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Accuracy of single molecule localization using electron-multiplying charge-coupled device cameras JERRY CHAO, Department of Electrical Engineering, University of Texas at Dallas, Richardson, Texas, E. SALLY WARD, Department of Immunology, University of Texas Southwestern Medical Center, Dallas, Texas, RAIMUND J. OBER, Department of Electrical Engineering, University of Texas at Dallas, Richardson, Texas — The electron-multiplying charge-coupled device (EMCCD) is an important technology for imaging under extremely low light conditions. Whereas a weak signal acquired under low light conditions can be overwhelmed by the readout noise of a conventional charge-coupled device (CCD), it is amplified in the case of an EMCCD such that the readout noise becomes insignificant. The EMCCD is therefore a commonly used image detector in applications such as single molecule microscopy. However, despite its wide use, there has been a lack of rigorous analyses to determine how accurately parameters of interest (e.g., location of a single molecule) can be estimated from an image it produces. Here, we model the EMCCD's stochastic multiplication of electrons as a geometrically multiplied branching process, and develop the theory for calculating the Fisher information for estimating parameters from an EMCCD image. A "noise coefficient" is also introduced which enables the comparison of a CCD and an EMCCD in terms of the best accuracy with which parameters can be estimated from the images they produce.

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