Real time blood testing using quantitative phase imaging

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ABSTRACT

We demonstrate a real-time blood testing system that can provide remote diagnosis with minimal human intervention in economically challenging areas. Our instrument combines novel advances from label-free optical imaging and parallel computing. Specifically, we use quantitative phase imaging for extracting red blood cell morphology with nanoscale sensitivity and NVIDIA's CUDA programming language to perform the cellular-level analysis in real time. While the blood smear is translated through focus, our system is able to segment and analyze all the cells in the one megapixel field of view, at a rate of 40 frames/ s. An entire blood smear can be analyzed in a matter of minutes. The variety of diagnostic parameters measured from each cell (e.g., surface area, sphericity, minimum cylindrical diameter) surpasses by far what can be obtained with current state of the art clinical instruments. In addition, we show that our instrument correctly recovers the red blood cell volume distribution, as evidenced by the excellent agreement with the cell counter results obtained on normal patients and those with microcytic and macrocytic anemia. The final data outputted by our instrument represent arrays of numbers associated with these morphological parameters and *not* images. Thus, the memory necessary to store these data is of the order of kilobytes, which allows for their remote transmission via, for example, the cellular network. We envision that such a system will help democratize access to blood testing and pave the way to *digital hematology*.