Washington University in St. Louis
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HIGH-SPEED, LOW-COST, SHORT-HAUL OPTICAL COMMUNICATIONS WITH ON-CHIP POLARIZATION DIVISION MULTIPLEXING

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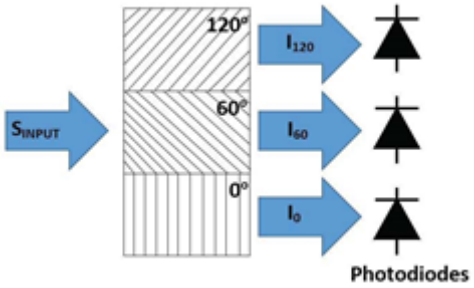
Technology Description

Engineers in Prof. Roger Chamberlain's laboratory have developed a low-cost multiplexing technology for high-speed optical communications in data centers and other short-haul applications. This visible light communication (VLC) system is designed to create distinct parallel optical channels using polarization division multiplexing (PDM). This approach increases bandwidth with on-chip filters and receivers that are less expensive to manufacture than conventional wavelength division multiplexing components. To date, the inventors have shown that PDM can increase data rate over short distances (chip-to-chip or board-to-board) by 3x over traditional systems, with the potential for up to 4x improvement. This VLC system could be particularly useful for expanding the number of channels in short haul (<100m) applications such as data centers.



Overview of three-channel PDM: *The light signal (S_{INPUT}) is modulated for three data channels (polarization angles of 0^o, 60^o and $120^{o)}$ and reaches the polarization filter array and the output light signals from the filters (I_0, I_{60} and I_{120}) are then received by separate photodiodes.*

Applications

- **Short distance optical communications** – transceivers for short-haul transmissions (<100m, chip-to-chip, board-to-board), such as those in **data centers**

Key Advantages

- **High-speed:**
  - data rate 2x, 3x, 4x faster than conventional baseband modulated system
  - encoding enhancements could enable ~4x faster data rate
- **Low-cost, CMOS-compatible manufacturing:**

- bonding of fabricated aluminum nanowire optical filters used for polarization on both receivers and transmitters on chip
- less expensive manufacturing than wavelength division multiplexing so it can be used for short distance high speed communications

Stage of Research

- **Simulations** – The inventors used a Cadence and VerilogA models to simulate a PDM VLC system based on aluminum nanowire Division of Focal Plane (DoFP) polarimeters mounted on a custom CMOS for various types of multichannel (2 to 4) optical communication links that use air or fiber optic cables as communication media. They demonstrated the viability of two- or three- channel designs with the potential for four- channels with improved channel signal coding.
- **Prototype** – The inventors have fabricated a custom CMOS chip to empirically verify their simulations and did some preliminary testing
- **Testing** – The inventors performed PDM VLC test on optical bench using air as communication media. They demonstrated the viability of two- channel designs with the potential for three- or four- channels with improved channel signal coding.
- **Additional testing** – The inventors plan to perform tests on non-preserving polarization and preserving polarization fiber optic cables up to 100 meters long to determine how polarized light travels thru fiber optic cables used as communication media.

Publications

- Ivanovich, D., Powell, S. B., Gruev, V., & Chamberlain, R. D. (2018, February). Polarization division multiplexing for optical data communications. In *Optical Interconnects XVIII* (Vol. 10538, p. 105381D). International Society for Optics and Photonics.

Patents

- Provisional patent application pending