Light Flicker to Sound Conversion

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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 and isolates the flicker component of the light, and an audio amplifier that amplifies the flicker component so that it can be converted to sound by a speaker or headphones. This makes it easy for ordinary people to identify and characterize sources of light flicker.

2 TECHNICAL FIELD

The present invention relates generally to test and measurement instrumentation and more particularly toward instrumentation to detect and characterize light source flicker. The present invention also relates generally to instrumentation to detect and characterize environmental conditions that might be unpleasant or hazardous to humans.

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. Although 120 Hertz is above the so-called flicker fusion frequency for humans and is not consciously perceived as flickering, in sensitive individuals flickering light at this frequency can produce undesirable symptoms,

including headache, fatigue, distraction, and reduced productivity [4] [5].

Because flicker at 120 Hertz is above the 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 can cause headaches or other discomfort in sensitive individuals [4] [5]. An individual may not even realize that flicker is the cause of discomfort. Flicker can be identified by constructing an appropriate electronic circuit and observing its output on an oscilloscope [3], but most people will not have the expertise nor resources to do so. There is therefore a need to be able easily and inexpensively to identify flicker sources and their magnitude and character.

The present invention comprises a photodetector that senses the intensity of incident visible light, signal processing (such as bandpass filtering) to detect and separate the flicker component of the incident light, and amplification circuitry that converts the imperceptible flicker of light into easily perceptible sounds via a speaker or headphones.

One object of the present invention, therefore, is to provide an easily used and inexpensive means of identifying lighting flicker.

Another object is to allow the user to identify sources of flicker so that the user can avoid those sources or replace them with light sources that do not flicker.

Another object is to allow the user to identify flicker as a possible source of discomfort.

Another object is to allow consumers, architects, building managers, manufacturers, and sellers easily to identify products that produce light flicker. This can allow products to be identified as flickering or not, so that buyers can select products that do not flicker, and so that manufacturers and sellers can be motivated to produce and sell products that do not flicker.

4 DISCLOSURE OF INVENTION

A photodetector is employed that produces an output voltage that is proportional to the intensity of ambient light over a wide range of light intensity. It is necessary that the photodetector respond to changes in light frequency faster than the highest flicker frequency to be detected.

The output of the photodetector is subjected to signal processing, such as bandpass filtering, to isolate the flicker component of the ambient light. The output of the signal processing module is the input to an audio amplifier that amplifies the flicker signal for presentation as audible sound through a speaker or headphones.

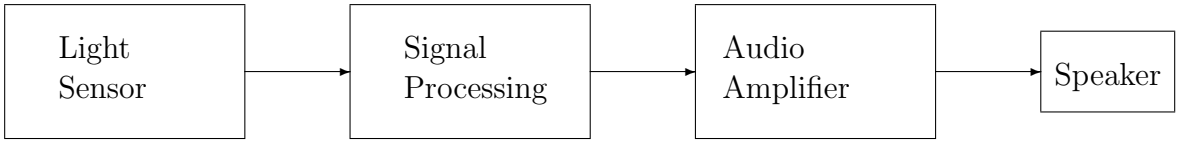

Figure 1: Block Diagram

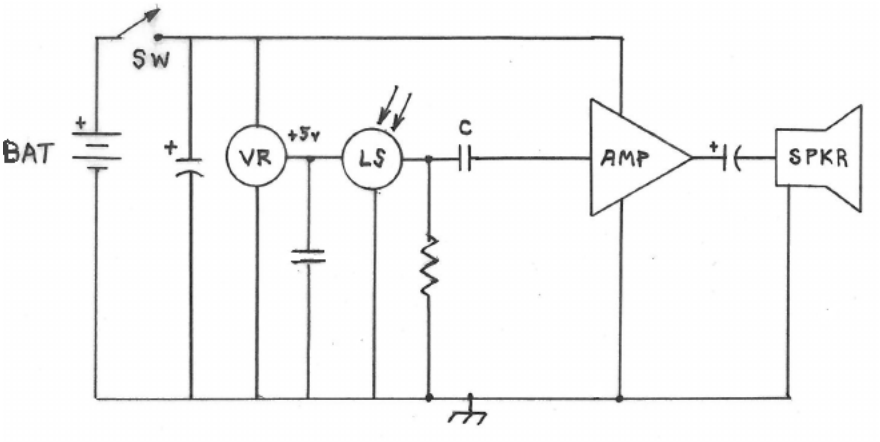

Figure 2: Circuit Diagram

5 BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a simplified block diagram showing circuitry for measuring light intensity, isolating the flicker component of the light, and amplifying the signal for presentation as sound through a speaker.

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

6 BEST MODE FOR CARRYING OUT THE INVENTION

Referring to FIG. 1, 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 audio amplifier module, which increases the electrical signal to be presented to the user as sound via a speaker or headphones.

Referring now to FIG. 2, the circuit diagram of an implementation of the invention is shown.

Components in the circuit of Fig. 2 are:

BAT	Battery, 9 volt
SW	Switch
VR	Voltage Regulator, 5 volts
LS	Light Sensor, AMS-TAOS TSL251
C	Capacitor
AMP	Audio Amplifier, LM386
SPKR	Speaker

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 audio amplifier **AMP** and provides signal processing (high-pass filtering) to isolate the flicker component of the incident light. The audio amplifier **AMP** amplifies the signal to be presented to the user as sound via a speaker **SPKR**.

In the preferred embodiment of this invention, the wiring, circuitry, and batteries used for the invention would be enclosed in a small plastic box.

The flicker to sound converter of the present invention has been implemented and tested. The invention makes it fast and easy for an ordinary person to identify and characterize various sources of light flicker, such as artificial lighting, computer screens, and television screens.

I claim:

1. An electronic device having a light sensor capable of sensing visible light and having a fast response time, signal processing to identify and isolate the flicker component of the incident light signal, and amplification to present the flicker signal to the user as sound.

2. The device of claim 1, 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. The signal processing may be performed by analog electronic circuitry, digital electronic circuitry, digital computer processing, or some combination of these.

3. The device of claim 1, where an adjustment control is provided to allow the user of the device to adjust the sound level.

4. The device of claim 1, where a meter or other display device is used to present characteristics of the flicker signal, such as its fundamental frequency, amplitude, flicker percentage, or other flicker characteristic measurements [2].

5. The device of claim 1, incorporating terminals to which an oscilloscope can be connected to display the flicker waveform.

6. The device of claim 1, using a digital camera as a light sensor and incorporating signal processing of the camera output to derive a representation of the flicker signal as sound.

7. The use of the techniques of the above claims to provide audible, visual, or other warnings of 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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