Light Flicker Canceling Glasses

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1 ABSTRACT

Most electric light sources flicker, that is, the intensity of the light that is produced varies substantially in a periodically repeating pattern. In sensitive individuals, light flicker can cause headaches and other undesirable symptoms. This invention comprises a light sensor that measures light intensity, signal processing that identifies the flicker component of the light, and electrically controlled lenses of glasses that rapidly darken or become more transparent so as to cancel most of the flicker. This reduces the flicker seen by the wearer of the glasses, reducing discomfort.

2 TECHNICAL FIELD

The present invention relates generally to variable density lenses and more particularly toward fast response time variable density lenses wherein density is controlled as a function of ambient light intensity to reduce light flicker. The present invention also relates generally to therapeutic or protective eyewear to prevent injurious or unpleasant light from reaching the eyes of the wearer.

3 BACKGROUND ART

Most electric light sources that are powered by alternating current (AC) electricity flicker, that is, the intensity of the light produced by the light source varies substantially and rapidly as a periodic function of time. Flickering light sources include fluorescent lights, compact fluorescents, light emitting diode (LED) lights powered by AC, television screens, and computer screens. Light dimmers that use pulse-width modulation (PWM) also introduce flicker: the apparent dimming of the light is caused by rapidly switching the electric power (and therefore the light) on and off.

Electric lights commonly flicker at twice the frequency of the electric power source [3] [1] [2], with a waveform that is similar to a full-wave rectified sinusoid. For 60 Hertz AC electricity, the primary flicker frequency is 120 Hertz. Because flicker at 120 Hertz is above the so-called flicker fusion frequency, it usually is not perceived as flickering by humans. However, flicker at this frequency can be detected by neural circuits in the brain [4] and in sensitive individuals can cause undesirable symptoms, including headache, fatigue, distraction, and reduced productivity [4] [5].

Although an individual might be able to control light flicker at home, it is usually not possible for an individual to control light source flicker in public locations such as workplaces and commercial buildings. There is a need for individuals to be able to ameliorate flicker due to ambient artificial lighting, television screens, and computer screens.

In an indoor environment, there may be multiple sources of flicker, such as office lights and computer screens, and the flicker experienced by an individual can vary with the body motion and head motion of the individual.

The present invention comprises glasses containing a pair of photochromic lenses whose light transmissibility is electronically controlled (such as liquid crystal lenses), a photodetector that senses the intensity of incident visible light, signal processing to detect and separate the flicker component of the incident light, and amplification and control circuitry that rapidly adjusts the light transmissibility of the electronically controlled lenses so that the flicker component of the incident light is counteracted and reduced. By substantially canceling the flicker component of artificial light, these glasses can reduce the harmful effects that light flicker has on sensitive individuals.

One object of the present invention, therefore, is to provide variable density lenses that have a response time faster than the flicker component of artificial lighting sources.

Another object is to provide a fast response time variable density lens that is automatically controlled to substantially cancel the flicker component of light produced by artificial light sources.

Another object is signal processing to identify and separate the periodic flicker components of the ambient light, so that the flicker can be canceled without impeding variations in lighting that should be seen, such as those variations due to motion of objects in the field of vision, motion and variability in a television image, motion of the wearer of the glasses, and so forth.

Another object is to provide lenses having a density that is variable within a wide density range in response to flicker intensity and has a fast response time to allow the lens density to change rapidly in order to substantially cancel light flicker.

Another object is to provide therapeutic lenses having continuously variable controlled density, to ameliorate the undesirable symptoms produced in susceptible individuals by light flicker.

4 DISCLOSURE OF INVENTION

A spectacle lens, in accordance with the invention, comprises a layer of liquid crystal material sandwiched between a pair of identically curved glass lenses. Opposite outer surfaces of the liquid crystal layer are in contact with transparent electrically conductive electrodes. Polarized material is laminated on the outer surfaces of the two lenses whereby the light transmission density of the assembly is controlled as a function of the voltage applied to the electrodes.

A photodetector is employed that produces an output voltage that is proportional to the intensity of ambient visible light over a wide range of light intensity. It is necessary that the photodetector respond to changes in light frequency much faster than the highest flicker frequency to be cancelled; a frequency response of 2000 Hertz is twice as fast as the maximum firing rate of neurons in the brain and should be sufficient.

The output of the photodetector forms the input to signal processing, such as bandpass filtering, to isolate the flicker component of the ambient light so that the flicker component can be canceled without canceling other variations in the light that should be perceived. More sophisticated signal processing, such as Fourier spectral analysis and autocorrelation, memory of the flicker waveform, and predictive darkening can allow more precise cancelation of the flicker component.

The output of the signal processing module is the input to a control module that amplifies the control signal and adjusts it to the level appropriate to control the light transmission density of the lenses. This control could be improved by additional measurement of the light behind the lens to ensure that the flicker is effectively canceled.

Liquid crystal lenses have been used in the past for automatically adjusting the light transmissibility of glasses. U.S. Patent No. 4,701,912 covers use of a liquid crystal lens in a welding helmet; such a helmet varies automatically between maximum transparency and minimum transparency.

U.S. Patent No. 4,279,474 describes automatically controlled and continuously variable density glasses, as might be used for sunglasses. However, because that invention uses pulse width modulation (PWM) to control the lens density, that invention imposes substantial flicker onto largely non-flickering natural sunlight and would be unsuitable for flicker cancelation.

5 BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of a pair of glasses equipped with the light sensor and variable density lenses of the present invention.

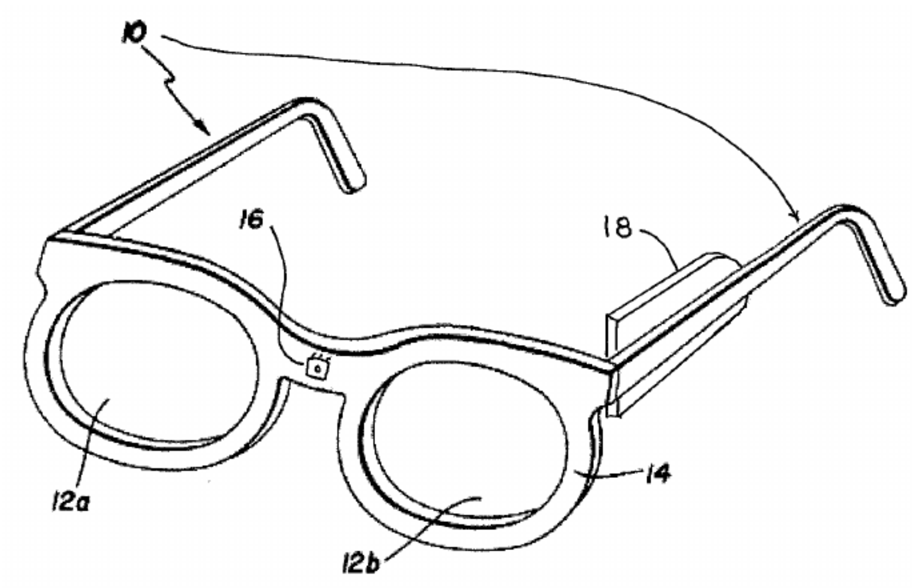

Figure 1: Glasses Assembly

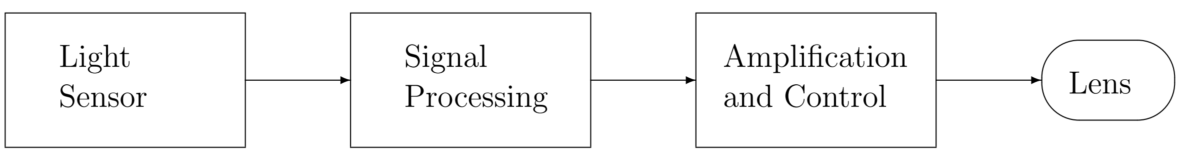

Figure 2: Block Diagram

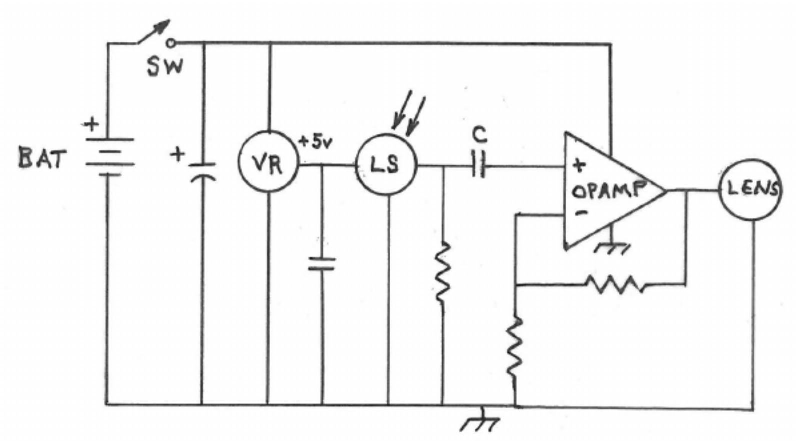

Figure 3: Circuit Diagram

FIG. 2 is a simplified block diagram showing circuitry for controlling the density of the lenses as a function of light intensity at the light sensor.

FIG. 3 is a more detailed circuit diagram of the control circuitry of FIG. 2.

6 BEST MODE FOR CARRYING OUT THE INVENTION

Referring to FIG. 1, a pair of glasses **10, 14** comprises a frame **14** carrying a pair of substantially identical variable density lenses **12a** and **12b** each containing a liquid crystal layer whose light transmissibility is controlled by an applied electric voltage. A light sensor **16** is attached to the front of the glasses and detects the overall light intensity at the front of the glasses; the light sensor has a fast response time so that it can rapidly detect changes in light intensity due to flicker of light sources. A battery case **18** is attached to a temple piece **10** of the glasses and contains batteries to power the circuitry and an on/off switch. Preferentially, the wiring and circuit components of the invention are miniaturized and are contained within the frame **14** of the glasses.

Referring now to FIG. 2, the output of the light sensor forms the input to a signal processing module that enhances and isolates the flicker component of the incident light. The output of the signal processing module forms the input to the amplification and control module, which increases the electrical signal to be strong enough and of an appropriate voltage to control the density of the lens.

Referring now to FIG. 3, the circuit diagram of an implementation of the invention is shown. The lenses as used in this implementation are adapted from a pair of Sony PlayStation 3 active shutter glasses; the circuitry of the Sony glasses is removed, and the circuit described in Fig. 3 is used instead. Components in the circuit of Fig. 3 are:

BAT	Battery, 2 x CR2032
SW	Switch
VR	Voltage Regulator, 5 volts
LS	Light Sensor, AMS-TAOS TSL251
C	Capacitor
OPAMP	Operational Amplifier, Texas Instruments TLV2772
LENS	Photochromic Lenses from Sony Playstation 3 glasses

Referring again to FIG. 3, the battery **BAT** and switch **SW** provide power for the circuit. The voltage regulator **VR** controls the battery voltage as required by the light sensor **LS**. The capacitor **C** couples the output of the light sensor **LS** to the operational amplifier **OPAMP** and provides signal processing (high-pass filtering) to isolate the flicker component of the incident light. The operational amplifier **OPAMP** amplifies the signal to be at an appropriate voltage and current to control the lenses **LENS**.

In the preferred embodiment of this invention, the wiring, circuitry, and batteries used for the invention are miniaturized and hidden inside the frame **14 in FIG. 1** of the glasses, or are enclosed in small modules attached to the temple pieces **10 in FIG. 1** of the glasses.

The flicker canceling glasses of the present invention have been implemented, and they have been tested on a person who suffers from migraine headaches and who finds that flickering light sources cause headaches. The test subject reported that the glasses of the present invention were effective in preventing headaches caused by light flicker.

I claim:

1. Glasses having lenses with continuously variable light transmission density that is controlled by an applied electric voltage, a light sensor capable of sensing visible light and having a fast response time, and amplification and control circuitry suitable for controlling the voltage applied to the lenses so as to cancel the majority of the flicker that is present in the incident light.

2. The glasses of claim 1, with signal processing to identify and isolate the flicker component of incident light, whether such signal processing is comprised of analog electronic circuitry, digital electronic circuitry, digital computer processing, or some combination of these.

3. The glasses of claim 1 or claim 2, where signal processing techniques are used, which may include low-pass filtering, high-pass filtering, bandpass filtering, Fourier spectral analysis, autocorrelation, time delays, feedback, or other advanced techniques.

4. The glasses of claim 1 or claim 2, where an adjustment control is provided to allow the wearer of the glasses to adjust the overall darkness of the lenses.

5. The glasses of claim 1 or claim 2, where an adjustment control is provided to allow the wearer of the glasses to adjust the degree of cancelation of the flicker component of incident light.

6. The glasses of claim 1 or claim 2, incorporating a memory component in which a representation of the flicker waveform of the light can be stored, and the use of this memory of the flicker waveform to improve cancelation of the flicker by the variable density lens.

7. The glasses of claim 1 or claim 2, using a digital camera as a light sensor and incorporating signal processing of the camera output to control lens densities.

8. The glasses of claim 1 or claim 2, incorporating an additional light sensor behind the variable density lens, and the use of the signal provided by the additional sensor to provide better control of the variable density lens so as to better cancel the flicker.

9. The glasses of claim 1 or claim 2, incorporating the ability to separately control the light transmission densities of parts of a lens, or individual pixels of a lens, and where multiple light sensors or a digital camera are used to sense light intensity.

10. The use of the techniques of the above claims to control the density of a window, windshield, face shield, camera lens, or other variable density transparent media. These techniques may be used to remove flicker or to defend against possibly harmful or distracting light sources such as lasers aimed at a driver, pilot, military soldier, or public safety officer.

References

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