EXPERIMENTAL INVESTIGATION OF THE OPTICAL HIGHWAY USING LARGE FREE SPACE OPTICAL COMPONENTS

Ruby Raheem, Yann Tissot, Gordon Russell, Craig Moir, Keith Symington and John Snowdon
DEPARTMENT OF PHYSICS, HERIOT-WATT UNIVERSITY, EDINBURGH EH14 4AS

Key words to describe the work: Free space optics, optical switching, optical interconnects, optical highway, polarisation

Key Results: Demonstrated experimentally the feasibility of the Optical Highway using AMOS (Analysis and Modelling of Optoelectronic Systems) design.

How does the work advance the state-of-the-art? Establish experimentally the feasibility of the Optical Highway and demonstrate the advantages of the optical interconnect.

Motivation (problems addressed): Experimental verification of a theoretical design of optical switching using a square grid of three and four laser source units and two or more stages.

Abstract

A multi-source laser diode system emitting in the 670nm range is aligned through an optical system to deliver beams through a free space optical configuration consisting of three relay stages. Signals were detected at each stage verifying the validity of the theoretical AMOS model and the nature of the image orientation at each relay stage.

Introduction

Several papers and presentations on the use of optical signal integrated with electronics designed to maximise the speed and efficiency of signal transmission for computing have been written and explored [1 - 4].

The experimental set up uses a widely discussed model [5] using parallel array of optical beam and polarising system, aligned to switch signals and deliver them at more than one receiving stages.

The motivation and the description of the strategic and computational aspects behind this approach is described in the paper presented by G. A. Russell

Experimental Procedure

The experiment explores the design previously discussed by Gordon Russell et al [4, 5]. Laser diode square grid consisting of three or four parallel sources, spaced approximately 25mm apart are used to demonstrate feasibility. Large optical lens system used in conjunction with the source help control the dimensions of the parallel signal from the laser diode grid reaching the smaller source lens of 80mm focal length and about 15mm lens diameter. The object grid size is reduced to 3.5mm at the object plane of the source lens, which is the start of the Optical Highway.

Beams emerging from the source lens are reflected through a beam splitter to a lens system pair where the polarising array will selectively pass plane-polarised beams at each stage. Each of the plane-polarised beams is either parallel or perpendicularly oriented depending on the pre-selected state of polarisation. Thus the beam being delivered at a stage can have two states of orientation. The polarisation orientation in conjunction with the polarisation state of the polarising system will determine the beam delivery from each of the leg of the optical grid to each of the delivery stages examined. By dynamically controlling the polarising system, each leg of the beams can be switched on and off.

The current project focuses on the feasibility and optical characterisation of the optical highway with additional stages and multiple sources. The grid (source) is transformed by the lens system as well as by the reflecting mirrors, introducing image inversions and reflections respectively. Signal division at beam splitters and reflection losses contribute to weaker signals delivered at each stage. These can be minimised through process improvement. The signals from the laser diodes are reduced to point objects in the object plane of the source lens at the start of the Optical Highway, thus maintaining high resolution and minimising aberration and misalignment contributions at the polarising planes.

Results

Preliminary efforts resulted in well defined signal detection at each stage, though with decreasing intensity. Minimal effort went into collimating and aligning the beam. Most of the optical components were seated in dedicated micro-machined slots on a heavy metal chassis. Despite such initial limitations and dusty environment, the output signals at each stage were well defined and reproduced the predicted pattern output [7]. With focussed effort, the signal quality and intensity between stages could be considerably improved and larger number of stages could be introduced.

Conclusions

As a preliminary investigation, the experiment proved beyond doubt that the design and concept of the [4 -7] optical highway for optically interconnected computing is not only possible, but works well even in the absence of dedicated devices, signal optimisation and alignment. Alternate optical components and devices could be used to enhance the performance of the optical interconnect for integration and packaging.

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