Gamifying Fidget Stick and Physiological Sensors for Human Stress Management

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ABSTRACT

Maybe it's morning traffic gridlocks, demanding boss, relationship problems, or even a global warming issue. Whatever the cause, it's likely we all experience some level of stress daily.

Stress can be described as a feeling of anxiety and physical tension occurring when demands placed on someone to exceed their abilities to cope or is an event that makes an individual frustrated, angry, or nervous. Although there are technologies that have made contributions towards the wellbeing of humans, current devices are bulky, clinical professional-centric, and most importantly not common user friendly.

There are many stress-relieving gadgets (Example: Fidget Stick, Cube Spinner, Stress Ball, etc.) available in the market and they have also shown good results in reducing individuals' stress levels.

The objective of this study is to leverage one of the stress-relieving gadgets, Fidget Stick and add quantifiable intelligence to help users to identify their current stress level and guide users with gamification based tangible interactions to reduce their stress.

During this study, I tried integrating fidget stick with heart and galvanic skin sensors to gamify quantification of human stress detection and reduction. The initial test result shows a good amount of potentials with this integrated device. This device can become a personal digital stress management device for anyone with stress and anxiety issues.

Author Keywords

Human anxiety and stress detection; Assistive technologies; Fidget stick-based stress detection; Sensor-based human stress detection;

CSS Concepts

Human-centered computing; Human computer interaction (HCI); Interaction design; Tangible interaction; Haptic devices; User studies;

INTRODUCTION

Stress is commonly defined as mental strain and pressure. There is evidence that stress is linked with many diseases, playing a crucial role in the development of cardiovascular diseases, diabetes, or asthma, and it also significantly influences the later course of these diseases. If stress could be reliably and automatically identified, this could directly help users manage stressful situations, and it could also be used in medical intelligence applications, for example, in refining blood glucose predictions for diabetics during daytime under influence of stress. However, the available methods for automated stress detection based on low price, ubiquitous sensors, are yet immature.

There are many stress-relieving gadgets or toys are available in the market and they have also shown good results in reducing individuals' stress levels. In general, people are very comfortable carrying and using these stressbuster gadgets. However, most of these gadgets have not shown any quantifiable intelligence before and after human interaction in the stress level.

Following design goals are considered for this study:

- Exploring fidget gadget based interactive personal - assisting device to help individuals to learn and relive personal stress level
- Educating individuals about their stress and mental health in the most interactive and user-friendly way

BACKGROUND RESEARCH

There are many ways to identify human stress and potential solutions to relieve stress too. However, my primary objective of this research was to identify and quantify the most simplified human-centric methods. I did initial research to get a more detailed understanding of following broad level aspects:

- Psychological and emotional sign of stress

- Simplified scientific methods to confirm the human stress
- Identifying an existing tangible device

Psychological and emotional sign of stress

Some of the psychological and emotional signs show that any human being is stressed out include Depression or anxiety, anger, irritability or restlessness, feeling overwhelmed, unmotivated or unfocused, problems with memory or concentration, etc.

Similarly, some of the effective stress relievers include meditation, yoga, socializing or connecting with people, getting enough sleep, eating a healthy diet, etc.

Scientific methods to confirm the human stress

Biodot

I found the most simplified stress identification method is Biodots. Biodots are a great way to begin. Biodots measure stress in the body by monitoring blood flow. Put them on the back of the hand to sense body temperature. The more blood flow through the body, the more expanded blood vessels, the less stress.

The less blood flow, or colder body temperature associated with blood vessel restriction/contraction, the higher the stress response or greater level of stress the individual is experiencing. The dots change color depending on body temperature.

A color-coded key accompanies the dots and explains the color associated with each stress level.

Table 1. Biodots and color-coded stress feedback.

These little dots are not only fun but are an excellent biofeedback visual tool to help children monitor their stress response. As you repeatedly use these dots at varying stress levels, this enhances mind/body awareness too. Also, Biodots has the most simplified adaptation in the product form. Biodots cards are simple visiting card size stress detection tools available for a quick and easy way to identify human stress. Most importantly, Biodots are very cost-effective. Biodots-based cards neither require any external power supply to view human stress level nor product usage training.

They are easy to carry and store in any place. Biodots cards support personalization and specific branding too. Nowadays, many healthcare service providers, clinics, insurance companies distribute Biodots cards to their patients, and customers free of cost.

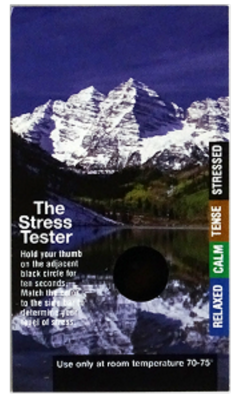

Figure 2: Biodots card.

The Stress Thermometer

The another most cost-effective scientific method is Stress Thermometer. The Stress Thermometer a physical device allows you see changes in your hand temperature, which is a reflection of your blood flow and a measure of your stress response.

Figure 3: The stress thermometer.

When we're stressed, tiny blood vessels under our skin constrict, and the flow of blood is redirected to our major muscles and internal organs. This is why our hands feel cold when we are under stress. The blood has been rushed away from our fingers, to the more vital parts of our body because of the fight-or-flight response.

Hand temperatures can range greatly, from a low of 60° to as high as 99° F. When you're stressed, 5° changes can take place in seconds.

Below 79°F	79-84°F	84-90°F	90-95°F	Over 95°F
Below 26°C	26-29°C	29-32°C	32-35°C	Over 35°C

Highly Tense	Tense	Calm	Relaxed	Deeply Relaxed

Figure 4: Stress thermometer's color-coded stress feedback.

The basic rule for interpreting our temperature change is simple, **"Cold hands are tense, warm hands are relaxed."**

There are few web-based tools also offers phycological personalized assessment to identify human stress level.

Mystresstools.com

Mystresstools.com is a responsive web-based tool available on Desktop, tablet, and mobile and helps us understand the root causes of our stress and gives us various tools we need to rise to the challenge of living well in a sometimes-stressful world.

An existing tangible stress identification device

When I was looking for any reference for an interactive tangible device concept for human stress level identification, I found a few concepts which are trying to identify human stress level in the innovative and most interactive way. One of the interesting concepts designed by Simone Schramm, The interactive Stressball.

The interactive Stressball

The interactive Stressball determines a user's stress level by measuring the skin conduction with an external sensor. The value is translated into a physical transformation of its spherical surface – the change oscillates between a smooth and a rough texture.

Figure 5: The interactive Stressball by Simone Schramm.

By touching the surface, the measurement can be experienced in a haptic way. The transformation is created by miniature nobs, which move out the ball's surface. The length of the nobs reflects the intensity of the stress level.

Through actively touching, pressing or stroking the object, the user quickly starts to sharpen his or her tactile perceptual capacity and to associate different surface conditions with his or her stress level. When the colored nobs expand, their movement changes the unicolored surface into a multicolored sculpture.

The interactive Stressball project has lots of potential, however the overall size of the prototype makes this more restricted, conceptual and lab-oriented device only than personalized stress management device.

CONCEPT DEVELOPMENT

Since the primary focus is designing a personalized interactive stress detection and reliver device, I started exploring couple of fidget gadgets along with physiological/biochemical sensors. The initial concept is to integrate one of the identified fidget toys and physiological/biochemical sensors to offer gamified, tangible interactions for stress detection and stress reliving activities.

Fidget stick

In my initial research, I found that there are many stress relieving gadgets available in the market and they have shown good results in reducing individuals stress level. In general, people are very comfortable carrying and using these stressbuster gadgets. However, most of these gadgets have not shown any quantifiable intelligence before and after human interaction in the stress level.

Fidget is a toy that is being promoted for helping people to focus or those who fidget to relieve nervous energy, anxiety, or psychological stress. It is claimed that these toys can help calm down people who have anxiety and other neurological disorders.

Fidgets come in all different shapes, sizes, and textures and are often referred to by various names. Stress balls, cube, sticks or tangles can all be used as fidget toys to promote movement and tactile input that is critical for anyone who is dealing with personal stress and anxiety issues.

For this study, I have used fidget stick, the one which has become very popular fidget tabletop toy for play because of ergonomic advantages such as size, share, weight and most importantly simplicity.

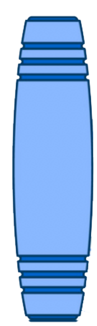

Figure 6: Typical fidget stick toy, which is available in the various form like; wood, plastic, etc.

Interacting with Fidget stick

Stand it the stick vertical on a hard surface or tabletop. Gently knock it down and it will flip a couple of times before it stops. You can also spin it horizontally. Turn a few more if you want to try more complicated tricks.

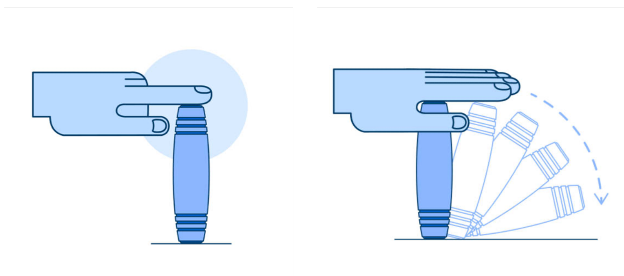

Figure 7: Common interactions with Fidget stick. Tap, flip, roll and spin.

Physiological biochemical Sensors

One approach to measuring stress involves using various physiological and biochemical measures including blood pressure, heart rate, galvanic skin response, respiration rate, and increase desecration of stress hormones such as cortisol and epinephrine. These changes with activation of the sympathetic division of the autonomic nervous system. Stress and emotion produce changes in these physiological indexes. The hormones epinephrine and norepinephrine are produced in the adrenal medulla in association with the experience of stress. Measurement of these two hormones in either blood or urine samples can provide an index of stress. Having these measurements taken may be a stressful experience that can interfere with the assessment. However, the advantages of such physiological measures of stress are that they are direct, highly reliable, and easily quantified.

Also, clinical research has demonstrated that heart rate variability (HRV) is one of the most reliable indicators of stress. When HRV levels are high, a person experiences low levels of stress and greater resiliency. When HRV levels are low, this is an indication of greater stress and lower resiliency HRV is the variation in the time interval between one heartbeat and the next. HRV can be assessed by measures of variance in beat-to-beat intervals over time (called time-domain analysis) and by methods involving time series analysis that dissert continuous beat-to-beat intervals into high and low-frequency components.

For this study, I had particularly used Galvanic Skin Response (GSR) and Pulse Rate sensors.

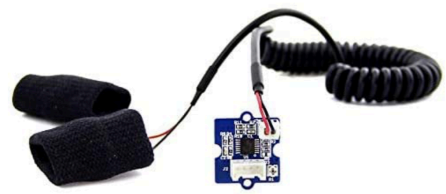

Figure 8: Galvanic Skin Response (GSR) sensor

Galvanic Skin Response (GSR) sensor helps to measure the electrical conductance of the skin. It can also be used to reflect the human emotional activity. When people are emotionally stressed or have strong expressions on the face, sympathetic activity increases and promotes the secretion of sweat glands, which increases the skin's electrical conductivity.

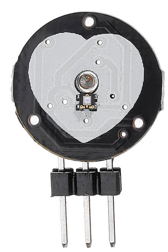

Figure 9: Pulse Rate Sensor

A pulse rate sensor is designed to give the digital output of heat beat when a finger is placed on it.

PROTOTYPING

For integrating both sensors, Galvanic Skin Response (GSR) and Pulse Rate sensor with Fidget stick, I used Arduino UNO, an open-source microcontroller board.

In the concept prototyping setup, I did place both sensors in a way that while performing fidget stick tricks, sensors would touch human finger and skin.

Galvanic Skin Response (GSR) sensor integrated with Arduino UNO to measure the electrical conductance of the skin and that can be concluded into human stress identification. Similarly, Pulse sensor would detect human heart rate variability (HRV) during the stress out of the situation.

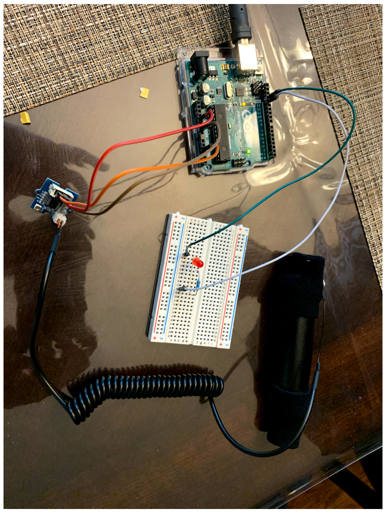

Figure 10: Arduino UNO and Galvanic Skin Response (GSR) integration

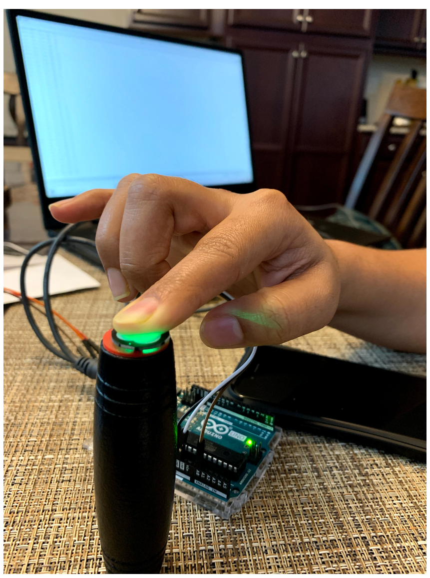

Figure 11: Arduino UNO and Pulse Rate Sensor integration

DISCUSSION

This study was based on developing a tangible interaction model for users to learn about their stress levels and overcome it. The primary objective of this study to build a conceptual tangible interaction model using an Arduino UNO circuit and adding Galvanic Skin Response (GSR) sensor and Pulse Sensor with integration with fidget stick toy to see how a user interacts with this model during the stress time to learn more about stress and their efforts to reduce stress. As other fidget-based research studies proven that fidget toys are helping in reducing the human stress level, I too observed before and after fidget activity stress variation with help of pulse and skin electrical conductance sensors.

Future plans involve adding a digital screen or haptic capabilities to the fidget stick so that users can get confirmed feedback about their stress levels and stress-relieving activities. Also, another objective is to make a fidget stick completely wireless for better movability.

I will be focusing on maintaining the natural shape, and size of the proposed device so that the user can adopt this device in any user environment.

Further, I am planning to conduct formal usability testing with an identified user group to get more insights. These user findings would be included in the refined product version.

CONCLUSION

Physiological signals such as GSR, Pulse, can be successfully employed to detect users' stress when using computing devices and applications. However, each physiological sensor has its weaknesses, usage limitations. For the actual accuracy of results, it is recommended to use multiple (a combination of many) Physiological sensors to detect and conclude human stress.

Making user-friendly medical devices are always a demanding and challenging task. Manufactures of physiological sensors need future considerations about human-specific device usage patterns and other possibilities while designing and crating sensors so that it will help designers and application developers to include sensors in more human-centric objects that users would not be hesitant to use.

Recent years are bringing an increasing number of sensor-based integration concepts: sensors have been included in commercial devices such as the Samsung Gear S and the Apple Watch are able to measure users' HR and EDA in real-time. However, these sensors are currently limited to fitness activity tracking, future and more sophisticated versions of these devices will likely be used to accurately detect users' stress and emotions.

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