6. Conclusion

This paper describes the background and research status of QoS routing issues, with the simple introduction of the ant colony algorithm, tabu search algorithm, the basic principles of artificial fish swarm algorithm, and several algorithms and their advantages and disadvantages. Artificial fish swarm algorithm is proposed as the improvement ideas, there are two main aspects: Firstly, the artificial fish swarm algorithm and ant colony algorithm combination, and secondly, the artificial fish swarm algorithm and tabu search algorithm combination, then combine the features of QoS routing issue, and apply both algorithms to solve the QoS routing issue. Adopt numerical simulation cases, and the results show that the improved algorithm for solving QoS routing issue has better performance than normal algorithm, better speed and efficiency than other algorithms.

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Mobile Healthcare System for Driver Based on Drowsy Detection Using EEG Signal Analysis

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Abstract
With economic development, vehicles have been popular among families and the malignant accidents such as drowsy driving increases in recent years. Currently, common driver drowsy detection methods are limited without a high prevalence rate. This paper takes brain signals as drowsy detection tools and designs a real-time drowsy test system with the mobile phone as the platform, which is supported by the technology provided by the portable computer. Based on the drowsy test analysis carried out among 20 subjects, the result shows that the coincidence degree between the system and the real drowsy feeling of subjects is over 85%.
Key words: DROWSY DETECTION, ELECTROENCEPHALOGRAM(EEG), DRIVING,MOBILE SYSTEM

1. Introduction

With the constant development of economy and society, vehicles have been popular among common families. However, transportation has brought a rise in traffic accident. In 2012, there were 204,196 traffic accidents in China, among which 59,997 people died and 224,327 people got hurt. In 2009 , there were 310,667 traffic accidents in United States, and 33,808 people died while 33808 got hurt; in Germany, there were 310,667, 4,152 died; in 2010 , there were 725773 traffic accidents, 5745 died; in Italy, there were 211404 and 4090 died.

Driver drowsy is the main cause of traffic accidents, according to the statistics, about 30% of traffic accidents were associated with drowsy. Inattention due to driver drowsy is the main reason leading to traffic accidents. However, the method of judging driver drowsy is subjective, and the technical identification lags behind. In accordance with relevant regulations, driving a motor vehicle for more than 4 consecutive hours without rest or having a rest less than 20 minutes is identified as drowsy. Besides, stay up for a long time, or lack of sleep, excessive fatigue also belong to fatigue driving.

A glittering array of scholars begin to adopt various methods to test the drowsy because the damages of drowsy driving is becoming more and more serious. Right now, researches on drowsy driving are mainly divided into objective detection and subjective detection, among which subjective detection is recorded by the driver, Stanford sleep scale table, sleep habits questionnaire and subjective questionnaire. Objective diction mainly includes heart, muscle, brain, eyes, respiratory tract test, and respiratory effects as well as the temperature measurements when arterial oxygen blood is saturated.

ECG HR (Heart Rate) index and HRV (Hart Rate Variability) index are important physiological indicators implying drowsy driving. Patel etc [1] found that heart rate variability can be re garded as the characteristic parameters of drowsy driving and the accuracy can reach 90% because the neural networks realize drowsy driving test. Mao Zhe etc collect various physiological indicators under different driving conditions (electromyography, breathing, skin temperature, heart rate, Galvanic Skin etc) so as to study their physiological characteristics while paying different attentions. Besides, they also adopt fuzzy clustering method to identify their drowsy conditions[2]. Relevant personnel in University of Tokyo tested the alcohol, ammonia and lactic acid content in human sweat to determine driver's drowsy level and there will be effective alarming if there should be drowsy driving. Based on driving imitation experiment, Wierwille puts forward PERCLOS as indicators for drowsy and designed corresponding drowsy testing device[3]. Murphy Chutorian developed six-stance tracking system to test the attention of drivers.

In the process of studying on EEG, researchers found out that adopting EEG is able to respectively identify driver's drowsy state [4]. Yeo divided the brain signals through the detection model established based on SVM [5]. Zhao Xiao Hua and others [6] adopted EEG to obtain the brain signals in driving stimulation and used power spectrum to calculate wave energy distribution in different frequency bands. In addition, based on BP neural network, the alcohol degree is tested. Based on different frequency distortion, we successfully quantified the drowsy degrees of drivers [7].

Even though, drowsy detection methods and studies have achieved rich results, applied detection systems are rare. The development of electronic and network makes smart phones become a daily standard equipment. Nowadays, smart phones with general configuration can be comparable to a computer which makes it possible to carry out real-time detection. This paper takes android system smart phones as platforms and collects EEG signals via portable computers to design a portable and real-time drowsy detection system.

2. Method

In order to improve transfer efficiency, the device output collected by the portable computers is not the original EEG but the processed one. In addition, the output of some equipment is the value of each frequency band calculated by hardware. Judging from the efficiency, the direct transmission frequencies are more efficient. Taking 512 sample rate as an example, if it transfers the original signals, it has to transfer 512 data per second, but only need the data below 50Hz, it need transfers 40 data per second, For application systems without high demands in terms of accuracy, the frequency band transmission can meet the application demand. However, in terms of the discussed drowsy detection system, such transmission will lose a large amount of real information and affects the application. Therefore, this system adopts direct mode, and the EEG signal acquisition is primary filter and advanced calculation is carried out based on smart phones.

While integrating the data accuracy and system efficiency. This paper designs the approach showing in Fig. 1 and the whole system can be divided into two parts: EEG acquisition and mobile devices.

2.1 System Architecture

As shown in Fig 1, the EEG acquisition can be divided into four parts: EEG Sensor, EEG filter, MCU and Bluetooth Transmitter Module. EEG Sensor adopts two conducting forehead patch and the left mastoid process is regarded as the reference electrode. EEG filter carries out the first filtering on the acquired EEG signal and removes the direct current jam and external direct current jam. MCU controls the signal transmission, adjusts transmission frequency and sends out the signal per second. Bluetooth Transmitter Module sends the signals to the Bluetooth module of the mobile device.

The mobile device includes Signal Preprocessing, Feature Extractor, Classifier, Save, Alarm, Display and Bluetooth Receive Module .

Bluetooth Receive Module: it receives the EEG signals sent by Sensor Module.

Signal Preprocessing: it carries out data preprocessing of the EEG.

Feature Extractor: it conducts feature extraction of driver's EEG.

Classifier: it carries out differential count of the characteristics

Save: Store the extracted characteristics

Alarm: Judge whether it is necessary to remind the driver based on the calculated result

Display: Judge the drowsy and data, predict the result

Among which, signal preprocessing, feature extractor, classifier and save consist of the core data processing units; Alarm and Display consist of the applied units of the system.

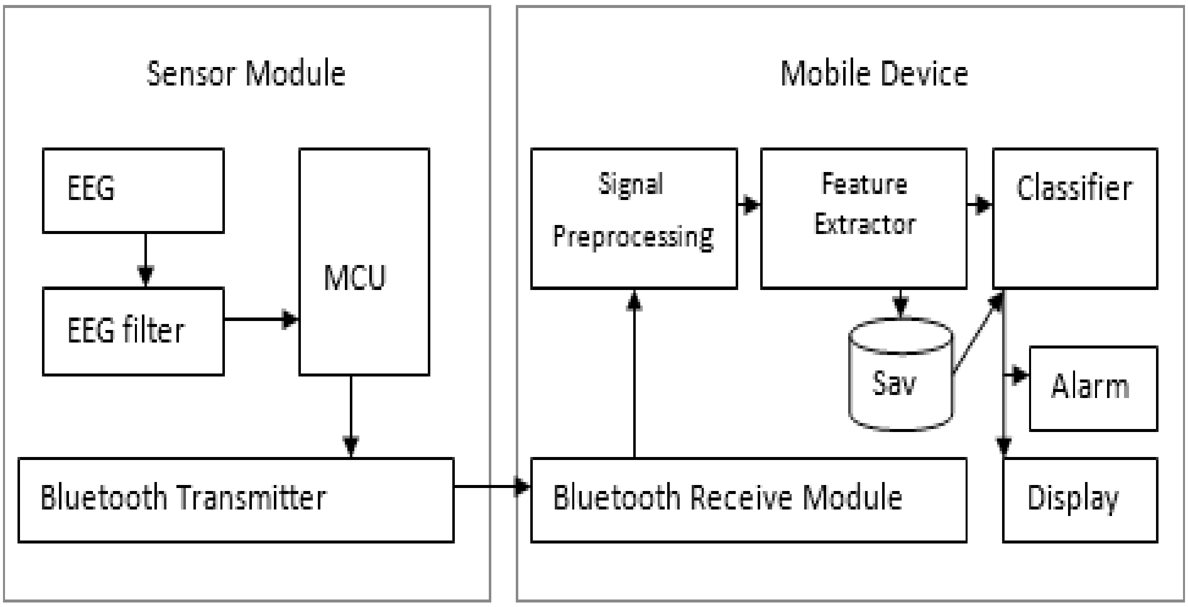

Figure 1. The integral system structure

2.2 Data processing unit

The EEG sent by the Bluetooth receiver module of sensor module is the original and if the signal is only conducted preliminary hardware filter, there should be noise frequency along with data acquisition and transmission. In order to reduce the noise, there should be data preprocessing before extracting the data and the early research results show that Kalman filter is good at dealing with the EEG filtering and its approach is shown in the following

The discrete system is shown as follows:

$$X_{K+1} = \Phi_{K+1} X_K + \Gamma_{K+1} W_K \tag{1}$$

$$Z_{K+1} = H_{K+1} X_{K+1} + V_{K+1} \tag{2}$$

Among which, X is the vector of n; is the transition probability matrix of n*n; W is the dynamic noise vector of p; is the jamming transition matrix of n*p; Z is the measurement vector of m; H is the measurement vector of m*n; V is the measurement error vector of m.

Suppose the dynamic noise and measured noise is unrelated zero mean Gaussian sequence, suppose the initial state is the Gaussian random vector of n and is not related to , then

$$EW_k W_L^T = Q_k \delta_{k,L} \tag{3}$$

$$EV_{K+1} V_{L+1}^T = R_{K+1} \delta_{K,L} \tag{4}$$

$$E(X_0 - \overline{X_0}) \times (X_0 - \overline{X_0})^T = P_0 \tag{5}$$

Based on the above, we can get the following five Kalman filter formulas:

$$P_{K+1/K} = \Phi_{K+1,K} P_K \Phi_{K+1,K}^T + \Gamma_{K+1,K} Q_K \Gamma_{K+1,K}^T \tag{6}$$

$$K_{K+1} = P_{K+1/K} H_{K+1}^T (H_{K+1} P_{K+1/k} H_{K+1}^T + R_{K+1})^{-1} \tag{7}$$

$$\hat{X}_{K+1/k} = \Phi_{K+1,k} \hat{X}_k \tag{8}$$

$$\hat{X}_{K+1} = \hat{X}_{K+1/K} + K_{K+1}(Z_{K+1} - H_{K+1} \hat{X}_{K+1/k}) \tag{9}$$

$$P_{K+1} = (1 - K_{K+1} H_{K+1}) P_{K+1/K} \tag{10}$$

The EEG characteristics are different under different drowsy conditions, and this paper adopts EEG frequency ratio under different drowsy conditions. Therefore, for different people, even the frequency ratio is same, the drowsy condition is not same. In order to flexibly demonstrate the drowsy conditions, we have to determine the threshold under different conditions, namely to determine when it is necessary to remind the driver if he is tired or not. This paper adopts the following ratio calculating method:

The s means proportion of different frequencies:

$$S(\omega) = \frac{\int_{\omega 1}^{\omega 2} f(t)A(t)dt}{\int_{1}^{50} f(t)A(t)dt} \tag{11}$$

Among which refers to four frequency bands of , refer to the floor level and upper limit, refer to EEG function after the transformation of time function and AR module.

The calculation method of frequency ratio K shows as follows:

$$k = \left[\left(\frac{S(\alpha) + S(\beta)}{S(\delta) + S(\vartheta)} \right) \times 100 \right] \tag{12}$$

The above four frequency bands are defined as α : 8~12Hz, β :13~30Hz, δ :4~7Hz, ϑ :1~3Hz.

In order to accurately position the users state of drowsy, we have to carry out signal collections on the drowsy condition before the monitoring. It adopts offline module to conduct the ratio calculation to get the drowsy ratio range and then carries out practical operation of the alarming. The concrete online and offline data processing flow shows in figure

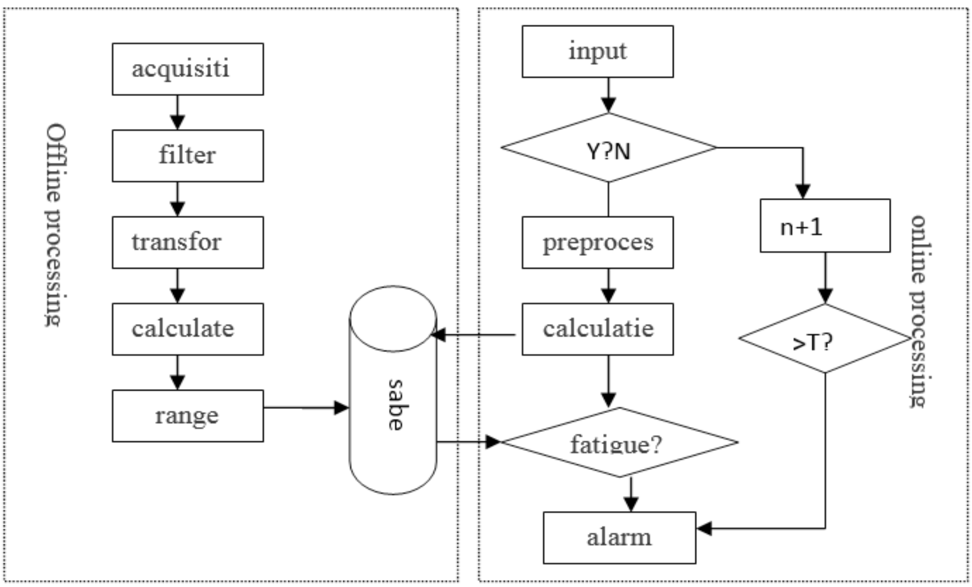

Figure 2. Data flow diagram

The left shows the offline processing, mainly to get the drowsy alert ratio range, which is calculated based on the formula 2. The EEG collected by the collection equipment is available which is tested by people and the collection time is the one when drivers are tired. Besides the drowsy state can be obviously shown by certain Method. The EEG collected is filtered by digital and EEG between 1~30Hz is saved. The time-frequency transformation changes the original time domain into frequency domain based on signal analysis approach and this paper adopts FFT approach. Every time, it adopts EEG input of 3 seconds to calculate the ratio and store the records. After many times calculations, it carries out the drowsy range and store the data as the detection references.

Online implementation phase refers the condition that drivers use this system while driving and when the drivers are tired, it will remind them and the right of the figure 2 shows the online data processing steps:

1. Signal input stage: send the EEG from sensor module and store the data, calculate per three second;

2. Signal test stage: judge whether the signal is available or not, and if the signal is not available the EEG is abnormal and the signal monitor semaphore is n+1; when the threshold n> is input T, the input equipment is abnormal and the system will alarm, the users should check the EEG to ensure the EEG input quality;

3. Preprocecessing stage: if the input signal is available, the EEG frequency just moves the low frequency and high frequency interference and 1~30Hz EEG is not necessary. Therefore, the offline processing is same and the input EEG should be filtered and the frequency should be transferred.

4. Ratio calculation stage: when the EEG is preprocessed, we can adopt formula 2 to calculate the frequency ratio.

5. Drowsy test stage: store the calculation result so as to keep continuous data; compare the calculation ratio and stored drowsy range and if the calculation ratio is among the range it shall alarm, which elaborates that the drivers feel tired.

2.3 System application unit

With the development of science and technology, smart phones have become more and more popular. Among smart operating systems, android system has occupied a large amount of market share because of its properties and its market share in China exceeds 90%. The system applied units in this paper include alarm and demonstration. Among which, alarm refers to the condition that the system will create different alarm sounds when the drivers are tired or have other abnormal conditions, showing in the interactive interface. The structure of the interactive interface shows in figure 3:

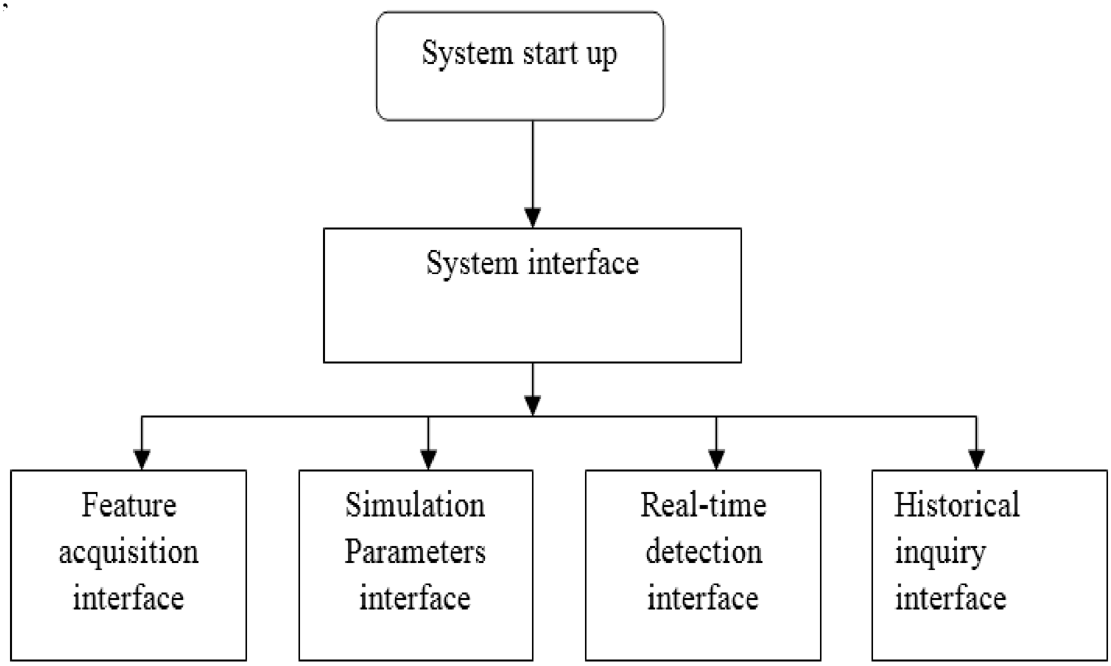

Figure 3 . System interface structure

The acquisition interface mainly aims to obtain the drowsy range of drivers offline.

Simulation Parameters interface mainly set various performance parameters of the system.

Real-time detection interface demonstrates the drowsy condition of drivers based on images and data;

The historical inquiry interface is able to help drivers check their drowsy conditions while driving.

3. Result

According to the research result carried out by Moller [14], it is highly possible for drivers to be tired during 2p.m and 4p.m. Even though, the highest rate of drowsy is during the night, this paper takes data between 9:30-11:30 as the normal samples and the data between 2:00-4:00 as the experimental samples. To a same subject, the time interval of normal driving test and the drowsy collection time is four days; before the normal driving, the test is asked to have full sleep the tired subjects should have less than 5 hours sleep without drinking wine, tea and coffee and cannot have a noon break. A same subject should have 3 normal driving and drowsy driving.

This paper adopts the portable acquisition device of G-tech and uses 512Hz to collect forehead data (regions such as FP1 and FP2 of 10-20 standard), and the effective data is updated per three seconds.

The following figure cuts out four point in time and we can see the drivers' drowsy condition in the figure:

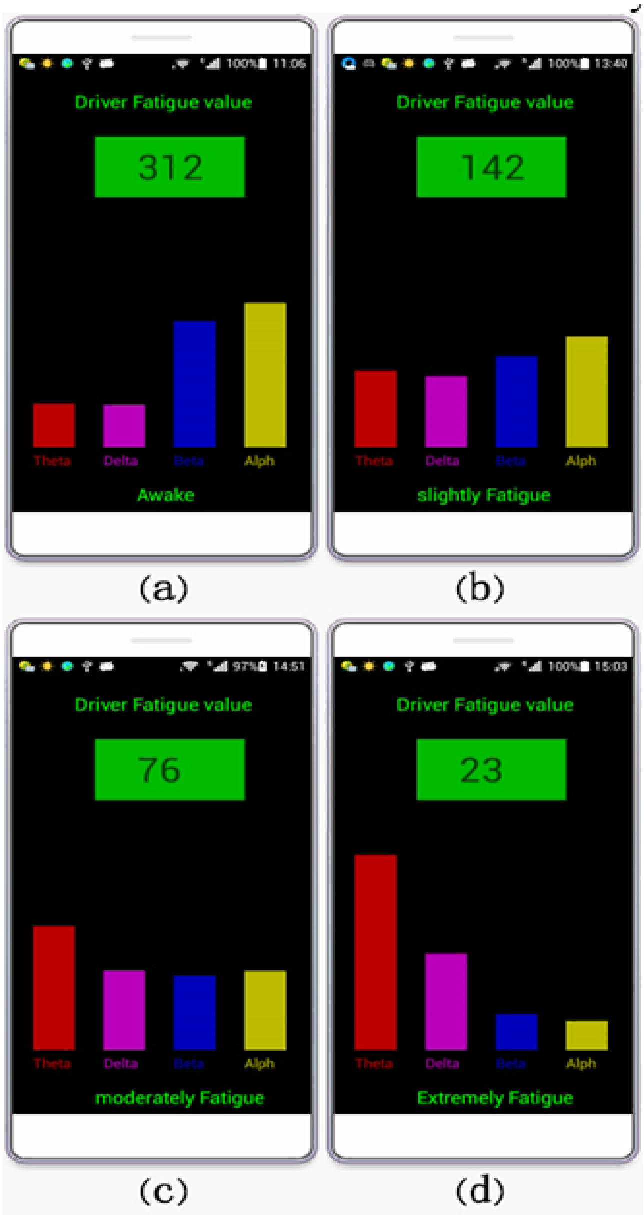

Figure 4. Cell phone display under four different conditions

Like above, Driver Drowsy value is an indicating label, showing the drowsy value. There are four energy dynamic distributions (awake, slightly drowsy, moderately drowsy and extremely drowsy) and users can adjust their reminding range according to their own needs.

The subjects carry out 2-hour EEG acquisition with acquisition equipment and there are parts of drifting EEG and invalid EEG. Besides, it takes shorter time for acquiring effective data of EEG than collecting data. Concerning the 20 subjects, the effective length shows in table 1:

Table 1. Subjects experimental parameter

Serial No.	Sex	Age	Average sleep time	annual mileage traveled(KM)	Valid data length(s)
1	male	37	8	54081	44900
2	female	38	6.5	22326	51600
3	male	26	8.5	38381	48200
4	male	39	8.5	50741	47700
5	female	34	8	63018	52800
6	male	26	7.5	67395	44000
7	male	28	6.5	41022	50600
8	female	33	7.5	14872	50600
9	male	39	8	15555	45300
10	female	39	6.5	22481	48000
11	male	27	8.5	59806	41100
12	male	40	6.5	22274	40800
13	male	39	7	58114	47400
14	female	32	7	21586	50900
15	male	37	8.5	65473	53100
16	female	26	8.5	28399	41800
17	male	31	8	18582	48000
18	male	39	7	22069	46600
19	female	37	8	45427	40200
20	female	39	6.5	36290	44700

The figure 5 shows the historical drowsy record of subject 1, including the variation tendency as well as the historical record:

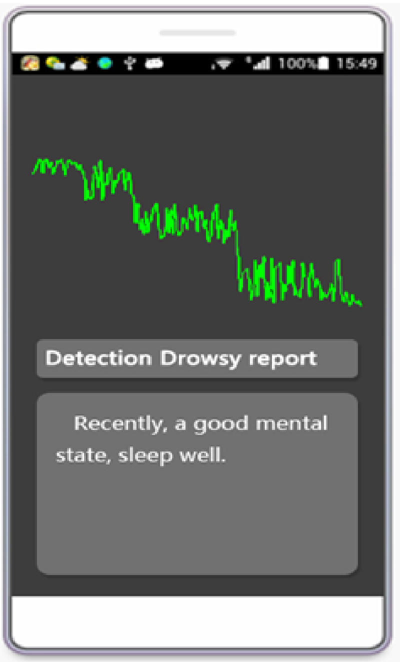

Figure 5 . Historical drowsy data of subjects

For different subjects, the rate of experimental data which is in accordance with the drowsy condition (accurate alarm), showing in figure 6.

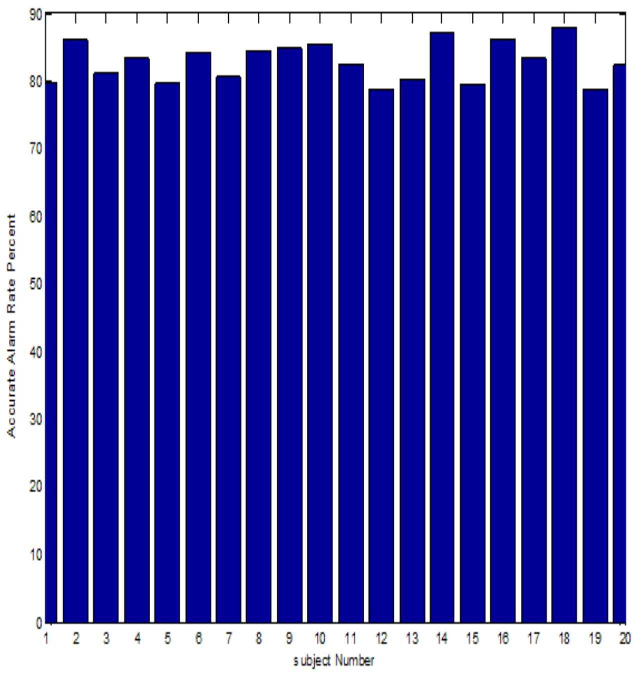

Figure 6. The accurate alarm rate of subjects

4. Discussions

Drowsy is a major factor in traffic accidents, and carrying out real-time monitoring on the drivers' drowsy condition can help to avoid vicious traffic accidents. However, the drowsy characteristics are private and different to different individuals. Therefore, in real environment, current drowsy detection methods remain to be improved. The appearance of brain drowsy directly shows in then changes of EEG. Therefore, real-time detection on the EEG can help to monitor the drowsy. This paper takes EEG as the detection subjects, adopting smart phones as the platforms to design the values in different frequency bands so as to realize the drowsy detection. The analysis on 20 subjects shows that the forecast accuracy has achieved the demand of application.

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