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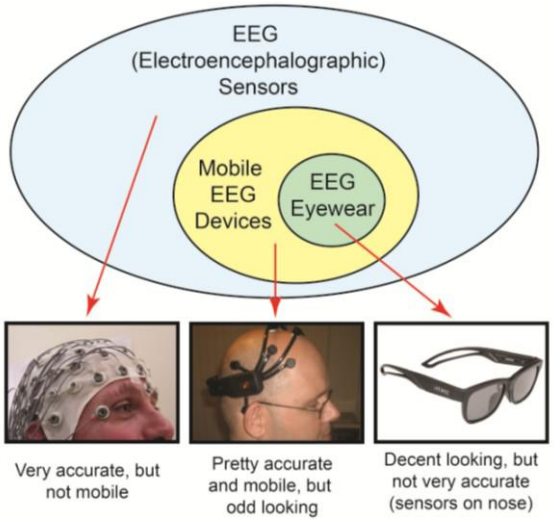
Medibotics Mobile Brain Activity Monitoring Devices including EEG Eyewear and Sleepwear



Medibotics is developing mobile brain monitoring devices, including eyewear with electroencephalographic (EEG) sensors for use during daily life and soft headbands with EEG sensors for use during sleep. EEG eyewear enables brain activity monitoring during daily life in a form which is less non-obtrusive than current device options. EEG eyewear can function as a Brain-to-Computer Interface (BCI) for communication, medical/health, entertainment, and sports/fitness applications. In addition to numerous consumer electronics applications, EEG eyewear also has potential medical applications which may dramatically improve the quality of life for people with certain conditions. For example, EEG sensors in eyewear may enable real-time detection and prediction of epileptic seizures to enable preventative measures and improve the quality of life for people with epilepsy.

Approximately 50 million people worldwide have epilepsy. In the U.S. alone, 3.4 million people have epilepsy, with 1.2 million having uncontrolled seizures despite medication. Seizures, including their unpredictability, lower quality of life[1-7]. Seizure prediction can reduce fear, prevent accidents, and enable better seizure management and prevention. A wearable device which can predict seizures during daily life would be particular useful[8-13]. Per focus groups, people with epilepsy want a discreet wearable for everyday use to predict seizures[14-16]. The medical and engineering literature indicates that detection and prediction of seizures is feasible[17-37]. EEG monitoring in a medical office with an array of wet electrodes is accurate, but not mobile. There is evidence that non-eyewear mobile EEG can detect seizures, but the devices used tend to be too odd looking for everyday use. There is an unmet need for reasonable-looking EEG eyewear to improve the quality of life by predicting, detecting, and possibly preventing seizures. Medibotics' prototype has not yet been used to predict seizures, but there is evidence in medical and engineering literature that this may be possible (Biswas et al. 2015).

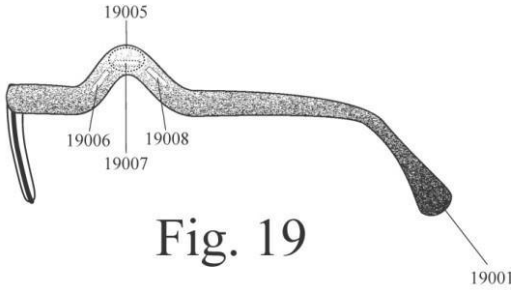


Fig. 19

Medibotics solution to this need is EEG eyewear with dry EEG sensors on arcuate side frames which contact sides of the forehead ultimately for real-time detection and prediction of epileptic seizures. Thus far, our prototype has had success in enabling a wearer to toggle a binary switch by changing their thought patterns. Medibotics' work on incorporating EEG sensors into eyewear started with patent applications and has progressed to sponsoring teams of engineering students at a local university for prototyping and was selected for a business pitch competition at the Mayo Clinic in 2018.

Medibotics IP portfolio for mobile EEG devices includes: patents 9,814,426 "Mobile Wearable Electromagnetic Brain Activity Monitor"; 9,968,297 "EEG Glasses (Electroencephalographic Eyewear)"; and 10,234,942 "Wearable and Mobile Brain Computer Interface (BCI) Device and Method"; publications 20160120474 "Wearable Device for the Ear with Electroencephalographic and Spectroscopic Sensors"; and 20160345901 "Wearable Brain Activity Monitor"; application 16022987 "Wearable Brain Activity Device with Auditory Interface"; and provisionals 62796901 "EEG Eyeglasses (Eyeglasses for Sensing Electromagnetic Brain Activity)" and 62791838 "Brain Monitoring Headband or Frame With Elastic and/or Stretchable Portions to be Worn During Sleep."

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Medibotics

EEG Eyewear for Predicting Epileptic Seizures

1. What Problem Are We Solving?

►Uncontrolled Epilepsy:

50 million people worldwide have epilepsy. In U.S., 3.4 million have epilepsy, with 1.2 million having uncontrolled seizures despite medication. Seizures, including their unpredictability, lower quality of life. [1-7]

► Opportunity to Improve Lives:

Seizure prediction can reduce fear, prevent accidents, and enable better seizure management and prevention. Wearables for daily living particularly useful [8-13]

2. What is Our Solution?

► **Demand for Unobtrusive Monitoring**:

Per focus groups, people with epilepsy want a discreet wearable for everyday use to predict seizures [14-16]

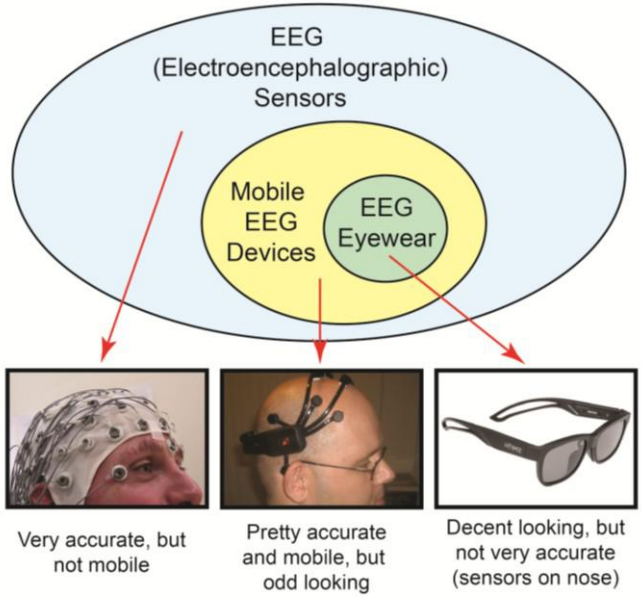
►**Seizure Detection and Prediction is Possible**:

Detection and prediction of seizures is feasible [17-37]

►**Medibotics' Solution:**

Eyewear with EEG sensors on sides of arcuate frame for real-time detection and prediction of epileptic seizures. Not yet tested for epilepsy, but success toggling binary switch by changing thought patterns.

Current Competitive Landscape:



This is our design.

(12) **United States Patent**
Connor

(10) **Patent No.: US 9,968,297 B2**
(45) **Date of Patent: May 15, 2018**

(54) **EEG GLASSES (ELECTROENCEPHALOGRAPHIC EYEWEAR)**

(71) Applicant: **Robert A. Connor**, St. Paul, MN (US)

(72) Inventor: **Robert A. Connor**, St. Paul, MN (US)

(73) Assignee: **MedItuitex LLC**, St. Paul, MN (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days. days.

(21) Appl. No.: **15/464,349**

(22) Filed: **Mar. 21, 2017**

(65) **Prior Publication Data**

US 2017/0188947 A1 Jul. 6, 2017

Related U.S. Application Data

(63) Continuation-in-part of application No. 15/136,008, filed on Apr. 24, 2016, and a continuation-in-part of application No. 14/562,719, filed on Dec. 7, 2014, and a continuation-in-part of application No. 14/330,649, filed on Jul. 14, 2014, said application No. 15/136,948 is a continuation-in-part of application No. 14/599,522, filed on Jan. 18, 2015, which is a continuation-in-part of application No. 14/562,719, filed on Dec. 7, 2014, said application No. 14/330,649 is a continuation-in-part of application No. 13/707,935, filed on Mar. 12, 2013, now Pat. No. 9,456,916, and a continuation-in-part of application No. 13/525,719, filed on Jun. 14, 2012, now Pat. No. 9,042,588.

(60) Provisional application No. 62/490,667, filed on Dec. 6, 2016, provisional application No. 62/322,594, filed on Apr. 14, 2016, provisional application No. 62/305,126, filed on Mar. 3, 2016, provisional application No. 62/189,661, filed on Jul. 2, 2015, provisional application No. 62/140,372, filed on May 12, 2015, provisional application No. 62/089,484, filed on Dec. 9, 2014, provisional application No. (Continued)

(51) **Int. Cl.**
A61B 5/04 (2006.01)
A61B 5/00 (2006.01)
A61B 5/0476 (2006.01)

(52) **U.S. Cl.**
CPC ***A61B 5/6801*** (2013.01); ***A61B 5/0006*** (2013.01); ***A61B 5/0476*** (2013.01)

(58) **Field of Classification Search**
CPC ..., A61B 5/6801; A61B 5/0006; A61B 5/0476
See application file for complete search history.

(56) **References Cited**

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(Continued)

Primary Examiner — Tiffany Weston
Assistant Examiner — Thu Tone

(57) **ABSTRACT**

This invention comprises EEG glasses (electroencephalographic eyewear) with a side section of an eyewear frame which spans forward and upward onto a portion of the person's forehead and then curves back downward to connect to the front section of the eyewear frame. These EEG glasses (electroencephalographic eyewear) further include a flexible protrusion which is attached to the side section and an electromagnetic energy sensor which collects data concerning electromagnetic brain activity, wherein the flexible protrusion holds the electromagnetic energy sensor.

1 Claim, 25 Drawing Sheets

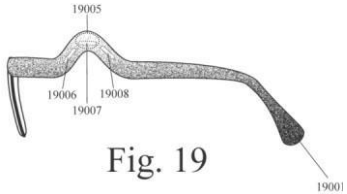
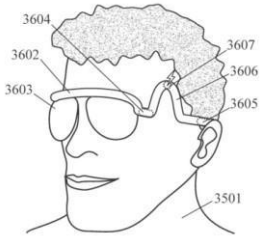


Fig. 19



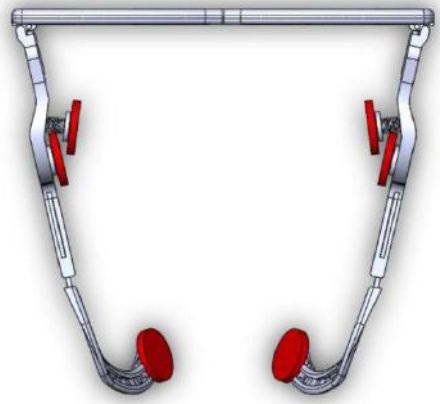


Figure 13: Relaxed state of eyewear with spring hinges set slightly closed

Current prototype in action. Toggle switch on/off by changing thought pattern.

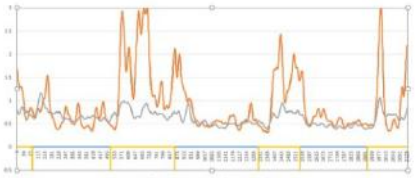
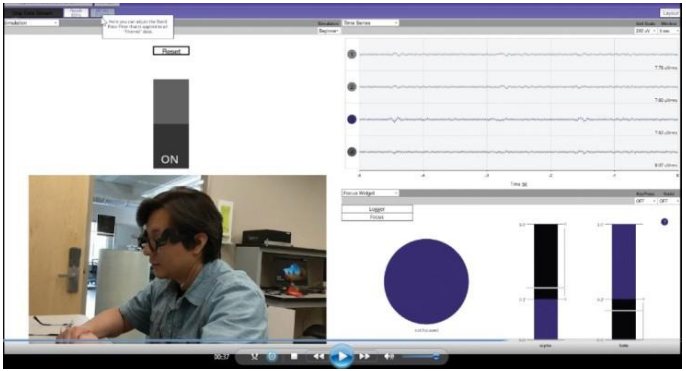


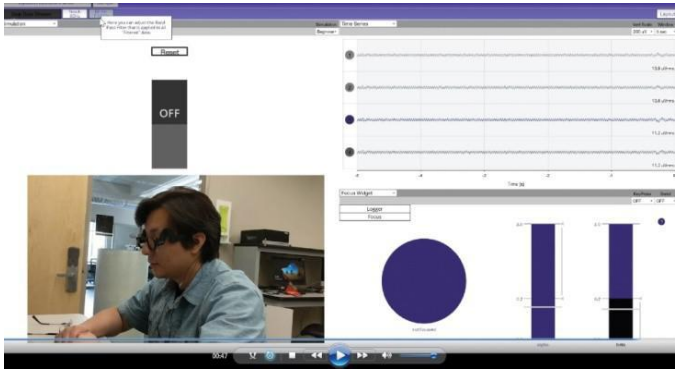
Figure 36: Two channel alpha average and beta average in time when focus and unfocused

➲ Brain activity measured by EEG sensors on sides of eyewear frame

➲ Alpha and Beta brainwaves analyzed via Fourier Transform to remotely turn switch on or off by changes in thought patterns



➲switch turned on by thought



➲switch turned off by thought

3. Why is Our Team Uniquely Qualified?

►**Minnesota:** In Minnesota, we don't like to brag about being the best --but we are the best: ☺ Medibotics is leader in incorporating accurate EEG sensors into eyewear.

►**Teamwork:** Team created prototype. Now refining more-compact design and better skin contact. Emily Whitwam -- “It was a lot of work but incredibly rewarding” [38]

►**Patents and Research PI Experience:** Multiple patents for EEG eyewear. Dr. Connor has been PI on grants, on panel for the Agency for Health Care Policy and Research, presented at Wearable Tech conferences.

4. Why Solve This Problem Now?

►Progress in EEG sensors, wearable tech, and pattern recognition. Why wait to improve lives?

5. How is Our Solution a Business?

►Large market, proprietary, value added

►Primary market is people with epilepsy not controlled by medication; goal at least 5% market

►Demand and willingness to pay

►Engineering teams, proprietary eyewear, physician advisory group, Epilepsy Foundation, NINDS SBIR grant, clinical trial, FDA 510(k)

►Secondary market Brain-Computer-Interface (BCI) for consumer electronics applications, communication, entertainment, sports/fitness

Multi-Year Financial Scenarios

		Low:	Middle:	High:
	People with epilepsy in U.S.	3,400,000	3,400,000	3,400,000
x	% uncontrolled by medication	30%	30%	30%
=	People with uncontrolled epilepsy	1,020,000	1,020,000	1,020,000
x	% who purchase Medibotics' EEG glasses	1%	5%	10%
=	Glasses sold in U.S. for epilepsy	10,200	51,000	102,000
+	Glasses sold in U.S. for other purposes	-	20,000	50,000
+	Glasses sold outside U.S.	-	-	102,000
=	Total glasses sold	10,200	71,000	254,000
x	Glasses price	$350	$400	$450
=	Sales revenue	$3,570,000	$28,400,000	$114,300,000
+	Grants and other non-sales revenue	-	$300,000	$1,000,000
=	Total revenue	$3,570,000	$28,700,000	$115,300,000
	Total glasses sold	10,200	71,000	254,000
x	Variable cost per glasses	$150	$125	$100
=	Variable cost	$1,530,000	$8,875,000	$25,400,000
+	Fixed cost (Regulatory)	$3,000,000	$3,000,000	$3,000,000
+	Fixed cost (Admin & Gen)	$400,000	$500,000	$600,000
=	Total cost	$4,930,000	$12,375,000	$29,000,000
	Profit(Loss)	$(1,360,000)	$16,325,000	$86,300,000

EEG Eyewear for Predicting Epileptic Seizures

Walleye Tank Competition at the Mayo Clinic, December 7, 2018

Robert A. Connor, MHA, Ph.D; CEO, Medibotics; robert.connor@medibotics.com

Thank you. Any Questions?

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