Performing Optical Fast Fourier Transforms Through the Use of Silicon Photonics

Maddipatla, Jagadeepram (School: Rock Ridge High School)

Data processing has grown to be increasingly important in our digitized world. A key component of data and signal processing is the Fast Fourier Transform (FFT), which allows for detailed analysis of signal frequency. FFT operations are widely used in the telecommunications industry, where frequency domain analysis is prevents corporations from encroaching on frequency band rights. FFTs also have the potential to revolutionize the training of artificial intelligence (AI) algorithms through batch multiplication. In the past, FFTs have been processed primarily through parallel processors; however, digital electronics cannot scale with FFT needs, and cannot efficiently execute recursive FFT algorithms. This project utilizes a silicon photonics chip with a series of Mach-Zehnder Interferometer (MZI) components to process FFT algorithms. This architecture is inherently analog, allowing for increased scalability and efficiency when processing FFT algorithms. In order to design this accelerator, the VPIDesignSuite tool and KLayout CAD software were both utilized. The MZI components incorporated two separate input branches to process laser-light inputs. A series of MZI components were arranged in two stages; stage one was designed to feed inputs into two separate MZI components placed in parallel within stage 2, which had a quarter-wavelength time delay. Thermo-optic modulators were implanted within the MZI branches to change the phase of light input. A transmission spectrum revealed that the chip was most active within wavelengths of 1550 to 1600 nanometers. The power intensity of the chip was calculated to 0.024 mW/mm2, with an on-chip signal loss of approximately -25 dB.

Awards Won: