High accuracy synchronous acquisition algorithm of multi-hop sensor networks for machine vibration monitoring

Xin Xiao, Baoping Tang, Lei Deng

PII: S0263-2241(17)30047-7
DOI: http://dx.doi.org/10.1016/j.measurement.2017.01.036
Reference: MEASUR 4559

To appear in: *Measurement*

Received Date: 10 December 2015
Revised Date: 2 January 2017
Accepted Date: 18 January 2017

Please cite this article as: X. Xiao, B. Tang, L. Deng, High accuracy synchronous acquisition algorithm of multi-hop sensor networks for machine vibration monitoring, *Measurement* (2017), doi: http://dx.doi.org/10.1016/j.measurement.2017.01.036

High accuracy synchronous acquisition algorithm of multi-hop sensor networks for machine vibration monitoring

Xin Xiao, Baoping Tang*, Lei Deng

The State Key Laboratory of Mechanical Transmission, Chongqing University, Chongqing 400030, P.R.China

Abstract

Condition-based maintenance (CBM) is an effective way to reduce the maintenance costs and improve the reliability of machine. Considering that wireless sensor networks(WSNs) can be employed in some special applications where wired mechanical vibration monitoring systems are hard to be deployed, WSNs attracts much attentions in the field of mechanical vibration monitoring. But it is still facing many challenges in this filed, synchronization data acquisition is a crucial one of them. In this paper, the synchronization acquisition algorithm of multi-hop network for mechanical vibration monitoring is focused. In this algorithm, nodes are organized as cluster network. To realize synchronization acquisition triggering, transmission delay of beacon between gateway and each acquisition node is calculated and compensated. To improve the accuracy of synchronous acquisition, crystal oscillator drift of routers and acquisition nodes are measured and calibrated. While acquiring data, the accumulatived synchronization errors between acquisition nodes can be estimate and calibrated in real time. Finally, a three-hop network is employed to test the performance of the algorithm. The results show that the maximum synchronization triggering error is 0.64us, the average value is 0.3663us. At the sampling rate of 40ksps, the maximum synchronization acquisition error is 1.053us, the average value is 0.826us in 100s.

Keywords: Machine vibration monitoring; Wireless sensor networks; Crystal oscillator drift; Synchronization acquisition.

1. Introduction

Unexpected failures of machinery can cause breakdowns and leading to significant economic loses[1]. Condition-based maintenance (CBM) is an effective way to improve the reliability of machine and reduce the maintenance costs[2]. At present, vibration-based condition monitoring is the most accepted approach to assess the mechanical condition[3]. In most cases, traditional wired monitoring system is employed to acquire the mechanical vibration. But in some special applications such as monitoring rotating parts like shafts and bearings, the traditional wired monitoring systems are difficult to be deployed[4].

The problem can be solved by using the emerging wireless sensor networks(WSNs). WSNs is a kind of distributed sensor networks that the nodes in the network can sense the outside world and communicate with each other by wireless. Since the acquired data can be transmitted without cable, it can be easily deployed in the special applications wired monitoring systems cannot be deployed[5]. Thus, WSNs attracts much attentions in the field of mechanical vibration monitoring

* Corresponding author. Tel.:+86-13658319901; fax: +86-023-65415883; E-mail address: bptang@cqu.edu.cn (B. Tang).