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Permalink
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Journal
ECE170A Paper Review, 1(1)

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Publication Date
2022-10-01

Paper Review on "Integrated structured light architectures"

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This review paper observes several photonics devices and emphasizes their functionality and relevance to the generalized light architecture proposed by engineers at SLAC.

INTRODUCTION

In this review paper, the writer wants to emphasize concepts and principles in the field of photonics by looking at a generalized light architecture proposed by engineers from SLAC[2]. The light architecture employed a concept called phased arrays which are known for their successful demonstration of several degrees of freedom[2]. This generalized light architecture can be seen in Figure 1. When a device has a great degree of freedom, lots of applications can use the device by adjusting several of its characteristics. In other words, this light architecture might be able to be used for lots of applications in the field of Photonics.
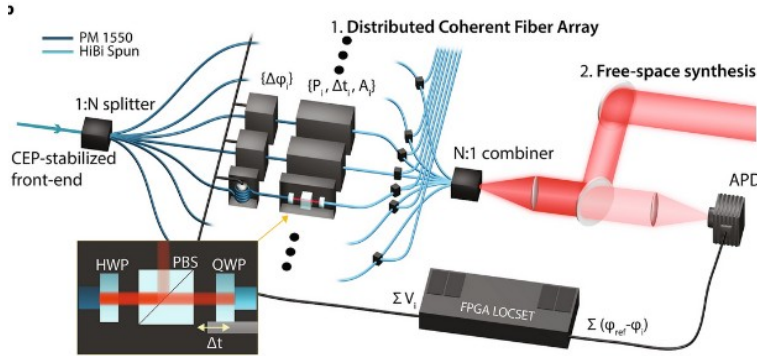

Figure 1. The generalized light architecture proposed by SLAC engineers

METHODS

In the device, SLAC engineers used half waveplates, polarized beam splitters, and quarter waveplates for modifying the phase, amplitude, polarization state, and timing of the beams[2]. These modifiable beams are symbolized as multiple black boxes in Figure 1. A half waveplate is known for its ability to change the rotation of a linearly polarized wave[3]. A quarter waveplate is known for its ability to transform a linearly polarized wave to a circular or elliptic polarization[3]. As both waveplates can change or modify the polarization, therefore, the proposed light architecture employed the functionality of a quarter waveplate and a half waveplate.

The beam splitter is used in many devices such as the Michelson Interferometer.[3] In Michelson Interferometer, the beam splitter is used to modify the intensity.[3] The polarizer can be used to modify the timing of the specific components of the beam.[3] Since SLAC engineers used polarized beam splitters, therefore, the timing and intensity of the beams can be modified. The writer believed that these 3 components are essential for beam modification.

To observe the topology of these beamlines, SLAC engineers used a Rayleigh-Sommerfeld diffraction formula.[2] In a gaussian beam, the Rayleigh range is described as the range in which a gaussian beam is still focused and can be calculated using Equation 1.[3] Since

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SLAC engineers used the Rayleigh-Sommerfeld diffraction formula, the beam can be observed in such a way that it's still focused.

$$z_R = \frac{kw_0^2}{2} = \frac{\pi n w_0^2}{\lambda}$$

Equation 1. Rayleigh range formula

The topology resolution is maximized by using a device called the avalanche photodiode.[2] In Figure 1, the APD is located after the polarized beam splitter.[2] The 7 beamlines can be examined by placing them parallel to each other and arranged hexagonally.[2] The Avalanche photodiode is known for its ability to accelerate the holes and electrons from the absorbed photon.[4] This means, any little photons can generate large results inside the avalanche photodiode. In this device, the avalanche photodiode is used as an amplifier.[2] Without the avalanche photodiode, the writer believed that it would be harder to see the topology clearly.

RESULTS AND INTERPRETATION

The results showed that by modifying phase and intensity, the device can produce Laguerre-Gaussian and helical shapes.[2] In the transverse plane, Laguerre-Gaussian has circular and radial symmetry.[3] The similarity between the shapes of the demonstration and the Laguerre-Gaussian shapes in several modes can be seen in Figure 2. For example, the shape in row 2 of Figure 2b is almost the same as the shape of the Laguerre-Gaussian mode 03 in Figure 2a. From these results, we can see that beam modification using half and quarter waveplates resulted in unique shapes. To be exact, the SLAC engineers mentioned that these results shine a light on the adaptive and dynamic distributions.[2] Without the Rayleigh-Sommerfeld diffraction formula and Avalanche Photodiode, the writer believed that these shapes won't be easy to observe.
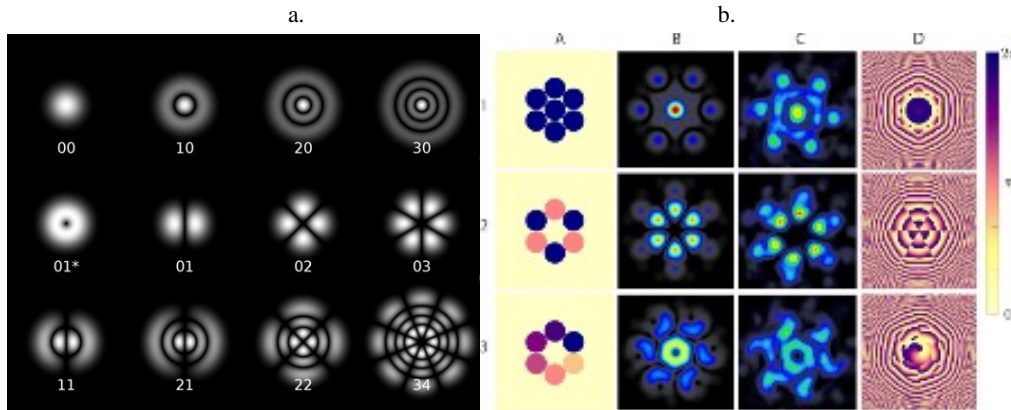

Figure 2. (a) Laguerre Gaussian shapes for several modes.[1] (b) 3 from 8 shapes obtained through several demonstrations

CONCLUSIONS

From this review, the writer concludes that in light architecture, there are many important components. By using two types of waveplates and polarizing beam splitter, engineers can modify beams with several degrees of freedom. While experimenting, the utilization of the Rayleigh-Sommerfeld diffraction formula and Avalanche Photodiode are also important for observation. In the future, hopefully, the amount of research being done on the topic of light architecture increases.

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