OPTICAL IMAGING SYSTEM WITH MULTIPLE IMAGING CHANNEL OPTICAL SENSING

TECHNICAL FIELD

[0001] The present disclosure relates generally to an infusion pump with chromatic multiplexing, in particular, the pump uses single or multiple light sources, a single lens, mirrors, and beam combiners to enable use of a single color image sensor to provide distinct images for multiple distinct portions of the pump.

BACKGROUND

[0002] Monochrome image sensors are generally less costly than color image sensors. However, for simultaneously received multiple images, monochrome sensors cannot be used to separate the respective images, for example to generate, display, or operate upon the respective images, using conventional signal processing. For example, when a pixel in the monochrome sensor receives light, the sensor cannot determine which of the respective images the light pertains to.

SUMMARY

[0003a] According to a first aspect illustrated herein, there is provided an optical imaging system for use with an infusion tube having a drip chamber including a first portion with a drip tube, a second portion with an exit port, and a third portion located between the first and second portions, the optical imaging system comprising: at least one light source for emitting at least two of first, second, or third spectrums of light, said respective first, second and third spectrums being of distinct and non-overlapping wavelengths; an optics system including: a single lens for receiving and transmitting at least two of:the first spectrum of light transmitted through the first portion; the second spectrum of light transmitted through the second portion; or, the third spectrum of light transmitted through the third portion; a single image sensor for: receiving the at least two of the first, second, or third spectrums of light from the single lens; and, generating and transmitting data characterizing the at least two of the first, second, or third spectrums of light received from the single lens; a memory element for storing computer executable instructions; and, at least one processor configured to execute the computer executable instructions to generate, using the data, at least two of first, second, or third images of the first, second, and third portions, respectively.

[0003b] According to a second aspect illustrated herein, there is provided an optical imaging system for use with an infusion tube having a drip chamber including a first portion with a drip tube, a second portion with an exit port, and a third portion located between the first and second portions, the optical imaging system comprising: a single light source for emitting first, second, or third spectrums of light, said respective first, second and third spectrums being of distinct and non-overlapping wavelengths; an optics system including: a single lens for receiving and transmitting at least two of: the first spectrum of light transmitted through the first portion; the second spectrum of light transmitted through the second portion; and, the third spectrum of light transmitted through the third portion; a single color image sensor for: receiving the at least two of the first, second, or third spectrums of light from the single lens; and, generating and transmitting data characterizing the at least two of the first, second, or third spectrums of light received from the single lens; a memory element for storing computer executable instructions; and, at least one processor configured to execute the computer executable instructions to generate, using the data, at least two of first, second, or third images of the first, second, and third portions, respectively.

[0003c] According to a third aspect illustrated herein, there is provided a method of imaging an infusion tube having a drip chamber including a first portion with a drip tube, a second portion with an exit port, and a third portion located between the first and second portions, comprising: storing, in a memory element, computer executable instructions; emitting at least two of first, second, or third spectrums of light from at least one light source; receiving and transmitting, using a single lens at least two of: the first spectrum of light transmitted through the first portion; the second spectrum of light transmitted through the second portion; or, the third spectrum of light transmitted through the third portion, said respective first, second and third spectrums being of distinct and non-overlapping wavelengths; receiving, using a single image sensor, the at least two of the first, second, or third spectrums of light from the single lens; generating and transmitting, using the single image sensor, data characterizing the at least two of the first, second, or third spectrums of light received from the single lens; and, executing, using at least one processor, the computer executable instructions to generate, using the data, at least two of first, second, or third images of the first, second, and third portions, respectively.

[0003d] According to a fourth aspect illustrated herein, there is provided a method of imaging an infusion tube having a drip chamber including a first portion with a

drip tube, a second portion with an exit port, and a third portion located between the first and second portions, comprising: storing computer executable instructions in a memory element; emitting, using a single light source, at least two of first, second, or third spectrums of light: receiving and transmitting, using a single lens, at least two of: the first spectrum of light transmitted through the first portion; the second spectrum of light transmitted through the second portion; or, the third spectrum of light transmitted through the third portion, said respective first, second and third spectrums being of distinct and non-overlapping wavelengths; receiving, using a single color image sensor, the at least two of the first, second, or third spectrums of light from the single lens; generating and transmitting, using a single color image sensor, data characterizing the at least two of the first, second, or third spectrums of light received from the single lens; and, executing, using at least one processor, the computer executable instructions to generate, using the data, at least two of first, second, or third images of the first, second, and third portions, respectively.

[0003e] ~~According to aspects illustrated herein, there is provided~~Herein disclosed is an optical imaging system for use with an infusion tube having a drip chamber including a first portion with a drip tube, a second portion with an exit port, and a third portion located between the first and second portions, the optical imaging system including: at least one light source for emitting at least two of first, second, or third spectrums of light; an optics system including a single lens for receiving and transmitting at least two of the first spectrum of light transmitted through the first portion, the second spectrum of light transmitted through the second portion, or the third spectrum of light transmitted through the third portion. The optical system includes a single image sensor for receiving the at least two of the first, second, or third spectrums of light from the single lens and generating and transmitting data characterizing the at least two of the first, second, or third spectrums of light received from the single lens. The imaging system includes a memory element for storing computer executable instructions; and at least one processor configured to execute the computer executable instructions to generate, using the data, at least two of first, second, or third images of the first, second, or third portions, respectively.

[0004] ~~According to aspects illustrated herein, there is provided~~Herein disclosed is an optical imaging system for use with an infusion tube having a drip chamber including a first portion with a drip tube, a second portion with an exit port, and a third portion located between the first and second portions, the optical imaging system including: a single light source for emitting at least two of first, second, or third spectrums of light; and an optics system including a single lens for receiving and transmitting at least two of: the first spectrum of light transmitted through the first portion; the second spectrum of light transmitted through the second portion; and the third spectrum of light transmitted through the third portion; and a single color image sensor for: receiving the at least two of the first, second, or third spectrums of light from the single lens; and generating and transmitting data characterizing the at least two of the first, second, or third spectrums of light received from the single lens. The imaging system includes a memory element for storing computer executable instructions, and at least one processor configured to execute the computer executable instructions to generate, using the data, at least two of first, second, or third images of the first, second, or third portions, respectively.

[0005] According to aspects illustrated herein, there is provided an optical imaging system for use with an infusion tube having a drip chamber including a first portion with a drip tube, a second portion with an exit port, and a third portion located between the first and second portions. The optical imaging system includes: at least one of a first light source for emitting a first spectrum of light only, a second light source for emitting a second spectrum of light only, or third source of light for emitting a third spectrum of light only; and an optics system including a single lens for receiving and transmitting at least one of: the first spectrum of light transmitted through the first portion; the second spectrum of light transmitted through the second portion; and the third spectrum of light transmitted through the third portion. The optical system includes a single color image sensor for receiving the at least one of the first, second, or third spectrums of light from the single lens and generating and transmitting data characterizing the at least one of the first, second, or third spectrums of light received from the single lens. The imaging system includes a memory element for storing computer executable instructions, and at least one processor configured to execute the computer executable instructions to generate, using the data, at least one of first, second, or third images of the first, second, or third portions, respectively. The first, second, and third spectrums of light are free of overlapping wavelengths amongst each other.

[0006] ~~According to aspects illustrated herein, there is provided~~Herein disclosed is a method of imaging an infusion tube having a drip chamber including a first portion with a drip tube, a second portion with an exit port, and a third portion located between the first and second portions, including: storing, in a memory element, computer executable instructions; emitting at least two of first, second, or third spectrums of light from at least one light source; receiving and transmitting, using a single lens at least two of: the first spectrum of light transmitted through the first portion; the second spectrum of light transmitted through the second portion; or the third spectrum of light transmitted through the third portion; receiving, using a single image sensor, the at least two of the first, second, or third spectrums of light from the single lens; generating and transmitting, using the single image sensor data characterizing the at least two of the first, second, or third spectrums of light received from the single lens; and executing, using the at least one processor, the computer executable instructions to generate, using the data, at least two of first, second, or third images of the first, second, or third portions, respectively.

[0007] ~~According to aspects illustrated herein, there is provided~~Herein disclosed is a method of imaging an infusion tube having a drip chamber including a first portion with a drip tube, a second portion with an exit port, and a third portion located between the first and second portions, including: storing computer executable instructions in a memory element; emitting, using a single light source, at least two of first, second, or third spectrums of light: receiving and transmitting, using a single lens at least two of: the first spectrum of light transmitted through the first portion; the second spectrum of light transmitted through the second portion; or the third spectrum of light transmitted through the third portion; receiving, using a single color image sensor, the at least two of the first, second, or third spectrums of light from the single lens; generating and transmitting, using a single color image sensor, data characterizing the at least two of the first, second, or third spectrums of light received from the single lens; and executing, using at least one processor, the computer executable instructions to generate, using the data, at least two of first, second, or third images of the first, second, or third portions, respectively.

[0008] According to aspects illustrated herein, there is provided a method of imaging an infusion tube having a drip chamber including a first portion with a drip tube, a second portion with an exit port, and a third portion located between the first and second portions, including: storing computer executable instructions in a memory element; and emitting at least one of a first spectrum of light only using a first light

What Is Claimed Is:

1. An optical imaging system for use with an infusion tube having a drip chamber including a first portion with a drip tube, a second portion with an exit port, and a third portion located between the first and second portions, the optical imaging system comprising:

at least one light source for emitting at least two of the first, second, or third spectrums of light, said respective first, second and third spectrums being of distinct and non-overlapping wavelengths;

an optics system including:

a single lens for receiving and transmitting at least two of:

the first spectrum of light transmitted through the first portion;

the second spectrum of light transmitted through the second portion; or,

the third spectrum of light transmitted through the third portion;

a single image sensor for:

receiving the at least two of the first, second, or third spectrums of light from the single lens; and,

generating and transmitting data characterizing the at least two of the first, second, or third spectrums of light received from the single lens;

a memory element for storing computer executable instructions; and,

at least one processor configured to execute the computer executable instructions to generate, using the data, at least two of first, second, or third images of the first, second, and third portions, respectively.

2. The optical imaging system of claim 1, wherein the single image sensor consists of a single color image sensor.

3. The optical imaging system of claim 1, wherein the at least one light source consists of a single light source.

4. The optical imaging system of claim 1, wherein the at least one light source includes a plurality of light sources.

5. The optical imaging system of claim 1, wherein the at least one light source

includes three light sources.

6. The optical imaging system of claim 1, wherein:

the first portion includes a drop pendant from the drip tube and the first image includes an image of the drop;

the at least one ~~specially programmed~~ processor is configured to determine a volume of the pendant drop using the first image;

the third portion includes a meniscus for fluid in the drip chamber and the third image includes an image of the meniscus; and,

the at least one processor configured to execute the computer executable instructions to determine a position of the meniscus using the third image.

7. The optical imaging system of claim 1, wherein an air bubble is present in the second portion and the second image includes an image of the air bubble.

8. The optical imaging system of claim 7, the at least one processor configured to execute the computer executable instructions to determine a volume of the air bubble using the second image.

9. The optical imaging system of claim 1, wherein:

the at least one light source emits at least two of red, blue, and green spectrum light;

the first spectrum of light consists of one of the red, blue, or green spectrum light;

the second spectrum of light consists of one of the red, blue, or green spectrum light not included in the first spectrum; and,

the third spectrum of light consists of one of the red, blue, or green spectrums of light not included in the first or second spectrums of light.

10. The optical imaging system of claim 1, wherein the optics system includes a mirror for reflecting one only of the first, second, or third spectrums of light transmitted by the first, second, or third portions, respectively.

11. The optical imaging system of claim 1, wherein the optics system includes:

a first mirror for reflecting one only of the first, second, or third spectrums of light transmitted by the first, second, or third portions, respectively; and,

a second mirror for reflecting another only of the first, second, or third spectrums of light transmitted by the first, second, or third portions, respectively.

12. The optical imaging system of claim 1, wherein the optics system includes a beam combiner for reflecting two only of the first, second, or third spectrums of light transmitted by the first, second, or third portions, respectively.

13. The optical imaging system of claim 1, wherein the optics system includes a mirror for:

transmitting to one of the first, second, or third portions, one only of the first, second, or third spectrums of light emitted by the at least one light source; or,

reflecting to one of the first, second, or third portions, one only of the first, second, or third spectrums of light emitted by the at least one light source.

14. An optical imaging system for use with an infusion tube having a drip chamber including a first portion with a drip tube, a second portion with an exit port, and a third portion located between the first and second portions, the optical imaging system comprising:

a single light source for emitting first, second, or third spectrums of light, said respective first, second and third spectrums being of distinct and non-overlapping wavelengths;

an optics system including:

a single lens for receiving and transmitting at least two of:

the first spectrum of light transmitted through the first portion;

the second spectrum of light transmitted through the second portion; and,

the third spectrum of light transmitted through the third portion;

a single color image sensor for:

receiving the at least two of the first, second, or third spectrums of light from the single lens; and,

generating and transmitting data characterizing the at least two of the first, second, or third spectrums of light received from the single lens;

a memory element for storing computer executable instructions; and,

at least one processor configured to execute the computer executable instructions to generate, using the data, at least one of first, second, or third images of the first, second, and third portions, respectively, wherein:

the first, second, and third spectrums of light are free of overlapping wavelengths amongst each other.

18. The optical imaging system of claim 17, wherein the optics system includes:

a first mirror for reflecting one only of the first, second, or third spectrums of light transmitted by the first, second, or third portions, respectively; and,

a second mirror for reflecting another only of the first, second, or third spectrums of light transmitted by the first, second, or third portions, respectively.

19. The optical imaging system of claim 17, wherein the optics system includes a beam combiner for reflecting two only of the first, second, or third spectrums of light transmitted by the first, second, or third portions, respectively.

20. A method of imaging an infusion tube having a drip chamber including a first portion with a drip tube, a second portion with an exit port, and a third portion located between the first and second portions, comprising:

storing, in a memory element, computer executable instructions;

emitting at least two of the first, second, or third spectrums of light from at least one light source;

receiving and transmitting, using a single lens at least two of:

the first spectrum of light transmitted through the first portion;

the second spectrum of light transmitted through the second portion; or,

the third spectrum of light transmitted through the third portion, said respective first, second and third spectrums being of distinct and non-overlapping wavelengths;

receiving, using a single image sensor, the at least two of the first, second, or third spectrums of light from the single lens;

generating and transmitting, using the single image sensor, data characterizing the at least two of the first, second, or third spectrums of light received from the single lens; and,

executing, using the at least one processor, the computer executable instructions to generate, using the data, at least two of first, second, or third images of the first, second, and third portions, respectively.

receiving and transmitting, using a single lens, at least two of:

the first spectrum of light transmitted through the first portion;

the second spectrum of light transmitted through the second portion; or,

the third spectrum of light transmitted through the third portion, said respective first, second and third spectrums being of distinct and non-overlapping wavelengths;

receiving, using a single color image sensor, the at least two of the first, second, or third spectrums of light from the single lens;

generating and transmitting, using a single color image sensor, data characterizing the at least two of the first, second, or third spectrums of light received from the single lens; and,

executing, using at least one processor, the computer executable instructions to generate, using the data, at least two of first, second, or third images of the first, second, and third portions, respectively.

34. The method of claim 33, further comprising:

reflecting, using a first mirror, one only of the first, second, or third spectrums of light transmitted by the first, second, or third portions, respectively; and,

reflecting, using a second mirror, another only of the first, second, or third spectrums of light transmitted by the first, second, or third portions, respectively.

35. The method of claim 33, further comprising reflecting, using a beam combiner, two only of the first, second, or third spectrums of light transmitted by the first, second, or third portions, respectively.

36. A method of imaging an infusion tube having a drip chamber including a first portion with a drip tube, a second portion with an exit port, and a third portion located between the first and second portions, comprising:

storing computer executable instructions in a memory element;

emitting at least one of:

a first spectrum of light only using a first light source;

a second spectrum of light only using a second light source; or,

a third spectrum of light only using a third light source;

receiving and transmitting, using a single lens, at least one of:

the first spectrum of light transmitted through the first portion;