EXHIBIT 2109

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SLEBOEUF.011A

APPARATUS AND METHODS FOR PHYSIOLOGICAL MONITORING USING LIGHT-GUIDING EARBUDS

RELATED APPLICATION

This application claims the benefit of and priority to U.S. Provisional Patent Application No. 61/208,567 filed 02/25/2009, U.S. Provisional Patent Application No. 61/208,574 filed 02/25/2009, and U.S. Provisional Patent Application No. 61/212,444 filed 4/13/2009.

FIELD OF THE INVENTION

The present invention relates generally to devices and methods for physiological monitoring and, more particularly, to wireless physiological monitoring with light-guiding audio earbuds.

BACKGROUND OF THE INVENTION

There is growing market demand for personal health and environmental monitors, for example, for gauging overall health and metabolism during exercise, athletic training, dieting, daily life activities, sickness, and physical therapy. However, traditional health monitors and environmental monitors may be bulky, rigid, and uncomfortable – generally not suitable for use during daily physical activity. There is also growing interest in generating and comparing health and environmental exposure statistics of the general public and particular demographic groups. For example, collective statistics enable the healthcare industry and medical community to direct healthcare resources to where they are most highly valued. However, methods of collecting these statistics may be expensive and laborious, often utilizing human-based recording/analysis steps at multiple sites.

As such, improved ways of collecting, storing and analyzing physiological information are needed. In addition, improved ways of seamlessly extracting physiological information from a person during everyday life activities, especially during high activity levels, are essential for enhancing fitness training and healthcare quality, promoting and facilitating prevention, and reducing healthcare costs.

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SUMMARY

In view of the above discussion, apparatus and methods for monitoring various physiological factors are provided. According to some embodiments of the present invention, real-time, noninvasive physiological monitors include a plurality of compact sensors integrated within small, low-profile devices. Physiological data, and in some cases environmental data, is collected and wirelessly transmitted into a wireless network, where the data is stored and/or processed.

In some embodiments of the invention, an earpiece functions as a physiological monitor. In some embodiments, the earpiece is, or includes, an earbud. In some embodiments, the earbud is a light-guiding earbud designed to direct optical energy to and from a particular region of the ear.

In some embodiments, the earpiece combines physiological monitoring with a wireless personal communicator. The earpiece can take advantage of commercially available open-architecture wireless paradigms, such as Bluetooth®, Wi-Fi, or ZigBee. In some embodiments, a small, compact earpiece contains at least one microphone and one speaker, and is configured to transmit information wirelessly to a recording device such as, for example, a cell phone, a personal digital assistant (PDA), and/or a computer. The earpiece contains a plurality of sensors for monitoring personal health and environmental exposure. Health and environmental information, sensed by the sensors is transmitted wirelessly, in real-time, to a recording device, capable of processing and organizing the data into meaningful displays, such as charts. In some embodiments, an earpiece user may monitor health and environmental exposure data in real-time, and may also access records of collected data throughout the day, week, month, etc., by observing charts and data through an audio-visual display.

In some embodiments, an earpiece can integrate personal physiological and environmental exposure information with biofeedback and personal entertainment. In other embodiments of the present invention, earpiece monitor devices enable a variety of networks, applications, games, and business methods.

In some embodiments of the present invention, a monitoring

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apparatus includes a housing configured to be attached to the body of a person, one or more physiological sensors and one or more environmental sensors supported by (within and/or on) the housing. Each physiological sensor is configured to detect and/or measure physiological information from the person, and each environmental sensor is configured to detect and/or measure environmental conditions in a vicinity of the person wearing the apparatus. The apparatus also includes a signal processor that is configured to receive and process signals produced by the physiological and environmental sensors. A wireless transmitter is responsive to the signal processor and is configured to wirelessly transmit physiological and environmental sensor signals as processed by the signal processor from the signal processor to a remote terminal in real-time.

Each physiological sensor is configured to detect and/or measure one or more of the following types of physiological information: heart rate, pulse rate, breathing rate, blood flow, heartbeat signatures, cardio-pulmonary health, organ health, metabolism, electrolyte type and/or concentration, physical activity, caloric intake, caloric metabolism, blood metabolite levels or ratios, blood pH level, physical and/or psychological stress levels and/or stress level indicators, drug dosage and/or dosimetry, physiological drug reactions, drug chemistry, biochemistry, position and/or balance, body strain, neurological functioning, brain activity, brain waves, blood pressure, cranial pressure, hydration level, auscultatory information, auscultatory signals associated with pregnancy, physiological response to infection, skin and/or core body temperature, eye muscle movement, blood volume, inhaled and/or exhaled breath volume, physical exertion, exhaled breath physical and/or chemical composition, the presence and/or identity and/or concentration of viruses and/or bacteria, foreign matter in the body, internal toxins, heavy metals in the body, anxiety, fertility, ovulation, sex hormones, psychological mood, sleep patterns, hunger and/or thirst, hormone type and/or concentration, cholesterol, lipids, blood panel, bone density, organ and/or body weight, reflex response, sexual arousal, mental and/or physical alertness, sleepiness, auscultatory information, response to external stimuli, swallowing volume, swallowing rate, sickness, voice characteristics, voice tone, voice pitch, voice volume, vital signs, head tilt,

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allergic reactions, inflammation response, auto-immune response, mutagenic response, DNA, proteins, protein levels in the blood, water content of the blood, pheromones, internal body sounds, digestive system functioning, cellular regeneration response, healing response, stem cell regeneration response

Each environmental sensor is configured to detect and/or measure one or more of the following types of environmental information: climate, humidity, temperature, pressure, barometric pressure, soot density, airborne particle density, airborne particle size, airborne particle shape, airborne particle identity, volatile organic chemicals (VOCs), hydrocarbons, polycyclic aromatic hydrocarbons (PAHs), carcinogens, toxins, electromagnetic energy, optical radiation, X-rays, gamma rays, microwave radiation, terahertz radiation, ultraviolet radiation, infrared radiation, radio waves, atomic energy alpha particles, atomic energy beta-particles, gravity, light intensity, light frequency, light flicker, light phase, ozone, carbon monoxide, carbon dioxide, nitrous oxide, sulfides, airborne pollution, foreign material in the air, viruses, bacteria, signatures from chemical weapons, wind, air turbulence, sound and/or acoustical energy, ultrasonic energy, noise pollution, human voices, animal sounds, diseases expelled from others, exhaled breath and/or breath constituents of others, toxins from others, pheromones from others, industrial and/or transportation sounds, allergens, animal hair, pollen, exhaust from engines, vapors and/or fumes, fuel, signatures for mineral deposits and/or oil deposits, snow, rain, thermal energy, hot surfaces, hot gases, solar energy, hail, ice, vibrations, traffic, the number of people in a vicinity of the person, coughing and/or sneezing sounds from people in the vicinity of the person, loudness and/or pitch from those speaking in the vicinity of the person.

In some embodiments, the signal processor is configured to process signals produced by the physiological and environmental sensors into signals that can be heard and/or viewed by the person wearing the apparatus. In some embodiments, the signal processor is configured to selectively extract environmental effects from signals produced by a physiological sensor and/or selectively extract physiological effects from signals produced by an environmental sensor.

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