CLAIMS

WHAT IS CLAIMED IS:

1. An optical orbital angular momentum (OAM) encoding system, the system comprising:

an optical source configured to generate a source light;

an optical OAM encoder configured to encode the source light based on OAM modes to generate an encoded light, wherein the optical OAM encoder comprises a plurality of OAM encoders, wherein each of the plurality of OAM encoders is controlled separately and is configured to encode or modulate the source light based on a different configuration of the OAM modes; and

an optical unit configured to direct the encoded light to a target.

2. The system of claim 1, further comprising a receiver configured to receive scattered light from the target and recover an image of the target.

3. The system of claim 1, wherein the optical OAM encoder comprises a single-phase plate, a phase spatial-light modulator or an amplitude spatial-light modulator.

4. The system of claim 3, wherein the phase spatial-light modulator is configured to generate a vortex phase pattern based on the OAM modes, wherein the vortex phase pattern is generated in binary or greyscale.

5. The system of claim 4, wherein the amplitude spatial-light modulator is configured to perform an amplitude-to-phase optical conversion based on the OAM modes.

~~6. The system of claim 1, wherein the optical OAM encoder comprises a plurality of OAM encoders, wherein each of the plurality of OAM encoders is controlled separately and is configured to encode or modulate the source light based on a different configuration of the OAM modes.~~

~~7~~6. The system of claim ~~6~~1, further comprising a combiner configured to combine encoded source lights from the plurality of OAM encoders and to direct a combined encoded

light to the optical unit, and wherein the optical unit comprises an optical telescope including a lens system.

~~8~~7. A remote sensing system based on optical OAM, the system comprising:

an optical source;

an optical modulator configured to modulate source light from the optical source with a transmit (TX) signal to generate a modulated signal;

an optical OAM encoder configured to encode the modulated light based on OAM modes to generate an encoded signal; and

a telescope configured to direct the encoded signal to a target~~.~~, wherein the telescope is configured to receive a return signal from the target and to direct the return signal to an optical OAM filter, wherein the optical OAM filter is integrated with the optical OAM encoder.

~~9. The system of claim 8, wherein the telescope is configured to receive a return signal from the target and to direct the return signal to an optical OAM filter, wherein the optical OAM filter is integrated with the optical OAM encoder.~~

~~10~~8. The system of claim ~~9~~7, wherein the optical OAM filter comprises a single-phase plate, a phase spatial-light demodulator or an amplitude spatial-light demodulator.

~~11~~9. The system of claim ~~9~~7, further comprising a TX/receive (RX) switch configured to direct an OAM-filtered return signal to a receiver.

~~12~~10. The system of claim ~~11~~9, wherein the receiver comprises a coherent receiver, and wherein the system further comprises an optical splitter configured to receive and split the source light and branch out a portion of the source light to the coherent receiver.

~~13~~11. The system of claim ~~8~~7, further comprising a receiver comprising an OAM splitter, a detector array and a digitizer, wherein the OAM splitter is configured to split received light into a plurality of spatial modes corresponding to topological orders of the OAM modes.

~~14~~12. The system of claim ~~13~~11, wherein the detector array comprises a plurality of delays, an optical combiner and an optical detector, and wherein the receiver comprises an OAM variable filter and the optical detector.

~~15~~13. The system of claim ~~13~~11, wherein a light output of the telescope is affected by a TX turbulent channel due to atmospheric turbulence in a TX path.

~~16~~14. The system of claim ~~15~~13, ~~further comprising a receiver, and~~ wherein a return light from the target is affected by an RX turbulent channel due to atmospheric turbulence in an RX path, and wherein the receiver comprises an OAM modes filter configured to reduce effects of an atmospheric turbulence from the TX and RX paths.

~~17~~15. A method comprising:

generating a source light;

encoding the light source based on OAM modes to generate an encoded light; ~~and~~

directing the encoded light to a target~~.~~; and

applying a transmission protocol to reduce impact of the background light on a receiver and to reduce an effect of a turbulence on a channel efficiency, the transmission protocol being optimized to a turbulence regime.

~~18~~16. The method of claim ~~17~~15, further comprising receiving return light from the target and decoding the return light to recover a target image.

~~19. The method of claim 17, further comprising applying a transmission protocol to reduce impact of background light on a receiver and to reduce an effect of a turbulence on a channel efficiency, the transmission protocol being optimized to a turbulence regime.~~

~~20~~17. The method of claim ~~17~~15, further comprising:

applying a first protocol for optimizing an optical sensing channel efficiency for a Lambertian-surface target;

applying a second protocol for optimizing channel efficiency for direct-detection remote sensing;

~~applying a third protocol for optimizing channel efficiency for direct-detection remote sensing;~~

applying a ~~fourth~~third protocol for optimizing channel efficiency for a direct-detection optical communication transceiver; and

applying a ~~fifth~~fourth protocol for channelization optimization of energy versus bandwidth for direct and coherent optical communication applications.