Tunable System for Generating Higher Order Bessel Beams (2019-013)

Orbital angular momentum system that generates higher order Bessel beams integrated in time (HOBBIT)

Market Overview

The use of a turntable system in conjunction with an acousto-optic deflector (AOD) can allow for fast and continuous tuning of the orbital angular momentum (OAM) topological charge number of the output of Bessel beams. This technique uses a simple and effective approach that is capable of generating beams with integer topological and fractional charge numbers. Unlike other technologies that are used to generate beams with OAM, this device offers much faster switching speeds that can reach up to 10's of MHz. The uniqueness of this approach centers on the use of the acousto-optic deflector to add a linear phase ramp to a beam that will ultimately be wrapped into an azimuthal phase. The use of the AOD in conjunction with the proper log-polar optics results in a system that can be used at high power, with fast and continuous OAM mode tuning. Clemson University researchers have a created a unqiue technique that can expand the networking potential of future computing technologies and establishes a base for which quantum signals can be propogated.

Technical Summary

The HOBBIT optical system is made up of an acousto-optic deflector (AOD) and log-polar transformation optics. The AOD is used to add a linear phase gradient to a Gaussian input beam. The output Gaussian beam from the AOD is then elongated into an elliptical Gaussian line and propagates through the log-polar HOBBIT optics that wrap the ellipse into an asymmetric annular-distribution. The log-polar HOBBIT optics consist of two diffractive phase only optics. The first optic performs the geometric log-polar coordinate mapping that wraps the elliptical Gaussian line into a ring. The second optic corrects for the phase of the transformed beam. Overall, this results in an elliptical Gaussian beam with linear phase being wrapped into an asymmetric ring with azimuthal OAM phase. A RF signal is applied to the AOD to produce a traveling wave in the crystal. The frequency of the acoustic signal corresponds to the angle of the 1st order diffraction relative to the 0^{th} order. The optical system is designed around this angle to produce specific OAM topological charge numbers. As the frequency of the applied signal is varied, the deflection angle of the 1st order changes accordingly. Each frequency corresponds to a specific deflection angle and therefore, a unique OAM charge number.

Application

Equipment Manufacturing, Precision Medicine, Precision Lasing, Quantum Communications

Development Stage

Proof of Concept

Advantages

- Technique has higher switching speeds and higher optical power handling capacity
- Can produce multiple output beams with different OAM charges
- Since the frequency can be controlled very precisely with continuous range, the generated OAM charge numbers can also be generated in a precise and continuous fashion

App Type	Country	Serial No.	Patent No.	CURF Ref. No.	Inventors
Provisional	United States	16/725,293	N/A	2019-013	Dr. Eric Johnson

About the Inventors

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Dr. Eric Johnson received his Ph.D. from the University of Alabama, Huntsville in Electrical Engineering. As the PamettoNet Endowed Chair in Optoelectronics at Clemson, he also serves as the head of the South Carolina SmartState Center for Economic Excellence in Optoelectronics. Prior to joining Clemson, Dr. Johnson held a joint appointment as a professor of Physics and Optical Science as well as Electrical and Computer Engineering at the University of North Carolina at Charlotte, where he also served as the Director of the Center of Optoelectronics and Optical Communications. His research interests include micro-optics and nano-photonics, with particular emphasis on active and passive photonic devices.

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