















### 3.4 Digital Encoding of Emotional Brainwaves

The 8 digital encoding of emotional brainwave characteristic band are shown in Table 6. The Table shows negative emotion Fear shares the same digital encoding of Surprise. Therefore, digital encoding along cannot effectively identify these two different emotions. As result, this research further proposes using highest energy sub-band to identify emotions. The result is shown in Table 7, it shows sub-band  $\delta 4$  and  $\delta 1$  of the  $\delta$  band can provides effective emotion identification.

Table 6 Digital Encoding of Positive-Negative Emotional Brainwave Characteristic Bands

Frequency Bands \ Emotions	$\delta$	$\theta$	$\alpha$	$\beta$
Joyful	0001	1100	01100	000000110
Angry	0001	1100	01110	000000110
Surprised	1001	1100	01100	000000110
Fear	1001	1100	01100	000000110
Protected	1001	1000	11100	000000110
Sad	0001	1000	11110	000000111
Satisfied	1000	1100	01110	000000110
Unconcerned	1001	1000	01100	000000110

Table 7 Comparison of Highest Brainwave Sub-band Energy of Emotion Surprise and Fear

Brainwave Frequency Bands	Surprised emotion		Fear emotion	
	the highest energy sub-band of emotional brainwave		the highest energy sub-band of emotional brainwave	
$\delta$	$\delta 4$ (3~4Hz)	0.24	$\delta 1$ (0.2~1Hz)	0.25
$\theta$	$\theta 1$ (4~5Hz)	0.24	$\theta 1$ (4~5Hz)	0.27
$\alpha$	$\alpha 2$ (9~10Hz)	0.52	$\alpha 2$ (9~10Hz)	0.60
$\beta$	$\beta 8$ (20~21Hz)	0.37	$\beta 8$ (20~21Hz)	0.38

### 4 Conclusions

This research form the perspective of cognitive neuroscience, extracts and computes the emotional brainwave energy using brainwave sensor. The emotional brainwave energy data are further analysis and characterize for different emotions. The

experiment use medical acoustic stimuli to stimulate brainwave responses of different types of positive and negative emotions. The experiment shows among 4 pairs of positive and negative emotions (Joyful-Angry、 Surprised-Fear、 Protected-Sad、 Satisfied-Unconcerned), all negative emotions have a greater energy compared to the positive emotion. There are three pairs of characteristic band encoding carry distinguishable difference and can be effectively identify through emotional brainwave digital encoding. However, the positive and negative emotion of Surprise and Fear shares the same emotional brainwave characteristic digital encoding and using the proposed highest energy brainwave sub-band comparison scheme can resolve these two different emotions effectively. The research shows the processed brainwave characteristic band digital encoding technique and highest sub-ban energy scheme can effectively identify brainwave of 8 types' positive and negative emotions.

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