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5	Foreign Reference	WO_2011063347_A2.pdf	10335553	no	76
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Doc code: IDS

Doc description: Information Disclosure Statement (IDS) Field

PTO/SB/08a (01-10)

Approved for use through 07/31/2012. OMB 0651-0031

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number		16/046,643
	Filing Date		July 26, 2018
	First Named Inventor	Angus Pacala	
	Art Unit	2878	
	Examiner Name	John R Lee	
	Attorney Docket Number	103033-1096583-P001USC2	

U.S. PATENTS								
Examiner Initial*	Cite No	Patent Number	Kind Code ¹	Issue Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear		
	1	11025885		Jun 1, 2021	Pacala et al.			
U.S. PATENT APPLICATION PUBLICATIONS								
Examiner Initial*	Cite No	Publication Number	Kind Code ¹	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear		
FOREIGN PATENT DOCUMENTS								
Examiner Initial*	Cite No	Foreign Document Number ³	Country Code ²	Kind Code ⁴	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear	T ⁵
	2	103048046	CN		Apr 17, 2013	Zhejiang University		
NON-PATENT LITERATURE DOCUMENTS								
Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.						T ⁶
	3	17/317,809 , "U.S. Patent Application No.", Optical System for Collecting Distance Information Within a Field, May 11, 2021, 40 pages						
	4	17/323,962 , "U.S. Patent Application No.", Optical System for Collecting Distance Information Within a Field, May 18, 2021, 39 pages						
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¹ See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. ² Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). ³ For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document.

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SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/ William L. Shaffer /	Date (YYYY-MM-DD)	2021-07-29
Name/Print	William L. Shaffer	Registration Number	37,234

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Abstract of CN103048046 (A)

The invention discloses a double-beam spectrometer, which comprises a light source for emitting reference light and detection light and a spectrometer main unit. The double-beam spectrometer is also provided with a first optical fiber, a second optical fiber and a third optical fiber, wherein the first optical fiber is used for transmitting the reference light from the light source to the spectrometer main unit; the second optical fiber is used for transmitting the detection light from the light source to a sample; and the third optical fiber is used for transmitting the detection light with sample information from the sample to the spectrometer main unit. The spectrometer main unit comprises a slit piece, a collimating lens, a plane grating, an imaging lens, a cylindrical lens and an area array detector, which are sequentially arranged along a light path. The emergent light of the first and second optical fibers enters the slit piece. The reference light and the detection light are simultaneously displayed and received, and the influence of light source fluctuation, stray light and electrical noise is effectively eliminated.

Abstract of CN103048046 (A)

The invention discloses a double-beam spectrometer, which comprises a light source for emitting reference light and detection light and a spectrometer main unit. The double-beam spectrometer is also provided with a first optical fiber, a second optical fiber and a third optical fiber, wherein the first optical fiber is used for transmitting the reference light from the light source to the spectrometer main unit; the second optical fiber is used for transmitting the detection light from the light source to a sample; and the third optical fiber is used for transmitting the detection light with sample information from the sample to the spectrometer main unit. The spectrometer main unit comprises a slit piece, a collimating lens, a plane grating, an imaging lens, a cylindrical lens and an area array detector, which are sequentially arranged along a light path. The emergent light of the first and second optical fibers enters the slit piece. The reference light and the detection light are simultaneously displayed and received, and the influence of light source fluctuation, stray light and electrical noise is effectively eliminated.



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(73) 专利权人 浙江大学

地址 310027 浙江省杭州市西湖区浙大路
38 号

(72) 发明人 刘康 庄振锋 余飞鸿

(74) 专利代理机构 杭州天勤知识产权代理有限公司 33224

代理人 胡红娟

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(56) 对比文件

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审查员 丁文

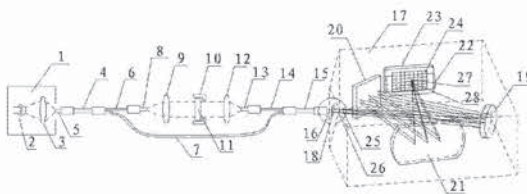
权利要求书1页 说明书5页 附图1页

(54) 发明名称

双光束光谱仪

(57) 摘要

本发明公开了一种双光束光谱仪, 包括用于发出参考光和探测光的光源, 以及光谱仪主机, 还设有: 第一光纤, 用于将来自光源的参考光输送至光谱仪主机; 第二光纤, 用于将来自光源的探测光输送至样品; 第三光纤, 用于将来自样品的已带有样品信息的探测光输送至光谱仪主机; 所述光谱仪主机包括沿光路依次布置的狭缝片、准直镜、平面光栅、成像镜、柱面镜和面阵探测器; 所述第一光纤和第三光纤的出射光线均进入所述狭缝片。本发明将参考光和探测光同时显示并接收, 有效消除了光源波动、杂散光、电噪声的影响。



1. 一种双光束光谱仪,包括用于发出参考光和探测光的光源,以及光谱仪主机,其特征在于,还设有:

第一光纤,用于将来自光源的参考光输送至光谱仪主机;

第二光纤,用于将来自光源的探测光输送至样品;

第三光纤,用于将来自样品的已带有样品信息的探测光输送至光谱仪主机;

所述光谱仪主机包括沿光路依次布置的狭缝片、准直镜、平面光栅、成像镜、柱面镜和面阵探测器;所述第一光纤和第三光纤的出射光线均进入所述狭缝片;

所述第一光纤、第二光纤和第三光纤组成双芯光纤,该双芯光纤具有贴近光源的第一双芯端口,以及靠近狭缝片的第二双芯端口。

2. 如权利要求1所述的双光束光谱仪,其特征在于,所述第一光纤和第二光纤的输入端组成所述的第一双芯端口,第一光纤和第三光纤的输出端组成第二双芯端口,所述第二光纤的输出端为第一单芯端口,所述第三光纤的输入端为第二单芯端口;所述的第一双芯端口、第二双芯端口、第一单芯端口和第二单芯端口均为 SMA905 接口,其出射或接收的光数值孔径为 0.22。

3. 如权利要求2所述的双光束光谱仪,其特征在于,所述第一双芯端口和第二双芯端口的两个纤芯直径相同,且两个纤芯沿端面直径方向对称排列。

4. 如权利要求3所述的双光束光谱仪,其特征在于,所述纤芯的直径为 100um 或 200um。

5. 如权利要求4所述的双光束光谱仪,其特征在于,所述两个纤芯中心距离为 600um、800um、1000um、1200um 或 1400um。

6. 如权利要求5所述的双光束光谱仪,其特征在于,所述光源包括发光灯泡,以及用于将光束聚焦到第一双芯端口端面的光束整形透镜。

7. 如权利要求6所述的双光束光谱仪,其特征在于,所述狭缝片设置为单缝或双缝。

8. 如权利要求7所述的双光束光谱仪,其特征在于,所述单缝位于狭缝片中芯,其缝宽 10um ~ 100um,狭缝长度 1mm;所述双缝位于狭缝片的中心,且竖直排列,其缝宽 10um ~ 100um,单缝长度 400um。

9. 如权利要求8所述的双光束光谱仪,其特征在于,所述面阵探测器 CCD、CMOS 或者 PDA 器件。

双光束光谱仪

技术领域

[0001] 本发明属于光谱测量领域,涉及一种可以同时显示和分析参考光和探测光的双光束光谱仪。

背景技术

[0002] 光谱仪是进行光谱研究和分析的基本光学检测仪器,通过对透射、反射、吸收光谱的测量来实现对光成分的分析、材料属性的分析、物质成分的鉴定等。目前,光谱仪广泛应用于光学检测、生物化学分析、冶金工业、环境检测、大气遥感、天文研究等领域,对于光谱测量的准确性要求也越来越高。

[0003] 光谱仪按照其仪器的光路结构通常可以分为单光束光谱仪和双光束光谱仪两类。单光束光谱仪采用单束复色光分别两次测量参考光和探测光来进行光谱测量和分析。该种光谱仪无法同时显示和测量参考光和探测光,其光路结构无法抵消光源波动带来的误差,同时由于需要取放被测样品会导致光束采集系统的机械位置变动而进一步引入测量误差;但是单光束光谱仪结构简单,体积可以做的很小,便于携带,并且由于是采用单束光照明被测样品,光强相比较双光束光谱仪的强,信噪较高,仪器灵敏度高,价格较低。双光束光谱仪运用两束单色光同时测量和显示参考光和探测光,可以一定程度上抵消光源波动、杂散光和电路噪声带来的影响,在用于定点测量时,具有更好的光度准确度。双光路光谱仪内部运用机械转动机构来对单色波长进行扫描致使测量速度大大受限,另外双光束的机构是将同一束光分成两束降低了参考光的光强致使信噪比下降,这类仪器结构复杂,价格昂贵。

[0004] 国际上对于光谱仪中单光束和双光束的优劣看法不一:一种认为双光束光谱仪可以抵消一部分杂散光、电路噪声、光源波动对光谱仪稳定性的影响,光谱测量的结果准确性更高;另一种则认为由于光谱预处理算法的发展,单光束光谱仪的可靠性可以用软件来进行补偿,其性噪比高、体积小、测量快速、价格低廉的特点使其更有优势。

发明内容

[0005] 为克服传统单光束光谱仪和双光束光谱仪存在的问题和不足,本发明提供了一种能快速测量、具有双光路结构的双光束光谱仪,其内部没有转动机械部件,采集面阵探测器同时采集参考光和探测光,实现对光谱的准确、快速测量。

[0006] 一种双光束光谱仪,包括用于发出参考光和探测光的光源,以及光谱仪主机,其特征在于,还设有:

[0007] 第一光纤,用于将来自光源的参考光输送至光谱仪主机;

[0008] 第二光纤,用于将来自光源的探测光输送至样品;

[0009] 第三光纤,用于将来自样品的已带有样品信息的探测光输送至光谱仪主机;

[0010] 所述光谱仪主机包括沿光路依次布置的狭缝片、准直镜、平面光栅、成像镜、柱面镜和面阵探测器;所述第一光纤和第三光纤的出射光线均进入所述狭缝片。

[0011] 所述第一光纤、第二光纤和第三光纤组成双芯光纤,该双芯光纤具有贴近光源的

第一双芯端口,以及靠近狭缝片的第二双芯端口。

[0012] 采用双芯光纤可以有效的将光源光分成两束,形成参考光和探测光,并最后同时由光谱仪探测器接收。这种光纤连接的模式,结构紧凑,成本低,有效避免了开放光路装调的困难,适应了系统微型化的需求。

[0013] 所述第一光纤和第二光纤的输入端组成所述的第一双芯端口,第一光纤和第三光纤的输出端组成第二双芯端口,所述第二光纤的输出端为第一单芯端口,所述第三光纤的输入端为第二单芯端口;所述的第一双芯端口、第二双芯端口、第一单芯端口和第二单芯端口均为 SMA905 接口,其出射或接收的光数值孔径 (NA) 为 0.22。SMA905 和 NA0.22 为光谱仪器中最为常用的光纤接口方式和数值孔径,使用该种接口和数值孔径可以保证双芯光纤与光谱仪主机的连接。

[0014] 第二光纤和第三光纤之间依次设有第一光纤准直镜、样品架和第二光纤准直镜,第一光纤准直镜用于将第二光纤出射的光束准直后照射到样品上,第二光纤准直镜用于将带有样品信息的探测光聚焦到第二单芯端口并耦合进入第三单芯光纤。上述的第一光纤准直镜和第一光纤准直镜可以是单透镜、双胶合消色差透镜、双分离消色差透镜或自聚焦透镜。

[0015] 所述光源包括发光灯泡,以及用于将光束聚焦到第一双芯端口端面的光束整形透镜。发光灯泡根据测量波段可以选取氙灯(紫外可见波段)、卤钨灯(可见近红外波段)或者氙灯(紫外可见近红外波段)。

[0016] 所述第一双芯端口和第二双芯端口的两个纤芯直径相同,且两个纤芯沿端面直径方向对称排列。第一双芯端口中两个相同直径纤芯,可以保证从光源接收到同等光强的光用作参考光(第一光纤)和照明光束(第二光纤)。第二双芯端口中两个相同直径的纤芯,其中一个纤芯为第一光纤,另一个纤芯(第三光纤)必须保证与第一光纤纤芯相同,保证在无样品情况下第一光纤与第二、三光纤两路光路的能量同等传输。

[0017] 双芯光纤的设计中,纤芯的直径需要与两纤芯中心距离相配合。纤芯的直径决定了探测器像面上成像点的大小,纤芯的中心距离决定了两束光(第一光纤和第三光纤)在探测器上成像点的距离。如果两者设置不当,会造成两束光成像的串扰,无法再探测器上分辨两束光的光强。本发明选用了 100um 纤芯的光纤配合中心距离 800um,可以很清晰的在探测器上分辨出参考光和探测光。纤芯的中心距离不可以过大,否则也会影响成像质量,考虑到实际加工的工艺,纤芯和纤芯距离必须是偶数,故所述纤芯的直径为 100um 或 200um,所述两个纤芯中心距离为 600um、800um、1000um、1200um 或 1400um。

[0018] 所述狭缝片设置为单缝或双缝;所述单缝位于狭缝片中芯,其缝宽 10um ~ 100um;所述双缝位于狭缝片的中心,且竖直排列,其缝宽 10um ~ 100um。狭缝的缝宽与光谱仪的分辨率有关,缝宽越小分辨率越高采集到的光能也就越小,光谱仪的分辨率要求与测量要求有关。本实例选取了 25um 宽的狭缝片来构建光谱仪。单缝结构:狭缝长度需要不影响双芯端口两个纤芯的通光,本发明狭缝长度设置为 1mm;双缝结构:单缝的长度需要确保双芯端口的单个纤芯的通光,本发明将单缝长度设置为 400um。

[0019] 所述面阵探测器 CCD、CMOS 或者 PDA 器件。CCD (Charge-Coupled Device) 中文全称:电荷耦合器件。CMOS (Complementary Metal Oxide Semiconductor) 中文全称:互补金属氧化物半导体。PDA (Photo-Diode Array) 中文全称:光电二极管阵列。针对目前主流

的商品化成像器件,本实例选取了成像质量更好,噪声更小的 CCD 器件作为光谱仪的光电探测器。

[0020] 本发明的优点是:

[0021] (1) 双光束光谱仪同时用面阵探测器接收并显示参考光和探测光,有效消除了光源波动、杂散光、电噪声的影响,避免了单光束光谱仪需要两次测量带来的测量误差;

[0022] (2) 本发明的双光束光谱仪不包含机械扫描转动结构,测量速度快,体积小,成本低,可以适合于各种条件下的光谱测量。

附图说明

[0023] 图 1 为本发明双光束光谱仪的光学结构示意图。

[0024] 图 2 为本发明的双芯光纤和狭缝片连接示意图。

[0025] 图 3 为本发明的面阵探测器成像结果示意图。

[0026] 图 4 为本发明的双芯端口和单芯端口示意图。

具体实施方式

[0027] 下面结合附图对本发明的双光束光谱仪作进一步的说明。

[0028] 如图 1 所示,一种双光束光谱仪包括光源 1、第一光纤 7、第二光纤 6、第三光纤 14 和光谱仪主机 17,光谱仪主机 17 包括沿光路依次布置的狭缝片 18、准直镜 19、平面光栅 20、成像镜 21、柱面镜 22 和面阵探测器 23。

[0029] 光源 1 包括发光灯泡 2 和光束整形透镜 3;光束整形透镜 3 用于将发光灯泡 2 发出的探测光和参考光聚焦到光纤端面上,有效提高了光源效率和光纤耦合效率。

[0030] 第一光纤 7、第二光纤 6 和第三光纤 14 组成双芯光纤 4 和双芯光纤 15,双芯光纤 4 具有贴近光源 1 的第一双芯端口 5,双芯光纤 15 具有靠近狭缝片 18 的第二双芯端口 16;第一双芯端口 5 包括第一光纤 7 的输入端和第二光纤 6 的输入端,第二双芯端口 16 包括第一光纤 7 的输出端和第三光纤 14 的输出端;第二光纤 6 的输出端为第一单芯端口 8,第三光纤 14 的输入端为第二单芯端口 13。

[0031] 如图 2 所示,第一双芯端口 5 和第二双芯端口 16 的两个纤芯直径相同,可以为 75 μm 、100 μm 或 200 μm ;且两个纤芯沿端面直径方向对称排列,纤芯中心距离可以是 600 μm 、800 μm 或 1400 μm ,本发明优选为 100 μm 纤芯的光纤配合中心距离为 800 μm 。

[0032] 第一单芯端口 8 和第二单芯端口 13 具有单个光纤纤芯,纤芯位于端面中心,纤芯直径可以为 75 μm 、100 μm 或 200 μm 。

[0033] 第一光纤 7、第二光纤 6 和第三光纤 14 的纤芯通光波段为 200 ~ 1100nm,且纤芯为普通多模光纤。

[0034] 第二光纤 6 和第三光纤 14 之间依次设有第一光纤准直镜 9、样品架 10 和第二光纤准直镜 12,第一光纤准直镜 9 用于将第二光纤 6 出射的光束准直后照射到样品 11 上,第二光纤准直镜 12 用于将带有样品信息的探测光聚焦到第二单芯端口 13 并耦合进入第三光纤 14。

[0035] 第一光纤准直镜 9 和第二光纤准直镜 12 可以是单透镜、双胶合消色差透镜、双分离消色差透镜或自聚焦透镜。

[0036] 光谱仪主机 17 为尔尼特纳光学结构,第二双芯端口 16 紧贴狭缝片 18,如图 3 所示,狭缝片 18 的缝可以为单缝 30 或双缝 29。若采用单缝 30 的狭缝片 18,单缝 30 应位于狭缝片中心,缝宽 $10\mu\text{m} \sim 100\mu\text{m}$,狭缝长度 1mm ;若采用双缝 29 的狭缝片,双缝 29 的两个狭缝位于狭缝片的中心,竖直排列,缝宽 $10\mu\text{m} \sim 100\mu\text{m}$,单缝长度 $400\mu\text{m}$ 。狭缝的宽度与光谱仪的分辨率有关,缝宽的选取取决于光谱测量的分辨率要求。

[0037] 准直镜 19 为球面发射镜;成像镜 21 可以是球面反射镜,也可以是校正慧差的抛物面反射镜,且成像镜表面镀铝,具有较高的能量利用率。

[0038] 平面光栅 20 可以是平面刻划光栅或平面全息光栅;本发明优选为平面全息光栅,其具有更好的色散效率和更低的杂散光。

[0039] 由于面阵探测器 23 接收到的是色散后的狭缝像(长条形),必须使用柱面镜 22 会聚光谱仪非色散方向的光,将长条形的像斑会聚到一点,提高光能利用率并保证参考光和探测光不会在面阵探测器 23 上相互重叠和串扰。该柱面镜 22 可以是普通柱面镜、楔形柱面镜或者自由曲面柱面镜,其材料可以是石英玻璃或 K9 玻璃。

[0040] 面阵探测器 23 可以是 CCD、CMOS 或者 PDA 器件,面阵探测器 23 光谱范围可以是紫外、可见、近红外波段范围。本发明采用 SONY 公司的 ICX285AL(黑白)探测器,具有较好的分辨率和灵敏度。面阵探测器 23 的光敏元表面 24 如图 4 所示,认为该面阵探测器 23 接收到的上半部分光谱 31 均为色散后的探测光,下半部分光谱 32 均为色散后的参考光。

[0041] 上述的装置工作过程如下:

[0042] 发光灯泡 2 发出的参考光和探测光在光束整形透镜 3 作用下,经第一双芯端口 4 分别进入第一光纤 7 和第二光纤 6,参考光从第二双芯端口 16 出射至狭缝片 18,探测光经第一单芯端口 8 出射并通过第一光纤准直镜 9 作用后照射到样品 11 上,第二光纤准直镜 12 将来自样品 11 的且带有样品信息的探测光聚焦到第二单芯端口 12 并耦合进入第三光纤 14 传输,然后带有样品信息的探测光经第二双芯端口 16 出射至狭缝片 18,参考光和探测光沿狭缝长度方向竖直排列,两束光经过准直镜 19 后平行入射到平面光栅 20 上,平面光栅 20 将两束光色散后由成像镜 21 成像,柱面镜 22 将两束光在非色散方向聚焦,并在面阵探测器 23 的光敏元表面 24 上同时成像为参考光谱 27 和探测光谱 28。

[0043] 本发明的双光束光谱仪,参考光和探测光的光能损耗不一致,即在光路中不放置样品 11 时,面阵探测器 23 接收到的两路光能信号 27 和 28 不相等,所以,在进行样品透过率计算时需要进行补偿,补偿系数 η 定义为:

[0044]

$$\eta = \frac{I_{\text{sample}_c}(\lambda_i)}{I_{\text{ref}_c}(\lambda_i)}$$

[0045] 式中, $I_{\text{sample}_c}(\lambda_i)$ 表示不放置样品 11 时光谱仪接收的探测光的光谱分布, $I_{\text{ref}_c}(\lambda_i)$ 表示同一时间参考光的光谱分布。最终计算样品透过率光谱分布需要将加上该补偿系数 η :

[0046]

$$T(\lambda_i) = \eta \cdot \frac{I_{\text{sample}}(\lambda_i)}{I_{\text{ref}}(\lambda_i)}$$

[0047] 式中, $I_{\text{sample}}(\lambda_i)$ 表示带有样品信息的探测光的光谱分布, $I_{\text{ref}}(\lambda_i)$ 表示参考光的光谱分布;样品测量之前需要对光谱仪进行波长定标。

[0048] 本发明最终可以将参考光和探测光同时显示并接收,有效消除了光源波动、杂散光、电噪声的影响,并解决了单光束光谱仪需要两次测量的不便和误差。本发明的光谱仪不包含机械扫描转动结构,测量速度快。本发明结合一般单光束光谱仪和双光束光谱仪特点的同时解决了两者的技术缺陷,可以快速精确进行光谱测量。

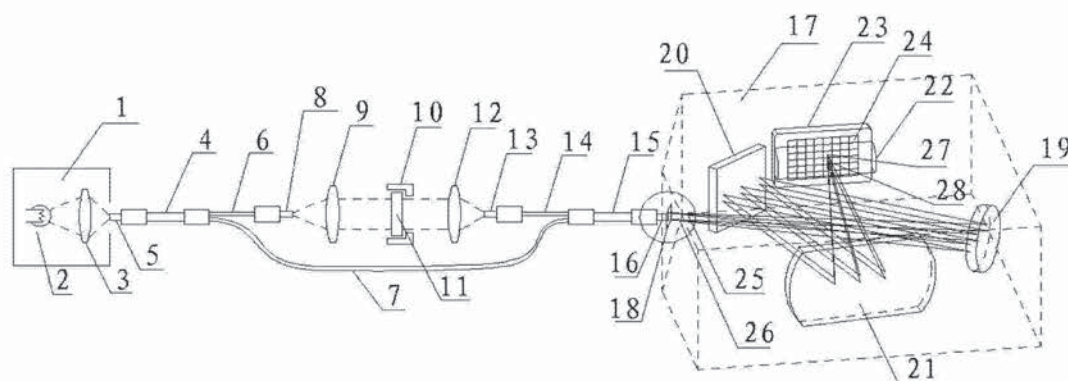


图 1

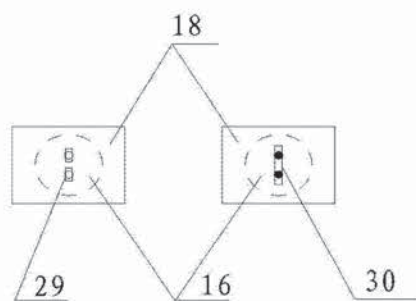
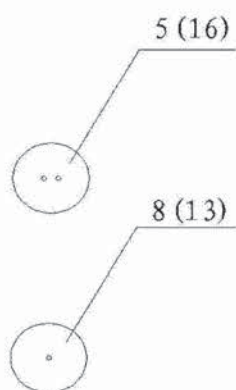


图 3

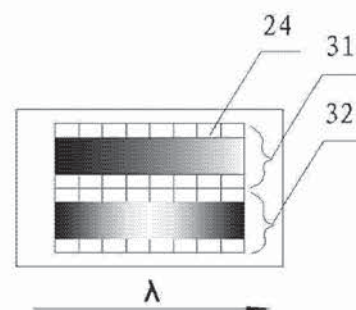


图 4

图 2

Electronic Patent Application Fee Transmittal				
Application Number:		16046643		
Filing Date:		26-Jul-2018		
Title of Invention:		OPTICAL IMAGING SYSTEM WITH A PLURALITY OF SENSE CHANNELS		
First Named Inventor/Applicant Name:		Angus Pacala		
Filer:		William Leland Shaffer/LaRenda Meyer		
Attorney Docket Number:		103033-P001USC2-1096583		
Filed as Small Entity				
Filing Fees for Utility under 35 USC 111(a)				
Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Miscellaneous:				
SUBMISSION- INFORMATION DISCLOSURE STMT	2806	1	130	130
Total in USD (\$)				130

Electronic Acknowledgement Receipt	
EFS ID:	43383984
Application Number:	16046643
International Application Number:	
Confirmation Number:	1720
Title of Invention:	OPTICAL IMAGING SYSTEM WITH A PLURALITY OF SENSE CHANNELS
First Named Inventor/Applicant Name:	Angus Pacala
Customer Number:	20350
Filer:	William Leland Shaffer/LaRenda Meyer
Filer Authorized By:	William Leland Shaffer
Attorney Docket Number:	103033-P001USC2-1096583
Receipt Date:	29-JUL-2021
Filing Date:	26-JUL-2018
Time Stamp:	19:50:06
Application Type:	Utility under 35 USC 111(a)

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Submitted with Payment	yes
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Payment was successfully received in RAM	\$ 130
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			97840f584fbfaeac1f8e6555d081f3f2c4ea96f9		
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5	Fee Worksheet (SB06)	fee-info.pdf	38031	no	2
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LEE, JOHN R

ART UNIT

PAPER NUMBER

2878

DATE MAILED: 08/18/2021

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/046,643	07/26/2018	Angus Pacala	103033- P001USC2-1096583	1720

TITLE OF INVENTION: OPTICAL IMAGING SYSTEM WITH A PLURALITY OF SENSE CHANNELS

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	SMALL	\$600	\$0.00	\$0.00	\$600	11/18/2021

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(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/046,643	07/26/2018	Angus Pacala	103033- P001USC2-1096583	1720

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nonprovisional	SMALL	\$600	\$0.00	\$0.00	\$600	11/18/2021

EXAMINER	ART UNIT	CLASS-SUBCLASS
LEE, JOHN R	2878	250-559170

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.

☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-09 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list

(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,

(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1	
2	
3	

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document must have been previously recorded, or filed for recordation, as set forth in 37 CFR 3.11 and 37 CFR 3.81(a). Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE

(B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent): ☐ Individual ☐ Corporation or other private group entity ☐ Government

4a. Fees submitted: ☐ Issue Fee ☐ Publication Fee (if required) ☐ Advance Order - # of Copies _____

4b. Method of Payment: (Please first reapply any previously paid fee shown above)

☐ Electronic Payment via EFS-Web ☐ Enclosed check ☐ Non-electronic payment by credit card (Attach form PTO-2038)

☐ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment to Deposit Account No. _____

5. Change in Entity Status (from status indicated above)

☐ Applicant certifying micro entity status. See 37 CFR 1.29

☐ Applicant asserting small entity status. See 37 CFR 1.27

☐ Applicant changing to regular undiscounted fee status.

NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.

NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.

NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature _____ Date _____

Typed or printed name _____ Registration No. _____



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UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/046,643	07/26/2018	Angus Pacala	103033- P001L/SC2-1096583	1720
20350 7590 08/18/2021 Kilpatrick Townsend & Stockton LLP - West Coast Mailstop: IP Docketing - 22 1100 Peachtree Street Suite 2800 Atlanta, GA 30309			EXAMINER LEE, JOHN R	
			ART UNIT 2878	PAPER NUMBER
DATE MAILED: 08/18/2021				

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b) (Applications filed on or after May 29, 2000)

The Office has discontinued providing a Patent Term Adjustment (PTA) calculation with the Notice of Allowance.

Section 1(h)(2) of the AIA Technical Corrections Act amended 35 U.S.C. 154(b)(3)(B)(i) to eliminate the requirement that the Office provide a patent term adjustment determination with the notice of allowance. See Revisions to Patent Term Adjustment, 78 Fed. Reg. 19416, 19417 (Apr. 1, 2013). Therefore, the Office is no longer providing an initial patent term adjustment determination with the notice of allowance. The Office will continue to provide a patent term adjustment determination with the Issue Notification Letter that is mailed to applicant approximately three weeks prior to the issue date of the patent, and will include the patent term adjustment on the patent. Any request for reconsideration of the patent term adjustment determination (or reinstatement of patent term adjustment) should follow the process outlined in 37 CFR 1.705.

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

OMB Clearance and PRA Burden Statement for PTOL-85 Part B

The Paperwork Reduction Act (PRA) of 1995 requires Federal agencies to obtain Office of Management and Budget approval before requesting most types of information from the public. When OMB approves an agency request to collect information from the public, OMB (i) provides a valid OMB Control Number and expiration date for the agency to display on the instrument that will be used to collect the information and (ii) requires the agency to inform the public about the OMB Control Number's legal significance in accordance with 5 CFR 1320.5(b).

The information collected by PTOL-85 Part B is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 30 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. **DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450.** Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Notice of Allowability	Application No. 16/046,643	Applicant(s) Pacala et al.	
	Examiner JOHN R LEE	Art Unit 2878	AIA (FITF) Status Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to the amendment and terminal disclaimer filed on 05/10/2021.
☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

3. ☒ The allowed claim(s) is/are 1-50 . As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.

4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
Certified copies:
a) ☐ All b) ☐ Some* c) ☐ None of the:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).
* Certified copies not received: _____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.
Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).

6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☒ Notice of References Cited (PTO-892) 2. ☒ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date <u>See Continuation Sheet</u> . 3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material _____. 4. ☐ Interview Summary (PTO-413), Paper No./Mail Date. _____.	5. ☐ Examiner's Amendment/Comment 6. ☒ Examiner's Statement of Reasons for Allowance 7. ☐ Other _____.
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/JOHN R LEE/ Primary Examiner, Art Unit 2878	
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Continuation of Attachment(s) 2. Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date: 02/09/2021; 04/15/2021; 05/10/2021; 06/03/2021; 07/12/2021; and 07/29/2021.

Notice of Pre-AIA or AIA Status

The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

Terminal Disclaimer

The terminal disclaimer filed on 05/10/2021 disclaiming the terminal portion of any patent granted on this application which would extend beyond the expiration date of any patent granted on SN 15/880,491 has been reviewed and is accepted. The terminal disclaimer has been recorded.

Reasons for Allowance

The following is an examiner's statement of reasons for allowance: Claims 1-34 remain allowed for the reasons provided in the Office action mailed on 02/10/2021. Claims 35-40 are allowed in view of the terminal disclaimer filed on 05/10/2021 noted above. Claims 41-43 are allowed by virtue of their claim dependency upon an allowed claim.

Claim 44 is allowed because the prior art fails to teach or fairly suggest an optical imaging system comprising: a bulk imaging optic; a plurality of pixels arranged behind the bulk imaging optic, wherein each pixel in the plurality of pixels comprises a plurality of single photon avalanche diodes (SPADs) and has a field of view that is non-overlapping beyond a threshold distance in a field external to the optical imaging system with fields of view of all other pixels in the plurality of pixels, and wherein the plurality of pixels includes at least a first pixel and a second pixel; an aperture layer disposed between the bulk imaging optic and the plurality of pixels, the aperture layer comprising a plurality of apertures separated from each other by a stop region, the plurality of apertures including a first aperture disposed in a first optical path extending between the bulk imaging optic and the first pixel and a second aperture disposed in a second optical path extending between the bulk imaging optic and the

second pixel; a bulk transmitting optic disposed adjacent to the bulk imaging optic; and a plurality of emitters arranged to project electromagnetic radiation through the bulk transmitting optic and into the field according to an illumination pattern where electromagnetic radiation output from each emitter in the illumination pattern is coincident with a field of view of a corresponding pixel in the plurality of pixels. Claims 45-50 are allowed by virtue of their claim dependency upon allowed claim 44.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to JOHN R. LEE whose telephone number is (571)272-2477. The examiner can normally be reached on Monday - Friday, 8:00 am - 5 pm.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at <http://www.uspto.gov/interviewpractice>.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Georgia Epps can be reached on (571) 272- 2328. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <https://ppair-my.uspto.gov/pair/PrivatePair>. Should you have questions on access to the Private PAIR system, contact

Application/Control Number: 16/046,643
Art Unit: 2878

Page 4

the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/JOHN R LEE/
Primary Examiner, Art Unit 2878

Notice of References Cited	Application/Control No. 16/046,643		Applicant(s)/Patent Under Reexamination Pacala et al.	
	Examiner JOHN R LEE		Art Unit 2878	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
*	A	US-11086013-B2	08-2021	Pacala; Angus	G01S7/4865	1/1
	B					
	C					
	D					
	E					
	F					
	G					
	H					
	I					
	J					
	K					
	L					
	M					

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	CPC Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

<i>Index of Claims</i> 	Application/Control No. 16/046,643	Applicant(s)/Patent Under Reexamination Pacala et al.
	Examiner JOHN R LEE	Art Unit 2878

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

CLAIMS									
☒ Claims renumbered in the same order as presented by applicant ☐ CPA ☒ T.D. ☐ R.1.47									
CLAIM		DATE							
Final	Original	02/05/2021	08/12/2021						
	1	=	=						
	2	=	=						
	3	=	=						
	4	=	=						
	5	=	=						
	6	=	=						
	7	=	=						
	8	=	=						
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	12	=	=						
	13	=	=						
	14	=	=						
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	32	=	=						
	33	=	=						
	34	=	=						
	35	✓	=						
	36	✓	=						
	37	✓	=						
	38	✓	=						
	39	O	=						
	40	O	=						
	41	=	=						
	42	=	=						

<i>Index of Claims</i> 	Application/Control No. 16/046,643	Applicant(s)/Patent Under Reexamination Pacala et al.
	Examiner JOHN R LEE	Art Unit 2878

CLAIM		DATE								
Final	Original	02/05/2021	08/12/2021							
	43		=							
	44		=							
	45		=							
	46		=							
	47		=							
	48		=							
	49		=							
	50		=							

<i>Search Notes</i> 	Application/Control No. 16/046,643	Applicant(s)/Patent Under Reexamination Pacala et al.
	Examiner JOHN R LEE	Art Unit 2878

CPC - Searched*		
Symbol	Date	Examiner
H04N13/0217, H04N13/0207, H04N13/0203, H04N13/0495, H04N13/0488, G02B3/0056, G02B3/0037, G02B3/0006, G02B5/005, G02B5/208, G02B5/20, G02B27/2214, G02B27/22, G01J1/08, G02B6/002, G01J1/02, G01J1/0266, G01J1/029, H04N13/218, G02B30/27, G02B27/46	01/26/2021	jl
Above to date.	08/11/2021	jl

CPC Combination Sets - Searched*		
Symbol	Date	Examiner

US Classification - Searched*			
Class	Subclass	Date	Examiner

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

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<i>Search Notes</i> 	Application/Control No. 16/046,643	Applicant(s)/Patent Under Reexamination Pacala et al.
	Examiner JOHN R LEE	Art Unit 2878

Search Notes		
Search Notes	Date	Examiner
Inventor name search.	01/26/2021	jl
Assignee search.	01/26/2021	jl
Consulted SN: 62/232,222; 15/276,532; 15/419,053; 15/861,330; 15/880,491; PCT/US17/39306; 62/112,553; 62/227,558; 15/934,338 and 16/584,515.	01/26/2021	jl
EAST; see search history print out.	01/26/2021	jl
Updated above; see search history print out.	08/11/2021	jl
Consulted SN 17/317,809 and 17/323,962.	08/11/2021	jl

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner
	US-PGPUB and USPAT; see search history print out.	08/11/2021	jl

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Issue Classification 	Application/Control No. 16/046,643	Applicant(s)/Patent Under Reexamination Pacala et al.
	Examiner JOHN R LEE	Art Unit 2878

CPC						
Symbol					Type	Version
H04N	/	13	/	218	F	2018-05-01
G02B	/	5	/	005	I	2013-01-01
G02B	/	3	/	0056	I	2013-01-01
G02B	/	5	/	208	I	2013-01-01
G02B	/	27	/	46	I	2013-01-01
G02B	/	30	/	27	I	2020-01-01

CPC Combination Sets					
Symbol		Type	Set	Ranking	Version
	/				

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	50	
/JOHN R LEE/ Primary Examiner, Art Unit 2878	12 August 2021	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	1

Issue Classification 	Application/Control No. 16/046,643	Applicant(s)/Patent Under Reexamination Pacala et al.
	Examiner JOHN R LEE	Art Unit 2878

INTERNATIONAL CLASSIFICATION				
CLAIMED				
H04N	/	13	/	218
G02B	/	5	/	20
G02B	/	27	/	46
G02B	/	3	/	00
G02B	/	5	/	00
	/		/	
	/		/	
	/		/	

NON-CLAIMED				
	/		/	

US ORIGINAL CLASSIFICATION	
CLASS	SUBCLASS

CROSS REFERENCES(S)						
CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)					

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	50	
/JOHN R LEE/ Primary Examiner, Art Unit 2878	12 August 2021	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	1

Issue Classification 	Application/Control No. 16/046,643	Applicant(s)/Patent Under Reexamination Pacala et al.
	Examiner JOHN R LEE	Art Unit 2878

☒ Claims renumbered in the same order as presented by applicant ☐ CPA ☒ T.D. ☐ R.1.47															
CLAIMS															
Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original

NONE (Assistant Examiner) _____ (Date) _____		Total Claims Allowed: 50	
/JOHN R LEE/ Primary Examiner, Art Unit 2878 (Primary Examiner) _____ (Date) 12 August 2021		O.G. Print Claim(s) 1	O.G. Print Figure 1

Doc code: IDS

Doc description: Information Disclosure Statement (IDS) Field

PTO/SB/08a (01-10)

Approved for use through 07/31/2012. OMB 0651-0031

U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number		16/046,643	
	Filing Date		July 26, 2018	
	First Named Inventor		Angus Pacala	
	Art Unit		2878	
	Examiner Name		John R Lee	
	Attorney Docket Number		103033-1096583-P001USC2	

U.S. PATENTS								
Examiner Initial*	Cite No	Patent Number	Kind Code ¹	Issue Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear		
U.S. PATENT APPLICATION PUBLICATIONS								
Examiner Initial*	Cite No	Publication Number	Kind Code ¹	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear		
FOREIGN PATENT DOCUMENTS								
Examiner Initial*	Cite No	Foreign Document Number ³	Country Code ²	Kind Code ⁴	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear	T ⁵
	1	2011063347	WO		May 26, 2011	Pelican Imaging Corporation		
	2	20120137432	KR		Dec 20, 2012	Qualcomm Incorporated		
	3	20130038388	KR		Apr 17, 2013	Fraunhofer-Gesellschaft Zur Foerderung Der Angewandten Forschung E.V.		
	4	2015037211	WO		Mar 19, 2015	Sony Corporation		
	5	20150072439	KR		Jun 29, 2015	Qualcomm Incorporated		
NON-PATENT LITERATURE DOCUMENTS								
Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.						T ⁵
EXAMINER SIGNATURE								
Examiner Signature		/JOHN R LEE/			Date Considered		08/11/2021	

KILPATRICK TOWNSEND 74957472 1

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /J.R.L./

Doc code: IDS

Doc description: Information Disclosure Statement (IDS) Field

PTO/SB/08a (01-10)

Approved for use through 07/31/2012. OMB 0651-0031

U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

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	Filing Date		July 26, 2018	
	First Named Inventor		Angus Pacala	
	Art Unit		2878	
	Examiner Name		John R Lee	
	Attorney Docket Number		103033-1096583-P001USC2	

U.S. PATENTS								
Examiner Initial*	Cite No	Patent Number	Kind Code ¹	Issue Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear		
	1	6028306	A	02-22-2000	Hayashi			
U.S. PATENT APPLICATION PUBLICATIONS								
Examiner Initial*	Cite No	Publication Number	Kind Code ¹	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear		
	2	20080037114		Feb 14, 2008	Sheblee et al.			
	3	20200041646		Feb 6, 2020	Pacala et al.			
	4	20200116560		Apr 16, 2020	Pacala et al.			
	5	20200116836		Apr 16, 2020	Pacala et al.			
	6	20200209355		Jul 2, 2020	Pacala et al.			
FOREIGN PATENT DOCUMENTS								
Examiner Initial*	Cite No	Foreign Document Number ³	Country Code ²	Kind Code ⁴	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear	T ⁵
	7	07181023	JP		Jul 18, 1995	Komatsu Ltd		
	8	09257440	JP		Oct 3, 1997	Takaoka Electric Mfg Co Ltd		
	9	10311950	JP		Nov 24, 1998	Olympus Optical Co Ltd		
	10	2004247461	JP		Sep 2, 2004	Toyota Central Res & Dev Lab Inc		
	11	2012202776	JP		Oct 22, 2012	Toyota Central R&D Labs Inc		
	12	2012530917	JP		Dec 6, 2012	Toyota Motor Europe NV/SA		
NON-PATENT LITERATURE DOCUMENTS								

KILPATRICK TOWNSEND 74670542 1

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /J.R.L./

Doc code: IDS

Doc description: Information Disclosure Statement (IDS) Field

PTO/SB/08a (01-10)

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number		16/046,643
	Filing Date		July 26, 2018
	First Named Inventor	Angus Pacala	
	Art Unit	2878	
	Examiner Name	John R Lee	
	Attorney Docket Number	103033-1096583-P001USC2	

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T ⁵
	13	15/880,491 , "Corrected Notice of Allowability", February 25, 2021, 2 pages	
	14	15/880,491 , "Notice of Allowability", March 16, 2021, 2 pages	
	15	Application No 16/584,515 , Notice of Allowance, Mailed On March 12, 2021, 11 pages	
	16	Application No CN201780015714.1 , Office Action, Mailed On March 11, 2021, 18 pages	
	17	Application No DKPA201970244 , Office Action, Mailed On February 12, 2021, 3 pages	
	18	Application No JP2019-516177 , Office Action, Mailed On April 1, 2021, 4 pages	

EXAMINER SIGNATURE

Examiner Signature	/JOHN R LEE/	Date Considered	08/11/2021
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*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

¹ See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. ² Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). ³ For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document.

⁴ Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. ⁵ Applicant is to place a check mark here if English language translation is attached.

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

☐ That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e) (1).

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Doc code: IDS

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number	16/046,643
	First Named Inventor	Angus Pacala
	Art Unit	2414
	Examiner Name	
	Attorney Docket Number	103033-1096583-P001USC2

U.S. PATENTS								
Examiner Initial*	Cite No	Patent Number	Kind Code ¹	Issue Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear		
U.S. PATENT APPLICATION PUBLICATIONS								
Examiner Initial*	Cite No	Publication Number	Kind Code ¹	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear		
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NON-PATENT LITERATURE DOCUMENTS								
Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.						T ⁵
	1	15/880,491, "Notice of Allowance", February 2, 2021, 7 pages						
	2	IN201847031610, "First Examination Report", January 28, 2021, 5 pages						
EXAMINER SIGNATURE								
Examiner Signature		/JOHN R LEE/			Date Considered		08/11/2021	
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EAST Search History

EAST Search History (Prior Art)

jl;
updated.

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S204	156	Pacala-Angus\$.in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/08/11 13:45
S205	113	Frichtl-Mark\$.in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/08/11 13:46
S206	99	Ouster.as.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/08/11 13:46
S207	238	(H04N13/0217).CPC.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/08/11 13:46
S208	217	(H04N13/0207).CPC.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/08/11 13:46
S209	437	(H04N13/0203).CPC.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/08/11 13:46
S210	101	(H04N13/0495).CPC.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/08/11 13:46
S211	47	(H04N13/0488).CPC.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/08/11 13:46
S212	12,197	(G02B3/0056).CPC.	US-PGPUB; USPAT; USOCR;	OR	ON	2021/08/11 13:46

			FPRS; EPO; JPO; DERWENT; IBM_TDB			
S213	2,766	(G02B3/0037).CPC.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/08/11 13:46
S214	4,562	(G02B3/0006).CPC.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/08/11 13:46
S215	8,529	(G02B5/005).CPC.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/08/11 13:46
S216	17,869	(G02B5/208).CPC.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/08/11 13:46
S217	12,089	(G02B5/20).CPC.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/08/11 13:46
S218	3,075	(G02B27/2214).CPC.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/08/11 13:46
S219	1,177	(G02B27/22).CPC.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/08/11 13:46
S220	150,249	((3d or "3-d" or (three adj dimension\$4)) same (image or imager or imaging or distance)) and (pixel or array) and (aperture or stop or pinhole or (pin adj hole))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/08/11 13:46
S221	90,924	S220 and ((bulk with optic\$4) or lens or objective)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/08/11 13:46

S222	5,162	S221 and (collimating with lens)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/08/11 13:46
S223	1,742	S221 and (diffusing or diffuser) with (detect\$4 or sens\$4 or pixel or photodetect\$4 or photosens\$4 or spad or pd)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/08/11 13:46
S224	292	S222 and S223	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/08/11 13:46
S225	275	(S222 or S223) and (single with photon with avalanche)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/08/11 13:46
S226	107	(S222 or S223) and (resonan\$4 with cavity with (photodiode or diode))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/08/11 13:47
S227	6,515	(S222 or S223) and (transmit\$4 or emitt\$4 or laser or led)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/08/11 13:47
S228	153	(resonan\$4 adj cavity adj (photodiode or diode))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/08/11 13:47
S229	2,514	(G01J1/08).CPC.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/08/11 13:47
S230	5,763	(G02B6/002).CPC.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/08/11 13:47
S231	3,802	(G01J1/02).CPC.	US-PGPUB; USPAT; USOCR; FPRS; EPO;	OR	ON	2021/08/11 13:47

			JPO; DERWENT; IBM_TDB			
S232	1,608	(G01J1/0266).CPC.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/08/11 13:47
S233	224	(G01J1/029).CPC.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/08/11 13:47
S234	3,227	(H04N13/218).CPC.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/08/11 13:47
S235	17,313	(G02B30/27).CPC.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/08/11 13:47
S236	3,587	(G02B27/46).CPC.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/08/11 13:47
S237	2	((("20110038459") or ("20080037114")).PN.	US-PGPUB; USPAT	OR	OFF	2021/08/11 16:14

EAST Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S238	5,132	((3d or "3-d" or (three adj dimension\$4)) same (image or imager or imaging or distance)) and (pixel or array) and (aperture or stop or pinhole or (pin adj hole))and ((bulk with optic\$4) or lens or objective) and (collimating with lens)	US-PGPUB; USPAT	OR	ON	2021/08/11 13:47
S239	1,738	((3d or "3-d" or (three adj dimension\$4)) same (image or imager or imaging or distance)) and (pixel or array) and (aperture or stop or pinhole or (pin adj hole))and ((bulk with optic\$4) or lens or objective) and (diffusing or diffuser) with (detect\$4 or sens\$4 or pixel or photodetect\$4 or photosens\$4 or spad or pd)	US-PGPUB; USPAT	OR	ON	2021/08/11 13:47



S240	176	S238 and (single with photon with avalanche)	US-PGPUB; USPAT	OR	ON	2021/08/11 13:47
S241	92	S238 and (resonan\$4 with cavity with (photodiode or diode))	US-PGPUB; USPAT	OR	ON	2021/08/11 13:47
S242	5,091	S238 and (transmit\$4 or emitt\$4 or laser or led)	US-PGPUB; USPAT	OR	ON	2021/08/11 13:47
S243	120	(resonan\$4 adj cavity adj (photodiode or diode))	US-PGPUB; USPAT	OR	ON	2021/08/11 13:47

8/11/2021 5:21:37 PM

C:\Users\jlee\Documents\EAST\Workspaces\16046643_amd_3.pts

Doc code: IDS

Doc description: Information Disclosure Statement (IDS) Field

PTO/SB/08a (01-10)

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number	16/046,643
	Filing Date	July 26, 2018
	First Named Inventor	Angus Pacala
	Art Unit	2878
	Examiner Name	John R Lee
	Attorney Docket Number	103033-1096583-P001USC2

U.S. PATENTS								
Examiner Initial*	Cite No	Patent Number	Kind Code ¹	Issue Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear		
	1	11025885		Jun 1, 2021	Pacala et al.			
U.S. PATENT APPLICATION PUBLICATIONS								
Examiner Initial*	Cite No	Publication Number	Kind Code ¹	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear		
FOREIGN PATENT DOCUMENTS								
Examiner Initial*	Cite No	Foreign Document Number ³	Country Code ²	Kind Code ⁴	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear	T ⁵
	2	103048046	CN		Apr 17, 2013	Zhejiang University		
NON-PATENT LITERATURE DOCUMENTS								
Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.						T ⁶
	3	17/317,809, "U.S. Patent Application No.", Optical System for Collecting Distance Information Within a Field, May 11, 2021, 40 pages						
	4	17/323,962, "U.S. Patent Application No.", Optical System for Collecting Distance Information Within a Field, May 18, 2021, 39 pages						
EXAMINER SIGNATURE								
Examiner Signature	/JOHN R LEE/			Date Considered	08/11/2021			
*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.								

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Doc code: IDS

Doc description: Information Disclosure Statement (IDS) Field

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	Filing Date		July 26, 2018	
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	Examiner Name		John R Lee	
	Attorney Docket Number		103033-1096583-P001USC2	

U.S. PATENTS								
Examiner Initial*	Cite No	Patent Number	Kind Code ¹	Issue Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear		
U.S. PATENT APPLICATION PUBLICATIONS								
Examiner Initial*	Cite No	Publication Number	Kind Code ¹	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear		
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	1.	Application No. 17/317,809 filed May 11, 2021, 81 pages.						
	2.	Application No. 17/323,962, filed May 18, 2021, 78 pages.						
EXAMINER SIGNATURE								
Examiner Signature		/JOHN R LEE/			Date Considered		08/11/2021	
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KILPATRICK TOWNSEND 74841391 1

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /J.R.L./

Bibliographic Data

Application No: 16/046,643

Foreign Priority claimed: ☐ Yes ☒ No

35 USC 119 (a-d) conditions met: ☐ Yes ☒ No ☐ Met After Allowance

Verified and Acknowledged:

/JOHN R LEE/

Examiner's Signature

Initials

Title:

OPTICAL IMAGING SYSTEM WITH A PLURALITY OF SENSE CHANNELS

FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
07/26/2018	250	2878	103033-P001USC2-1096583
RULE			

APPLICANTS

Ouster, Inc., San Francisco, CA,

INVENTORS

Angus Pacala, San Francisco, CA, UNITED STATES

Mark Frichtl, San Francisco, CA, UNITED STATES

CONTINUING DATA

This application is a CON of 15880491 01/25/2018 PAT 11025885

15880491 is a CON of 15276532 09/26/2016 PAT 9992477

15276532 has PRO of 62232222 09/24/2015

FOREIGN APPLICATIONS

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STATE OR COUNTRY

UNITED STATES

ADDRESS

Kilpatrick Townsend & Stockton LLP - West Coast

Mailstop: IP Docketing - 22

1100 Peachtree Street

Suite 2800

Atlanta, GA 30309

UNITED STATES

FILING FEE RECEIVED

\$1,085

Doc code: IDS

Doc description: Information Disclosure Statement (IDS) Filed

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number	16046643
	Filing Date	2018-07-26
	First Named Inventor	Pacala
	Art Unit	2878
	Examiner Name	John R Lee
	Attorney Docket Number	103033-P001USC2-1096583

U.S. PATENTS							Remove	
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	1	20110038459	A1	2011-02-17	ANDREWS, et al.			
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Examiner Initial*	Cite No	Foreign Document Number ³	Country Code ²ⁱ	Kind Code ⁴	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear	T ⁵
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**INFORMATION DISCLOSURE
STATEMENT BY APPLICANT**
(Not for submission under 37 CFR 1.99)

Application Number	16046643
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First Named Inventor	Pacala
Art Unit	2878
Examiner Name	John R Lee
Attorney Docket Number	103033-P001USC2-1096583

1

CN201780015714.1, "Supplemental Search Report", March 4, 2021, 1 page

If you wish to add additional non-patent literature document citation information please click the Add button

EXAMINER SIGNATURE

Examiner Signature	/JOHN R LEE/	Date Considered	08/11/2021
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¹ See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. ² Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). ³ For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. ⁴ Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. ⁵ Applicant is to place a check mark here if English language translation is attached.

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	Attorney Docket Number		103033-P001USC2-1096583	

U.S. PATENTS						
Examiner Initial*	Cite No	Patent Number	Kind Code ¹	Issue Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear

U.S. PATENT APPLICATION PUBLICATIONS						
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	1	20150115131		4/30/2015	Webster, et al.	

FOREIGN PATENT DOCUMENTS								
Examiner Initial*	Cite No	Foreign Document Number ³	Country Code ²	Kind Code ⁴	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear	T ⁵
	2	2007103590	JP		4/19/2007	Nikon Corp.		

NON-PATENT LITERATURE DOCUMENTS			
Examiner Initial*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T ⁵
	3	U.S. Patent Application No. 16/584,515, Notice of Allowance, mailed August 13, 2021, 10 pages	
	4	U.S. Patent Application No. 17/317,809, Notice of Allowance, mailed August 18, 2021, 33 pages	

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	Examiner Name	John R Lee
	Attorney Docket Number	103033-P001USC2-1096583

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Name/Print	William L. Shaffer	Registration Number	37,234

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JP2007103590A IMAGE PICK-UP DEVICE, FOCUS DETECTOR AND IMAGE PICK-UP SYSTEM

[0001] The present invention relates to an image sensor capable of acquiring a captured image and acquiring a shooting condition (state) such as focus detection, a focus detection apparatus including the same, and an imaging system.

[0002] It has been proposed that pixel cells for captured images are two-dimensionally arranged on a substrate of an image sensor, and pixel cells for focus detection are arranged in a predetermined layout therein (for example, Patent Documents 1 and 2). See). Further, in Patent Document 1, the focus detection by the phase difference detection method is taken as an example, and the pixel cell is made the same size as the pixel cell for the photographed image. In Patent Document 2, the focus detection of the contrast detection method is taken as an example, and the pixel cell is made smaller in size than the pixel cell for the photographed image.

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[0003] However, in the imaging device described above, the size of the focus detection pixel cell is the same as that of the captured image pixel cell (or smaller than the captured image pixel cell), so that the focus detection responsiveness is reduced at low luminance. There was a problem. This problem is not limited to focus detection pixel cells, and can occur in the same manner when pixel cells for distance measurement, photometry, and the like are arranged. An object of the present invention is to provide an imaging device, a focus detection device, and an imaging system that can improve responsiveness at low luminance when acquiring imaging conditions (for example, performing focus detection or distance measurement).

[0004] An imaging device according to the present invention includes a first pixel cell including a first photoelectric conversion unit that generates an electric charge according to incident light and an optical that collects incident light in the imaging device that captures an image by a photographing optical system. A second pixel cell including an element and a second photoelectric conversion unit that generates an electric charge according to light condensed by the optical element, and having a cell size larger than that of the first pixel cell. The first pixel cell and the second pixel cell are two-dimensionally arranged on the substrate.

[0005] Moreover, it is preferable that the cell size of the second pixel cell is an integer multiple of the first pixel cell. The first and second pixel cells each include an optical element that collects incident light on the first and second photoelectric conversion units, and the optical element of the second pixel cell is the first pixel cell. The aperture size is preferably larger than the optical element of the pixel cell.

[0006] An imaging element according to the present invention includes an optical element that collects incident light in an imaging element that captures an image by a photographing optical system, and a first photoelectric conversion that generates an electric charge according to the light collected by the optical element. A second pixel including a first pixel cell that includes a first pixel cell, an optical element that condenses incident light, and a second photoelectric conversion unit that generates a charge in accordance with the light collected by the optical element. A first pixel cell and a second pixel cell are two-dimensionally arranged on a substrate, and an optical element of the second pixel cell is an optical element of the first pixel cell. The opening size is larger than that.

[0007] The optical element of the first pixel cell preferably has an aperture size smaller than 20 μm . In addition, each of the second pixel cells includes a plurality of the second photoelectric conversion units, and each of the plurality of second photoelectric conversion units via the optical element of the second pixel cell. It is preferably substantially conjugate with the exit pupil of the photographing optical system.

[0008] In addition, it is preferable that two of the plurality of second photoelectric conversion units form a pair, and filters of different colors are arranged in each of the two second photoelectric conversion units forming the pair. Further, it is preferable that a focus adjustment state of the photographing optical system is detected based on a photoelectric output obtained by the second pixel cell. In addition, the optical element includes an optical element that collects incident light and a third photoelectric conversion unit that generates an electric charge according to the light collected by the optical element, and the cell size is different from that of the second pixel cell. It is preferable to further include a third pixel cell.

[0009] Moreover, it is preferable that the cell size of the third pixel cell is equal to that of the first pixel cell. Further, it is preferable that a focus adjustment state of the photographing optical system is detected based on a photoelectric output obtained by the second pixel cell and the third pixel cell. The focus detection apparatus of the present invention includes the above-described image sensor and detection means for performing focus detection based on the output of the second pixel cell.

[0010] A focus detection apparatus of the present invention includes the above-described imaging device, and a detection unit that performs focus detection based on at least one of the output of the second pixel cell and the output of the third pixel cell. is there. An imaging system of the present invention includes the above-described focus detection device and a photographing optical system disposed on the object side of the imaging element, and the detection unit performs focus detection of the photographing optical system.

[0011] In addition, the captured image is displayed based on the output of the first pixel cell, and the display of the position of the second pixel cell is superimposed on the captured image as a region where the detection unit performs focus detection. Preferably means are provided. In addition, an image signal at the position of the first pixel cell is generated based on the output of the first pixel cell, and an image signal at the position of the second pixel cell is generated by the second pixel cell. It is preferable that the image forming apparatus includes a generation unit configured to generate by interpolation processing based on the output of the surrounding first pixel cell.

[0012] In addition, when generating the image signal at the position of the second pixel cell, the generating unit generates each color component of the image signal by the interpolation process, and the luminance component of the image signal is converted to the second pixel. It is preferable to generate based on the output of the cell.

[0013] According to the present invention, it is possible to improve the responsiveness at the time of low luminance when acquiring photographing conditions (states) (for example, performing focus detection, distance measurement, photometry, etc.).

[0014] Hereinafter, embodiments of the present invention will be described in detail with reference to the drawings. (First Embodiment) Here, an image pickup device capable of acquiring a photographed image and acquiring information related to focus detection will be described. Further, description will be given by taking focus detection by the phase difference detection method as an example. The information related to focus detection is one of various conditions (shooting conditions) when acquiring a shot image, and corresponds to the defocus amount of the shooting optical system arranged on the object side of the image sensor. When the photographing optical system is in focus (ideally defocus amount = 0), a clear subject image is formed on the image sensor.

[0015] The image sensor 10 of the first embodiment includes a pixel cell 11 for a photographed image shown in FIG. 1A and a pixel cell 12 for focus detection shown in FIG. 1B, as shown in FIG. 1C. And arranged on a substrate. In FIG. 1C, each pixel cell 11 and 12 is hatched for easy understanding. FIGS. 1A to 1C are schematic views seen from the photographic optical system side. In addition to the pixel cells 11 and 12, the imaging element 10 is provided with a vertical scanning circuit, a horizontal scanning circuit, and the like (not shown).

[0016] In the present embodiment, each of the pixel cells 11 and 12 has a square shape. In addition, the focus detection pixel cell 12 has a larger cell size than the captured image pixel cell 11, and the four pixel cells 11 can be densely arranged in the size of one pixel cell 12. That is, the cell size of the focus detection pixel cell 12 is four times the cell size of the captured image pixel cell 11. In this case, the length A12 of one side of the pixel cell 12 is twice the length A11 of one side of the pixel cell 11.

[0017] On the substrate of the image sensor 10, the pixel cells 11 for captured images are two-dimensionally arranged almost densely, and focus detection pixel cells 12 are periodically embedded therein. The arrangement of the pixel cells 11 is a substantially square lattice. The pixel cell 11 for a captured image (FIG. 1A) is provided with a circular microlens 13 and a rectangular photoelectric conversion unit 14. The microlens 13 is an optical element that collects incident light and guides it to the photoelectric conversion unit 14. The photoelectric conversion unit 14 is a photodiode that generates an electric charge according to the light collected by the microlens 13. Although not shown, any one of RGB color filters is disposed between the microlens 13 and the

photoelectric conversion unit 14. The color filters of the plurality of pixel cells 11 have a predetermined RGB array (for example, a Bayer array).

[0018] In the pixel cell 11, the power of the microlens 13 is set so that an output proportional to the size of the exit pupil of the photographing optical system (that is, the aperture diameter of the photographing optical system) can be obtained. For this purpose, it is necessary to guide the light beam from the entire exit pupil to the photoelectric conversion unit 14 regardless of the exit pupil size, and the exit pupil size when the aperture diameter is maximized (for example, F1.4). The power of the microlens 13 is set based on this.

[0019] The pixel cell 12 for focus detection (FIG. 1B) is provided with a circular microlens 15 and two photoelectric conversion units 16 and 17 having a rectangular shape. The microlens 15 is an optical element that collects incident light and guides it to the photoelectric conversion units 16 and 17. The photoelectric conversion units 16 and 17 are photodiodes that generate charges in accordance with the light collected by the microlens 15, respectively. These two photoelectric conversion units 16 and 17 form a pair and are used for focus detection by the phase difference detection method using the microlens 15.

[0020] In addition, as can be seen from the cross-sectional view of FIG. 2, the pair of photoelectric conversion units 16 and 17 includes a surface p+ layer 23 and an n layer 24 of the substrate 22, respectively. A gate insulating film 25 (SiO₂ film) is formed on the surface of the substrate 22. Such a cross-sectional structure is similar to the above-described pixel cell 11 for a captured image. In the focus detection pixel cell 12, an infrared cut filter 21 is disposed between the pair of photoelectric conversion units 16 and 17 and the microlens 15 in order to remove infrared light unnecessary for focus detection. Is done. Incidentally, since the pair of photoelectric conversion units 16 and 17 are not provided with a color filter, light beams in the entire wavelength region of visible light are incident.

[0021] Further, in this pixel cell 12, in order to realize focus detection by the phase difference detection method, the pair of photoelectric conversion units 16 and 17 and the exit pupil of the photographing optical system are conjugated via the micro lens 15. That is, the power of the microlens 15 is set so that the pair of photoelectric conversion units 16 and 17 can be projected onto the exit pupil of the photographing optical system. Such a conjugate relationship is illustrated in FIG. In FIG. 3A, the exit pupil 18 is indicated by a thick dotted line. When the exit pupil 18 is viewed from the direction of the optical axis 19 of the photographing optical system (not shown), it is substantially circular as shown in FIG. The regions 8A and 8B in the exit pupil 18 are regions where the pair of photoelectric conversion units 16 and 17 are projected by the microlens 15 and have a substantially rectangular shape.

[0022] The regions 8A and 8B are arranged substantially symmetrically about the optical axis 19. Then, the light beam that has passed through the region 8 □/ b □ A of the exit pupil 18 enters one photoelectric conversion unit 16, and the light beam that has passed through the region 8 □/ b □ B enters the other photoelectric conversion unit 17. That is, the light beam passing through the exit pupil 18 can be divided into two and guided to the photoelectric conversion units 16 and 17 (pupil division method). It should be noted that when focus detection is performed using the phase difference detection method, when the pair of regions 8A and 8B partially protrudes from the exit pupil 18, light beams guided to the pair of photoelectric conversion units 16 and 17 (light beams used for focus detection). As a result, the focus detection accuracy deteriorates. Accordingly, in the pixel cell 12 for focus detection, the microlens 15 is arranged so that the pair of regions 8A and 8B are accommodated in the exit pupil 18 regardless of the size of the exit pupil 18 (that is, the aperture diameter of the photographing optical system). The power is set. Therefore, the power of the microlens 15 is set based on the size of the exit pupil 18 when the aperture diameter is minimum (for example, F2.8 or F5.6).

[0023] Furthermore, in this embodiment, the microlenses 13 and 15 are circular (FIGS. 1A and 1B), and the respective opening sizes (diameters) are the lengths A11 and A12 of one side of the pixel cells 11 and 12, respectively. Configured to be equal. Accordingly, by making the length A12 of one side of the pixel cell 12 longer than the length A11 of one side of the pixel cell 11 as described above, the aperture size of the microlens 15 for focus detection is set to that of the microlens 13 for the photographed image. It can be larger than the opening size. The aperture area can be increased by increasing the aperture size, and many light beams can be incident on the pair of photoelectric conversion units 16 and 17 through the microlens 15.

[0024] Further, the charge accumulated in the photoelectric conversion unit 14 of the pixel cell 11 for the captured image and the charge accumulated in the pair of photoelectric conversion units 16 and 17 of the pixel cell 12 for focus detection are, for example, FIG. It can be read out by the MOS type circuit configuration

shown in FIG. 4 shows 4×4 pixels (that is, 12 pixel cells 11 and 1 pixel cell 12) of the pixel cell 11, and a readout circuit thereof.

[0025] Since the focus detection pixel cell 12 includes the two photoelectric conversion units 16 and 17, the circuit portion of the pixel cell 12 corresponds to two pixel cells 11 for the captured image. Further, since the cell size of the pixel cell 12 corresponds to four times that of the pixel cell 11, the locations 30 (1), 30 (2) adjacent to the circuit portion of the pixel cell 12 and corresponding to two pixel cells 11.) Becomes empty. These locations 30 (1) and 30 (2) may be dummy.

[0026] The photoelectric conversion unit 14 of the captured image pixel cell 11 and the pair of photoelectric conversion units 16 and 17 of the focus detection pixel cell 12 are respectively a transfer switch MOS transistor 31 and a reset MOS transistor 32. The source follower amplifier MOS transistor 33 and the horizontal selection switch MOS transistor 34 are connected to the vertical output line V. The MOS transistors 31, 32, and 34 are connected to the vertical scanning circuit 41 through control lines R, P, and S, respectively. The vertical scanning circuit 41 controls on / off of the MOS transistors 31 and 33 and the like.

[0027] Further, a load MOS transistor 35 is connected to one end of the vertical output line V, and a horizontal output line H is connected via an output storage capacitor 37 and a horizontal transfer MOS transistor 38. An output amplifier 43 is connected to one end of the horizontal output line H. Further, a horizontal scanning circuit 42 is connected to the MOS transistor 38. The MOS transistor 35 constitutes a source follower similar to the MOS transistor 33 and is connected to a control circuit (not shown) via a control line L. The horizontal scanning circuit 42 controls on / off of the MOS transistor 38.

[0028] When accumulating charges in the photoelectric conversion units 14, 16, and 17, first, the control line L is set to high level to reset the vertical output line V, and then the control line L is set to low level. Next, the vertical scanning circuit 41 sets the control lines R and P to the high level to reset the photoelectric conversion units 14, 16 and 17, and then sets the control lines R and P to the low level. By this operation, the photoelectric conversion units 14, 16, and 17 are reset to a predetermined potential, and charge accumulation in the photoelectric conversion units 14, 16, and 17 is started.

[0029] When reading the charges of the photoelectric conversion units 14, 16, and 17, first, the vertical scanning circuit 41 sets the control line P to the high level to turn on the MOS transistor 31, and the charges of the photoelectric conversion units 14, 16, and 17 are changed. Applied to the gate of the MOS transistor 33. Further, the control line S is set to the high level to turn on the MOS transistor 34, and the charge on the horizontal line is selected as a reading target. At this time, the MOS transistor 33 generates an amplified signal in accordance with the amount of charge applied to its gate, and outputs it to the output storage capacitor 37 via the vertical output line V.

[0030] Each output stored in the output storage capacitor 37 is transferred to the horizontal output line H via the MOS transistor 38 in response to a scanning timing signal from the horizontal scanning circuit 42 to the MOS transistor 38. Further, the signal is transferred to the output amplifier 43 through the horizontal output line H, and read out through the signal amplification in the output amplifier 43. The output of the pixel cell 11 read out in this manner is caused by the electric charge accumulated in the photoelectric conversion unit 14, and is used for displaying a captured image in the imaging system including the imaging device 10 of the first embodiment. It is done. Further, the output of the pixel cell 12 is caused by the electric charges accumulated in the pair of photoelectric conversion units 16 and 17, and in the focus detection apparatus and the imaging system including the imaging device 10 of the first embodiment, the phase difference detection method is used. Used for focus detection.

[0031] When performing phase difference detection type focus detection based on the output of the pixel cell 12, the first subject image is captured from the output related to one of the plurality of pixel cells 12 and the other photoelectric conversion unit 17. The second subject image is taken in from the output related to, and the positional phase difference between the two subject images (that is, the positional deviation amount in the arrangement direction of the pair of photoelectric conversion units 16 and 17) is obtained by, for example, correlation calculation. Then, by converting this phase difference into a defocus amount (that is, a positional deviation amount in the optical axis direction) of the photographing optical system, information related to focus detection is generated.

[0032] In the imaging device 10 of the first embodiment, the aperture size of the focus detection microlens 15 is set to be used for a captured image in order to make the cell size of the focus detection pixel cell 12 larger than

the cell size of the captured image pixel cell 11. The opening size of the microlens 13 can be made larger, and the opening area can be increased accordingly. Therefore, as compared with the case where the focus detection pixel cell 12 has the same cell size as that of the captured image pixel cell 11 (or a cell size smaller than the pixel cell 11), a large amount of light flux passes through a pair of microlenses 15. The light can enter the photoelectric conversion units 16 and 17. As a result, an output level necessary for focus detection can be secured in a normal charge accumulation time even at low luminance, and responsiveness at low luminance can be improved.

[0033] Furthermore, in the image sensor 10 of the first embodiment, even when the cell size of the pixel cell 11 for photographed images is reduced (for example, when the pixel size is reduced to the wavelength order) as the number of pixels increases, the pixels for the photographed images are used. Compared with the microlens 13 of the cell 11, the aperture size of the microlens 15 of the focus detection pixel cell 12 can be ensured, and the influence of diffraction in the microlens 15 can be reduced.

[0034] Here, in order to explain the relationship between the aperture size of the microlens 15 and the influence of diffraction on the microlens 15, diffraction simulations (FIGS. 5 to 9) were performed. The simulation condition assumes a circular exit pupil 18 corresponding to F2.8 (FIG. 5A), assumes an XY coordinate system with the optical axis 19 of the imaging optical system as the origin, and starts from the exit pupil 18. The distance to the microlens 15 is 100 mm, and the size of the rectangular photoelectric conversion unit 16 (FIG. 5B) conjugate to the exit pupil 18 is $X = -2$ to -12 mm, and $Y = -10$ to 10 mm. This size is such that the photoelectric conversion unit 16 is projected in a substantially inscribed manner on the exit pupil 18 in an ideal case where there is no influence of diffraction as in the diffraction image 8C shown in FIG. 5. The wavelength was 500 nm.

[0035] Further, when the microlens 15 is circular (see FIG. 1B) and the opening size (diameter) of the microlens 15 is 20 μm , 10 μm , 4 μm , and 2 μm , the results are shown in FIGS. 6A to 9A. FIGS. 6A to 9A are schematic shapes of a diffraction image 8C of the photoelectric conversion unit 16 by the microlens 15 having each opening size. FIG. 6B to FIG. 9B are intensity distributions at $Y = 0$ of each diffraction image 8C.

[0036] As shown in FIGS. 6A and 6B, when the aperture size (diameter) of the microlens 15 is 20 μm , the influence of diffraction is small, and most of the diffraction image 8C (about 96%) is F2.8 within the exit pupil 18. Further, as shown in FIGS. 7A and 7B, when the aperture size (diameter) of the microlens 15 is 10 μm , the influence of diffraction increases, and a part (base) of the diffraction image 8C is F2.8. It protrudes from the exit pupil 18. The portion included in the exit pupil 18 is about 92%.

[0037] Further, as shown in FIGS. 8A and 8B, when the aperture size (diameter) of the microlens 15 is 4 μm , the influence of the diffraction is further increased, and the edge of the diffraction image 8C is staggered, and the diffraction image 8C protrudes from the exit pupil 18 of F2.8. The portion included in the exit pupil 18 is about 81%. Further, as shown in FIGS. 9A and 9B, when the aperture size (diameter) of the microlens 15 is 2 μm , the influence of diffraction further increases, and the diffraction image 8C spreads in a circular shape, and the diffraction image 8C. About half of the projection protrudes from the exit pupil 18 of F2.8. The portion included in the exit pupil 18 is about 60%.

[0038] As can be seen from this simulation, when the aperture size (diameter) of the microlens 15 becomes 20 μm or less, the projection performance of the microlens 15 deteriorates, and the shape of the diffraction image 8C projected on the exit pupil 18 is affected by the influence of diffraction. The collapse starts, and a part of the diffraction image 8C starts to spread outside the exit pupil 18. As the aperture size of the microlens 15 becomes smaller, the influence of diffraction increases, and about half of the diffraction image 8C protrudes outside the exit pupil 18 at a diameter of 2 μm as shown in FIGS.

[0039] That is, the influence of diffraction in the microlens 15 becomes prominent when the aperture size (diameter) is smaller than 20 μm . For this reason, when the aperture size (diameter) of the microlens 13 of the pixel cell 11 for captured images is smaller than 20 μm , the aperture size of the microlens 15 of the focus detection pixel cell 12 is smaller than that of the microlens 13. It is particularly effective to ensure a large value, and the influence of diffraction on the microlens 15 can be reliably reduced.

[0040] If the influence of diffraction in the microlens 15 can be reduced, the portion included in the exit pupil 18 in the pair of regions 8A and 8B (FIG. 3) projected onto the exit pupil 18 by the microlens 15 is increased (For example, FIG. 8 $\rightarrow$ FIG. 6), and the vignetting of the light beam used for focus detection can be suppressed. For this reason, the intensity distribution shapes of the two subject images described above can be substantially

matched, and an error in computation (for example, correlation computation) when obtaining the positional phase difference between the two subject images can be reduced. Therefore, it is possible to avoid a situation in which the focus detection accuracy is lowered as the number of pixels is increased.

[0041] Furthermore, when the aperture size (diameter) of the microlens 15 is larger than 20 μm , the pair of photoelectric conversion units 16 and 17 can be accurately projected onto the exit pupil 18 by the microlens 15 (see FIG. 5A). In other words, the projection can be performed so that the pair of regions 8A and 8B can be accommodated in the exit pupil 18, and the light flux used for focus detection can be eliminated to maintain good focus detection accuracy.

[0042] Further, in the image sensor 10 of the first embodiment, the cell size of the focus detection pixel cell 12 is set to four times the cell size of the captured image pixel cell 11 (see FIG. 1). Compared to the basic circuit configuration in the case where the image sensor is configured only from the pixel cells 11, it is not necessary to make a significant change. For this reason, even when the cell size of the focus detection pixel cell 12 is increased, the circuit configuration of the image sensor 10 is facilitated. Further, the microlens 15 can be easily manufactured. Further, no special change is required for the operation control of the image sensor 10.

[0043] (Second Embodiment) Here, an image pickup system 40 including the image pickup device 10 (FIGS. 1 to 4) will be described with reference to FIGS. As shown in FIG. 10, the imaging system 40 according to the second embodiment includes a photographing optical system 41, an aperture 42, an imaging element 10, a signal processing unit 43, an AD conversion unit 44, a signal processing unit 45, a memory unit 46, and timing generation. A unit 47, a control unit 48, interfaces (IF) 49 and 50, and an operation unit 51 are provided.

[0044] The photographing optical system 41 includes a lens group that forms a subject image on the image pickup surface of the image pickup device 10 and includes a focusing lens. The diaphragm 42 adjusts the amount of light flux that passes through the photographing optical system 41. The image sensor 10 captures a subject image by the photographing optical system 41 and outputs a signal for a photographed image and a signal for focus detection. The signal processing unit 43 includes a gain variable amplifier that amplifies the output of the image sensor 10 and a gain correction circuit that corrects the gain value. The AD converter 44 converts the signal (analog signal) after passing through the signal processor 43 into a digital signal. The signal processing unit 45 performs various corrections on the data output from the AD conversion unit 44. The memory unit 46 temporarily stores data after passing through the signal processing unit 45.

[0045] The timing generator 47 outputs various timing signals to the image sensor 10, signal processors 43 and 45, and AD converter 44. The control unit 48 performs various calculations and overall control of the imaging system 40. The IF 49 performs data recording and reading with respect to the removable recording medium 9A. The recording medium 9A is, for example, a semiconductor memory. The IF 50 communicates with an external computer (not shown). The operation unit 51 outputs a command corresponding to an operation from the outside to the control unit 48.

[0046] An operation (FIG. 11) of the imaging system 40 of the second embodiment will be described. First (step S1), after the main power supply is turned on, the control system power supply is turned on, and the imaging system circuit such as the AD converter 44 is turned on. Thereafter, the control unit 48 opens the aperture 42 in order to control the exposure amount. The output from the image sensor 10 is stored in the memory unit 46 after passing through the signal processing unit 43, the AD conversion unit 44, and the signal processing unit 45.

[0047] When the focus adjustment (steps S2 to S4) is started, the phase difference detection method is firstly performed using the data corresponding to the output of the focus detection pixel cell 12 among the data stored in the memory unit 46. Focus detection is performed (step S2). That is, for example, the positional phase difference between the two subject images described above is obtained by a well-known correlation calculation, and the defocus amount of the photographing optical system 41 is calculated.

[0048] Next (step S3), it is determined based on this defocus amount whether or not the photographing optical system 41 is in focus. If it is not yet in focus (step S3 is No), based on the defocus amount. The focusing lens of the photographing optical system 41 is driven and moved toward the in-focus position (step S4). Thereafter, the process returns to step S2, and the focus adjustment (steps S2 to S4) is repeated until the defocus amount becomes zero.

[0049] If it is determined that the photographing optical system 41 is in focus (Yes in Step S3), the process proceeds to Step S5, and when it is detected that the release button of the operation unit 51 is pressed, the

photographing operation is executed. (Step S6). That is, the output from the image sensor 10 is stored in the memory unit 46 via the AD conversion unit 44 or the like. Next, the control unit 48 generates an image signal by using data corresponding to the output of the pixel cell 11 for the photographed image among the data stored in the memory unit 46 by the photographing operation of Step S6 (Step S7).). An image signal at the position of the pixel cell 11 of the image sensor 10 is generated based on the data of the pixel cell 11. The image signal at the position of the focus detection pixel cell 12 is generated by interpolation processing based on the data of the pixel cells 11 around the pixel cell 12.

[0050] An example of image signal generation will be described. Here, it is assumed that the RGB array of the color filters of the plurality of pixel cells 11 is a Bayer array as shown in FIG. In this case, an image signal for one pixel at the position of the pixel cell 11 is obtained from the outputs of four adjacent pixel cells 11 (for example, G11a, B11, R11, G11b) by the following equations (1) to (4). Can be generated according to In the expressions (1) to (4), the output of each pixel cell 11 is I (G11a), I (B11), I (R11), I (G11b). Equation (1) is the luminance component I_{y11} of the image signal. Expressions (2) to (4) are the green component I_{g11} , red component I_{r11} , and blue component I_{b11} of the image signal, respectively. k_1 to k_3 are predetermined coefficients.

[0051] $I_{y11} = k_1 \times [I(G11a) + I(G11b)] + k_2 \times I(R11) + k_3 \times I(B11)$ (1) $I_{g11} = [I(G11a) + I(G11b)] / I_{y11}$ (2) $I_{r11} = I(R11) / I_{y11}$ (3) $I_{b11} = I(B11) / I_{y11}$ (4) Further, an image signal for one pixel at the position of the pixel cell 12 may be generated by the following interpolation processing. it can. First, assuming that the four pixel cells 11 (G22a, B22, R22, G22b) shown in FIG. 12B are arranged at the position of the pixel cell 12, the pixel cells 11 in four directions around the pixel cell 12 are arranged. (G12a, G21a, G23a, G32a,...) Are substituted into the following equations (5) to (8) to output the pixel cell 11 (G22a, B22, R22, G22b) in FIG. The data corresponding to is obtained. Calculations of equations (5) to (8) correspond to averaging processing.

[0052] $I(G22a) = [I(G12a) + I(G21a) + I(G23a) + I(G32a)] / 4$ (5) $I(G22b) = [I(G12b) + I(G21b) + I(G23b) + I(G32b)] / 4$... (6) $I(R22) = [I(R12) + I(R21) + I(R23) + I(R32)] / 4$... (7) $I(B22) = [I(B12) + I(B21) + I(B23) + I(B32)] / 4$ (8) Then, using the results of the expressions (5) to (8), the position of the pixel cell 12 is determined according to the following expressions (9) to (12). The image signal for one pixel can be generated. Equation (9) is the luminance component I_{y22} of the image signal. Expressions (10) to (12) are the green component I_{g22} , red component I_{r22} , and blue component I_{b22} of the image signal, respectively.

[0053] $I_{y22} = k_1 \times [I(G22a) + I(G22b)] + k_2 \times I(R22) + k_3 \times I(B22)$ (9) $I_{g22} = [I(G22a) + I(G22b)] / I_{y22}$ (10) $I_{r22} = I(R22) / I_{y22}$ (11) $I_{b22} = I(B22) / I_{y22}$ (12) When the generation of the image signal (processing in step S7 in FIG. 11) is completed in this way, these data are also stored in the memory unit 46. Is written to. Then, for the next photographing operation, the process returns to the process of step S2 and the processes such as focus detection are repeated. On the other hand, the image signals (luminance component, green component, red component, blue component) stored in the memory unit 46 are recorded on the recording medium 9A through the IF 49 under the control of the control unit 48. Further, the image signal may be processed by being output to an external computer or the like via the IF 50.

[0054] As described above, in the imaging system 40 of the second embodiment, focus detection of the imaging optical system 41 is performed based on the output of the pixel cell 12 for focus detection provided in the imaging device 10 (step S2 in FIG. 11). Therefore, it is possible to adjust the focus of the photographing optical system 41 with good responsiveness and accuracy even at low luminance. As a result, it is possible to obtain a focused image quickly even at low luminance.

[0055] Furthermore, in the imaging system 40 of the second embodiment, color filters are provided in the pair of photoelectric conversion units 16 and 17 of the pixel cell 12 in order to generate an image signal at the position of the focus detection pixel cell 12 by interpolation processing. Even if it is not, a good captured image can be obtained. (Modification 1) Here, a modification of the generation of the image signal at the position of the pixel cell 12 will be described.

[0056] When the outputs of the four pixel cells 11 (G22a, B22, R22, G22b) shown in FIG. 12B are obtained by interpolation processing, the pixel cells 11 (G11a, G12a, G13a, G21a) around the pixel cell 12 are displayed. , G23a, G31a, G32a, G33a, etc.) may be used for averaging processing similar to the above equations (5) to (8). Furthermore, weighting according to the relative position between the pixel cell 12 and the surrounding pixel cell 11 may be performed during the averaging process. By performing such processing, the accuracy of the interpolation processing is improved.

[0057] Further, when the luminance component I_{y22} is generated from the image signal at the position of the pixel cell 12, not the output of the four pixel cells 11 (G_{22a} , B_{22} , R_{22} , G_{22b}) obtained by the interpolation process, but the pixel cell 12 Output may be used. For example, if the outputs of the pair of photoelectric conversion units 16 and 17 of the pixel cell 12 are $I(W_{22a})$ and $I(W_{22b})$ (FIG. 12C), and these are substituted into the following equation (13), the luminance Component I_{y22} can be produced. k_4 is a predetermined coefficient.

[0058] $I_{y22} = k_4 \times [I(W_{22a}) + I(W_{22b})]$ (13) In this case, the color components I_{g22} , I_{r22} , and I_{b22} of the image signal are output from the pixel cell 12 in the above equations (10) to (12). Substituting the luminance component I_{y22} (Equation (13)) obtained from the above and the outputs of the four pixel cells 11 (G_{22a} , B_{22} , R_{22} , G_{22b}) obtained by the interpolation process.

[0059] Thus, by generating the luminance component I_{y22} of the image signal at the position of the pixel cell 12 based on the output of the pixel cell 12, the accuracy in generating the luminance component I_{y22} and the color components I_{g22} , I_{r22} , and I_{b22} is improved. improves. (Third Embodiment) Here, the digital still camera 60 of FIG. 13 will be described as a specific example of the imaging system 40 including the imaging device 10 (FIGS. 1 to 4).

[0060] The digital still camera 60 includes an interchangeable lens 61 and a camera body 62 and is coupled by a mount unit 63. The interchangeable lens 61 is provided with a photographing optical system (64, 65), a diaphragm 66, driving units 67, 68, and a lens CPU 69. The photographing optical system (64, 65) includes a lens 65 for focusing. The drive unit 67 drives the lens 65 for focusing. The drive unit 68 drives the diaphragm 66. The lens CPU 69 controls the operation of the drive units 67 and 68.

[0061] The camera body 62 is provided with the imaging device 10, a focus detection unit 71, a body CPU 72, a liquid crystal display element 73, an eyepiece lens 74, and a liquid crystal driving unit 75. The image sensor 10 is disposed on the planned imaging plane of the photographing optical system (64, 65) of the interchangeable lens 61. The focus detection unit 71 performs focus detection of the imaging optical system (64, 65) based on the output of the pixel cell 12 of the image sensor 10. The body CPU 72 performs overall operation control of the digital still camera 60. The liquid crystal display element 73 and the eyepiece lens 74 constitute a liquid crystal viewfinder. The liquid crystal driving unit 75 drives the liquid crystal display element 73 in accordance with an instruction from the body CPU 72.

[0062] The body CPU 72 and the lens CPU 69 are connected to various information (lens characteristics information such as an open F value, focus adjustment information for lens driving, and information for aperture control via an electrical contact 76 provided on the mount 63.). In the digital still camera 60 of the third embodiment, when the focus detection unit 71 performs focus detection of the imaging optical system (64, 65) based on the output of the pixel cell 12 of the image sensor 10, the focus detection unit 71 performs imaging for the body CPU 72. A defocus amount representing the focus adjustment state of the optical system (64, 65) is output. The body CPU 72 determines whether or not the photographing optical system (64, 65) is in an in-focus state based on the defocus amount. If the in-focus state is not in focus, the lens CPU 69 drives the lens according to the defocus amount. Output information.

[0063] The lens CPU 69 controls the drive unit 67 based on the lens drive information, and moves the focusing lens 65 toward the in-focus position. Further, the body CPU 72 generates an image signal based on the output of the pixel cell 11 of the image sensor 10, outputs this image signal to the liquid crystal drive unit 75, and displays a photographed image on the liquid crystal display element 73 of the liquid crystal viewfinder. Let At this time, it is preferable to perform an interpolation process similar to the above to generate and display an image signal at the position of the focus detection pixel cell 12.

[0064] As described above, in the digital still camera 60 according to the third embodiment, the focus detection of the imaging optical system (64, 65) of the interchangeable lens 61 is performed based on the output of the focus detection pixel cell 12 of the image sensor 10. Therefore, it is possible to adjust the focus of the photographing optical system (64, 65) with good responsiveness and accuracy even at low luminance. As a result, it is possible to obtain a focused image quickly even at low luminance.

[0065] (Fourth Embodiment) Here, an example of an image pickup device having two types of pixel cells for focus detection will be described with reference to FIGS. The image sensor 80 of the fourth embodiment is provided with a pixel cell 81 shown in FIG. 14A in addition to the pixel cells 11 and 12 shown in FIGS. In other words, the imaging element 80 is provided with the pixel cell 11 for a captured image and two types of pixel

cells 12 and 81 for focus detection. The configuration and operation of the pixel cells 11 and 12 shown in FIGS. 1A and 1B are the same as described above, and a description thereof is omitted here.

[0066] FIG. 14B shows a layout of the pixel cells 11, 12, 81. On the substrate of the image sensor 80, the pixel cells 11 for captured images are two-dimensionally arranged almost densely (square lattice shape), and one pixel cell 12 for focus detection is periodically embedded therein. The other pixel cells 81 for focus detection are arranged almost densely in a predetermined area. The pixel cell 81 shown in FIG. 14A has a square shape like the pixel cells 11 and 12. The pixel cell 81 has a cell size different from that of the focus detection pixel cell 12 and is the same as the pixel cell 11 for captured image. The length A81 of one side of the pixel cell 81 is equal to the length A11 of one side of the pixel cell 11. In other words, the newly provided focus detection pixel cell 81 is smaller than the focus detection pixel cell 12 described above. In the following description, the small pixel cell 81 and the large pixel cell 12 are referred to as necessary.

[0067] A small pixel cell 81 is provided with a circular microlens 82 and two rectangular photoelectric conversion units 83 and 84. The microlens 82 is an optical element that collects incident light and guides it to the photoelectric conversion units 83 and 84, and the opening size (diameter) thereof is equal to the length A 81 of one side of the pixel cell 81. The photoelectric conversion units 83 and 84 are photodiodes that generate charges in accordance with the light collected by the microlens 82, respectively. These two photoelectric conversion units 83 and 84 form a pair and are used for phase difference detection type focus detection using the microlens 82. For this reason, the pair of photoelectric conversion units 83 and 84 are arranged in a conjugate manner with the exit pupil of the photographing optical system (not shown) via the microlens 82 (see FIG. 3).

[0068] The cross-sectional structure of the pixel cell 81 (FIG. 15) is the same as the cross-sectional structure of the pixel cell 12 (FIG. 2), and the photoelectric conversion units 83 and 84 are formed on the surface p + layer 23 and the n layer 24 of the substrate 22. The gate insulating film 25 is formed on the surface of the substrate 22, and the infrared cut filter 21 is disposed between the photoelectric conversion units 83 and 84 and the microlens 82. Further, in the pixel cell 81, a pair of photoelectric conversion portions 83 and 84 are formed with the floating diffusion (FD) portion 2 A of the P-type well of the substrate 22 interposed therebetween. Then, in order to read out the charges accumulated in the pair of photoelectric conversion units 83 and 84 individually (or by adding) through the FD unit 2A, the transfer switch MOS transistors 85, 86 is provided. The MOS transistors 85 and 86 are connected to a vertical scanning circuit (not shown) via control lines P ' and P '' shown in FIG.

[0069] Therefore, the charges accumulated in the pair of photoelectric conversion units 83 and 84 can be transferred individually (or added) to the FD unit 2A in accordance with on / off of the MOS transistors 85 and 86 by the vertical scanning circuit. it can. For example, when one of the MOS transistors 85 is selectively turned on, only the charge of the photoelectric conversion unit 83 corresponding to the MOS transistor 85 is selectively transferred to the FD unit 2A. If both MOS transistors 85 and 86 are simultaneously turned on, the charges of the pair of photoelectric conversion units 83 and 84 are simultaneously transferred to the FD unit 2A and added there.

[0070] Further, the FD portion 2A is connected to the control line R ' via the reset MOS transistor 87, and is connected to the control line S ' and the vertical via the source follower amplifier MOS transistor 88 and the horizontal selection MOS transistor 89. Connected to the output line V. For this reason, the charge transferred to the FD unit 2A is amplified via the MOS transistor 88 and transferred to the vertical output line V via the MOS transistor 89.

[0071] The circuit configuration shown in FIG. 16 corresponds to one small pixel cell 81, and this pixel cell 81 has the same cell size as the pixel cell 11 for a captured image. For this reason, when the circuit portion of the pixel cell 81 is incorporated in the circuit configuration of FIG. Note that the control lines P ', P'', R ', and S ' in FIG. 16 are provided in common or independently with the control lines P, R, and S in FIG. 4, respectively.

[0072] Since the image sensor 80 of the fourth embodiment has two types of pixel cells 12 and 81 for focus detection, the two types of pixel cells 12 and 81 are selectively used according to various shooting conditions, and a focus suitable for the shooting conditions. Detection can be performed. For example, when it is desired to ensure the focus detection response at low luminance, it is preferable to use the output of the large pixel cell 12. Further, when it is desired to increase the accuracy of focus detection at high luminance, it is preferable to use the output of the small pixel cell 81. Since the small pixel cell 81 has a fine detection pitch, it is suitable for a fine subject.

[0073] Further, in the image sensor 80 of the fourth embodiment, the cell size of the large pixel cell 12 is four times the cell size of the captured image pixel cell 11 and the cell size of the small pixel cell 81 is the cell size of the pixel cell 11. Therefore, it is not necessary to make a significant change compared to the basic circuit configuration in the case where the image sensor is configured only from the pixel cell 11 for the captured image. For this reason, the circuit configuration of the image sensor 80 is facilitated. Further, the microlenses 15 and 82 can be easily manufactured.

[0074] (Fifth Embodiment) Here, the operation of an imaging system (see FIGS. 10 and 13) provided with an imaging device 80 of the fourth embodiment will be described with reference to the flowchart of FIG. The operation procedure shown in FIG. 17 is provided with steps S11 to S13 instead of step S2 in FIG. Here, focus adjustment (steps S11 to S13, S3, S4) will be described.

[0075] In step S11, it is determined based on the output of a photometric sensor (not shown) provided in the imaging system whether or not the luminance of the subject is smaller than a predetermined value. If the luminance is smaller than the predetermined value (step S11 is Yes), focus detection is performed using the output of the large pixel cell 12 with high low luminance performance (step S13). On the other hand, when the luminance is equal to or higher than the predetermined value (No in step S11), focus detection is performed using the output of the small pixel cell 81 with high focus detection accuracy (step S12).

[0076] Therefore, in the imaging system of the fifth embodiment, focus adjustment can be performed with good responsiveness at low luminance, and focus adjustment can be performed with high accuracy at high luminance. Moreover, such proper use can be performed automatically. At high luminance, focus detection may be performed using both the pixel cells 12 and 81 having two large and small cell sizes.

[0077] (Modification 2) Here, an example will be described in which two types of focus detection pixel cells 12 and 81 (FIG. 14) having different cell sizes are switched in accordance with manual settings, various camera settings, interchangeable lens characteristics, and the like. When switching according to the focus adjustment mode, a small pixel cell 81 is selected with priority given to focus detection accuracy during one-shot AF (mode in which the lens is locked after focusing), and continuous AF (after focusing) is selected. It is conceivable that the large pixel cell 12 is selected with priority given to responsiveness in the mode in which the lens is driven by following the back and forth movement of the subject without locking the lens.

[0078] When switching according to the still image / moving image shooting mode, the small pixel cell 81 is selected with priority given to the focus detection accuracy in the still image shooting mode (still image shooting mode), and the moving image shooting mode (video It is conceivable to select the large pixel cell 12 in order to give priority to responsiveness in the image capturing mode). When switching according to the shooting mode of single shooting / continuous shooting, a small pixel cell 81 is selected with priority given to focus detection accuracy in the single shooting mode (mode for shooting images one by one), and the continuous shooting mode is selected. It is conceivable that the large pixel cell 12 is selected with priority given to responsiveness in the case of (a mode in which images are continuously captured).

[0079] When switching according to the portrait / sports shooting mode, the small pixel cell 81 is prioritized with focus detection accuracy in the portrait shooting mode (shooting mode suitable for shooting a stationary subject). It is conceivable to select the large pixel cell 12 with priority given to responsiveness in the sports shooting mode (shooting mode suitable for shooting a moving subject).

[0080] When switching according to the aperture value at the time of shooting, a small pixel cell 81 is selected with priority on focus detection accuracy when the aperture value is brighter than a predetermined value, and a large size with priority on responsiveness when darker than the predetermined value. It is conceivable to select the pixel cell 12. When switching according to the photographing magnification, when the photographing magnification is smaller than a predetermined value, the small pixel cell 81 is selected with priority on focus detection accuracy, and when larger than the predetermined value, the large pixel cell is given priority on responsiveness. It is conceivable to select 12.

[0081] When switching according to the open F value of the attached interchangeable lens, when the open F value is brighter than the predetermined value, the small pixel cell 81 is selected giving priority to the focus detection accuracy, and when it is darker than the predetermined value, responsiveness is selected. It is conceivable to select the large pixel cell 12 with priority given to. When switching according to the focal length of the attached interchangeable lens, priority is given to focus detection accuracy when the focal length is

shorter than a predetermined value, and small pixel cells 81 are selected, and priority is given to response when the focal length is longer than the predetermined value. Then, it is conceivable to select a large pixel cell 12.

[0082] When switching according to non-use / use of the strobe, the small pixel cell 81 is selected with priority given to the focus detection accuracy when shooting without using the strobe, and responsiveness when shooting using the strobe. It is conceivable to select the large pixel cell 12 with priority given to. When switching between using / not using a tripod, the small pixel cell 81 is selected with priority given to focus detection accuracy when shooting with the camera fixed to a tripod, etc., and the camera is not fixed to the tripod. It is conceivable to select the large pixel cell 12 with priority given to responsiveness when hand-held.

[0083] (Modification 3) Here, a modification of the layout of each pixel cell in the image sensor 10 (FIG. 1C) and the image sensor 80 (FIG. 14B) will be described. As shown in FIG. 18, the pixel cells 11 for photographed images may be arranged almost densely, and the focus detection pixel cells 12 may be shifted in every other row in a staggered manner. In the case of such a layout, even if the size of the pattern of the subject image (for example, a linear pattern) is approximately the same as the arrangement pitches D1 and D2 of the pixel cells 12, focus detection can be performed regardless of the position.

[0084] As shown in FIG. 19, the pixel cells 11 for photographed images may be arranged almost densely, and the pixel cells 12 for focus detection may be arranged almost densely in a predetermined region therein. In the case of such a layout, even if the size of the pattern of the subject image (for example, a dot pattern) is approximately the same as the arrangement pitch D1 of the pixel cells 12, focus detection can be performed regardless of the position. As shown in FIG. 20, the pixel cells 11 for photographed images are arranged almost densely, the pixel cells 12 for focus detection are arranged almost densely in a predetermined area, and are shifted by a half pitch for each row. May be. In this case, even if the size of the pattern of the subject image (for example, a linear pattern or a dot pattern) is approximately the same as the arrangement pitches D3 and D1 of the pixel cells 12, focus detection can be performed regardless of the position.

[0085] As shown in FIG. 21, a pixel cell 26 having a cell size different from that of the pixel cell 12 is provided for focus detection, and the length A26 of one side of the pixel cell 26 is the length of one side of the pixel cell 11 for a photographed image. It may be 2.5 times A11. The cell size of the pixel cell 26 is 6.25 times that of the pixel cell 11. In FIG. 21, the pixel cells 11 for captured images are arranged substantially densely, and the pixel cells 26 are arranged substantially densely in a predetermined region therein. As described above, the cell size of the focus detection pixel cell is not limited to an integer multiple of the captured image pixel cell 11 and can be freely set. When the effect of mitigating the influence of diffraction is insufficient, a desired effect can be obtained by appropriately adjusting the ratio of the cell sizes of the focus detection pixel cell and the captured image pixel cell 11. it can.

[0086] As shown in FIG. 22, a pixel cell 27 having a different aspect ratio is provided for focus detection, and the length A27 of one side of the pixel cell 27 in the horizontal direction is twice the length A11 of one side of the pixel cell 11 for the photographed image. The length A28 in the vertical direction may be equal to the length A11 of the pixel cell 11. The cell size of the pixel cell 27 is twice that of the pixel cell 11. Since the vertical length A27 of the focus detection pixel cell 27 is equal to that of the captured image pixel cell 11, the image quality can be maintained even when interpolation processing is performed when generating the image signal. Further, it is not necessary to change the circuit configuration by arranging the pixel cell 27.

[0087] As shown in FIG. 23, two types of pixel cells 12 and 81 for focus detection (see FIG. 14) are arranged almost densely in a predetermined region in which the pixel cells 11 for captured images are arranged almost densely. The large pixel cells 12 may be arranged in a staggered manner by shifting every other column (see FIG. 18), and the small pixel cells 81 may be disposed substantially densely therebetween. As shown in FIG. 24, the pixel cells 12 for focus detection may be arranged in a line frame shape while the pixel cells 11 for captured images are arranged almost densely. In this case, a captured image is displayed on the screen of the liquid crystal viewfinder of the imaging system based on the output of the pixel cell 11, and the position of the pixel cell 12 is superimposed on the captured image as a focus detection area (focus frame). It is preferable to display. The focus frame display is performed by, for example, fixed data. Thus, since the position of the pixel cell 12 is displayed as the focus frame, it is not necessary to generate an image signal at the position of the pixel cell 12 by interpolation processing from the output of the surrounding pixel cells 11 or the like.

[0088] (Modification 4) Here, a modification of the photoelectric conversion unit of the pixel cell for focus detection will be described. As in the pixel cell 90 for focus detection shown in FIG. 25, four photoelectric conversion units 91 to 94 may be provided. In this case, any two of the four photoelectric conversion units 91 to

94 can be selectively combined to form a pair of photoelectric conversion units that can be used for phase difference detection type focus detection. In the focus detection by the phase difference detection method, the positional phase difference between the two subject images (that is, the positional deviation amount in the arrangement direction of the pair of photoelectric conversion units) is obtained by, for example, correlation calculation. For this reason, the focus detection in a different direction can be performed according to the arrangement direction of the selected pair of photoelectric conversion units.

[0089] For example, when performing horizontal focus detection in the figure, the outputs of the photoelectric conversion units 91 and 93 or the outputs of the photoelectric conversion units 92 and 94 are used. Further, the addition output of the photoelectric conversion units 91 and 92 and the addition output of the photoelectric conversion units 93 and 94 may be used. When performing vertical focus detection, the outputs of the photoelectric conversion units 91 and 92 or the outputs of the photoelectric conversion units 93 and 94 are used. Further, the addition output of the photoelectric conversion units 91 and 93 and the addition output of the photoelectric conversion units 92 and 94 may be used. In the case of focus detection in the upward and diagonal direction, each output of the photoelectric conversion units 91 and 94 is used. In the case of focus detection in the upward and diagonal direction, the outputs of the photoelectric conversion units 92 and 93 are used. In this manner, multidirectional focus detection can be performed with one type of pixel cell 90.

[0090] Furthermore, like the pixel cell 100 for focus detection shown in FIG. 26, six photoelectric conversion units 101 to 106 may be provided, and any one of RGB color filters may be provided for each. In this case, the two photoelectric conversion units 101 and 104 arranged along the focus detection direction (lateral direction in the figure) have the same R color component, the photoelectric conversion units 102 and 105 have the same G color component, and the photoelectric conversion units 103 and 104. Reference numeral 106 denotes the same B color component.

[0091] When performing focus detection by the phase difference detection method using the pixel cell 100, the addition output of the three photoelectric conversion units 101 to 103 arranged along the direction perpendicular to the focus detection direction is obtained, and the photoelectric conversion unit 104 is obtained. 106 are obtained, and the positional phase difference between the two subject images (here, the amount of positional deviation in the horizontal direction in the figure) is obtained from these two addition outputs by, for example, correlation calculation.

[0092] Further, when generating an image signal at the position of the pixel cell 100, the addition output (R color component) of the two photoelectric conversion units 101 and 104 arranged along the focus detection direction is obtained, and the photoelectric conversion unit 102 is also obtained. , 105 and the addition output (B color component) of the photoelectric conversion units 103 and 106 are obtained. Then, these three addition outputs may be substituted into the equations (9) to (12) instead of the respective color components (equations (5) to (8)) obtained by the interpolation processing described above.

[0093] Similarly, like the pixel cell 110 for focus detection shown in FIG. 27, six photoelectric conversion units 111 to 116 are arranged along the focus detection direction (horizontal direction in the figure), and any one of RGB is respectively arranged. Two color filters may be provided. In this case, the two photoelectric conversion units 113 and 114 that are symmetrical with respect to the center of the pixel cell 110 have the same R color component, the photoelectric conversion units 112 and 115 have the same G color component, and the photoelectric conversion units 111 and 116 have the same B color. Let it be a color component.

[0094] When performing focus detection by the phase difference detection method using the pixel cell 110, the addition outputs of the three photoelectric conversion units 111 to 113 arranged along the focus detection direction are obtained, and the photoelectric conversion units 114 to 116 are also detected. The addition output is obtained, and the positional phase difference (here, the amount of positional deviation in the horizontal direction in the figure) of the two subject images is obtained from these two addition outputs by, for example, correlation calculation. Further, when generating the image signal at the position of the pixel cell 110, the addition output (R color component) of the two photoelectric conversion units 113 and 114 symmetrical to the center of the pixel cell 110 is obtained and the photoelectric conversion is performed. The addition output (G color component) of the units 112 and 115 is obtained, and the addition output (B color component) of the photoelectric conversion units 111 and 116 is further obtained. Then, these three addition outputs may be substituted into the equations (9) to (12) instead of the respective color components (equations (5) to (8)) obtained by the interpolation processing described above.

[0095] Therefore, when generating an image signal at the position of the pixel cell 100 (or the pixel cell 110), it is not necessary to interpolate from the output of the pixel cell 11 for the captured image around the pixel cell 100 (or the pixel cell 110). Even if the pixel cells 100 (or the pixel cells 110) are arranged almost densely in a large area, the image quality does not deteriorate. Further, when focus detection is performed using the pixel cell 100 (or the pixel cell 110), focus detection may be performed for each color component without adding the output of each color component of RGB. In this way, accurate focus detection can be performed even when the photographic optical system has chromatic aberration. In addition, focus detection can be performed on a subject having a color change even at the same brightness. Further, a color component used for focus detection may be selected manually or automatically, and focus detection may be performed using the output of the selected color component. In this way, it is possible to selectively perform focus detection for a subject of a specific color.

[0096] Furthermore, when focus detection is performed using the pixel cell 110 of FIG. 27, the color component used for focus detection may be changed according to the open F value of the attached interchangeable lens. For example, the B color component photoelectric conversion units 111 and 116 located on the outer side take in the light beam that has passed outside the exit pupil of the photographing optical system, so that a lens with a brighter open F value than a predetermined value is mounted or high. It is preferably used when focus detection accuracy is required. Since the photoelectric conversion units 113 and 114 for the R color component located inside capture the light beam that has passed near the center of the exit pupil, the defocus amount becomes large when a lens with an open F value that is darker than a predetermined value is attached. It is preferably used when a lens (a lens with a long focal length) is attached.

[0097] In the above example, the pair of photoelectric conversion units 16, 17, 91 to 94,... Of the pixel cell for focus detection are each rectangular, but the present invention is not limited to this. For example, as in the pixel cell 120 illustrated in FIG. 28, it is conceivable that the pair of photoelectric conversion units 121 and 122 are each substantially semicircular, and the two are combined into a substantially circular shape. In this case, the light beam inside the exit pupil (predetermined F value) of the photographing optical system can be taken into the photoelectric conversion units 121 and 122 without waste and used for focus detection. This is advantageous in terms of securing the amount of light at the time of focus detection. The size of the photoelectric conversion units 121 and 122 is irrelevant to securing the light amount.

[0098] (Modification 5) Here, a modification of the microlenses 13, 15,... Of the pixel cell will be described. In the above example, the example in which the aperture size (diameter) of the microlenses 13 and 15 is equal to the lengths A11 and A12 of one side of the pixel cells 11 and 12 has been described, but the present invention is not limited to this. The opening size of the microlens may be smaller than the length of one side of the pixel cell. In this case, even if the pixel cell for the captured image and the pixel cell for focus detection have the same cell size, the aperture size of the micro lens in the pixel cell for focus detection is set to be smaller than the aperture size of the micro lens in the pixel cell for captured image. By increasing the size, the same effect as described above can be obtained.

[0099] In the above example, the microlens has a circular shape inscribed in the square pixel cell, but the present invention is not limited to this. For example, as shown in FIGS. 29 (a) and 29 (b), a circular four-direction portion (hatched portion) larger than the pixel cell is cut off, and a square central portion is cut out and formed into the same shape as the pixel cell. A microlens may be used. It can be applied to microlenses for photographed images and focus detection. In this case, the opening size of the microlens corresponds to the length of one side of the square shape. In this way, the light beam incident on the image sensor can be used for shooting, focus detection, and the like without waste.

[0100] Further, in the focus detection pixel cell 27 having a different aspect ratio as shown in FIG. 22, a circular portion in two vertical directions (hatching portions) larger than the pixel cell 27 is hatched as shown in FIG. 29C. A microlens that is cut off one by one and cut out at a rectangular central portion and shaped into the same shape as the pixel cell 27 may be used. Even in this case, the light beam incident on the image sensor can be used for focus detection without waste.

[0101] In the above example, the microlens is used as an optical element that condenses incident light to the pixel cell and guides it to the photoelectric conversion unit. However, the present invention is not limited to this. Instead of the microlens, a gradient index optical element or a reflective optical element may be used. However, since the microlens is easy to manufacture, it is advantageous in terms of cost. Furthermore, in the above example, an optical element such as a microlens is provided in the pixel cell for a captured image, but the present invention can be applied to a case where this is omitted.

[0102] (Modification 6) Here, another modification will be described. In the above example, the square pixel cells are arranged in a square lattice shape, but the present invention is not limited to this. The present invention can also be applied when the pixel cell is rectangular or hexagonal. When the pixel cell has a hexagonal shape, it can be considered that the pixel cells are arranged in a two-dimensional honeycomb shape with a half-pitch shift for each row. The focus detection pixel cell may be replaced with a plurality of adjacent captured image pixel cells.

[0103] In the above example, the phase detection pixel cell for focus detection is described as an example, but the present invention is not limited to this. In addition, the present invention can be applied to a case where a pixel cell for focus detection using a contrast detection method is provided. In the case of the contrast detection method, the number of photoelectric conversion units in the pixel cell may be one, but the outputs of two or more photoelectric conversion units may be added. Furthermore, in the above-described example, the example of the image sensor including the pixel cell for the captured image and the pixel cell for focus detection has been described, but the present invention is not limited to this. The present invention can also be applied to a case where a pixel cell for distance measurement, photometry, light adjustment, or the like is disposed instead of the pixel cell for focus detection (or in combination with the pixel cell for focus detection). Even in the case of a pixel cell for distance measurement, photometry, dimming, etc., the responsiveness at low luminance can be improved by making the cell size larger than the pixel cell for the photographed image.

[0104] As an image sensor having a pixel cell for distance measurement, for example, when the object to be measured is irradiated with pulse-modulated laser light or the like, the reflected light from the object to be measured is detected for each pixel cell. One can be considered (International Publication No. 97/01111). In order to measure the distance to the object to be measured, the round trip time of light is measured for each pixel cell, and this is converted into a distance. A special metering or dimming filter (such as a visual sensitivity filter) is placed in the photometric pixel cell that measures the subject brightness or the dimming pixel cell that detects the strobe light reflected from the subject. In addition, a special circuit configuration that can monitor the amount of accumulated charge in a non-destructive manner in real time is added. When such a special circuit configuration is added to the pixel cell for photometry or dimming, the pixel cell for photometry or dimming is made larger than the pixel cell for photographed image, so The chip area can be increased, which is advantageous in terms of circuit layout.

[0105] In the above example, pixel cells for captured images are arranged two-dimensionally, and pixel cells for acquiring imaging conditions (focus detection, distance measurement, photometry, dimming, etc.) are arranged therein. However, the present invention is not limited to this. A pixel cell for a photographed image may be arranged one-dimensionally, and a pixel cell for obtaining a photographing condition may be arranged therein. Furthermore, in the above example, the MOS type imaging device (see FIG. 4 of the circuit configuration) has been described as an example, but the present invention is not limited to this. In addition, the present invention can be applied to a CCD type image pickup device.

[0106] In the above example, a digital still camera (see FIG. 13) has been described as a specific example of the imaging system, but the present invention is not limited to this. In addition, the present invention can be applied to the case where the above-described imaging device is incorporated in an imaging system such as a digital microscope or a surveillance camera.

[0107] It is a figure which shows the structure of the image pick-up element 10 of 1st Embodiment. 2 is a diagram showing a cross-sectional structure of a pixel cell 12. FIG. 3 is a diagram for explaining a conjugate relationship between a pair of photoelectric conversion units 16 and 17 and an exit pupil 18. FIG. 1 is a diagram illustrating a circuit configuration of an image sensor 10. It is a figure explaining the conditions of a diffraction simulation. It is a figure explaining the result of diffraction simulation (when opening size of micro lens 15 is 20 micrometers). It is a figure explaining the result of diffraction simulation (when opening size of micro lens 15 is 10 micrometers). It is a figure explaining the result of diffraction simulation (when opening size of micro lens 15 is 4 micrometers). It is a figure explaining the result of diffraction simulation (when opening size of micro lens 15 is 2 micrometers). It is a block diagram which shows the structure of the imaging system 40 of 2nd Embodiment. 3 is a flowchart showing an operation procedure of the imaging system 40. FIG. 4 is a diagram for explaining generation of an image signal in the image sensor 10. It is the schematic which shows the structure of the digital still camera 60 of 3rd Embodiment. It is a figure which shows the structure of the image pick-up element 80 of 4th Embodiment. 2 is a diagram showing a cross-sectional structure of a pixel cell 81. FIG. 2 is a diagram illustrating a circuit configuration of a pixel cell 81. FIG. It is a flowchart which shows the operation | movement procedure of the imaging system of 5th Embodiment. It is a figure which shows the modification of

the layout of a pixel cell. It is a figure which shows the modification of the layout of a pixel cell. It is a figure which shows the modification of the layout of a pixel cell. It is a figure which shows the modification of the layout of a pixel cell. It is a figure which shows the modification of the layout of a pixel cell. It is a figure which shows the modification of the photoelectric conversion part of the pixel cell for focus detection. It is a figure which shows the modification of the photoelectric conversion part of the pixel cell for focus detection. It is a figure which shows the modification of the photoelectric conversion part of the pixel cell for focus detection. It is a figure which shows the modification of the photoelectric conversion part of the pixel cell for focus detection. It is a figure which shows the modification of a micro lens.

Explanation of symbols

[0108] 10,80 Image sensor; 11,12,26,27,81,90,100,110,120 Pixel cell; 13,15,82 Microlens; 14,16,17,83,84,91-94,101 106, 111-116, 121, 122 Photoelectric conversion unit; 18 Exit pupil; 40 Imaging system; 41, 64, 65 Imaging optical system; 60 Digital still camera

CLAIMS

1. In an imaging device that captures an image by a photographing optical system, a first pixel cell including a first photoelectric conversion unit that generates a charge according to incident light, an optical element that collects incident light, and the optical element A second photoelectric conversion unit that generates a charge in response to the collected light, and has a second pixel cell having a larger cell size than the first pixel cell, and the first pixel cell is provided on the substrate. An image sensor, wherein the pixel cell and the second pixel cell are two-dimensionally arranged.

The image sensor according to claim 1, wherein the second pixel cell has an integer cell size that is an integral multiple of the first pixel cell.

2. The image sensor according to claim 1, wherein each of the first and second pixel cells includes an optical element that condenses incident light on the first and second photoelectric conversion units, and the second pixel cell. The optical element has an aperture size larger than that of the optical element of the first pixel cell.

An image pickup device that picks up an image by a photographing optical system includes a first optical element that collects incident light and a first photoelectric conversion unit that generates electric charge according to the light collected by the optical element. A second pixel cell including a pixel cell, an optical element that condenses incident light, and a second photoelectric conversion unit that generates an electric charge according to the light condensed by the optical element; The first pixel cell and the second pixel cell are two-dimensionally arranged, and the optical element of the second pixel cell has a larger aperture size than the optical element of the first pixel cell. An image sensor characterized by the above.

5. The image pickup device according to claim 1, wherein an opening size of the optical element of the first pixel cell is smaller than 20 μm . 6.

6. The imaging device according to claim 1, wherein each of the second pixel cells includes a plurality of the second photoelectric conversion units, and the plurality of second photoelectric conversion units. Each of the imaging elements is substantially conjugate with the exit pupil of the photographing optical system via the optical element of the second pixel cell.

The imaging device according to claim 6, wherein two of the plurality of second photoelectric conversion units form a pair, and each of the two second photoelectric conversion units forming the pair includes filters of different colors. An image sensor in which is arranged.

8. The imaging device according to claim 1, wherein a focus adjustment state of the photographing optical system is detected based on a photoelectric output obtained by the second pixel cell. Image sensor.

9. The image pickup device according to claim 1, wherein an optical element that condenses incident light and a third photoelectric conversion that generates electric charge according to the light collected by the optical element And a third pixel cell having a cell size different from that of the second pixel cell.

The imaging device according to claim 9, wherein the third pixel cell has a cell size equal to that of the first pixel cell.

11. The imaging device according to claim 9, wherein a focus adjustment state of the photographing optical system is detected based on a photoelectric output obtained by the second pixel cell and the third pixel cell. An image sensor.

A focus detection apparatus comprising: the image pickup device according to claim 8; and a detection unit that performs focus detection based on an output of the second pixel cell.

12. A focus, comprising: the imaging device according to claim 11; and a detection unit configured to perform focus detection based on at least one of an output of the second pixel cell and an output of the third pixel cell. Detection device.

A focus detection apparatus according to claim 12 or 13, and a photographing optical system disposed on the object side of the image sensor, wherein the detection means performs focus detection of the photographing optical system. Imaging system.

15. The imaging system according to claim 14, wherein a captured image is displayed based on an output of the first pixel cell, and the position of the second pixel cell is used as an area where the detection unit performs focus detection. An imaging system comprising display means for displaying an image superimposed on the image.

16. The imaging system according to claim 14, wherein an image signal at the position of the first pixel cell is generated based on an output of the first pixel cell, and an image signal at the position of the second pixel cell. An imaging system comprising: generating means for generating an image by interpolation processing based on an output of the first pixel cell around the second pixel cell.

17. The imaging system according to claim 16, wherein the generation unit generates each color component of the image signal by the interpolation processing when generating the image signal at the position of the second pixel cell, A luminance component is generated based on an output of the second pixel cell.

Electronic Patent Application Fee Transmittal				
Application Number:		16046643		
Filing Date:		26-Jul-2018		
Title of Invention:		OPTICAL IMAGING SYSTEM WITH A PLURALITY OF SENSE CHANNELS		
First Named Inventor/Applicant Name:		Angus Pacala		
Filer:		William Leland Shaffer/LaRenda Meyer		
Attorney Docket Number:		103033-P001USC2-1096583		
Filed as Small Entity				
Filing Fees for Utility under 35 USC 111(a)				
Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Miscellaneous:				
SUBMISSION- INFORMATION DISCLOSURE STMT	2806	1	130	130
Total in USD (\$)				130

Electronic Acknowledgement Receipt	
EFS ID:	43632760
Application Number:	16046643
International Application Number:	
Confirmation Number:	1720
Title of Invention:	OPTICAL IMAGING SYSTEM WITH A PLURALITY OF SENSE CHANNELS
First Named Inventor/Applicant Name:	Angus Pacala
Customer Number:	20350
Filer:	William Leland Shaffer/LaRenda Meyer
Filer Authorized By:	William Leland Shaffer
Attorney Docket Number:	103033-P001USC2-1096583
Receipt Date:	30-AUG-2021
Filing Date:	26-JUL-2018
Time Stamp:	11:07:43
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	\$ 130
RAM confirmation Number	E20218TB08224696
Deposit Account	201430
Authorized User	LaRenda Meyer
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows: 37 CFR 1.16 (National application filing, search, and examination fees) 37 CFR 1.17 (Patent application and reexamination processing fees)	

37 CFR 1.19 (Document supply fees)					
37 CFR 1.20 (Post Issuance fees)					
37 CFR 1.21 (Miscellaneous fees and charges)					
File Listing:					
Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		IDS-P001USC2-1096583.pdf	194333	yes	5
			d2ae101bc754530c8b0ecbf46bed95041de b9fd		
	Multipart Description/PDF files in .zip description				
	Document Description		Start	End	
	Transmittal Letter		1	2	
	Information Disclosure Statement (IDS) Form (SB08)		3	5	
Warnings:					
Information:					
2	Foreign Reference	JP2007103590A_Translation. pdf	244160	no	17
			881f65888367c4c8e5b83a7edec6c1aacff20 329		
Warnings:					
Information:					
3	Non Patent Literature	2021-08-13_16584515-NOA.pdf	550554	no	10
			bc1c1538bbb400460351cbac3fa35fa3c30 90fa		
Warnings:					
Information:					
4	Non Patent Literature	2021-08-18_17317809_NOA. pdf	1442215	no	33
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Warnings:					
Information:					
5	Fee Worksheet (SB06)	fee-info.pdf	38033	no	2
			a057e2691a830c8f2dds3aa1363fad7e7ee6 7d45		
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New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

I hereby certify that this correspondence is being filed via
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on August 30, 2021

PATENT
Attorney Docket No.: 103033-1096583-P001USC2
Client Ref. No.: P001USC2

KILPATRICK TOWNSEND & STOCKTON LLP

By: /La Renda Meyer-Johnson/

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

Angus Pacala

Application No.: 16/046,643

Filed: July 26, 2018

For: OPTICAL IMAGING SYSTEM
WITH A PLURALITY OF SENSE
CHANNELS

Customer No.: 20350

Confirmation No.: 1720

Examiner: John R Lee

Technology Center/Art Unit: 2878

**INFORMATION DISCLOSURE
STATEMENT**

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Commissioner:

The references cited on attached form PTO/SB/08A are being called to the attention of the Examiner. In accordance with the provisions of 37 CFR §1.98(a)(2), copies of any cited U.S. Patents and U.S. Patent Application Publications are not provided. Copies of the remaining cited references are provided.

It is respectfully requested that the cited references be expressly considered during the prosecution of this application and the references be made of record therein and appear among the "references cited" on any patent to issue therefrom.

As provided for by 37 CFR §1.97(g) and (h), no inference should be made that the information and references cited are prior art merely because they are in this statement and no

KILPATRICK TOWNSEND 75099539 1

representation is being made that a search has been conducted or that this statement encompasses all the possible relevant information. This Information Disclosure Statement is being filed after an action closing prosecution, but before the payment of the Issue Fee.

I hereby certify under 37 CFR §1.97(e)(1) that Refs 1 and 2 in this Information Disclosure Statement were first cited in a communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of this statement.

I hereby certify under 37 CFR §1.97(e)(2) that Refs 3 and 4 contained in the Information Disclosure Statement were not cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the Information Disclosure Statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the Information Disclosure Statement.

The Commissioner is authorized to charge the fee set forth in §1.17(p) to the firm's credit card for consideration of this paper. The Commissioner is authorized to charge any additional fee due to Deposit Account No. 20-1430.

Respectfully submitted,

/ William L. Shaffer /

William L. Shaffer
Registration No. 37,234

KILPATRICK TOWNSEND & STOCKTON LLP

Attachment

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number		16/046,643	
	Filing Date		July 26, 2018	
	First Named Inventor		Angus Pacala	
	Art Unit		2878	
	Examiner Name		John R Lee	
	Attorney Docket Number		103033-P001USC2-1096583	

U.S. PATENTS						
Examiner Initial*	Cite No	Patent Number	Kind Code ¹	Issue Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear

U.S. PATENT APPLICATION PUBLICATIONS						
Examiner Initial*	Cite No	Publication Number	Kind Code ¹	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear

FOREIGN PATENT DOCUMENTS								
Examiner Initial*	Cite No	Foreign Document Number ³	Country Code ²	Kind Code ⁴	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear	T ⁵

NON-PATENT LITERATURE DOCUMENTS			
Examiner Initial*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T ⁵
	1	Application No 17/323,962 , Non-Final Office Action, Mailed On August 31, 2021, 9 pages	

EXAMINER SIGNATURE			
Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

¹ See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. ² Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). ³ For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document.

⁴ Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. ⁵ Applicant is to place a check mark here if English language translation is attached.

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number	16/046,643
	Filing Date	July 26, 2018
	First Named Inventor	Angus Pacala
	Art Unit	2878
	Examiner Name	John R Lee
	Attorney Docket Number	103033-P001USC2-1096583

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

☐ That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e) (1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e) (2).

☒ See attached certification statement.

☒ Fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☐ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/ William L. Shaffer /	Date (YYYY-MM-DD)	2021-09-03
Name/Print	William L. Shaffer	Registration Number	37,234

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

Electronic Patent Application Fee Transmittal				
Application Number:		16046643		
Filing Date:		26-Jul-2018		
Title of Invention:		OPTICAL IMAGING SYSTEM WITH A PLURALITY OF SENSE CHANNELS		
First Named Inventor/Applicant Name:		Angus Pacala		
Filer:		William Leland Shaffer/LaRenda Meyer		
Attorney Docket Number:		103033-P001USC2-1096583		
Filed as Small Entity				
Filing Fees for Utility under 35 USC 111(a)				
Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Miscellaneous:				
SUBMISSION- INFORMATION DISCLOSURE STMT	2806	1	130	130
Total in USD (\$)				130

Electronic Acknowledgement Receipt	
EFS ID:	43687186
Application Number:	16046643
International Application Number:	
Confirmation Number:	1720
Title of Invention:	OPTICAL IMAGING SYSTEM WITH A PLURALITY OF SENSE CHANNELS
First Named Inventor/Applicant Name:	Angus Pacala
Customer Number:	20350
Filer:	William Leland Shaffer/LaRenda Meyer
Filer Authorized By:	William Leland Shaffer
Attorney Docket Number:	103033-P001USC2-1096583
Receipt Date:	03-SEP-2021
Filing Date:	26-JUL-2018
Time Stamp:	18:17:26
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	\$ 130
RAM confirmation Number	E202193118033750
Deposit Account	201430
Authorized User	LaRenda Meyer
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows: 37 CFR 1.16 (National application filing, search, and examination fees) 37 CFR 1.17 (Patent application and reexamination processing fees)	

37 CFR 1.19 (Document supply fees)					
37 CFR 1.20 (Post Issuance fees)					
37 CFR 1.21 (Miscellaneous fees and charges)					
File Listing:					
Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		IDS-P001USC2-1096583.pdf	190842	yes	4
			887b62272e27f40b0589d2ebc707d68887e a48d3		
	Multipart Description/PDF files in .zip description				
	Document Description		Start	End	
	Transmittal Letter		1	2	
	Information Disclosure Statement (IDS) Form (SB08)		3	4	
Warnings:					
Information:					
2	Non Patent Literature	NPL_NFOA_08-31-2021.pdf	1089005	no	29
			33e486bac68ae7f9a6b48c44f0710f92dc38 3130		
Warnings:					
Information:					
3	Fee Worksheet (SB06)	fee-info.pdf	38033	no	2
			a7b6cf742bc14772a898d2341dd47290aba 3b2a8		
Warnings:					
Information:					
Total Files Size (in bytes):			1317880		

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New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

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on September 3, 2021

PATENT
Attorney Docket No.: 103033-1096583-P001USC2
Client Ref. No.: P001USC2

KILPATRICK TOWNSEND & STOCKTON LLP

By: /La Renda Meyer-Johnson/

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

Angus Pacala

Application No.: 16/046,643

Filed: July 26, 2018

For: OPTICAL IMAGING SYSTEM
WITH A PLURALITY OF SENSE
CHANNELS

Customer No.: 20350

Confirmation No.: 1720

Examiner: John R Lee

Technology Center/Art Unit: 2878

**INFORMATION DISCLOSURE
STATEMENT**

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Commissioner:

The references cited on attached form PTO/SB/08A are being called to the attention of the Examiner. In accordance with the provisions of 37 CFR §1.98(a)(2), copies of any cited U.S. Patents and U.S. Patent Application Publications are not provided. Copies of the remaining cited references are provided.

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As provided for by 37 CFR §1.97(g) and (h), no inference should be made that the information and references cited are prior art merely because they are in this statement and no

KILPATRICK TOWNSEND 75145541 1

representation is being made that a search has been conducted or that this statement encompasses all the possible relevant information. This Information Disclosure Statement is being filed after an action closing prosecution, but before the payment of the Issue Fee.

I hereby certify under 37 CFR §1.97(e)(2) that the reference contained in the Information Disclosure Statement was not cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the Information Disclosure Statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the Information Disclosure Statement.

The Commissioner is authorized to charge the fee set forth in §1.17(p) to the firm's credit card for consideration of this paper. The Commissioner is authorized to charge any additional fee due to Deposit Account No. 20-1430.

Respectfully submitted,

/ William L. Shaffer /

William L. Shaffer
Registration No. 37,234

KILPATRICK TOWNSEND & STOCKTON LLP

Attachment



UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/046,643	07/26/2018	Angus Pacala	103033- P001USC2-1096583	1720
20350	7590	09/16/2021	EXAMINER	
Kilpatrick Townsend & Stockton LLP - West Coast Mailstop: IP Docketing - 22 1100 Peachtree Street Suite 2800 Atlanta, GA 30309			LEE, JOHN R	
			ART UNIT	PAPER NUMBER
			2878	
			NOTIFICATION DATE	DELIVERY MODE
			09/16/2021	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

KTSDocketing2@kilpatrick.foundationip.com
ipefiling@kilpatricktownsend.com

Corrected Notice of Allowability	Application No. 16/046,643	Applicant(s) Pacala et al.	
	Examiner JOHN R LEE	Art Unit 2878	AIA (FITF) Status Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to the I.D.S.'s filed on 08/30/2021 and 09/03/2021.
☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

3. ☒ The allowed claim(s) is/are 1-50. As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.

4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
Certified copies:
 a) ☐ All b) ☐ Some* c) ☐ None of the:
 1. ☐ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. _____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).
 * Certified copies not received: _____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.
Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).

6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☐ Notice of References Cited (PTO-892) 2. ☒ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date 08/30/2021 and 09/03/2021. 3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material _____. 4. ☐ Interview Summary (PTO-413), Paper No./Mail Date _____.	5. ☐ Examiner's Amendment/Comment 6. ☐ Examiner's Statement of Reasons for Allowance 7. ☐ Other _____.
--	---

	/JOHN R LEE/ Primary Examiner, Art Unit 2878
--	---

Doc code: IDS

PTO/SB/08a (01-10)

Doc description: Information Disclosure Statement (IDS) Field

Approved for use through 07/31/2012. OMB 0651-0031

U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number		16/046,643	
	Filing Date		July 26, 2018	
	First Named Inventor		Angus Pacala	
	Art Unit		2878	
	Examiner Name		John R Lee	
	Attorney Docket Number		103033-P001USC2-1096583	

U.S. PATENTS						
Examiner Initial*	Cite No	Patent Number	Kind Code ¹	Issue Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear

U.S. PATENT APPLICATION PUBLICATIONS						
Examiner Initial*	Cite No	Publication Number	Kind Code ¹	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear

FOREIGN PATENT DOCUMENTS								
Examiner Initial*	Cite No	Foreign Document Number ³	Country Code ²	Kind Code ⁴	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear	T ⁵

NON-PATENT LITERATURE DOCUMENTS			
Examiner Initial*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T ⁵
	1	Application No 17/323,962, Non-Final Office Action, Mailed On August 31, 2021, 9 pages	

EXAMINER SIGNATURE			
Examiner Signature	/JOHN R LEE/	Date Considered	09/10/2021

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

¹ See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. ² Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). ³ For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document.

⁴ Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. ⁵ Applicant is to place a check mark here if English language translation is attached.

Doc code: IDS

PTO/SB/08a (01-10)

Doc description: Information Disclosure Statement (IDS) Field

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	Attorney Docket Number		103033-P001USC2-1096583	

U.S. PATENTS						
Examiner Initial*	Cite No	Patent Number	Kind Code ¹	Issue Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear

U.S. PATENT APPLICATION PUBLICATIONS						
Examiner Initial*	Cite No	Publication Number	Kind Code ¹	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
	1	20150115131		4/30/2015	Webster, et al.	

FOREIGN PATENT DOCUMENTS								
Examiner Initial*	Cite No	Foreign Document Number ³	Country Code ²	Kind Code ⁴	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear	T ⁵
	2	2007103590	JP		4/19/2007	Nikon Corp.		

NON-PATENT LITERATURE DOCUMENTS			
Examiner Initial*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T ⁵
	3	U.S. Patent Application No. 16/584,515, Notice of Allowance, mailed August 13, 2021, 10 pages	
	4	U.S. Patent Application No. 17/317,809, Notice of Allowance, mailed August 18, 2021, 33 pages	

Doc code: IDS

PTO/SB/08a (01-10)

Doc description: Information Disclosure Statement (IDS) Field

Approved for use through 07/31/2012. OMB 0651-0031

U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number	16/046,643
	Filing Date	July 26, 2018
	First Named Inventor	Angus Pacala
	Art Unit	2878
	Examiner Name	John R Lee
	Attorney Docket Number	103033-P001USC2-1096583

EXAMINER SIGNATURE			
Examiner Signature	/JOHN R LEE/	Date Considered	09/10/2021
*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.			
¹ See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. ² Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). ³ For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. ⁴ Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. ⁵ Applicant is to place a check mark here if English language translation is attached.			

CERTIFICATION STATEMENT			
Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):			
☐ That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e) (1).			
OR			
☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e) (2).			
☒ See attached certification statement.			
☒ Fee set forth in 37 CFR 1.17 (p) has been submitted herewith.			
☐ A certification statement is not submitted herewith.			
SIGNATURE			
A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.			
Signature	/ William L. Shaffer /	Date (YYYY-MM-DD)	2021-08-20
Name/Print	William L. Shaffer	Registration Number	37,234

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number		16046643	
	Filing Date		2018-07-26	
	First Named Inventor	Pacala		
	Art Unit	2878		
	Examiner Name	John R Lee		
	Attorney Docket Number	103033-1096583-P001USC2		

U.S. PATENTS						
Examiner Initial*	Cite No	Patent Number	Kind Code ¹	Issue Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear

If you wish to add additional U.S. Patent citation information please click the Add button.

U.S. PATENT APPLICATION PUBLICATIONS						
Examiner Initial*	Cite No	Publication Number	Kind Code ¹	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear

If you wish to add additional U.S. Published Application citation information please click the Add button.

FOREIGN PATENT DOCUMENTS								
Examiner Initial*	Cite No	Foreign Document Number ³	Country Code ²	Kind Code ⁴	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear	T ⁵
								☐

If you wish to add additional Foreign Patent Document citation information please click the Add button

NON-PATENT LITERATURE DOCUMENTS			
Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T ⁵

**INFORMATION DISCLOSURE
STATEMENT BY APPLICANT**
(Not for submission under 37 CFR 1.99)

Application Number	16046643
Filing Date	2018-07-26
First Named Inventor	Pacala
Art Unit	2878
Examiner Name	John R Lee
Attorney Docket Number	103033-1096583-P001USC2

1	17/323,962, "Notice of Allowance", September 29, 2021, 7 pages	☐
1		☐
1		☐
1		☐
1		☐

If you wish to add additional non-patent literature document citation information please click the Add button

EXAMINER SIGNATURE

Examiner Signature		Date Considered	
--------------------	--	-----------------	--

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

¹ See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. ² Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). ³ For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. ⁴ Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. ⁵ Applicant is to place a check mark here if English language translation is attached.

**INFORMATION DISCLOSURE
STATEMENT BY APPLICANT**
(Not for submission under 37 CFR 1.99)

Application Number	16046643
Filing Date	2018-07-26
First Named Inventor	Pacala
Art Unit	2878
Examiner Name	John R Lee
Attorney Docket Number	103033-1096583-P001USC2

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

- ☐ That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

- ☒ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

- ☐ See attached certification statement.
- ☒ The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.
- ☐ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/ William L. Shaffer /	Date (YYYY-MM-DD)	2021-10-12
Name/Print	William L. Shaffer	Registration Number	37,234

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Electronic Patent Application Fee Transmittal				
Application Number:		16046643		
Filing Date:		26-Jul-2018		
Title of Invention:		OPTICAL IMAGING SYSTEM WITH A PLURALITY OF SENSE CHANNELS		
First Named Inventor/Applicant Name:		Angus Pacala		
Filer:		William Leland Shaffer/LaRenda Meyer		
Attorney Docket Number:		103033-P001USC2-1096583		
Filed as Small Entity				
Filing Fees for Utility under 35 USC 111(a)				
Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Miscellaneous:				
SUBMISSION- INFORMATION DISCLOSURE STMT	2806	1	130	130
Total in USD (\$)				130

Electronic Acknowledgement Receipt	
EFS ID:	44012830
Application Number:	16046643
International Application Number:	
Confirmation Number:	1720
Title of Invention:	OPTICAL IMAGING SYSTEM WITH A PLURALITY OF SENSE CHANNELS
First Named Inventor/Applicant Name:	Angus Pacala
Customer Number:	20350
Filer:	William Leland Shaffer/LaRenda Meyer
Filer Authorized By:	William Leland Shaffer
Attorney Docket Number:	103033-P001USC2-1096583
Receipt Date:	12-OCT-2021
Filing Date:	26-JUL-2018
Time Stamp:	19:11:50
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	\$ 130
RAM confirmation Number	E20210BJ12300204
Deposit Account	201430
Authorized User	LaRenda Meyer
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows: 37 CFR 1.16 (National application filing, search, and examination fees) 37 CFR 1.17 (Patent application and reexamination processing fees)	

37 CFR 1.19 (Document supply fees)
 37 CFR 1.20 (Post Issuance fees)
 37 CFR 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Non Patent Literature	NPL-2021-09-29-NOA.PDF	502023	no	9
			80e003f95d19225c75f88d9dcba89e8102ce51		

Warnings:

Information:

2	Information Disclosure Statement (IDS) Form (SB08)	P001USC2_IDS.pdf	65915	no	4
			5d229381dfff119c5b1a6383435f709bda42dc8a2		

Warnings:

Information:

This is not an USPTO supplied IDS fillable form

3	Fee Worksheet (SB06)	fee-info.pdf	38031	no	2
			05153175eb4fc3cbc4b33e1d709f1ba117f14e7		

Warnings:

Information:

Total Files Size (in bytes): 605969

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.



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UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/046,643	07/26/2018	Angus Pacala	103033- P001USC2-1096583	1720
20350	7590	10/26/2021	EXAMINER	
Kilpatrick Townsend & Stockton LLP - West Coast Mailstop: IP Docketing - 22 1100 Peachtree Street Suite 2800 Atlanta, GA 30309			LEE, JOHN R	
			ART UNIT	PAPER NUMBER
			2878	
			NOTIFICATION DATE	DELIVERY MODE
			10/26/2021	ELECTRONIC

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The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

KTSDocketing2@kilpatrick.foundationip.com
ipefiling@kilpatricktownsend.com

Corrected Notice of Allowability	Application No. 16/046,643	Applicant(s) Pacala et al.	
	Examiner JOHN R LEE	Art Unit 2878	AIA (FITF) Status Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--
 All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to the I.D.S. filed on 10/12/2021.
☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.
2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.
3. ☒ The allowed claim(s) is/are 1-50. As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.
4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
Certified copies:
 a) ☐ All b) ☐ Some* c) ☐ None of the:
 1. ☐ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. _____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

* Certified copies not received: _____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.
Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).
6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☐ Notice of References Cited (PTO-892) 2. ☒ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date 10/12/2021. 3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material _____. 4. ☐ Interview Summary (PTO-413), Paper No./Mail Date _____.	5. ☐ Examiner's Amendment/Comment 6. ☐ Examiner's Statement of Reasons for Allowance 7. ☐ Other _____.
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/JOHN R LEE/ Primary Examiner, Art Unit 2878	
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Doc code: IDS

Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (01-10)

Approved for use through 07/31/2012. OMB 0651-0031

U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number		16046643	
	Filing Date		2018-07-26	
	First Named Inventor	Pacala		
	Art Unit	2878		
	Examiner Name	John R Lee		
	Attorney Docket Number	103033-1096583-P001USC2		

U.S. PATENTS						
Examiner Initial*	Cite No	Patent Number	Kind Code ¹	Issue Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear

If you wish to add additional U.S. Patent citation information please click the Add button.

U.S. PATENT APPLICATION PUBLICATIONS						
Examiner Initial*	Cite No	Publication Number	Kind Code ¹	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear

If you wish to add additional U.S. Published Application citation information please click the Add button.

FOREIGN PATENT DOCUMENTS								
Examiner Initial*	Cite No	Foreign Document Number ³	Country Code ²	Kind Code ⁴	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear	T ⁵
								☐

If you wish to add additional Foreign Patent Document citation information please click the Add button

NON-PATENT LITERATURE DOCUMENTS			
Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T ⁵

**INFORMATION DISCLOSURE
STATEMENT BY APPLICANT**
(Not for submission under 37 CFR 1.99)

Application Number	16046643
Filing Date	2018-07-26
First Named Inventor	Pacala
Art Unit	2878
Examiner Name	John R Lee
Attorney Docket Number	103033-1096583-P001USC2

1	17/323,962, "Notice of Allowance", September 29, 2021, 7 pages	☐
1		☐
1		☐
1		☐
1		☐

If you wish to add additional non-patent literature document citation information please click the Add button

EXAMINER SIGNATURE

Examiner Signature	/JOHN R LEE/	Date Considered	10/21/2021
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*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

¹ See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. ² Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). ³ For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. ⁴ Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. ⁵ Applicant is to place a check mark here if English language translation is attached.

"FEE ADDRESS" INDICATION FORM**Address to:**

**Mail Stop Maintenance Fee
Director of the United States
Patent and Trademark Office
P.O. Box 1450
Alexandria, VA 22313-1450**

-OR-

**Fax to:
571-273-6500**

INSTRUCTIONS: The issue fee must have been paid for the application(s) listed on this form. In addition, only an address represented by a Customer Number can be established as the fee address for maintenance fee purposes (hereafter, fee address). A fee address should be established when correspondence related to maintenance fees should be mailed to a different address than the correspondence address for the application.

When to check the first box below: If you have a Customer Number to represent the fee address.

When to check the second box below: If you have no Customer Number representing the desired fee address, in which case a completed Request for Customer Number (PTO/SB/125) must be attached to this form. For more information on Customer Numbers, see the Manual of Patent Examining Procedure (MPEP) § 403.

For the following listed application(s), please recognize as the "Fee Address" under the provisions of 37 CFR 1.363 the address associated with:

☒ Customer Number: 00197

OR

☐ The attached Request for Customer Number form (PTO/SB/125)

PATENT NUMBER
(if known)

APPLICATION NUMBER

16/046,643

Completed by (check one):

☐ Applicant/Inventor

☒ Attorney or Agent of record 37,234
Reg. No.

☐ Assignee of record of the entire interest. See
37 CFR 3.71. Statement under 37 CFR 3.73(c)
(Form PTO/AIA/96) is enclosed or was filed on

(Date)

/ William L. Shaffer /

Signature

William L. Shaffer

Typed or printed name

858-350-6104

Requester's telephone number

Oct. 27, 2021

Date

NOTE: Signatures of all the inventors or assignees of record of the entire interest or their representative(s) are required. If the assignee is a juristic entity, this form must be signed by a patent practitioner (attorney or agent) of record. Submit multiple forms if more than one signature is required, see below*.

☒ *Total of 1 forms are submitted

This collection of information is required by 37 CFR 1.363. The information is required to obtain or retain a benefit by the public, which is to indicate (and for the USPTO to process) a fee address. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 5 minutes to complete, including gathering, preparing, and submitting the completed form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND COMPLETED FORMS TO THE PREVIOUS ADDRESS. **SEND COMPLETED FORMS TO: Mail Stop Maintenance Fee, Director of the United States Patent and Trademark Office, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.



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ELECTRONIC PAYMENT RECEIPT

APPLICATION # 16/046,643	RECEIPT DATE / TIME 10/27/2021 05:55:33 PM ET	ATTORNEY DOCKET # 103033-P001USC2-1096583
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Title of Invention

OPTICAL IMAGING SYSTEM WITH A PLURALITY OF SENSE CHANNELS

Application Information

APPLICATION TYPE	Utility - Nonprovisional Application under 35 USC 111(a)	PATENT #	-
CONFIRMATION #	1720	FILED BY	Erica Rojas
PATENT CENTER #	60373014	AUTHORIZED BY	Bill Shaffer
CUSTOMER #	20350	FILING DATE	07/26/2018
CORRESPONDENCE ADDRESS	-	FIRST NAMED INVENTOR	Angus Pacala

Payment Information

PAYMENT METHOD CARD / 8410	PAYMENT TRANSACTION ID E20210QH56342950	PAYMENT AUTHORIZED BY Erica Rojas
PRE-AUTHORIZED ACCOUNT 201430	PRE-AUTHORIZED CATEGORY 37 CFR 1.16 (National application filing, search, and examination fees); 37 CFR 1.17 (Patent application and reexamination processing fees); 37 CFR 1.19 (Document supply fees); 37 CFR 1.21 (Miscellaneous fees and charges)	

FEE CODE	DESCRIPTION	ITEM PRICE(\$)	QUANTITY	ITEM TOTAL(\$)
2501	UTILITY ISSUE FEE	600.00	1	600.00
TOTAL AMOUNT:				\$600.00

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), by mail or fax, or via EFS-Web.

By mail, send to: Mail Stop ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

By fax, send to: (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

20350 7590 08/18/2021
Kilpatrick Townsend & Stockton LLP - West Coast
Mailstop: IP Docketing - 22
1100 Peachtree Street
Suite 2800
Atlanta, GA 30309

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being transmitted to the USPTO via EFS-Web or by facsimile to (571) 273-2885, on the date below.

Erica M. Rojas	(Typed or printed name)
/Erica M. Rojas/	(Signature)
October 27, 2021	(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/046,643	07/26/2018	Angus Pacala	103033- P001USC2-1096583	1720

TITLE OF INVENTION: OPTICAL IMAGING SYSTEM WITH A PLURALITY OF SENSE CHANNELS

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	SMALL	\$600	\$0.00	\$0.00	\$600	11/18/2021

EXAMINER	ART UNIT	CLASS-SUBCLASS
LEE, JOHN R	2878	250-559170

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.

☒ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-09 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list

(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,

(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1 Kilpatrick Townsend & Stockton LLP

2 _____

3 _____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document must have been previously recorded, or filed for recordation, as set forth in 37 CFR 3.11 and 37 CFR 3.81(a). Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE

Ouster, Inc.

(B) RESIDENCE: (CITY and STATE OR COUNTRY)

San Francisco, California

Please check the appropriate assignee category or categories (will not be printed on the patent): ☐ Individual ☒ Corporation or other private group entity ☐ Government

4a. Fees submitted: ☒ Issue Fee ☐ Publication Fee (if required) ☐ Advance Order - # of Copies _____

4b. Method of Payment: (Please first reapply any previously paid fee shown above)

☒ Electronic Payment via EFS-Web ☐ Enclosed check ☐ Non-electronic payment by credit card (Attach form PTO-2038)

☒ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment to Deposit Account No. 201430

5. Change in Entity Status (from status indicated above)

☐ Applicant certifying micro entity status. See 37 CFR 1.29

☐ Applicant asserting small entity status. See 37 CFR 1.27

☐ Applicant changing to regular undiscounted fee status.

NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.

NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.

NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature / William L. Shaffer /

Date Oct. 27, 2021

Typed or printed name William L. Shaffer

Registration No. 37,234



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PATENT AND TRADEMARK OFFICE

P.O. Box 1450
Alexandria, VA 22313 - 1450
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ELECTRONIC ACKNOWLEDGEMENT RECEIPT

APPLICATION #
16/046,643

RECEIPT DATE / TIME
10/27/2021 05:55:33 PM ET

ATTORNEY DOCKET #
103033-P001USC2-1096583

Title of Invention

OPTICAL IMAGING SYSTEM WITH A PLURALITY OF SENSE CHANNELS

Application Information

APPLICATION TYPE Utility - Nonprovisional Application
under 35 USC 111(a)

PATENT # -

CONFIRMATION # 1720

FILED BY Erica Rojas

PATENT CENTER # 60373014

FILING DATE 07/26/2018

CUSTOMER # 20350

FIRST NAMED INVENTOR Angus Pacala

CORRESPONDENCE ADDRESS -

AUTHORIZED BY Bill Shaffer

Documents

TOTAL DOCUMENTS: 2

DOCUMENT	PAGES	DESCRIPTION	SIZE (KB)
2021-10-27_Fee_Address_Indication_Form_103033-P001USC2-1096583.pdf	2	Maintenance Fee Address Change	226 KB
2021-10-27_Issue_Fee_Transmittal_103033-P001USC2-1096583.pdf	1	Issue Fee Payment (PTO-85B)	199 KB

Digest

DOCUMENT	MESSAGE DIGEST(SHA-512)
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2021-10-27_Fee_Address_Indication_Fo	5DB301BBC567AB413680ADACAFF3AF4E48C56D61FB156D44
rm_103033-P001USC2-	1AAB353A496282706C1C7AFFBCCF8360CF243C74CF4061387
1096583.pdf	897043D5788B397F059030F09DCEE28

2021-10-27_Issue_Fee_Transmittal_103	3CBB6DF4334AF2EF89ADE920BE14E3BA3863FC4A826FCA07
033-P001USC2-1096583.pdf	1651B1A3ECF3404F6FF1104D01DF5E910C0ADE482ED488A3B
	BA2A435302A212039438E1988B3F4D4

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Doc code: IDS

PTOSB08a (01-10)

Doc description: Information Disclosure Statement (IDS) Field

Approved for use through 07312012. OMB 0651-0031

U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Under the Paperwork Reduction Act of 1995 no persons are required to respond to a collection of information unless it contains a valid OMB control number.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number		Herewith
	Filing Date		January 25, 2018
	First Named Inventor	Angus PACALA	
	Art Unit	Not yet assigned	
	Examiner Name	Not yet assigned	
	Attorney Docket Number	103033-P001USC2-1096583	

	120	20160047896	A1	02-18-2016	Dussan	
	121	20160047897	A1	02-18-2016	Dussan	
	122	20160047898	A1	02-18-2016	Dussan	
	123	20160047899	A1	02-18-2016	Dussan	
	124	20160047900	A1	02-18-2016	Dussan	
	125	20160047903	A1	02-18-2016	Dussan	
	126	20160097858	A1	04-07-2016	Mundhenk, et al.	
	127	20160218727	A1	07-28-2016	Maki	
	128	20160265902	A1	09-15-2016	Nawasra, et al.	
	129	~~201602911434~~ 20160291134	A1	10-16-2016	Droz, et al.	
	130	20160306032	A1	10-20-2016	Schwarz, et al.	
	131	20160328619	A1	11-10-2016	Yi, et al.	
Change(s) applied	132	20170219426	A1	08-03-2017	~~Quoter, Inc.~~ Pacala, et al.	
to document,	133	2009/0295910	A1	12/03/2009	Mir Jose et al.	
/D.M./	134	2010/0020306	A1	01/28/2010	Hall David S.	
8/20/2021	135	2010/0123893	A1	05/20/2010	~~Yang Dezhong~~ Yang	
	136	2011/0032398	A1	02/10/2011	Lenchenkov Victor	
	137	201110216304	A1	09/08/2011	Hall David S.	
	138	2012/0154914	A1	06/21/2012	MoriQuchi Chihiro et al.	
	139	2012/0182464	A1	07/19/2012	Shpunt Alexander et al.	
	140	2014/0211194	A1	07/31/2014	Pacala Angus et al.	
	141	2015/0192677	A1	07/09/2015	Yu Tianyue et al.	
	142	2015/0293224	A1	10/15/2015	Eldada Louay et al.	

KILPATRICK TOWNSEND 70968829 1

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /J.R.L./

Doc code: IDS

PTOSB08a (01-10)

Doc description: Information Disclosure Statement (IDS) Field

Approved for use through 07312012. OMB 0651-0031

U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

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	First Named Inventor	Angus PACALA	
	Art Unit	Not yet assigned	
	Examiner Name	Not yet assigned	
	Attorney Docket Number	103033-P001USC2-1096583	

Change(s) applied to document, /D.M./ 8/24/2021	26	7969558		~~01/09/2012~~ 06/2011	Hall, David S.	
	27	8089618		12/11/2012	Yang, Dezhong	
	28	8330840		~~05/06/2014~~ 12/2012	Lenchenkov, Victor	
	29	8717488		~~09/15/2016~~ 05/2014	Shpunt, Alexander, et al.	
	30	9285477		07/05/2016	Smith, Scott T., et al.	
	31	9383753		~~11/09/2002~~ 07/2016	Templeton, Bradley, et al.	
	32	6721262	B1	Apr 13 2004	Jordache et al.	
	33	7433042	B1	Oct 7 2008	Cavanaugh et al.	
	34	8384997	B2	02-26-2013	Shpunt, et al.	
	35	8494252	B2	07-23-2013	Freedman, et al.	
	36	8675181	B2	03-18-2014	Hall	
	37	8742325	B1	06-03-2014	Droz, et al.	
	38	8743176	B2	06-03-2014	Stettner, et al.	
	39	8761495	B2	06-14-2014	Freedman, et al.	
	40	8767190	B2	07-01-2014	Hall	
	41	8829406	B2	09-09-2014	Akerman, et al.	
	42	8836922	B1	09-16-2014	Pennecot, et al.	
	43	8848039	B2	09-30-2014	Spektor, et al.	
	44	9041915	B2	05-26-2015	Earnhart, et al.	
	45	9063549	B1	06-23-2015	Pennecot, et al.	
	46	9071763	B1	06-30-2015	Templeton, et al.	
	47	9086273	B1	07-21-2015	Gruver, et al.	
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number	Herewith
	Filing Date	January 25, 2018
	First Named Inventor	Angus PACALA
	Art Unit	Not yet assigned
	Examiner Name	Not yet assigned
	Attorney Docket Number	103033-P001USC2-1096583

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Mailstop: IP Docketing - 22
1100 Peachtree Street
Suite 2800
Atlanta, GA 30309

ISSUE NOTIFICATION

The projected patent number and issue date are specified above.

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b) (application filed on or after May 29, 2000)

The Patent Term Adjustment is 517 day(s). Any patent to issue from the above-identified application will include an indication of the adjustment on the front page.

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (<http://pair.uspto.gov>).

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INVENTOR(s) (Please see PAIR WEB site <http://pair.uspto.gov> for additional inventors):

Angus Pacala, San Francisco, CA;
Mark Frichtl, San Francisco, CA;

APPLICANT(s) (Please see PAIR WEB site <http://pair.uspto.gov> for additional applicants):

Ouster, Inc., San Francisco, CA;

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