying it in order to create predictions is the second phase. In order to make precise prediction and train network we used "Back Propagation" Back propagation is the method by which we improve our weight values as well. The output mean square error is first derivative by the back-propagation algorithm. The mean square error is equal to the sum of squares of all differences between actual and predicted outputs. It is given by the following equation.

$$e = \frac{1}{2}\Sigma(actual\ output - predicted\ output)^2 \quad (1)$$

$$\frac{de}{dw_n} = \frac{de}{dw_n}\left(\frac{1}{2}\Sigma(actual\ output - predicted\ output)^2\right) \quad (2)$$

By going back to the necessary weight variable w_n the above formula can then be made simpler. Simplifying the aforementioned equation, we obtain:

$$\frac{de}{dw_n} = -(O_p - O_a).sigmoid\ (\Sigma w_j * O_l)(1 - sigmoid(\Sigma w_j * O_l)).O_l \quad (3)$$

Where:

Op: Predicted output.

Oa: Actual output.

Ol: Output of hidden layers.

Thus, the new weight function will become:

$$w_{n,new} = w_n - \sigma\frac{de}{dw_n} \quad (4)$$

Where:

σ: Learning rate.

We can converge on a set of values that will start producing accurate predictions by iteratively updating all of the network's weights using the aforementioned back propagation algorithm, and we can therefore say that our network has been trained.After this a classification model needs to be trained before classification. We employed the "Keras" machine learning framework, which quickly gave us a sequential model for training for this purpose. 1400 input nodes, 2 hidden layers with 500 nodes each, and 5 output nodes make up our model. In this instance, we used 500 training sets to train our model. The accuracy that was reached, 85.43%, was significantly higher than that of other machine learning methods, including KNN (65%), SVM (63%), and Decision Tree Classifier (62%). We used the Arduino IDE to generate a model similar to our trained model by importing the csv file.

C. *Step 3*

The third and last phase requires us to run five distinct apps under the predictions our classifier makes. For example, we have applications for turning on and off lights, fans, TVs, and volume controls and setting off alarms and closing and opening doors. All applications are linked to Arduino's digital pins via a solid-state relay. It should be mentioned that brain training is a crucial component of how this project operates. To use programs, a user must gain control over his abilities to pay attention, meditate, and blink.

Fig. 9. Block Diagram

III. APPLICATIONS

A. *Brain control light bulb:*

The brain-managed mild bulb is a mind pc interface (BCI) [5] may be described as domestic automation equipment which permits the person to manipulate the mild thru mind-waves. These electric pulses or mind-waves are detected with the aid of using a Neuro-sky mind sensor. When a person delivers excessive meditation stage than the attenuation stage (sensed with the aid of using a sensor), it'll flip the Bulb On. High attenuation continues the bulb in an OFF state.

B. *Brain control Fan*

Brain-managed Fans could have the identical capability as Light Bulb. A strong Meditation sign could reason the fan to grow to become ON until it is going down a stage decrease than the attenuated sign.

C. *Brain control Alarm:*

For disabled or disabled users, when the user emits a strong meditation signal, the alarm will turn on and the sensor will detect it.

D. *Bain control TV*

Brain managed TV have 3 capabilities primarily based totally at the power of signal.

- Channel Shuffling.
- Volume Up/ down.
- TV ON/OFF.

IV. CONCLUSION

We conducted a thorough study of our project and covered every facet in detail in this report. These days, the term "brain machine interface" is in use, and with recent advancements in machine learning, its significance has increased. More BMI components are being developed through research. This, Neurosky Mindwave has created

various mobile applications that can be operated by brain impulses[6].

People's ability to move independently is crucial to their sense of worth. Nobody wants to be reliant on anyone else to fulfil basic requirements like turning on a light or fan. Consider an example of a crippled person who cannot walk or move his hands. It will be quite challenging for someone else to always be at his disposal. We have the opportunity to design and practice a fresh idea that would ease the struggle of such patients thanks to the marvels of current technology and engineering.

We conducted a thorough investigation of biological neural activity and brain rhythms for this report. We compiled research papers on BMI and home automation systems written by various researchers. Afterwards, we discussed the design and operation of an electroencephalography (EEG) device, particularly the Neurosky Mind wave head sensor. After that, we designed the system needed to deploy a home automation system and conducted a system analysis. The system's design called for using several parts, including Arduino, Bluetooth modules, etc., which were thoroughly addressed. The development and operation of a deep learning algorithm, an artificial neural network, was then discussed. Ultimately, we considered how all the components might be combined to further a broader goal. To summarize the topic, this project must be further developed by removing hardware dependencies. This is not generally difficult, but it will need time to develop. We must acknowledge that AI is the way of the future.

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