一种具有野值预剔除的 TTE 时钟补偿算法

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摘　要：时间触发以太网（Time-triggered Ethernet，TTE）通过精确的时间调度，保证了通信数据的实时性传输，在很多实时性要求高的数据传输领域中脱颖而出.分析 TTE 同步特性，工程中可通过最小二乘时钟补偿算法对同步主节点的本地时钟进行补偿，提高确定性和实时性.然而同步主节点本地时钟易受外界环境影响产生野值，影响到最小二乘时钟补偿算法的适用性.因此，本文提出一种具有野值预剔除的时钟补偿算法来提高系统的实时性.即首先利用拉依达准则（Pauta criterion）对最小二乘敏感的本地时钟野值进行预先剔除，然后利用最小二乘法对本地时钟补偿值进行估计，最后根据估计的时钟补偿值对本地的时钟进行补偿.仿真结果表明本文提出的方法解决了 TTE 时钟补偿中同步主节点出现本地野值的问题，结果证实在野值比例不大于 10%的情况下，所提出的算法时钟同步精度可达到 10　-6　秒级，远远高于没有野值预剔除的最小二乘时钟补偿算法的 10　-3　秒级的精度.

关键词：TTE；时钟补偿；最小二乘法；拉依达准则；

A TTE Clock Compensation Algorithm with Outlier Preclusion

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Abstract：Time-triggered Ethernet (TTE) guarantees real-time transmission of communication data through precise time scheduling, and stands out in many fields of data transmission with high real-time requirements. Analyze the TTE synchronous characteristic we can compensate the local clock of synchronous main node through the least square clock compensation algorithm in the project and improve determinacy and real-time nature. However, the local clock of the synchronous master node is vulnerable to the influence of the external environment to generate outliers, which affects the applicability of the least squares clock compensation algorithm. Therefore, this paper proposes a clock compensation algorithm with outlier pre-elimination to improve the real-time performance of the system. That is, firstly, the Least Square criterion (Pauta criterion) is used to pre-eliminate the least-squares-sensitivity local clock outliers, then the local clock compensation value is estimated by least-squares method, and finally the local clock is processed according to the estimated clock compensation value. Simulation results show that the proposed method solves the problem of local outliers occurring at the synchronous master node in the TTE clock compensation. The results show that the clock synchronization accuracy of the proposed algorithm can reach 10　-6　seconds when the outlier ratio is less than 10%. It is much higher than the 10　-3　second-level accuracy of the least squares clock compensation algorithm with no outlier pre-elimination.

Key words：TTE; clock compensation; least squares ; pauta criterion

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