SESSION THC2

OPTICAL COMMUNICATION SYSTEMS

PROBABILITY OF ERROR OF AN OPTICAL DPSK DETECTOR UNDER BROWNIAN LASER PHASE NOISE

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In this paper we analyze an optical, direct-detection DPSK receiver whose error probability is quantum-limited as the transmitting laser linewidth vanishes. The receiver design is based on a binary equiprobable hypothesis test with doubly stochastic point process observations, the conditional random rates of which depend on the transmitting laser phase noise, which is modeled as a Brownian motion. The receiver structure consists of a simple, delay-and-sum optical preprocessor followed by a photodetector. Upper and lower bounds on the receiver bit error rate are derived by developing bounds on the conditional rates of the point process, and it is shown that the error probability bounds converge to the true value as the transmitting laser linewidth decreases. Bounds on the power penalty are derived for parameters corresponding to existing semiconductor injection lasers, and are seen to be less than the limiting power penalty for the balanced DPSK receiver. (This work was partially supported by the U.S. National Science Foundation under grant ECS-8504752 and by the U.S. Office of Naval Research under grant N00014-87-K-0054.)

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AN ASYMPTOTICALLY EFFICIENT ESTIMATOR FOR A ONE-DIMENSIONAL PARAMETRIC MODEL OF QUANTUM STATISTICAL OPERATORS

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Let $\mathcal{H}$ be a Hilbert space representing a quantum system, and let $\{P_\theta \ ; \theta \in \Theta\}$ $(\Theta \subset \mathbb{R}^1)$ be a family of statistical operators (i.e., nonnegative Hermitian operators with trace 1) on $\mathcal{H}$ smoothly parametrized by a one-dimensional parameter θ. We consider the problem of estimating θ under the assumption that observations can be made on a number n of independent, identical systems, all with the same state P_θ. The following 'quantum Cramér-Rao inequality' derived by C.W. Helstrom is fundamental for the problem: in the state P_θ the variance of an arbitrary unbiased estimator based on n observations has the lower bound $1/(n\ I(\theta))$, where $I(\theta)$ is defined by $I(\theta) \triangleq \mathrm{Tr}\,[P_\theta\ (L_\theta)^2]$ from a Hermitian operator L_θ satisfying $dP_\theta/d\theta = (P_\theta L_\theta + L_\theta P_\theta)/2$. This paper shows an example of estimator which asymptotically achieves the lower bound. The estimation procedure is as follows. Choose the initial value $\hat{\theta}_0 \in \Theta$ arbitrarily, and carry out the following for n = 1, 2, 3, ... : perform the measurement of the observable $L\hat{\theta}_{n-1}$, x_n being the observed value, and then, using the obtained data $(x_1, x_2, \ldots, x_n)$, compute the maximum likelihood estimate $\hat{\theta}_n$.