

# Depression Identification by using PHQ-9 and SVM Classifier

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**Abstract:** Depression is one of the deadliest ailments hitting about a noteworthy populace around the world This work proposes a method to identify Depression in subject by using EEG database recorded on different people of different age groups and social organizations. by asking PHQ-9 score is computed for each subject. EEG frequency bands values are tabulated by using Bluetooth based Neurosky's Mindwave kit. In this work focus is to identify depression by Support Vector Machine (SVM). 47 Samples are set up by making inquiries from standard poll with a Wright and wrong replies in a diverse era from the individual in wearable head unit. 39 samples are trained and 8 are tested. In this work SVM classifier's confusion matrix is derived by MATLAB program and accuracy of 75 % is achieved.

**Keywords:** PHQ-9, EEG, MATLAB, SVM, DASS-21.

## Introduction

### Depression

The present way of life of individuals crosswise over globe is loaded with exercises performed with worry because of rivalry, volume of work, travel needs, arranging and characterized execution. The review demonstrates that the most changed age gathering is the youthful people who contribute a considerable measure of improvement exercises. The review demonstrates that, one of five individuals are inclined to despondency which may prompt nonperformance or endeavor to crush self from life.

Depression can occur at any age, however frequently starts in adulthood. To be determined to have despondency, the side effects must be available for no less than two weeks. Sorrow is currently perceived as happening in youngsters and youths, despite the fact that it some of the time presents with more noticeable fractiousness than low temperament. Numerous interminable state of mind and nervousness issue in grown-ups start as large amounts of tension in kids.

Depression, particularly in midlife or more established grown-ups, can happen with different genuine medicinal sicknesses, for example, diabetes, tumor, coronary illness, and Parkinson's malady. These conditions are frequently more regrettable when wretchedness is available. Some of the time drugs taken for these physical sicknesses may bring about symptoms that add to misery. A specialist experienced in treating these entangled ailments can help work out the best treatment procedure.

### Electroencephalogram

Electroencephalogram (EEG) is the test to find the action and reaction of the cerebrum cells for each lift from inside and remotely, in which EEG also called as Electroencephalography, which is the system for the mind testing. Electrical banner is remotely setting out from the neurons to various neurons, this make less requesting to get the data noninvasively by using the terminals, as indicated by the differing action and the state of the individual activity, unmistakable sorts of EEG signs will be made in the assorted side of the brain. Thusly to defeat these cathodes are put with a standard division between them. Relationship of the side of cerebral cortex measured for the circumstance of the anode as demonstrated by the 10/20 percent of partition between every electrode from left, suitable, from and back of it. There are five sorts of fold, Frontal, parietal, Temporal, Central, occipital.

### Literature Survey

A survey of writing review is made here to comprehend the use of brainwave flag preparing and using it for discouragement discovery strategies. An investigation of different research works distributed in rumored diaries is made. The concentrate of every writing is delineated for better comprehension of the work in this section.

The creator [1] utilized despondency screening estimations of Patient Health Questionnaire-9 (PHQ-9) and Depression Anxiety Stress Scale-21 (DASS-21) keeping in mind the end goal to distinguish the ordinary and dejection gatherings. A 32 channels EEG was utilized to recognize the distinction of alpha waves in dejection and typical gatherings. The alpha waves in dejection gathering were discovered to be lower contrasted with the ordinary gathering in both close eyes and open eyes conditions. [1]

The creators [2] have evaluated the discouragement level utilizing I-Vector method and fluffy enrolment capacities. Gloom level is assessed of every speaker by utilizing these two calculations. After that they have thought about the aftereffects of these two techniques. Fluffy enrolment capacities give more precision when contrasted with the I-Vector technique. Fluffy enrolment capacities give better execution as contrasted and before procedures. They got 99 for each penny precision in misery level estimation in sounds utilizing fluffy participation work technique. [2]

The creator [3] with his work displays the convenience of the temple EEG with cutting edge detecting innovation and flag handling calculations to bolster individuals with medicinal services needs, for example, observing rest, anticipating cerebral pains, and treating discouragement. The proposed framework for assessing rest quality is fit for distinguishing five rest stages to track daily rest designs. The despondency treatment screening framework can foresee the viability of quick upper operators. It is apparent that frontal EEG movement is fundamentally required in rest administration, cerebral pain counteractive action, and wretchedness treatment. The utilization of dry terminals on the brow takes into account simple and fast observing on a regular premise. The advances in EEG recording and examination guarantee a promising future in support of individual medicinal services arrangements. [3]

The creator [4] proposed a formalization of the expository framework in view of machine learning calculation, which would foresee the level of wretchedness for people and recommend particular cure. The "Recuperating Hands for Depressed People System" (DHH) performs to precisely correspond the level of sorrow and legitimize the cure given with the sentiments of specialists in space. [4]

The creator [5] in his work recorded the Encephalogram (EEG) exercises from 37 members amid preparing of outward appearance jolts. With both high-gamma and low-gamma groups, the intelligence in the correct side of the equator of ordinary controls was more noteworthy than that of somewhat depressive subjects, particularly for anodes P8, TP8, C4, FC4, and F8. In the low gamma band, the grouping coefficients of solid controls in the prefrontal projection (AF4, AFz, AF3, FC5, F4, and F6) and the parietal flap (P03, P04, and P2) were essentially higher than those of somewhat depressive subjects. The proportion of the trademark way length between the useful system of the somewhat discouraged gathering and the little world system was more noteworthy than 1. For the ordinary gathering, the proportion was close to 1. Here, the outcomes demonstrate nearer collaboration in the mind zones of right half of the globe in typical controls amid the intellectual procedure contrasted and the somewhat discouraged gathering, while the action of the prefrontal and parietal districts in gentle dejection was essentially lower than that of ordinary controls. [5]

The creators [6] through this paper have assessed the misery level of every discourse flag utilizing I-Vector procedure. Here, they have expelled hush from the discourse flag then removed components from sound utilizing I-Vector after which split covering capacity was connected to assess covered sound beats. At last, they have assessed discouragement utilizing relationship framework. This strategy has better execution as contrasted and existing strategies. The general outcome has demonstrated that the I-Vector system has great exactness to identify despondency in sounds. [6]

The creators [7] in their work ventures towards building up a characterization framework arranged approach, where highlight determination, grouping and combination based trials are led to construe which sorts of conduct (verbal and nonverbal) and conduct mixes can best separate amongst dejection and non-despondency. Utilizing measurable components separated from talking conduct, eye action, and head posture, they portray the conduct related with real dejection and inspect the execution of the characterization of individual modalities and when combined. Among the diverse combination approaches utilized here, component combination performed best with up to 88% normal exactness. [7]

The creator [8] utilizes three-cathode inescapable EEG authority to gather EEG information from Fp1, Fp2, and Fpz as areas of scalp anodes, since these areas are firmly identified with feelings, and revealed by hair. Exceptional outlined investigation was directed and absolutely 178 subjects' EEG information were gathered. At that point, the exploration utilizes k-NN (K-Nearest Neighbour), SVM (Support Vector Machine), ANN (Artificial Neuro Network) and DBN (Deep Belief Network) to break down the information. The outcomes demonstrate DBN performed superior to anything customary techniques utilizing shallow calculations. Besides, the outcomes recommended the outright energy of beta wave is a substantial trademark, which could be utilized for recognition of sadness. The precision achieved 78.24% utilizing the blend of DBN and the supreme energy of beta wave. This examination demonstrates the possibility of littler size inescapable framework for discouragement analysis. [8].

## Methodology

### Proposed Block Representation

The Depression level predictor uses EEG signals which are acquired by utilizing "Neurosky's Mindwave Mobile Kit", which gives the raw EEG waves. It is a non-obtrusive strategy which utilizes just single terminal. Individual is asked with 10 inquiries from the Standard PHQ.9 surveys and relying on his Depression, the distinctive EEG waves, to be specific Alpha, Beta, Theta, Delta and Gamma waves changes which are taken and spared by Lucid Scribe and are nourished to the Machine learner. Here, in the proposed module, the Electroencephalogram (EEG) signs of subjects are gotten by talking diverse age assemble subjects (47) with Depressed and Normal subjects. The elements are then separated from recurrence groups (Alpha, Beta, Delta, Gamma and Theta). Informational index of 47 subjects are readied that are sustained to the Machine learner to recognize depression where 39 are trained and 8 are tested to assess SVM execution. The proposed module is as appeared in Figure 1.

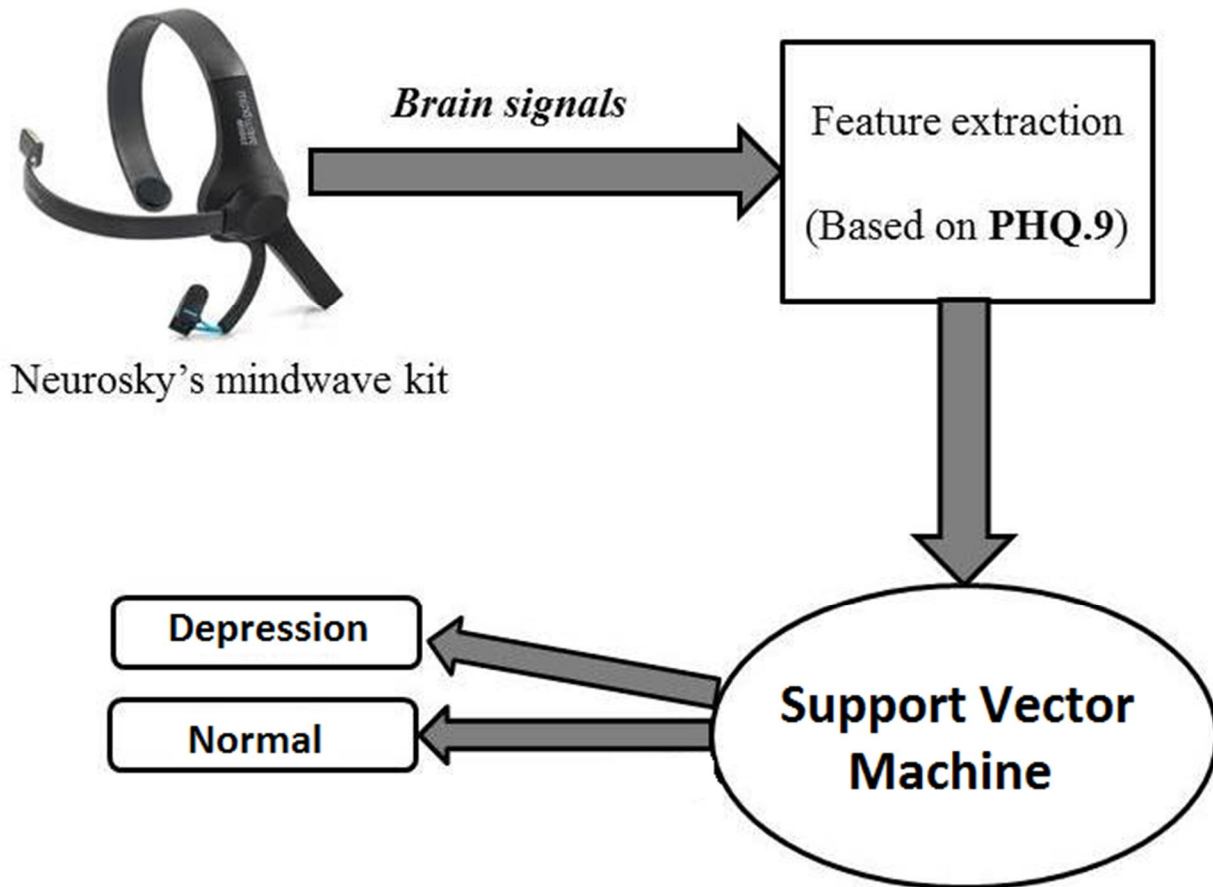


Figure.1 Proposed block representation of the module

### Neurosky's Mind wave mobile

Neurosky's maker out accompanied the "Mind wave mobile" brain wave kit work in 512-HZ of recurrence comprising of just sing electrode, the raw EEG signal is transmitted from the instrument by means of Bluetooth to the framework, by the support of "Lucid Scribe" programming which hold he log of the general time, EEG information from the instrument is appeared in Figure 2. Waves for each small scale second is put away with the information sheet of consistently, time, moment and seconds, by sending out this to the exceed expectations design we can get the numerical yield.

EEG Signals are recorded with neuro sky's mindwave pack. Data's of different age gather and unmistakable sex are taken. Lucid Scribe programming gives differing mind wave signals in regards to time. In Lucid Scribe Brain signs are assembled. The data is masterminded age, sex, alpha, gamma, theta, and delta for max, min and average qualities.



Figure. 2. Mind wave mobile

**Patient Health Questionnaires (PHQ-9)**

The PHQ-9 is a multipurpose instrument for screening, checking and measuring the severity of Depression. The PHQ-9 uses DSM-IV despairing characteristic criteria with other driving genuine depressive symptoms into a compact self - report instrument. The gadget rates the repeat of the signs which parts into scoring earnestness record. Address 9 on the PHQ-9 screens for the proximity and term of suicide ideation. An improvement, non-scored address on the PHQ-9 screens and the names weight to how much depressive issues have affected the patient's level of limit. The PHQ-9 is brief and important in clinical practice. The PHQ-9 is done by the patient in minutes and is immediately scored by the clinician. The PHQ-9 can moreover be coordinated on and on, which can reflect change or exacerbating of distress in light of treatment.

PHQ scores  $\geq 10$  indicates Depression

PHQ scores  $< 10$  exhibits subject is Normal

Figure 3 shows PHQ -9 sample format and Figure 4 shows sample collection by using Mobile mind wave kit by asking PHQ-9

**The Patient Health Questionnaire (PHQ-9)**

Patient Name \_\_\_\_\_ Date of Visit \_\_\_\_\_

Over the past 2 weeks, how often have you been bothered by any of the following problems?	Not At all	Several Days	More Than Half the Days	Nearly Every Day
1. Little interest or pleasure in doing things	0	1	2	3
2. Feeling down, depressed or hopeless	0	1	2	3
3. Trouble falling asleep, staying asleep, or sleeping too much	0	1	2	3
4. Feeling tired or having little energy	0	1	2	3
5. Poor appetite or overeating	0	1	2	3
6. Feeling bad about yourself - or that you're a failure or have let yourself or your family down	0	1	2	3
7. Trouble concentrating on things, such as reading the newspaper or watching television	0	1	2	3
8. Moving or speaking so slowly that other people could have noticed. Or, the opposite - being so fidgety or restless that you have been moving around a lot more than usual	0	1	2	3
9. Thoughts that you would be better off dead or of hurting yourself in some way	0	1	2	3

Column Totals \_\_\_\_\_ + \_\_\_\_\_ + \_\_\_\_\_

Add Totals Together - **Score** \_\_\_\_\_

10. If you checked off any problems, how difficult have those problems made it for you to Do your work, take care of things at home, or get along with other people?

- Not difficult at all  Somewhat difficult  Very difficult  Extremely difficult

Figure 3 Sample PHQ-9



Figure 4. sample collection by Asking PHQ-9

**Samples collection and Processing**

Lucid Scribe is the product which is utilized to gauge and furthermore to record the mind wave designs utilizing the Neurosky's unit that is associated with the head. Lucid Scribe is a software to record distinctive brain signals, perceive REM rest and trigger diverse yields when REM rest is distinguished. This document delineates the components of Lucid Scribe, how they work and how to use them. Clear Scribe can be used to record brain wave outlines using an EEG device related with the PC and play back sound archives or trigger another device when REM rest is perceived through eye improvement. For the recording the relating module for the EEG being utilized must be presented nearby the essential programming. For example to use Lucid Scribe with a headset or headband that contains a Think Gear, like the Mindwave, you have to present in any occasion Lucid Scribe and the Neurosky's Think Gear EEG module.

**Results and Discussion**

In this work focus is made on Depression Identification. 47 Samples are prepared by asking questions from PHQ-9 from the person. By using neurosky's Mindwave kit brain waves are recorded at the forehead and important features are tabulated as shown in Figure 5. Among them 39 data samples trained and 8 are tested. As Mindwave kit is wearable with Bluetooth support this work may be used in various applications. In this work confusion matrix is derived by MATLAB program and accuracy of 75 % is achieved. SVM Training and Testing results are as shown in Figure 6 and Figure 7.

GENDER	AGE	Alpha AVG	Alpha MIN	Alpha MA	Beta AVG	Beta MIN	Beta MAX	Delta AVG	Delta MIN	Delta MA	Gamma A	Gamma M	Gamma I	Theta AVG	Theta MIN	Theta MA	SCORE	LEVEL
Female	46	477.7462	2	856	300.6769	2	588	66.58462	0	102	233.7462	0	375	143.9	1	214	19	2
Male	54	391.8051	1	503	242.875	0	314	227.2022	0	293	121.4081	1	155	254.9007	0	335	21	3
Male	78	500.5	498	503	312.5	311	314	291.5	290	293	154	153	155	333	331	335	12	1
Female	63	500.4953	498	503	312.4972	311	314	291.5028	290	293	154.0019	153	155	333.0037	331	335	12	1
Female	72	500.5	498	503	312.5	311	314	291.5	290	293	154	153	155	333	331	335	17	2
Male	72	900.9639	339	999	894.4244	150	999	112.2646	66	145	361.0069	39	508	463.3505	154	598	0	0
Male	58	628.5079	394	908	603.9735	368	909	121.3095	86	148	228.8519	176	312	468.3677	375	635	4	0
Male	50	545.8604	375	799	357.782	219	532	123.1071	84	169	193.5564	134	249	270.8834	206	375	6	0
Male	35	744.7778	555	926	346.2027	272	466	129.7037	104	160	240.2047	129	312	369.9142	202	618	5	0
Male	29	797.8893	557	999	412.4842	271	563	140.7273	91	173	271.6818	183	349	536.0474	393	687	9	0
Male	52	316.2814	127	323	302.6317	223	552	29.65269	21	42	31.87126	8	34	114.3802	31	124	17	2
Female	45	361.8625	189	527	227.1859	97	435	87.25465	72	119	62.60037	40	94	133.9126	84	216	22	3
Female	36	438.7649	341	597	320.7331	215	464	103.8048	83	132	105.1116	76	135	227.998	145	299	14	1
Female	33	450.2151	321	586	199.9669	132	260	94.7114	61	123	83.13419	57	113	174.0349	124	224	21	3
Female	65	463.5813	223	693	196.0918	91	342	79.59465	54	91	78.33652	40	130	175.0459	97	297	19	2
Male	42	294.5867	157	424	190.7269	118	335	51.41697	38	68	72.4428	30	134	119.4188	82	161	14	1
Male	63	492.3727	267	939	269.1855	147	485	92.15636	41	179	128.0073	64	217	170.9291	72	348	4	0
Female	55	544.5213	395	667	407.1442	271	544	130.7024	101	177	200.0166	130	264	313.3863	197	493	25	3
Female	40	744.0019	90	999	744.3346	143	999	131.6615	14	167	286.7404	24	450	268.2135	39	387	17	2
Male	53	516.9134	356	708	369.2316	273	574	101.887	84	131	177.1186	99	258	241.8588	143	371	17	2
Female	41	710.2121	302	999	450.3729	241	760	133.7843	101	180	182.3912	126	245	303.7386	224	439	6	0
Male	47	813.3144	582	999	591.1207	311	935	132.9525	96	183	265.66	158	458	505.3784	222	589	11	1
Male	51	776.0389	527	999	812.9463	492	999	125.2352	95	149	377.8981	206	576	504.1907	406	614	13	1
Male	63	164.0492	21	307	136.2787	23	296	22.65574	6	45	152.6066	2	310	45.35	11	80	4	0

Figure 5: Data set table prepared

```

C:\Users\Mallikarjun\Desktop\malli\Depression_SVM.m
File Edit Text Go Cell Tools Debug Desktop Window Help
- 1.0 + 1.1 x
1 - clc;
2 - clear all;
3 - close all;
4 - dataread=xlread('svm_train.xls');
5 - [r,c] = size(dataread);
6 - [x] = dataread(:,1:17);
7 - t = dataread(:,18);
8 - inputs=x;
9 - targets = t;
10
11 % testdataread=xlread('svmnabntest.xlsx');
12 - testdataread=xlread('svm_test.xls');
13 - [y,z] = size(testdataread);
14 - a = testdataread(:,1:17);
15 - testdata=a;
16 - targetcheck= testdataread(:,18);
17
18
19 % svmstruct = svmtrain(inputs,targets,'boxconstraint',1,'kernel_function','rbf','rbf_sigma',0.8,'showplot','true');
20
21
22 % svmstruct = svmtrain(inputs(:, 1:5),targets,'boxconstraint',1,'kernel_function','rbf','rbf_sigma',0.8,'showplot','false');
23 - figure(1)
24 - svmstruct = svmtrain(inputs(:, [2,5]),targets,'boxconstraint',1,'kernel_function','linear','showplot','true');
25 % NAbnOp = svmclassify(svmstruct,testdata(:,1:5),'showplot','false');
26 - NAbnOp = svmclassify(svmstruct,testdata(:, [2,5]),'showplot','true');
27
28 ## performance
29 - cmat1 = confusionmat(targetcheck,NAbnOp);
30 - acc = 100*sum(diag(cmat1))./sum(cmat1(:));
31 - fprintf('accuracy = %.2f%%: ', acc);
32 - fprintf('\n Confusion Matrix for True and False:\n'), disp(cmat1)
    
```

Figure 6. SVM Program Run in MATLAB

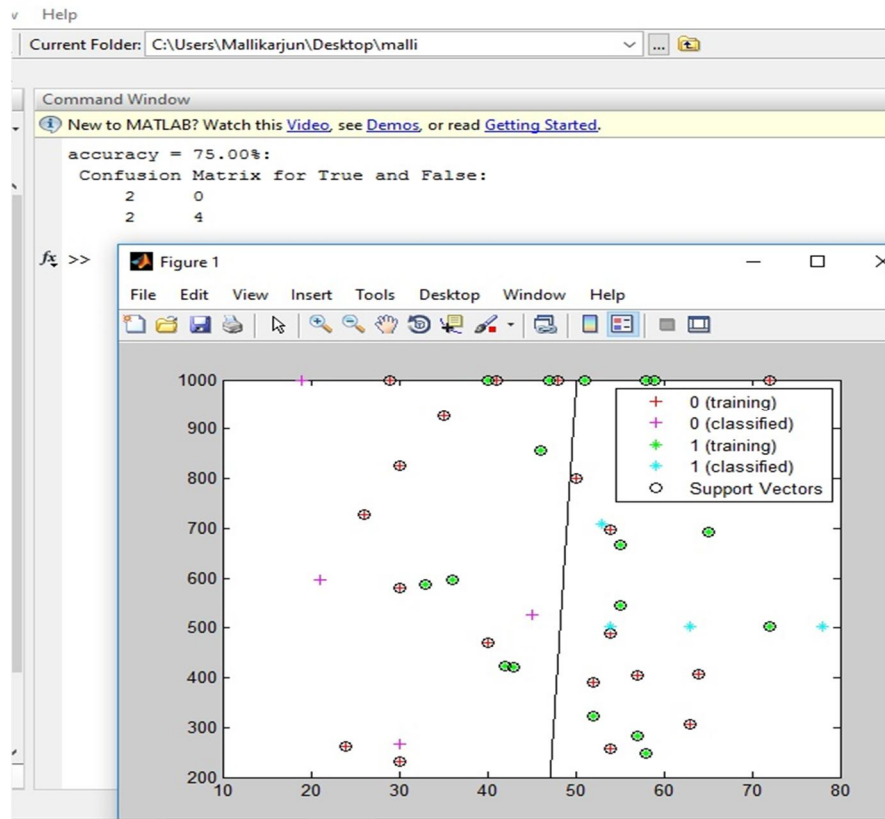


Figure 7. Results and Confusion matrix

## Conclusion and Future Work

Depression identification plays vital role to avoid suicide of the subject. In this work methodology is given by EEG samples and PHQ-9 based scores for the subjects. In this work, the SVM module gave 75 % accuracy.

The binary SVM classifier used could be replaced by multi-level SVM which gives Depression levels as Level 1,2,3 based on PHQ-9 score and EEG data.

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