another optical element to create a laser line coupled with the MEMS mirror or multiple emitters behind multiple diffractive optical elements to enable electronic scanning.

[0011] According to a first aspect of the present disclosure, there is provided a solid state electronic scanning optical system including: a light transmission module including a transmitter layer that includes an array of individual light emitters aligned to project illuminating beams into a field external to the optical system according to an illumination pattern; emitter array firing circuitry coupled to the array of light emitters and configured to execute a plurality of emission cycles where, during each emission cycle the emitter firing circuitry activates only a subset of light emitters at a time such that each activated light emitter in the subset emits one or more pulses of light at a specific time until every light emitters in the array of light emitters is activated thereby generating the illumination pattern; a light sensing module including a sensor layer that includes an array of photosensors configured to detect photons emitted from the array of light emitters and reflected from surfaces within the field external to the optical system, wherein each photosensor in the array of photosensors is paired with a corresponding light emitter in the array of light emitters and has a field of view that overlaps with a field of view of its paired corresponding light emitter; sensor array readout circuity coupled to the array of photosensors and configured to synchronize the readout of individual photosensors within the array concurrently with the firing of corresponding light emitters so that each photosensor in the array of photosensors can be readout once during each emission cycle in the plurality of emission cycles; and a processor configured to compute distances to the surfaces within the field external to the solid state optical system based on a time difference between when the pulses of light are emitted and when photons from reflected pulses are detected.

[0012] According to a second aspect of the present disclosure, there is provided a solid state electronic scanning optical system for performing distance measurements, the solid state optical system including: a light emission system comprising a bulk transmitter optic, and an illumination source comprising a two-dimensional array of light emitters arranged according to an illumination pattern and aligned to project discrete beams of light through the bulk transmitter optic into a field ahead of the optical system; a light detection system comprising a bulk receiver optic, an aperture layer including a plurality of apertures, and a photosensor layer including a two-dimensional array of photosensors configured to detect photons emitted from the illumination source and reflected from surfaces within the field after passing through the bulk receiver optic, wherein the aperture layer and the photosensor layer are arranged to form a plurality of sense channels arranged in a sensing pattern that corresponds to the illumination pattern and wherein each sense channel in the plurality of sense channels corresponds to an emitter in the array of emitters and includes an aperture from the aperture layer and a photosensor from the photosensor layer; emitter array firing circuitry coupled to the two-dimensional array of light emitters and configured to execute a plurality of emission cycles

where, during each emission cycle the emitter firing circuity sequentially activates different subsets of light emitters at a time until the illumination pattern is generated; and sensor array readout circuity coupled to the two-dimensional array of photosensors and configured to synchronize the readout of individual photosensors within the array concurrently with the firing of corresponding light emitters so that each photosensor in the array of photosensors can be readout during each emission cycle in the plurality of emission cycles.

[0013] According to a third aspect of the present disclosure, there is provided a solid state electronic scanning optical system for performing distance measurements, the solid state optical system including: a light emission system comprising a bulk transmitter optic, an illumination source including a two-dimensional array of light emitters aligned to project discrete beams of light through the bulk transmitter optic into a field external to the optical system according to an illumination pattern in which each discrete beam in the illumination pattern represents a non-overlapping field-of-view within the field; a light detection system configured to detect photons emitted from the illumination source and reflected from surfaces within the field, the light detection system comprising a bulk receiver optic, an aperture layer including a plurality of apertures, and a photosensor layer including a two-dimensional array of photosensors, wherein the aperture layer and the photosensor layer are arranged to form a plurality of sense channels having a sensing pattern in the field that substantially matches, in size and geometry across a range of distances from the system, the illumination pattern of the array of light emitters, and wherein each sense channel in the plurality of sense channels corresponds to an emitter in the array of emitters and includes an aperture from the aperture layer and a photosensor from the photosensor layer; emitter array firing circuitry coupled to the array of light emitters and configured to execute a plurality of emission cycles where, for each emission cycle the emitter array firing circuitry sequentially fires subsets of emitters within the array of light emitters according to a firing sequence until the illumination pattern is generated; and sensor array readout circuity coupled to the array of photosensors and configured to synchronize the readout of individual photosensors within the array concurrently with the firing of corresponding emitters within the array of light emitters.

[0014] Disclosed herein is a solid state optical system for performing distance measurements including a first illumination source including a first two-dimensional array of light emitters aligned to project discrete beams of light into a field external to the optical system according to a first illumination pattern, a second illumination source including a second two-dimensional array of light emitters aligned to project discrete beams of light into the field according to a second illumination pattern having a same size and geometry as the first illumination pattern, and a light detection module including an array of photosensors configured to detect photons emitted from

CLAIMS

1. A solid state electronic scanning optical system comprising:

a light transmission module including a transmitter layer that includes an array of individual light emitters aligned to project illuminating beams into a field external to the optical system according to an illumination pattern;

emitter array firing circuitry coupled to the array of light emitters and configured to execute a plurality of emission cycles where, during each emission cycle the emitter firing circuitry activates only a subset of light emitters at a time such that each activated light emitter in the subset emits one or more pulses of light at a specific time until every light emitters in the array of light emitters is activated thereby generating the illumination pattern;

a light sensing module including a sensor layer that includes an array of photosensors configured to detect photons emitted from the array of light emitters and reflected from surfaces within the field external to the optical system, wherein each photosensor in the array of photosensors is paired with a corresponding light emitter in the array of light emitters and has a field of view that overlaps with a field of view of its paired corresponding light emitter;

sensor array readout circuity coupled to the array of photosensors and configured to synchronize the readout of individual photosensors within the array concurrently with the firing of corresponding light emitters so that each photosensor in the array of photosensors can be readout once during each emission cycle in the plurality of emission cycles; and

a processor configured to compute distances to the surfaces within the field external to the solid state optical system based on a time difference between when the pulses of light are emitted and when photons from reflected pulses are detected.

2. The solid state electronic scanning optical system of claim 1 wherein a field of view for each light emitter matches a field of view for its corresponding photosensor.

3. The solid state electronic scanning optical system of claim 2 wherein the light transmission module further including a bulk transmitter optic and the light sensing module further includes a bulk receiver optic.

4. The solid state electronic scanning optical system of claim 3 wherein the array of individual light emitters is arranged in a two-dimensional array having first dimensions

and configured to project discrete beams of light through the bulk transmitter optic into a field external to the optical system; the array of photosensors is arranged in a two-dimensional array having second dimensions and configured to detect photons reflected from surfaces in the field after the photons pass through the bulk receiver optic; and the combination of first dimensions, second dimensions, bulk transmitter optics and bulk receiver optics is designed such that a field of view of each emitter column going through bulk transmitter optic is significantly the same as a field of view of a corresponding pixel column going through the bulk receiver optic.

5. The solid state electronic scanning optical system of claim 1 wherein the light sensing module further includes an aperture layer having a plurality of apertures and the aperture layer and array of photosensors are arranged to form a plurality of receiver channels with each receiver channel in the plurality of receiver channels includes an aperture from the plurality of apertures and a photosensor from the array of photosensors with the aperture defining the field of view of the photosensor in the receiver channel.

6. The solid state electronic scanning optical system of claim 5 wherein each photosensor in the array of photosensors includes an array of single photon avalanche diodes (SPADs), and each light emitter is a vertical-cavity surface-emitting laser (VCSEL).

7. The solid state electronic scanning optical system of claim 6 wherein the array of light emitters and array of photosensors are activated by column or by row.

8. The solid state electronic scanning optical system of claim 5 wherein:

the light transmission module is a first light transmission module, the transmitter layer is a first transmitter layer, and the array of individual light emitters is a first array of individual light emitters;

the system further comprising a second light transmission module including a second transmitter layer that includes a second array of individual light emitters; and

the first and second arrays of individual light emitters are aligned to project discrete beams of light into a field external to the optical system according to a first illumination pattern and a second illumination pattern, respectively, where the first and second illumination patterns are aligned such that one discrete beam from the first illumination pattern and one

discrete beam from the second illumination pattern falls within the field-of-view of each receiver channel in the plurality of receiver channels.

9. A solid state electronic scanning optical system for performing distance measurements, the solid state optical system comprising:

a light emission system comprising a bulk transmitter optic, and an illumination source comprising a two-dimensional array of light emitters arranged according to an illumination pattern and aligned to project discrete beams of light through the bulk transmitter optic into a field ahead of the optical system;

a light detection system comprising a bulk receiver optic, an aperture layer including a plurality of apertures, and a photosensor layer including a two-dimensional array of photosensors configured to detect photons emitted from the illumination source and reflected from surfaces within the field after passing through the bulk receiver optic, wherein the aperture layer and the photosensor layer are arranged to form a plurality of sense channels arranged in a sensing pattern that corresponds to the illumination pattern and wherein each sense channel in the plurality of sense channels corresponds to an emitter in the array of emitters and includes an aperture from the aperture layer and a photosensor from the photosensor layer;

emitter array firing circuitry coupled to the two-dimensional array of light emitters and configured to execute a plurality of emission cycles where, during each emission cycle the emitter firing circuity sequentially activates different subsets of light emitters at a time until the illumination pattern is generated; and

sensor array readout circuity coupled to the two-dimensional array of photosensors and configured to synchronize the readout of individual photosensors within the array concurrently with the firing of corresponding light emitters so that each photosensor in the array of photosensors can be readout during each emission cycle in the plurality of emission cycles.

10. The solid state electronic scanning optical system of claim 9 wherein a field of view for each light emitter represents a non-overlapping field of view within the field and matches a field of view for its corresponding photosensor.

11. The solid state electronic scanning optical system of claim 9 wherein the emitter array firing circuitry activates subsets of light emitters by one column or one row at a time and the sensor array readout circuitry synchronizes the readout of corresponding photosensors by one column or one row at a time.

12. The solid state electronic scanning optical system of claim 11 wherein each photosensor in the array of photosensors includes an array of single photon avalanche diodes (SPADs), and each light emitter is a vertical-cavity surface-emitting laser (VCSEL).

13. The solid state electronic scanning optical system of claim 11 wherein the emitter array firing circuitry sequentially activates columns or rows of light emitters in a single direction throughout each emission cycle.

14. The solid state electronic scanning optical system of claim 9 wherein, for each sense channel in the plurality of sense channels, a sensing area for the photosensor in the sense channel is larger than an area of its respective aperture.

15. The solid state electronic scanning optical system of claim 9 wherein the two dimensional array of emitters includes a plurality of columns separated from each other by a first pitch and the two dimensional array of photosensors includes a plurality of columns separated from each other by a second pitch that is equal to the first pitch.

16. The solid state electronic scanning optical system of claim 9 further comprising a micro-optic channel array disposed between the illumination source and the bulk transmitter optic, the micro-optic channel array defining a plurality of micro-optic transmitter channels, each micro-optic transmitter channel including a micro-optic lens spaced apart from a light emitter from the two-dimensional array of light emitters with the micro-optic lens being configured to receive a light cone from the light emitter in its respective transmitter channel and generate a reduced-size spot image of the light emitter at a focal point displaced from the light emitter at a location between the light emitter and the bulk transmitter optic.

17. The solid state electronic scanning optical system of claim 9 further comprising an optical filter disposed between the bulk receiver optic and the array of

photosensors, the optical filter configured to receive light passed through the bulk receiver optic and pass a narrow band of radiation that includes an operating wavelength of the plurality of emitters to the plurality of photosensors while blocking radiation outside the band.

18. A solid state electronic scanning optical system for performing distance measurements, the solid state optical system comprising:

a light emission system comprising a bulk transmitter optic, an illumination source including a two-dimensional array of light emitters aligned to project discrete beams of light through the bulk transmitter optic into a field external to the optical system according to an illumination pattern in which each discrete beam in the illumination pattern represents a non-overlapping field-of-view within the field;

a light detection system configured to detect photons emitted from the illumination source and reflected from surfaces within the field, the light detection system comprising a bulk receiver optic, an aperture layer including a plurality of apertures, and a photosensor layer including a two-dimensional array of photosensors, wherein the aperture layer and the photosensor layer are arranged to form a plurality of sense channels having a sensing pattern in the field that substantially matches, in size and geometry across a range of distances from the system, the illumination pattern of the array of light emitters, and wherein each sense channel in the plurality of sense channels corresponds to an emitter in the array of emitters and includes an aperture from the aperture layer and a photosensor from the photosensor layer;

emitter array firing circuitry coupled to the array of light emitters and configured to execute a plurality of emission cycles where, for each emission cycle the emitter array firing circuitry sequentially fires subsets of emitters within the array of light emitters according to a firing sequence until the illumination pattern is generated; and

sensor array readout circuity coupled to the array of photosensors and configured to synchronize the readout of individual photosensors within the array concurrently with the firing of corresponding emitters within the array of light emitters.

19. The solid state electronic scanning optical system of claim 18 wherein each photosensor in the two-dimensional array of photosensors includes an array of single photon avalanche diodes (SPADs), and each light emitter in the two-dimensional array of light emitters is a vertical-cavity surface-emitting laser (VCSEL).

20. The solid state electronic scanning optical system of claim 18 further comprising an optical filter disposed between the bulk receiver optic and the array of photosensors, the optical filter configured to receive light passed through the bulk receiver optic and pass a narrow band of radiation that includes an operating wavelength of the plurality of emitters to the plurality of photosensors while blocking radiation outside the band.