Emotion Recognition by Integrating Electroencephalography (EEG) and Facial Recognition

Savaridassan P., Ritul Kumar, Shubhangi Sharma, Eugansh Khatri, Prateek Khattri

Abstract: ***Feeling acknowledgment by examining electroencephalographic (EEG) accounts is a developing region of research. EEG can recognize neurological exercises and gather information speaking to cerebrum signals without the requirement for any obtrusive innovation or systems. EEG chronicles are discovered helpful for the discovery of feelings through observing the attributes of spatiotemporal varieties of initiations inside the cerebrum. Explicit otherworldly descriptors as highlights are removed from EEG information to measure the spatiotemporal varieties to recognize various feelings. A few highlights speaking to various cerebrum exercises are assessed for the arrangement of feelings. A mind PC interface utilizing EEG information encourages the control of machines through the examination and order of signs legitimately from the human cerebrum. The gathered EEG information is examined by an autonomous part investigation based component extraction system and ordered utilizing a multilayer neural system classifier into a few control signals for controlling a robot. The framework additionally gathers the information of electromyography signals characteristic of the development of the facial muscles. Research work is advancing to expand the scope of controls past a lot of discrete activities by refining the algorithmic advances and methods.***

Facial feeling acknowledgment (FER) is a significant point in the fields of PC vision and man-made brainpower attributable to its noteworthy scholastic and business potential. Despite the fact that FER can be directed utilizing different sensors, this survey centers around examines that solely utilize facial pictures, on the grounds that visual articulations are one of the principle data diverts in relational correspondence. This paper gives a short survey of investigates in the field of FER directed over the previous decades. To start with, traditional FER approaches are portrayed alongside a rundown of the delegate classes of FER frameworks and their fundamental calculations. Profound learning-based FER approaches utilizing profound systems empowering "start to finish" learning are then introduced.

Keywords : EEG, Positional Ternary Pattern, Feature Extraction, Probabilistic Neural Network, Neural Network Training, Haar Cascade, Principal Component Analysis.

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I. INTRODUCTION

Emotions are a very important part of the civilization. It is considered as one of the most important characteristics of Human behavior. An emotion can be expressed in the form of text, speech or even gestures. In this paper, we will concentrate on the emotions expressed by the face, in particular. There is an important need to study these emotions, as there has been increase in the role of Brain Computer Interface applications. Also, there has been increase in interaction with the digital media.

Emotion Recognition through the study of electroencephalography (EEG) datasets is a growing field of research. This paper, in general recognizes the impulses in brain that is also known as EEG, using the EEG Brain Sense – Brain computer interface. Brainwaves are created by synchronized electrical pulses from billions of neurons that speak with one another consistently. EEG can easily detect neurological activities without the need of any external procedures. EEG recordings are useful in detection of emotions through the continuously changing space-time variations of the brain activations. Specific facial features are extracted from the EEG data through the feature extraction process, which is useful for differentiating various emotions. The Brain Sense device uses EEG datasets that facilitates the analysis and classification of signals. The collected EEG data is further analyzed by a feature extraction methodology and then categorized using a multilayer neural network classifier. This system also collects the signals which are involved in the movement of facial muscles. The final step consists of putting these datasets into practice during the experimental phase, which then finally be analyzed for what results could be achieved.

II. RELATED WORKS

One of the initial proposals in Emotion Recognition using EEG was Murugappan et al. [1] which acquired the EEG signals based on the four emotion (disgust, happy, surprise and fear), as well as capturing the four emotions (disgust, happy, surprise and fear), and the results confirmed that two different LBWT i.e. lifting based wavelet transform should be used for emotion recognition. Shojaeilangari et al. [2] proposed using Extreme Sparse Learning for facial emotions recognition, enabling accurate classification when provided with noisy signals with natural setting, hence this proposed framework is able to achieve

state-of-the-art recognition accuracy. More recently, Abdullah et al. [3] have proposed that w.r.t Human-Machine Interaction, identification of the human emotion is an important input for enhancing the interaction, as well as it has been found that the accuracy of the detection was ranging from 50% to 70%, and the SAM technique was used to tag the training the data.

While all these techniques and approaches have proven to be effective and gave results, these approaches were unable to make it as an implementable form, more importantly feasible.

This paper focuses more on practical implementation and feasibility part, hence we've integrated the EEG technology with Facial Recognition, hence aiming on producing more accurate results with dynamicity of input.

III. PROPOSED METHODOLOGY

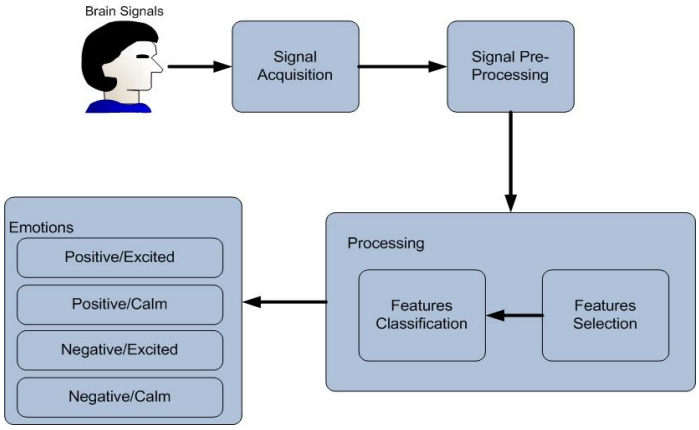

Fig. 1: Architecture Diagram

Proposed System:

In this framework, the feeling perceived by utilizing two unique methods so as to accomplish a precise output. The various systems are consideration investigation utilizing EEG and face feeling utilizing open-cv with grouping. Electroencephalographic (EEG) is an ahead tracker gadget. EEG straightforwardly quantifies cerebrum action and can along these lines legitimately identify an individual's degree of readiness. We can recognize the mind influxes of somebody who is wide wakeful and caution and somebody who is lazy and in danger of nodding off at the worst possible time, EEG is a precise and dependable proportion of laziness in numerous applications. EEG is commonly used to contemplate rest who is endeavoring to rest. An examination exhibited significant connections between an EEG calculation for identifying exhaustion and sluggishness under reenacted conditions. The greatest downside related to EEG as an on-street sleepiness location gadget is the trouble in acquiring accounts under regular driving conditions, making it a to some degree unreasonable alternative for the recognition of weakness. The measurement of the EEG information is moderately mind-boggling and a disconnected examination is frequently the most reasonable other option.

Algorithms to be used:

1. Positional Ternary Pattern

Positional Ternary Pattern (PTP), as edge-based one for programmed acknowledgment with the thought that, both shape (the craniofacial development) and skin (wrinkles and flaws), and identified on areas of face picture with high edge reaction.

2. Feature Extraction

Concentrates on the crude information in pictures, and gives data about pictures through which arrangement can be achieved.

3. Probabilistic Neural Network

PNN has habitually used all together issues. Exactly when data is accessible, the chief layer enrolls the great ways from the information vector to the arrangement input vectors. This conveys a vector where its segments show how close the information is to the planning input. The ensuing layer adds up to the responsibility for each class of wellsprings of information and produces its net yield as a vector of probabilities. Finally, a battle move deal with the yield of the ensuing layer picks the restriction of these probabilities and produces a 1 (positive distinctive evidence) for that class and a 0 (negative ID) for non-concentrated on classes.

4. Neural Network Training

During the time spent preparing, we will begin with an awful performing neural system and end up with coordinate with high exactness. As far as misfortune work, we expect the misfortune capacity to be a lot of lower toward the finish of preparing. And, also improving the system is conceivable, in light of the fact that we can change its capacity by altering loads.

5. Haar Cascade

Haar Cascade is an AI object disclosure estimation used to perceive inquiries in a picture or video and reliant on the possibility of features .

The run of the mill course classifier is an effective technique for face discovery. For the most part, many item discovery errands with unbending structure can be tended to by methods for this strategy, not constrained to confront location. The course classifier is a tree-based innovation, in which Haar-like highlights for human face identification. The Haar-like highlights can be utilized with all scales in the helped classifier and can be quickly registered from a fundamental variant of the picture to be identified in.

6. Principal Component Analysis

We use PCA, when there are a lot of variables i.e. features. It reduces the dimensions of data, and makes it easier to plot the data with lesser dimensions when compared to original data. As the name suggests, it separates the Principal components from the dataset.

Step 1: Fetch the data

Step 2: Give the fetched data a structure

Step 3: Standardization of data

Step 4: Get the co-variance of regulated grid i.e. Z

Step 5: Calculate the Eigen Vectors and the Eigen Values
Step 6: Sort the Eigen Vectors
Step 7: Calculate the new features
Step 8: Drop the immaterial features from the new set

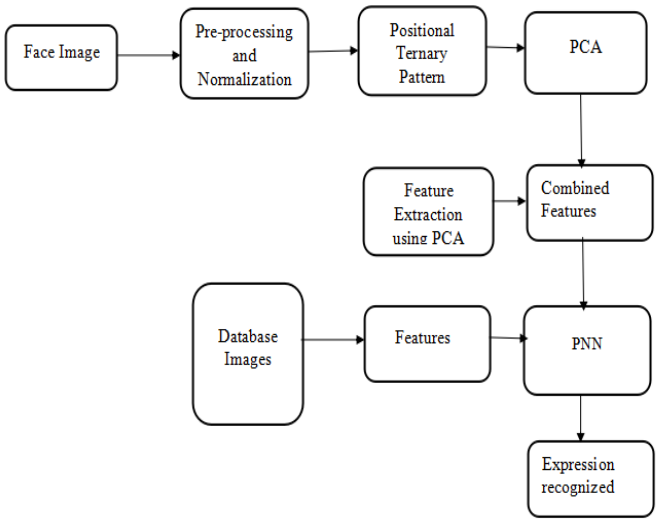

Fig. 2: Flow Chart

IV. IMPLEMENTATION

Implementation Process:

Step 1: Install the Bluetooth component in the ARDUINO chip.

Step 2: Connect the ARDUINO chip to the laptop through the USB.

Step 3: We will use the Brain Wave Sensor to measure the EEG Signal. This sensor also has the Bluetooth installed in it.

Step 4: Connect the ARDUINO chip and Brainwave Sensor through Bluetooth.

Step 5: Run the python code. All the data sets will go to the laptop.

Step 6: The Brain Sensor has 2 electrodes which are fitted in your left ear and other in the middle forehead.

Step 7: The Brain Sensor will send the ATTENTION value.

Step 8: The Attention value is the Average Value of 4 values that sensor measures. The conditions of the measured average values are:

a) if the value is greater than 40 - Print “ABNORMAL”
b) if the value is less than 40 – Print “ Normal”

Step 9: If the Attention Value is ABNORMAL then it will switch its method to Facial Recognition.

Step 10: The Facial Recognition System will measure 5 Mood Value and provide us with a histogram graph.

Step 11: Therefore it will give us the percentage of emotions. For example 60% happy, 10% sad, etc.

V. FUTURE ENCHANCEMENT

Difference in outcome between Existing System and Proposed System:

The system existed before were based on two types –

1. Emotion recognition method using face image:

Seven feelings and positive and negative feeling acknowledgment techniques utilizing facial pictures and the advancement of applications depend on this strategy. In past inquiries about, they utilized the profound learning innovation to produce models with feeling based outward appearances to perceived feelings. There are existing applications that express six feelings, however not seven feelings and positives and negatives in diagrams and rates. Accordingly, we perceived seven feelings, for example, Angry, Disgust, Fear, Happy, Sad, Surprise, and Neutral, and furthermore arranged the determined feeling acknowledgment scores into positive, negative, and nonpartisan feelings. At that point, we executed an application that gives the client seven feelings scored and the positive and negative feelings.

2. Emotion Classification using EEG signals:

The central processing unit of the human-machine is liable for different undertakings, for example, observation, cognizance, consideration, feeling, memory, and activity. In human life feelings essentially influence one's prosperity. Giving strategies to access to human feelings would be vital to fruitful human-machine association. Understanding Brain-Computer Interface (BCI) strategies to distinguish the feelings likewise help in supporting individuals to collaborate with the world like a typical man. Numerous strategies were formulated to distinguish the human feelings of which use of EEG signs to arrange the feelings as joy, dread, outrage, and misery were discovered promising.

The existed strategy anticipated the feelings through the face acknowledgment method and EEG signals. Both the framework estimated the state of mind and feelings of a human through:

1. Face Recognition: Measures the 7 parameters for example wrinkles, cheeks, lips, eyebrows, and so on.
2. EEG Signals: There are 5 sorts of waves inside our cerebrum.

This strategy estimated the feelings by perusing the sort of wave moving through the mind at that specific time utilizing the BCI strategies.

The fundamental issue that both the framework confronted was the exactness rate which made it difficult to accept the framework expectations.

In this framework, the feeling perceived by utilizing two distinct methods so as to accomplish a precise yield. The various strategies are consideration examination utilizing EEG and face feeling utilizing open-cv with characterization. The apparatuses utilized in the proposed framework are Anaconda Navigator, Arduino, and IDLE.

The consequence of this framework relies upon the consideration esteem which is broke down and determined by the BRAIN sensor. In light of its worth, it is chosen whether the condition is ordinary and irregular.

In the event that the condition comes out to be Abnormal, the

framework will consequently change to Facial acknowledgment. This facial acknowledgment estimates 5 disposition esteems and gives us a histogram chart. Finally, it gives us the conclusive outcome as the level of every feeling like 60% happy,20% tragic, and so on.

If the condition comes out to be Abnormal the system will automatically switch to Facial recognition. This facial recognition measures 5 mood values and provide us with a histogram graph. At last it gives us the final result as the percentage of each emotions like 60% happy,20% sad etc.

VI. RESULT AND DISCUSSION

The framework has been effectively been actualized which identifies the state of mind of an individual, utilizing the face location calculations and EEG datasets. This dataset of feeling can additionally be utilized in associations to actualize disposition based working examples for the representatives, thus expanding the efficiency of the association all in all and not hampering with the work process.

The results of this research paper are viz.,

- This information is introduced as charts utilizing Python.
- These datasets can be additionally used to identify the state of mind of any individual.

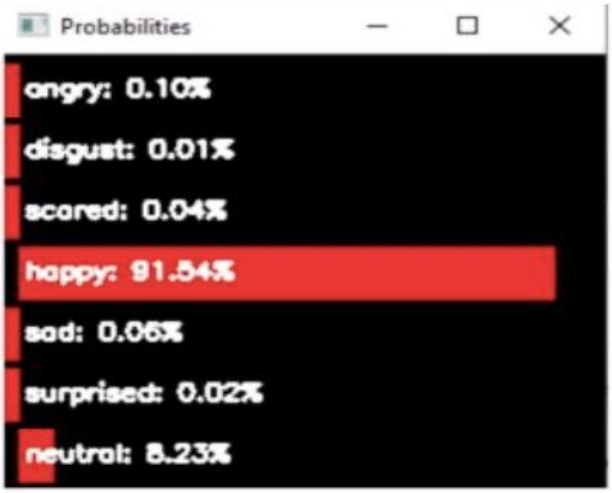

Fig. 3: Result showing probabilities

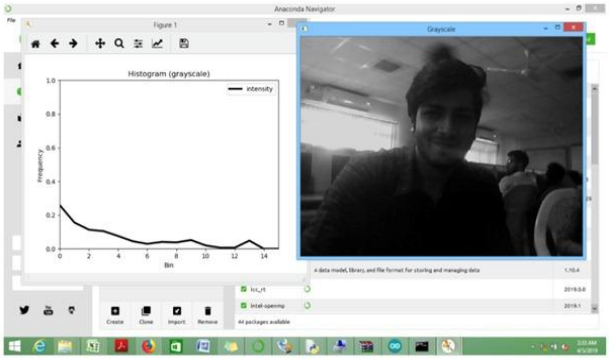

Fig. 4: Output

VII. CONCLUSION

This paper is a research on the topic - Emotion Recognition by Integrating Electroencephalography (EEG) and Face Recognition. We'll be integrating face recognition algorithms with the EEG datasets to detect the mood of the person at a particular moment of time. The EEG BrainWave is a device which can detect the EEG brainwaves in the brain and send those data to the computer via Bluetooth, our system can detect your mood and can be used to assign tasks according to the productivity levels for the continuity of the work and further will help an organization to increase the productivity levels.

Applications/ Future Aspects:

- Analysis of disabled people
- Driver Safety
- Driver Drowsy Detection System: These devices are seen as physiologically and intellectually discomforting to drivers. This is commonly definite anyway not reasonable. Since identifying cathodes would should be associated authentically onto the driver's body. It is bothering and redirecting the driver. Additionally, quite a while driving would achieve sweat on the sensors, diminishing their ability to screen correctly.
- Expanded security in uncommon fields: Facial pictures and fingerprints can regularly be gotten without the assent of subjects, however, this isn't the situation for brainwaves. Following an individual dependent on facial pictures, marks, or voices is basic, yet EEG information is hard to acquire. Regardless of whether an EEG information stockpiling framework was undermined, it is hard to locate the genuine character of an individual dependent on the highlights of his EEG information. This incredibly upgrades the security of enlisted customers.
- Circumvention: Much customary biometrics are handily manufactured or gathered without one's assent. Fingerprints can be taken from a cup that the client has held and voices and faces can be recorded covertly. In any case, as far as we could possibly know, no method has been created to empower the generation of brainwaves.

Longitudinal investigations and steady learning: The issue of format maturing can be overwhelmed by guaranteeing the fulfillment of the portrayal of each selected customer before the preparation of classifiers. This implies for every person, EEG information got under different conditions and on various occasions ought to be remembered for the preparation informational collections. Specifically, a few substances may influence mind action, for example, medication, tobacco, nicotine, caffeine, or liquor. In Marcel and Millán Jdel, the verification model was refreshed utilizing recently gained EEG chronicles dependent on the steady learning technique. These measures were appeared to intercede the drop in execution over a range of 3 days. In late advancements of biometrics in cell phone confirmation, the models utilized for face or unique mark acknowledgment are balanced during each login method. In a past report, we applied steady figuring out how to an EEG-based individual distinguishing proof framework.

The longitudinal variety was analyzed by having one of the 23 members over and over (multiple times inside 2 years) direct a finger development explore. Every meeting of EEG information, Sn (n = 2, 3, …, 19), was utilized to test the

accompanying: (1) the ID classifier prepared to utilize the primary meeting (S1); and (2) the ID classifier prepared to utilize the entirety of the information obtained in the past meetings, [S1, S2, … , Sn-1]. In 16 of the 18 testing meetings, the subsequent recognizable proof model accomplished preferred CRR overdid the main model, as appeared in Figure Figure2.2. These outcomes exhibit the possibility of gradual learning and show the significance of getting total preparing information so as to look after execution. We hence firmly suggest the utilization of longitudinal EEG securing and execution assessment during preparing steps so as to improve the transient tirelessness of EEG-based biometric frameworks.

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AUTHORS PROFILE

Savaridassan P. holds the office of an Assistant Professor (O.G) in SRM Institute of Science and Technology, Kattankulathur, India. His research interests are in the fields of Information Security and Assurance, Secure Coding, Database Security, and Network Security. Some of his publications include:

[1] Prasath V,Baskarane R,Savaridassan P, “Secure Architecture Evaluation for Agent Based Web Service Discovery”, International Journal on Recent Trends in Engineering (IJRTE’10), India, Vol.3, No. 2, pp. 15 - 17, 2010

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Ritul Kumar is a final year student of SRM Institute of Science and Technology, Kattankulathur, India in the domain of Information Technology.

He describes himself as a detailed-oriented, hard-working, and committed engineer, with a get-it-done and on-time spirit, and a slight experience in implementing, testing and delivering back-end and web applications using a variety of programming languages and technologies. He has technical proficiencies in Programming languages like C, C++, Java, Kotlin, Python, JavaScript, HTML, CSS, PHP, Spring Boot, Spring MVC, GraphQL, Apache Kafka, Database technologies like SQL, AWS DynamoDB, MongoDB, worked extensively on tools like Eclipse IDE, Netbeans IDE, IntelliJ IDEA, Git, Postman, JUnit, and implementing methodologies viz., Object-Oriented Programming, Procedural programming.

He have had the privilege of working for a FinTech start-up as an Intern and worked on niche technologies like Kotlin, Spring Boot, Apache Kafka, AWS DynamoDB, GraphQL along with Web technologies like JavaScript, HTML, and CSS.

Shubhangi Sharma has been pursuing her BTech degree from SRM University in Information Technology. She has performed 3 different projects on Web Development.

Data Base Management System and Hotel Management System (python project). Now she is working on her 4th project namely “Emotion Recognition By Integrating Electroencephalography (EEG) and Facial Recognition”.

The project is related Facial Reading which includes reading of different expression and recognizing different moods like sad, happy etc.

Has been looking for different opportunities coming in her way. She has worked on different languages like C, C++, SQL queries and python programming.

She has also explored her co-curricular side and has been outstanding in the field of painting, dancing and badminton.

Eugansh Khatri is a final year student of SRM Institute of Science and Technology, Kattankulathur, India in the domain of Information Technology and has experience of working on many aspects of different fields like web technology , Database Management System and is currently indulged in studying and working of Artificial Intelligence.

His educational background in IT has given him a broad base from which he can approach towards many different fields. He is very much fascinated with the new technology and ideas which can make life easier to live.

He also has a significant knowledge in programming languages like C, C++, Java, Python etc.

Prateek Khattri is a final year student of SRM Institute of Science and Technology, Kattankulathur, India. He is enrolled to BTech Information Technology domain. In this 4 years of engineering life he has a lot of experience in various fields like Blockchain, Web Development, Artificial Intelligence and Database Management. During his third year he was also the Chair of SRM ACM SIG-AI chapter i.e. Special interest group of Artificial Intelligence. His exposure in Information Technology field has given wide perspective, ability to combine hard work and smart work, adapt to new task problem and good leadership skills. Most importantly relating life of technology and love for the sports has taught him that an engineer in any field or anywhere has only one job “ To create and ease the difficulty” whether it’s a technology, project, sports etc.