BioBrace VR: Bio-Interactive Device with Personalized Avatar Therapy for SUD

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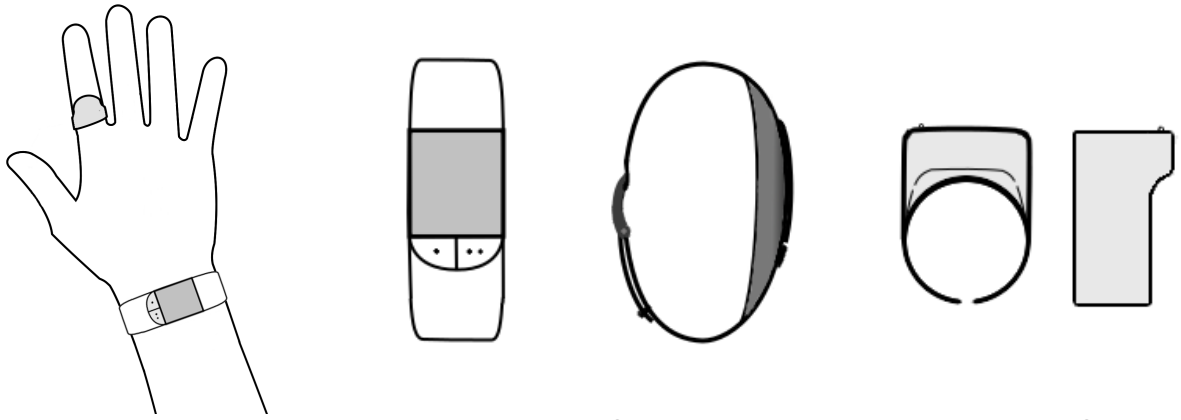
1. Research Idea

In 2013, an estimate of 127,000 casualties was attributed to substance use disorder (SUD). Multiple efforts to mitigate SUD rates have been considered, where therapy has shown significant promise. We enter this challenge with an optimistic attitude and propose a product that has a path for commercialization and further research appertaining to SUD. The product is referred to as **BioBrace VR**—a set of interactive sensors coupled with a personalized and intelligent virtual health avatar, aimed at reducing SUD rates and promoting healthier lifestyles by understanding the user's neurobiology.

The BioBrace VR ecosystem, as illustrated in Figure 1, is comprises of two components: a wristband and a ring. The wristband, as shown in Figure 1b, is an interactive biosensor device that works not only by collecting data as conventional bio-health wearables do but also with 3D environments, in particular virtual environments (VEs) that mitigate SUD through embodied conversational agents (ECAs). Along the same lines, the ring, as shown in Figure 1c, provides supplementary interaction capabilities to the wristband. Such capabilities include but are not limited to finger tracking and tactile feedback in 3D settings. The VEs are based on Web, mobile, desktop platforms, virtual reality (VR) headsets, and augmented reality (AR) glasses.

Our proposed research zeroes in on providing BioBrace VR as a cost-effective, practical, and engaging solution for all perspective users. BioBrace VR promotes a better understanding of a user's neurobiology. This is to be accomplished by the various sensor readings when operating in idle mode but also in an interactive mode when interfaced with different 3D VEs, including but not limited to ECAs. The "Brace" is to contain motion sensors (accelerometer, gyroscope, and magnetometer), galvanic skin response (GSR), humidity sensors, and electrocardiograph (ECG) sensors, among others. While the motion sensors provide an entertaining experience with VEs, the GSR, in conjunction with the aforementioned sensors, provides bio-readings that are useful to understand the users' neurobiology. Furthermore, all the sensors provide a dual use case—interaction and biodata. This is because GSR, an excellent stress and affective state predictor, can indicate to the ECAs the user's affective state while providing analytics for later diagnoses.



(a) Wrist band and Ring (b) Wrist Bio-Sensor Band (c) Bio-Ring Sensor

Figure 1: Bio Sensors

2. About The Team

BioMagic VR, Inc. is a recent filed corporation in the state of Florida (9/16/2016) with the purpose of working on biotechnology for SUD. The leading founders are Drs. Ortega and Barreto. All the founders are listed below.

Dr. Francisco R. Ortega is currently a Visiting Assistant Professor at Florida International University (FIU). He received his Ph.D. in Computer Science in 2014, co-advised by Dr. Naphtali Rishe and Dr. Armando Barreto. He has several publications, as well as a couple of books. His areas of expertise include 3D user interaction, wearables, and affective computing.

Dr. Armando Barreto is a professor in the Electrical and Computer Engineering Department at FIU. He has applied concepts of digital signal processing to the enhancement of User-Computer Interfaces, having developed computer interfaces based on electroencephalogram, electromyogram, eye gaze tracking, etc. He has authored or co-authored over 150 technical articles.

Mr. Jules Callela is a master's student with a Bachelor's in Electrical Engineering. He has been working for several years with embedded, wearables systems, biosensors, and motion sensors.

Mr. Alain Galvan is graduating December, 2016 with a Bachelor's in Computer Science. He has been working with computer graphics and software development for over 4 years.

Mr. Santiago Bolivar is currently pursuing a Bachelor's in Computer Science and has been working with Affective Computing for 3 years.

3. The Idea: BioBrace VR

A multitude of sensors that are low-power, small-profile, and simple-to-implement in small devices have become pervasive in recent years. Each of these sensors can provide data that can be used to monitor a person's bio-readings and additional information (e.g., motion sensors) to infer their neurobiology. Through the combination of sensors and the current state-of-the-art in virtual environments (e.g., avatars), a richer user experience will mitigate SUD rates.

Our solution includes 3D user interaction, embodied conversational agents, biosensor wearables, and the need to provide multiple options to mitigate the potentially deadly consequences of substance abuse disorder. Furthermore, our project concentrates on including low-cost devices for direct-to-consumer purchase while keeping more advanced options for medical and research facilities. BioBrace VR is composed of two major components: The wearables (e.g., brace and ring sensor) and the personalized virtual health avatar.

The **"Brace"** (as shown in Figure 1b) is a low-cost device, which includes (depending on the version) the following sensors: motion sensors (accelerometer, gyroscope, magnetometer), galvanic skin response (GSR), humidity sensors, and electrocardiograph (ECG), photoplethysmograph (heart rate), electromyogram (EMG), temperature sensor, and sweat sensor, among others. The closest device to our approach is called Empatica™. However, the Empatica™ solution differs from BioBrace VR in the following aspects: (1) Our device is meant for real-time interaction with VEs while theirs is only meant to obtain bio-readings; (2) Our device is to cost less than $100 dollars once manufactured (for the entry-level model), while theirs costs around $1600 to $1800 per unit; (3) Our project includes additional sensors, such as the Bio-Ring (as shown in Figure 1c). Other devices that may compare to our idea are the

FitBit™ and the Apple Watch™. However, these devices are not designed for real-time interaction and their cost is much higher.

The virtual health avatar, as shown in Figure 2, provides the second component of BioBrace VR**.** It allows the system to interact with the users and provide feedback, depending on their neurobiology using the non-intrusive sensors as well as other cues, which may be captured from a mobile system or desktop computer. The primary reason to include the virtual health avatar stems from the observation that ECAs can provide a complimentary value to therapy. Our solution is to bring avatars out of the research labs into households.

ECAs will help the user not only by providing feedback from data collected, but also by serving as companions with user-interaction capabilities. Many users lack the ability or the means to afford a therapist for a continuous and meaningful treatment. By having a virtual health companion, the users can positively improve their mood and overall health. In addition, the virtual companions can serve as an additional tool for the user and the therapist in environments where patients can afford specialized care.

Users will be able to select its preferred companion. The users will be able to interact with the ECA using the BioBrace VR and additional sensors that their system may already have but are not required (e.g., Cameras). Our sensors are designed for real-time interaction (while still able to record data for subsequent offline analysis). The selected avatar will assess feedback and possible ways to improve the current state using real-time biodata. Our system will use personalized avatars based on user's preferences to promote empathy and trustworthiness. In addition, BioBrace VR will have strict privacy controls to protect user's information.

In addition, we will also provide an application-programming interface (API) for other developers to create interactive systems with or without the avatars, in order to allow a larger eco-system of applications. This is very important because our device can be used for interactive games or other applications, including VR and AR devices.

Use case scenario: A treatment center provides a BioBrace VR to the user. She is encouraged to use the ECA as part of her daily treatment. The BioBrace VR reads the current affective state of the user; it provides feedback to the user. Over time, the user's data is also analyzed by the health professionals to better understand different triggers and her neurobiology. The user continues to use device and avatar once treatment is completed.

Figure 2: Embodied Conversational Agent – Virtual Health Companion.

4. Market Research and Commercialization Path

The critical step for the success of ***BioBrace VR*** is to create a market analysis to understand the path of commercialization. Based on the current understanding of the market, we believe that our direct customers would originate from three different segments (1) end-users; (2) medical and treatment centers; and (3) researcher facilities dealing with SUD (e.g., Crusada[1] at Florida International University).

The end-user will find our solutions affordable, thus providing an incentive to buy them post-treatment for relapse prevention. Reaching out this customer segment may prove to be difficult unless it is by referral of various treatment and health providers. Bio-Brace VR will come in different flavors, but the standard version will cost less than existing smart watches; additional features will be made available for additional rates. Hospitals and treatment centers are to act as intermediaries between these facilities and end users. In many instances (as it has been the case for Crusada[1]), great deals of SUD-affected individuals come from low socioeconomic backgrounds. Therefore, providing a cost-effective, multipurpose solution will incentivize these types of facilities to purchase many BioBrace VR. For instance, Dr. Mario de la Rosa, director of Crusada at Florida International University, has shown positive interest in our proposed solution. He mentions that affordability is of utmost concern for his center, as great deals of SUD-affected individuals are cared for in his center from Miami-Dade County and nearby areas. It is expected that our product will reach non-profit organizations and other interested institutions for the same reasons that Crusada stated.

An important aspect of BioBrace VR is that it can be an over-the-counter product. Our market research will use 80% of the funds awarded by the SUD challenge. We will contact various institutions, such as treatment centers, hospitals, and mental health facilities in order to gather information about their needs and see how our solution is to improve their lifestyles as a whole. We will also utilize our contacts at Florida International University and Florida Atlantic University to reach other professionals and non-profit organizations. While our initial contacts will be in the area of South Florida, we intend to extend to other areas and potential partners through network contacts and social networks, such as LinkedIn.

Through the early stages of our project, we have validated the sensors in pilot studies where the results have been positive, with user's feedback stating that using two braces will provide a better experience versus one of them. Our current assessment also takes into consideration the state-of-the-art of ECAs that have shown promise in mitigating SUD and other health disorders. In particular, studies have shown the benefits of having ECAs as companions, using the bio-readings from sensors.

In summary, we propose BioBrace VR — a cost-effective, and marketable, wearable solution with bio-signal tracking capabilities in 3D environments, aimed at diminishing SUD rates through their interface with virtual health assistants. We discussed our methodologies for development and market analysis. This team expects that through the manufacture and commercialization of BioBrace VR, prospect client organizations will effectively serve the communities affected by SUD and that end prospective will be able to enrich their interaction with 3D environments through the development resources that will be made available to foster research and creativity.

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[1] http://www.crusada.fiu.edu