time. After that, the classification of drunk and non-drunk subject was done using ANN. For a better classification, three different epochs were implemented. According to the best training result, an interface on MATLAB was designed for potential users. The interface allows users to determine readily whether a subject is drunk or not.

In this paper, the nature of EEG signal, the definition of ANN and Yule-Walker method are treated in Section 2. Section 3 is assigned to experimental application and performance evaluation. And Section 4 includes conclusion and recommended future works.

2. METHODOLOGY

2.1 Electroencephalography (EEG)

Bioelectrical signals obtained as a result of brain neural activity are called EEG [12]. Human mental activities can be observed via EEG signals. EEG signals are recorded by electrodes placed over the head. The amplitude of these signals varies between 1-100 μV and their frequency spectrum lies between 0.5 – 100 Hz. EEG signals are divided into 4 groups [13] according to their frequency contents as shown in table 1.

Table 1. Frequency ranges of EEG signals

Delta (δ)	0.5 – 3 Hz
Theta (θ)	4 – 7 Hz
Alpha (α)	8 – 13 Hz
Beta (β)	> 13 Hz

These frequency values vary depending on people's instant mental attitudes. Alpha waves are observed in normal, calm people. The amplitude value of these waves is approximately 50 μV. Beta waves occur usually in cases of stress. Theta waves are seen in children, and adults when they are disappointed and tensioned. Delta waves are observed in infants and in cases of severe organic brain diseases [13]. In Figure 2, EEG waves with their four rhythms are shown [14].

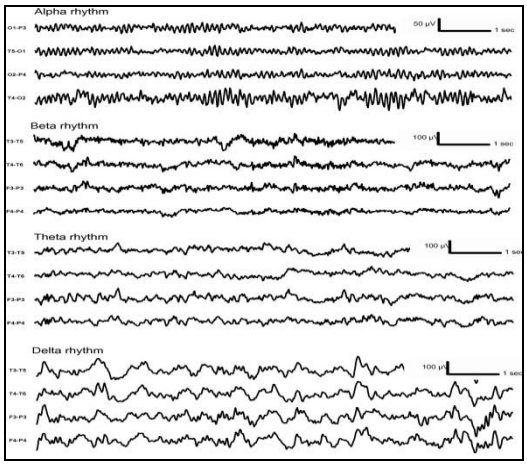

Fig 2: EEG waves with their four rhythms [14]

2.2 Artificial Neural Network (ANN)

ANN is developed on the model of human biological nervous system. ANN is a mathematical calculation method based on learning and making decisions [15]. It is a computer based system which is used to solve difficult and complex problems. A comparison of artificial neural network and biological neural network is given in Table 2 [16].

Table 2. A Comparison of Biological and Artificial Neural Network

Biological Neural Network	Artificial Neural Network
Neuron	Processing element
Synapse	Weight
Dendrite	Add Function
Cell Body	Transfer/Activation Function
Axon	Exit

ANN is categorized as feedforward and feedback according to their architectural structures. Similarly, ANN is classified into three groups with respect to learning approachs, namely supervised, unsupervised and reinforcement learning. Hebb, Hopfield, Kahonen and Delta are used as learning rules [17].

In this paper, feedforward error backpropagation ANN (FEBANN) is used. This ANN type is preferred due to the ease of implementation, higher speed and minor training sets requirement.

2.3 YULE-WALKER Method

This method is called autocorrelation in the some sources. Autocorrelation equations are available on the basis of Yule-Walker which is used for Autoregressive (AR) model, so these two names are used interchangeably in the literature [15]. In this method, AR coefficients ap(k) are calculated using autocorrelation equations.

$$\begin{bmatrix} r_x(0) & r_x^*(1) & r_x^*(2) & \cdots & r_x^*(p) \\ r_x(1) & r_x(0) & r_x^*(1) & \cdots & r_x^*(p-1) \\ r_x(2) & r_x(1) & r_x(0) & \cdots & r_x^*(p-2) \\ \vdots & \vdots & \vdots & & \vdots \\ r_x(p) & r_x(p-1) & r_x(p-2) & \cdots & r_x(0) \end{bmatrix} \begin{bmatrix} 1 \\ a_p(1) \\ a_p(2) \\ \vdots \\ a_p(p) \end{bmatrix} = \varepsilon_p \begin{bmatrix} 1 \\ 0 \\ 0 \\ \vdots \\ 0 \end{bmatrix}$$

Here,

$$r_x(k) = \frac{1}{N} \sum_{n=0}^{N-1-k} x(n+k)x^*(n); k = 0,1,.....p$$

If the matrix equation above is solved for ap(k), then

$$\left|b(0)\right|^2 = \varepsilon_p = r_X(0) + \sum_{k=1}^{p} ap(k) r_x^*(k)$$

is obtained.

As a result of this equality, it will be possible to make a prediction about the power spectrum [18].

3. EXPERIMENTAL WORK AND PERFORMANCE EVALUATION

A block diagram for experimental work procedure is provided in Figure 3.