Video quality fluctuation plays a significant role in human visual perception, and hence, many rate control approaches have been widely developed to maintain consistent quality for video communication. This paper presents a novel rate control framework based on the Lagrange multiplier in high-efficiency video coding. With the assumption of constant quality control, a new relationship between the distortion and the Lagrange multiplier is established. Based on the proposed distortion model and buffer status, we obtain a computationally feasible solution to the problem of minimizing the distortion variation across video frames at the coding tree unit level. Extensive simulation results show that our method outperforms the rate control used in HEVC Test Model (HM) by providing a more accurate rate regulation, lower video quality fluctuation, and stabler buffer fullness. The average peak signal-to-noise ratio (PSNR) and PSNR deviation improvements are about 0.37 dB and 57.14% in the low-delay (P and B) video communication, where the complexity overhead is ~4.44%.