In this device a single detector is intended to detect the fluorescence wavelengths around 700 nm and 800 nm.

The detector is filtered by a dual band–pass filter with a first bandwidth of between 689 and 725 nm, and a second bandwidth of between 803 and 853 nm.

The band–pass filters used for the Flare™ and Mini–Flare™ devices are marketed by Chroma under reference HQ 817/25.

A competing device proposed by SurgOptics is described in [4].

The excitation light source is a laser diode at a wavelength of 750 nm, whilst the lighting of the operating room is provided by a halogen lamp emitting white light.

A Chroma HQ 795/50 band–pass filter is positioned upstream of the detector to prevent transmission thereto of wavelengths longer than the fluorescence wavelength.

However, with all the above–described devices a fluorescent background can be seen in the images obtained which reduces the contrast with the fluorescence emitted by the organ or tissue of interest.

The authors generally attribute this phenomenon to tissue autofluorescence.

However, for the wavelengths of the near infrared under consideration, autofluorescence is negligible and cannot alone account for the observed fluorescent background.

Another hypothesis to explain this unsatisfactory quality of images could be insufficient filtering of the excitation light source.

At all events, there subsists a need to improve the quality of fluorescence images in the setting of an operating room.

~~It is therefore one objective~~Embodiment of the invention seek to ~~propose~~ provide a lighting and filtering system for operating room adapted for application of fluorescence, imaging, and which in particular allows optimised quality of a fluorescence image even in the presence of intense continuous illumination of the surgical field.

~~A further objective~~Embodiments of the invention ~~is further~~ seek to ~~propose~~ provide a filtering system which can easily be adapted to existing lighting equipment in an operating room and at moderate cost.

BRIEF DESCRIPTION OF THE INVENTION

~~For this purpose~~According to a first aspect of the present, invention, there is provided, a fluorescence imaging system ~~is proposed~~ for operating room comprising an operating room illuminating device capable of emitting white light and a fluorescence imaging device;

said fluorescence imaging device comprising:

- a light source capable of emitting radiation to excite a fluorescent marker in a range of emission wavelengths ~~emission range~~ of between 600 and 900 nm;

- a detector adapted to detect the fluorescent radiation emitted by the marker under the effect of excitation by the light source;

- a filter for the detector adapted to attenuate the excitation radiation and to transmit to the detector those photons ~~to the detector~~ which have a wavelength included in the range of fluorescent radiation wavelengths emitted by the marker;

the light emitted by the illuminating device being filtered by a low–pass filter ~~of~~ ~~which~~having a ~~the~~ cut–off wavelength ~~is~~ below the emission range of the fluorescent marker, said low–pass filter nonetheless being able to exhibit attenuation peaking or fluctuations at wavelengths above the emission range of the fluorescent marker.

According to embodiments of the invention, in a range of wavelengths extending from an upper cut–off wavelength of the detector filter that is below the wavelength on and after which attenuation peaking or fluctuations of the low–pass filter of the illuminating device are observed, the product of the attenuation of the detector filter and of the attenuation of the low–pass filter of the illuminating device leads to an attenuation by a factor of at least 10^6.

Herein the term « filter » may encompass an elementary filter or a combination of filters.

As explained in detail below, the effect of this filtering of the detector is to eliminate bias and background noise due to peaking of the low–pass filter of the illuminating device which, due to the intensity of operating room lighting, allows parasitic light to pass that is sufficiently intense to mask some of the fluorescence photons derived from deep regions and which are therefore few in number.

By means of this filtering, the detector becomes more sensitive to the fluorescence signal emitted from the deep layers and produces more contrasted images.

Also, since this filtering is applied to the detector which has a small surface area, it has no resultant effect on the cost of the system

According to one embodiment of the invention, the wavelength of excitation radiation is between 630 and 810 nm.

Preferably, the bandwidth in which the detector filter transmits fluorescent radiation is between 50 and 70 nm.

According to one particularly advantageous embodiment of the invention, the range of wavelengths in which the product of the attenuation of the detector filter and the attenuation of the low–pass filter of the illuminating device leads to an attenuation by a factor of at least 10^6, extends at least up to the limit detection wavelength of the detector

Therefore the range of wavelengths in which the product of detector filter attenuation and low–pass filter attenuation by the illuminating device leads to an attenuation by a factor of at least 10^6 preferably extends at least up to 1000 nm, and even further preferably up to 1150 nm.

In addition, in the range of wavelengths transmitted by the detector filter, the low–pass filter of the illuminating device exhibits attenuation by a factor of at least 10^6.

CLAIMS

1. A fluorescence imaging system for an operating room comprising an operating room illuminating device (B) capable of emitting white light, and a fluorescence imaging device (I),

the fluorescence imaging device (I) comprising:

- a light source (S) capable of emitting excitation radiation (L_E) to excite a fluorescent marker in a range of emission wavelengths (L_F) of between 600 and 900 nm;
- a detector (D) adapted to detect the fluorescent radiation (L_F) emitted by the marker under the effect of excitation by the light source (S);
- a filter (F_D) for the detector (D) adapted to attenuate the excitation radiation (L_E) and to transmit to the detector (D) those photons having a wavelength included in the range of wavelengths of fluorescent radiation (L_F) emitted by the marker,

the light emitted by the illuminating device (B) being filtered by a low–pass filter (F_B) having a cut–off wavelength (λ_{Bmax}) below the emission range (L_F) of the fluorescent marker, the low–pass filter (F_B) nonetheless being able to exhibit attenuation peaking or fluctuations at wavelengths above the emission range (L_F) of the fluorescent marker,

the system being **characterized** in that in a range of wavelengths (Z_D) extending from an upper cut–off wavelength (λ_{max}) below the wavelength on and after which attenuation peaking or fluctuations of the low–pass filter of the illuminating device are observed, the product of attenuation by the filter (F_D) of the detector and of attenuation by the low–pass filter (F_B) of the illuminating device leads to an attenuation by a factor of at least 10^6.

2. The system according to claim 1, characterized in that the wavelength of excitation radiation is between 630 and 810 nm.

3. The system according to one of claims 1 or 2, characterized in that the bandwidth in which the filter of the detector transmits fluorescent radiation is between 50 and 70 nm.

4. The system according to one of claims 1 to 3 characterized in that the range of wavelengths (Z_D), in which the product of attenuation by the detector filter and of attenuation by the low–pass filter of the illuminating device (B) leads to attenuation by a factor of at least 10^6, extends at least as far as the limit detection wavelength of the detector (D).

5. The system according to one of claims 1 to 4 characterized in that the range of wavelengths, in which the product of attenuation by the filter of the detector (D) and of attenuation by the low–pass filter of the illuminating device (B) leads to attenuation by a factor of at least 10^6, extends at least as far as 1000 nm, preferably as far as 1150 nm.

6. The system according to one of claims 1 to 5 characterized in that in the range (λ_{lower}, λ_{upper}) of wavelengths transmitted by the detector filter, the low–pass filter (F_B) of the illuminating device (B) exhibits attenuation by a factor of at least 10^6.

7. The system according to one of claims 1 to 6, characterized in that the illuminating device (B) comprises a dome-shaped light–head which can be positioned via a hinged arm.

8. The system according to one of claims 1 to 6, characterized in that the illuminating device (B) comprises a headlamp.

9. The system according to one of claims 1 to 8, characterized in that the illuminating device (B) is adapted to provide continuous lighting.

10. The system according to one of claims 1 to 9, characterized in that the illuminating device is adapted to provide pulsed lighting.

11. The system according to one of claims 1 to 10, characterized in that the illuminating device (B) comprises light–emitting diodes.

12. The system according to one of claims 1 to 11, characterized in that the power of the illuminating device is 40 kLux or higher.

13. The system according to one of claims 1 to 12, characterized in that the detector (D) is a CCD or CMOS camera.

14. The system according to one of claims 1 to 13, characterized in that the excitation wavelength is 780 nm and in that the filter (F_D) of the detector transmits radiation in a band between 820 and 850 nm.

15. The system according to one of claims 1 to 14, characterized in that the excitation wavelength is 750 nm and in that the filter (F_D) of the detector transmits radiation in a band between 780 and 870 nm.