

Mindtrack: Using Brain-Computer Interface to Translate Emotions into Music

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Introduction

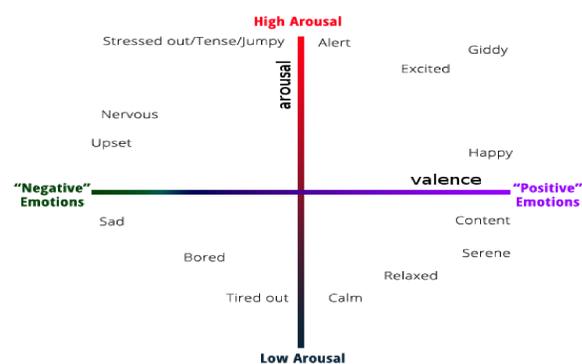
Brain computer interfaces (BCI) read brainwave data from a user, allowing them to be used in a range of mind controlled applications, such as brain drones. This work describes the Mindtrack system, which uses a BCI device to translate emotion driven electroencephalography (EEG) data into music.

Approach

Using a commercially available BCI device, emotional valence and arousal were calculated using the following formulas:

$$arousal = (\beta_{AF3} + \beta_{AF4}) / (\alpha_{AF3} + \alpha_{AF4})$$
$$valence = \beta_{AF4} / \alpha_{AF4} - \beta_{AF3} / \alpha_{AF3}$$

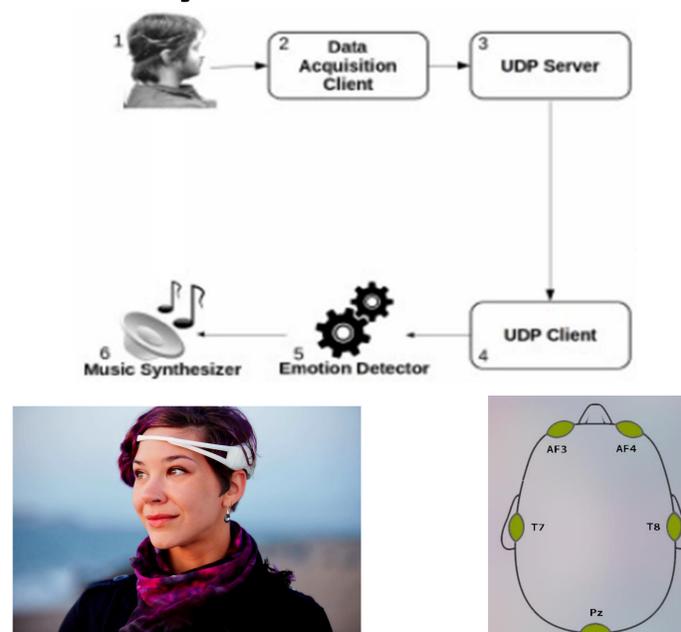
The valence and arousal levels were then mapped to various components of music created by the user.



Methodology

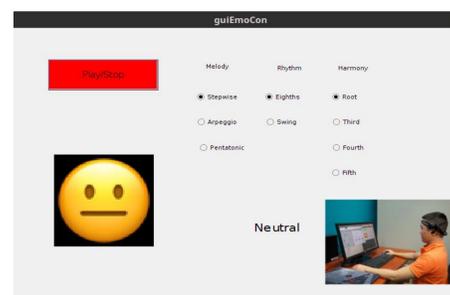
- **EMOTIV Insight:** five dry electrodes (AF3, AF4, T7, T8, Pz).
- **Data Acquisition Client:** translate raw EEG from BCI into brain waves.
- **User Datagram Protocol (UDP) Server:** broadcast brainwave data in real time.
- **UDP User Datagram Protocol Client:** receive broadcast data.
- **Emotion Detector:** calculate arousal and valence from brain waves to recognize emotions.
- **Music Synthesizer:** decide tempo and key signature; user puts on headset, selects melody, harmony, and rhythm.

System Overview



Results

- Alpha and beta waves for AF3 and AF4 used for emotion detection.
- Five degrees of emotions readable in the system: very sad, sad, neutral, happy, very happy.
- Valence and arousal values (vary among individuals), calculated and interpreted to construct musical elements.
- User selected melody (stepwise, arpeggio, or pentatonic) rhythm (swing or eighths), harmony (root, third, fourth, fifth, sixth).
- Valence mapped to melody, rhythm, harmony.
- Valence decided key signature; arousal was mapped to tempo



Conclusions

Mindtrack was effectively able to be used to translate emotions into music with minimal latency. This provides a significant amount of promise for BCI to be used in an emotional and musical context.

Future Work

- Allow individuals with physical limitations to create music and express themselves.
- New instrument that can be played recreationally.
- System modifications to allow for different instruments, harmonization, and rhythmic variation based on emotion.
- Expand amount of emotions that can be interpreted with BCI devices.
- Create soundscapes rather than a solo instrumental track.

References

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