Wrist-Wearable Anxiety Detection and Monitoring with Calming Techniques

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Anxiety is one of the most common mental disorders with the prevalence of anxiety symptoms rising each year [1], and these symptoms can have severe consequences of they persist, such as concentration problems [2], panic attacks, and depression. Studies show wearable technology can be a promising tool for detecting anxiety [3] and facilitating the implementation of a known control mechanism to reduce anxiety [4]. However, there are no consumer-tailored wrist sensors that can directly monitor and help mitigate anxiety. The Apple watch and other related smart watches that can track heartrate and other biometrics are mainly the only products available for consumers to measure stress. However, these watches come with limitations to monitoring stress such as mainly measuring stress through heartrate [5], not determining what kind of stress the body is going through, and only plotting the data on a graph that the user must monitor and interpret [6]. Even when a person can detect their anxiety levels rising, it is easy to forget their calming strategies in the moment of panic. Therefore, there should be a device for a common person to use that automates the detection of anxiety while incorporating mitigation strategies.

To detect common anxiety symptoms such as increased heart rate, shortness of breath, tension, and shakiness [6], we will develop a wrist wearable device that can measure heart rate, blood oxygen, muscle tension, and shakiness. The data from these sensors along with input from the user can be used to train artificial intelligence to recognize trends and signs of rising anxiety. When anxiety is detected, the device will buzz, notify the user's phone of the trend it is noticing, and provide mitigation strategies for them to try. The user can then give feedback to the phone to tell the artificial intelligence whether the strategy worked or not for the future. The feasibility of

this device is supported by the implementation of photoplethysmography, accelerometer, gyroscope, and thermometer sensors in smart watches to monitor biometrics along with sEMG sensors used in healthcare and pressure sensors to measure muscle tension. Thus, analyzing all the data from the sensors above with machine learning is expected to detect trends of anxiety symptoms to enable the start of the mitigation strategies. This will ultimately help the user identify and mitigate their rising anxiety to help prevent any future implications.

The objective of this device is to accurately detect rising symptoms of anxiety and provide effective calming strategies to the user.

- **Aim 1**: Make a comfortable wrist device that 1) measures and detects anxiety symptoms with biometric sensors and machine learning and 2) notify the user about their anxiety while recommending calming strategies.
    - *Aim 1a*: Use photoplethysmography, surface electromyography, piezoelectric pressure, accelerometer, gyroscope, and thermistor sensors to measure common anxiety symptoms. The layout of the sensors should be designed in a way that is comfortable for the user. Use a real-time deep learning model to interpret the measurements gathered above through trends and patterns and detect symptoms of rising anxiety. The device will then buzz to when it detects the symptoms of rising anxiety.
    - *Aim 1b*: An application will notify the user on their phone about their anxiety when the device notices an anxious state through Bluetooth. It will be created to allow the device to send this notification, showing what the sensors are reading. This should all be in a user-friendly format. The application will recommend

calming strategies with user feedback through machine learning to make it customizable for the user.

- **Aim 2**: Validate the effectiveness of the device by 1) ensuring the correctness of detecting anxiety and 2) the recommendations provide help to the user.

    o *Aim 2a*: At least ten participants will wear the device and be given a paper test with equations to solve. They will be timed, and the fastest person will be given a reward to increase the stress of the situation. Afterwards, they will be asked to rank their anxiety levels and if the device buzzed when they felt an increase in stress and anxiety. The same ten participants will undergo another test where they do nothing for 10 minutes. They will be asked to rank their anxiety levels again and if the device buzzed at all during the ten minutes.

    o *Aim 2b*: Another ten participants will be asked to use the application for a week. When the participants feel their anxiety increasing, they will be asked to use the application to calm them. After the week, each participant will be asked if the application helped them calm their anxiety.

The proposed project is in response to NIMH's strategic plan to bring knowledge to practice, improvements to services, and better outcomes to individuals. Completing the proposed aims will introduce a new everyday wearable tool to detect anxiety symptoms for people to mitigate through calming strategies. Ultimately, this device will help people overcome their anxiety before it turns into long term stress or panic attacks, improving quality of life and happiness.

References

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