DEVELOPMENT OF AN ALGORITHMIC SPECTROMETER FOR TARGET RECOGNITION USING QUANTUM –DOT INFRARED SENSORS

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ABSTRACT

By exploiting the quantum confined Stark effect, the intersubband transitions in a quantum-dots in a well (DWELL) can be designed to produce bias-dependent spectral curves[1]. Thus the spectral response of the same DWELL varies with changes in the applied bias across the device. The device consists of multiple stacks of InAs quantum dots buried in a (In,Ga)As quantum well, which are in turn placed in an AlGaAs matrix. In our earlier theoretical work[2], a signal-processing algorithm for spectral tuning had been developed by exploiting the spectrally overlapping responsivities from a QDIP corresponding to different applied biases. In this abstract we report the first experimental demonstration of reconstruction of the spectra of a given "target" using an algorithmic spectrometer based on the QDIP.

In our experiments, we probe a "target" scene, which consists of an arbitrarily chosen filter. We measure the photocurrent from the DWELL at different applied biases. Then we reconstruct the spectrum of the target filter using the spectral tuning algorithm as follows. First, a family of narrowband tuning filters in a spectral range of interest are mathematically approximated (synthesized) using weighted superpositions of the bias-dependent QDIP responsivities. Second, the target spectrum is reconstructed by linearly combining the experimentally measured bias-dependent photocurrents (viz., the QDIP-sensed data of the target) according to the weights obtained from the first step. Particularly, the weights associated with each synthesized tuning filter are used with the bias-dependent photocurrents to form a linear superposition photocurrent approximating the spectrum of the target at the center wavelength of the narrowband tuning filter. *We can therefore construct the target's spectrum without using any physical spectrometer*. In the experiments, we used four long-wave infrared (LWIR) target filters. The experimental reconstructions of the spectra are shown in Figure 1.

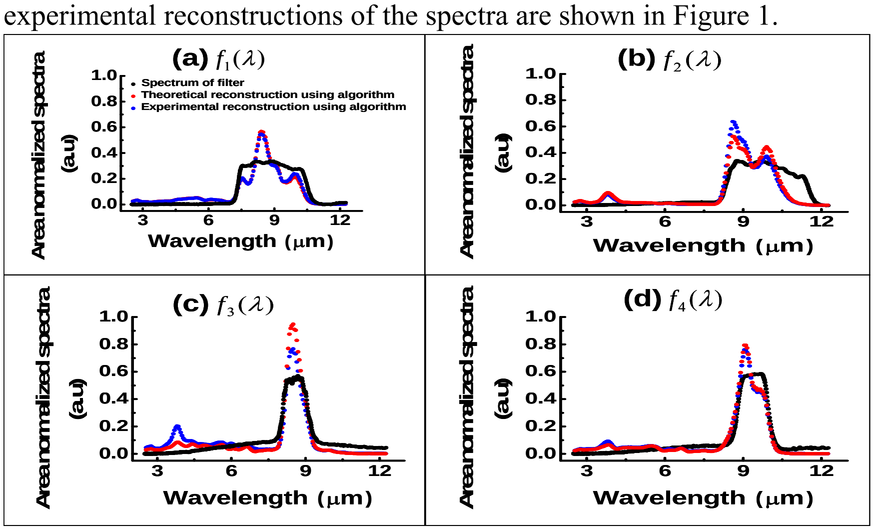

Fig. 1. Experimental results: constructions of four LWIR test filters obtained using the bias dependent photocurrent from a multi stack quantum dots in a well (DWELL) detector. Black: the true spectra of 4 LWIR filters; red: the theoretical estimations using algorithm; blue: the experimental reconstructions using algorithm without physical spectrometer.

[1] Krishna, S. InAs/InGaAs Quantum Dots in a Well Photodetectors. Journal of Physics D (Applied Physics); 38, 2142 - 2150 (2005)

[2] Sakoğlu, Ü, Hayat, M. M. , Tyo, J. S. , Dowd, P., Annamalai, S. , Posani, K. T. and Krishna, S. Applied Optics, 45, 7224 – 7234 (2006)