IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Enhancing Depression Diagnosis With Wearable EEG And Ant Lion Optimization Algorithm

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Abstract: Depression is a common mental illness affecting many people worldwide. The number of diagnosed cases has been increasing recently. Current methods for diagnosing depression are often slow and not very accurate. We need better tools to find depression. Scientists are using brain wave signals called EEG to help diagnose depression. But in the past, they mostly looked at the whole brain, which was complicated and took a long time. They realized that looking at a specific part of the brain, the prefrontal lobe, is better for finding depression. To use this prefrontal brain data well, we need lots of good quality data. The regular machines used for EEG are big and hard to use. Some smaller ones can't capture the right data. So, we made a wearable device to get good brain data. In this study, we made a system to help diagnose depression using this wearable device. It also has a smart way to figure out if someone has depression. Our work shows promise in helping diagnose depression quickly. We explain how we made the device and the smart way to find depression.

Index Terms **- EEG technology, Wearable EEG Sensor, ALO Algorithm**

I. INTRODUCTION

Depression, in its simplest terms, is a pervasive mental health challenge that exerts a profound impact on the emotional well-being and daily functionality of individuals. Its significance arises from the fact that millions of people worldwide have received diagnoses of depression, with this number continuing to escalate. Alarmingly, it is anticipated that depression will ascend to become one of the leading causes of disability and, distressingly, even death by the year 2030.

Traditionally, the diagnostic process for depression primarily hinges on verbal interactions and questionnaires conducted by medical professionals. These methods, while widely employed, do not consistently deliver precise diagnoses and can be notably time-consuming. Consequently, this diagnostic paradigm leaves a substantial portion of individuals afflicted by depression without the timely and appropriate support they require.

In response to these limitations, researchers have embarked on an alternative avenue to detect depression by utilizing brain wave signals referred to as Electroencephalography (EEG). Rather than scrutinizing the entirety of the brain, this innovative approach centers its attention on a specific brain region closely associated with emotions and mental health: the prefrontal lobe. This approach has shown promise as a more expedient and accurate method for diagnosing depression.

For this innovative approach to come to fruition, researchers have had to develop a wearable EEG device with the capability to capture high-quality data. Additionally, they have designed an intelligent algorithm tailored for the specific purpose of diagnosing depression.

In the present study, the authors introduce a comprehensive system for diagnosing depression that revolves around the utilization of this wearable EEG device and accompanying algorithm. The article delves into the details of the device's construction, its performance characteristics, and the findings derived from the associated research. Ultimately, the overarching objective is to furnish a superior and more objective means of identifying and providing support to individuals grappling with depression, addressing the inadequacies of traditional diagnostic methods.

II. RESEARCH METHODOLOGY

Algorithm for EEG-Assisted Depression Diagnosis with ALP-Based Feature Weighting and Selection:

Input:

Training Data (D)

Population of Antlions and Ants (P)

Total Iterations (T)

Output:

Optimal Feature Weights (ALET)

Initialization:

Initialize Population (P) and Total Iterations (T).

Fitness Function:

Calculate the fitness of antlions and ants using classification accuracy.

Elite Antlion (ALET):

Identify the elite antlion with the highest fitness (ALET).

Main Loop:

Start iterating from t = 2 to T.

Antlion Loop:

For each antlion (i = 1 to P):

Random Walk Creation:

Select two antlions (ET and RW) and create a normalized random walk around them.

Position Update:

Use Blend Crossover (BLX) to determine the new position of the i-th ant.

Calculate x1 and x2.

Generate a random value Sn within the range [x1, x2].

Feature Selection:

If feature selection is active:

Convert real values into binary values for selecting or rejecting features using a logistic function (P).

Antlion's Feature Weighting:

If feature selection is not active, use the real-valued Sn as the feature weight (ANti).

Fitness Evaluation:

Calculate the fitness of all ants using classification accuracy.

Antlion Replacement:

If an ant is fitter than any antlion, replace the position of the antlion with the ant's position.

Elite Antlion Update:

If an antlion is fitter than the elite antlion (ALET), update the elite antlion with the fitter antlion's position.

Iteration Update:

Move to the next iteration (t+1).

III. RESULTS AND DISCUSSION

Results:

The study's results demonstrate the successful development and implementation of a wearable EEG sensor equipped with flexible electrodes, specifically designed for high-quality prefrontal-lobe EEG data acquisition. The novel Ant Lion Optimization (ALO) algorithm has been introduced and applied for feature weighting and selection in the context of depression diagnosis.

Discussion:

The adoption of electroencephalography (EEG) signals, particularly focusing on the prefrontal lobe, as an objective means to detect depression showcases promising outcomes. By addressing the limitations of traditional EEG devices, such as their size, complexity, and discomfort for patients, the proposed wearable EEG sensor overcomes challenges in obtaining high-quality EEG data. The flexibility of electrodes

enhances the device's suitability for acquiring prefrontal-lobe three-lead EEG data, a crucial aspect in the study of emotions and mental health.

Moreover, the integration of the Ant Lion Optimization (ALO) algorithm contributes to the efficiency of the depression diagnosis process. By providing a method for feature weighting and selection, the algorithm enhances the accuracy and speed of depression screening. This not only improves the diagnostic precision but also addresses the time-consuming nature of traditional methods, allowing for more timely intervention and support for individuals affected by depression.

The combination of the wearable EEG sensor and the ALO algorithm presents a comprehensive EEG-assisted depression diagnosis system. This system offers a viable solution to the challenges posed by conventional diagnostic tools, paving the way for faster, more accurate, and accessible depression screening. The study's findings suggest that the proposed approach holds promise in revolutionizing the landscape of depression detection, ultimately contributing to improved mental health outcomes.

IV.ACKNOWLEDGMENT

We express our sincere gratitude to all those who contributed to the successful realization of this study on the diagnosis of depression using EEG signals and a wearable device. Special thanks to the individuals who participated in providing valuable brainwave data, enabling us to develop and refine our novel approach. This work represents a collaborative effort, and we acknowledge the support and guidance received from our peers and mentors throughout the research process. Their insights and encouragement have been instrumental in the development of this promising tool for quick and effective depression diagnosis.

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