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An efficient lossy link localization approach for wireless sensor networks

Key words: Lossy link localization; Redundancy eliminating algorithm; Set-covering; Wireless sensor networks (WSNs); Network diagnosis

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Motivation

- Network fault management is crucial for a wireless sensor network (WSN) to maintain a normal running state because
- faults (e.g., link failures) often occu.
- The existing lossy link localization (LLL) approach usually infers the most probable failed link set first, and then gives the fault hypothesis set.
- However, the inferred failed link set contains many possible failures that do not actually occur. That quantity of redundant information in the inferred set can pose a high computational burden on fault hypothesis inference.
- An efficient lossy link localization approach is needed.

Main idea

- We propose the conditional information entropy based redundancy elimination (CIERE), a redundant lossy link elimination approach, which can eliminate most redundant information while reserving the important information.
- Specifically, we develop a probabilistically correlated failure model that can accurately reflect the correlation between link failures and model the nondeterministic fault propagation.
- Through several rounds of mathematical derivations, the LLL problem is transformed to a set-covering problem. A heuristic algorithm is proposed to deduce the failure hypothesis set.

Method

1. We develop a probabilistically orrelated failure model, which gives the quantified impact that one failed link has on another one.
2. We construct a PWBG, which can effectively represent the nondeterministic causal relationships between lossy links and symptoms.
3. We propose a conditional information entropy based algorithm for redundancy elimination. With it, the lossy links that are less likely to occur are removed and a possible lossy link set that involves fewer redundant faults is obtained to realize lossy link filtering.

Method (Cont'd)

4. We formulate the LLL problem, and prove that it can be considered a set-covering problem. Additionally, we propose a heuristic algorithm to solve it efficiently.

Major results

- CIERE can always reserve real lossy links,The kernel attributes are all reserved and the classification ability is unchanged after redundancy reduction.

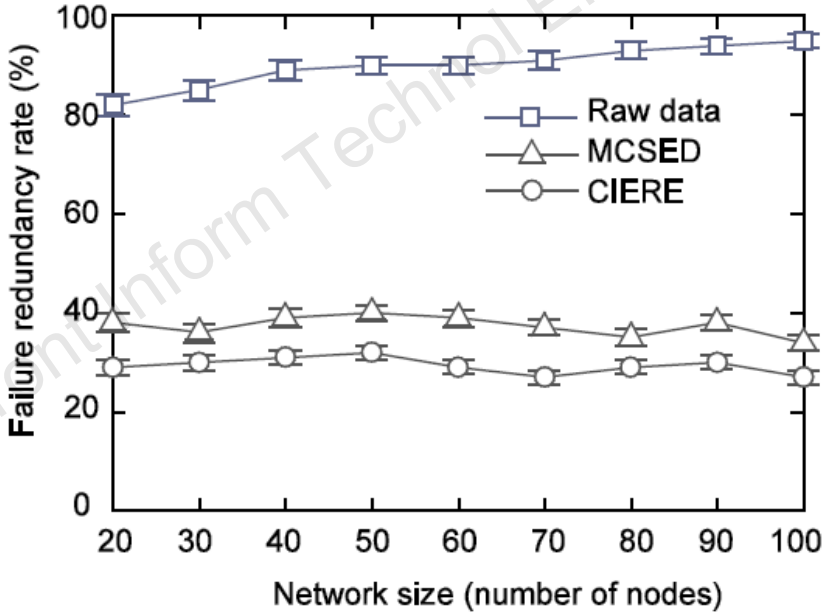
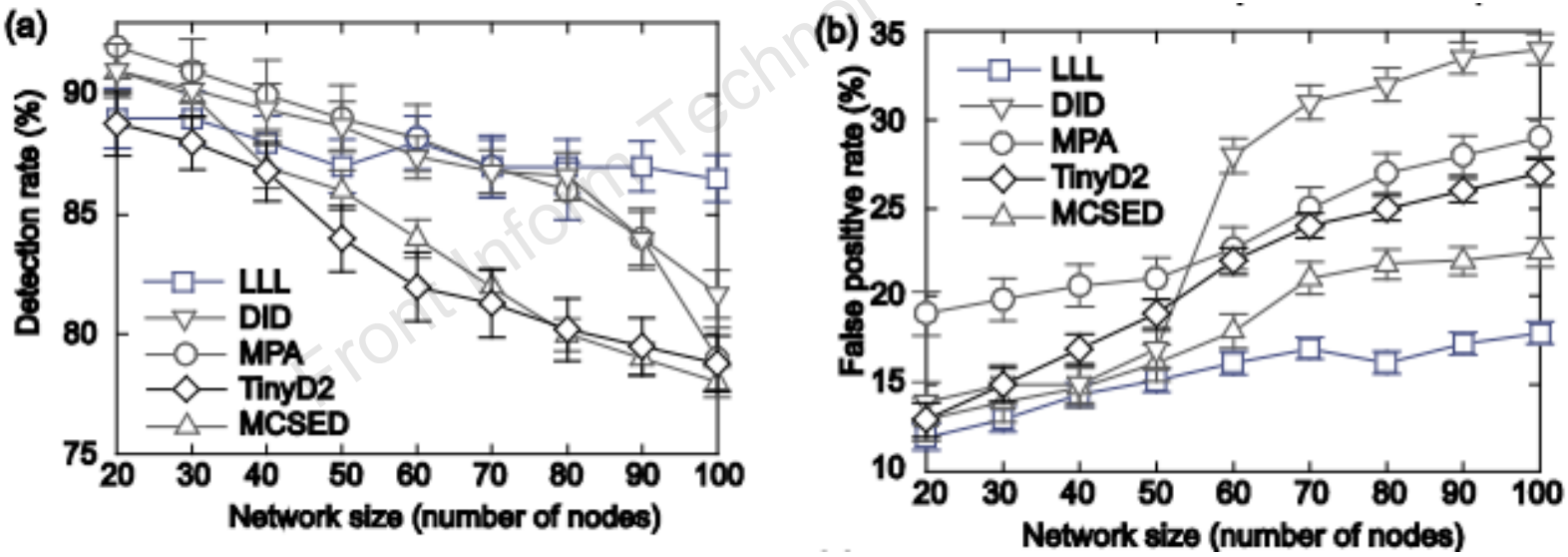


Fig. 5 Comparison of the failure (lossy link) redundancy rates with algorithms MCSED and CIERE

Major results (Cont'd)

- LLL has high localization accuracy and low localization time.



Major results (Cont'd)

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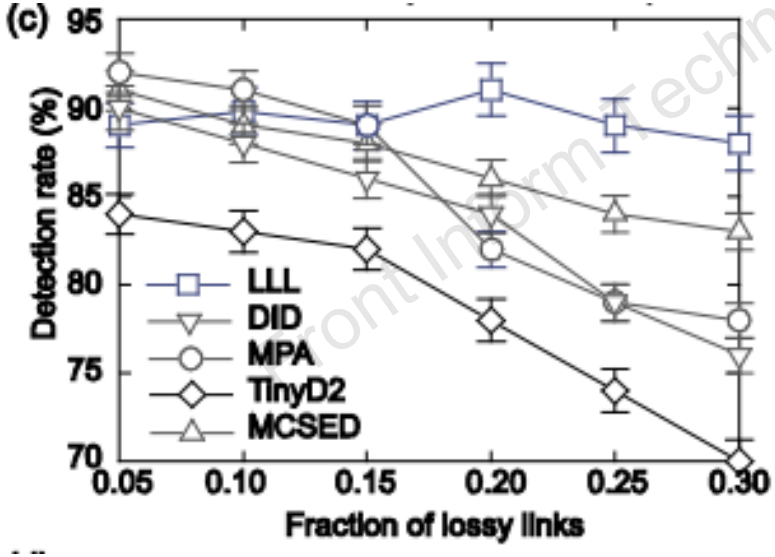

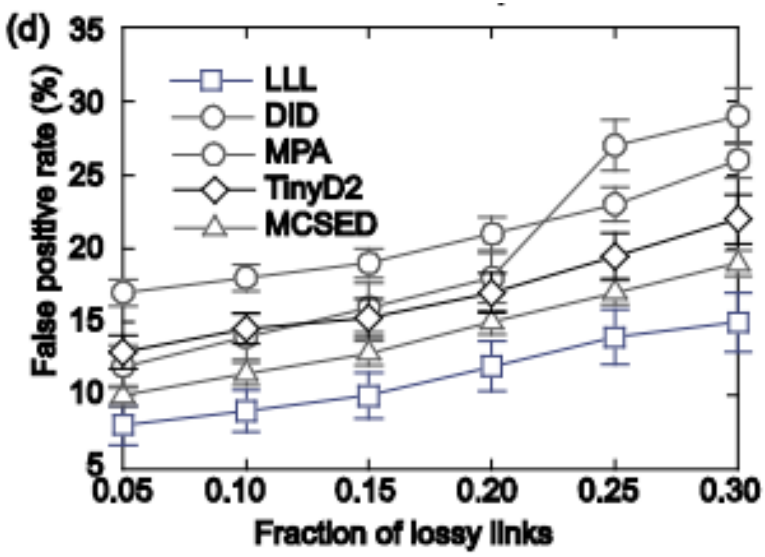

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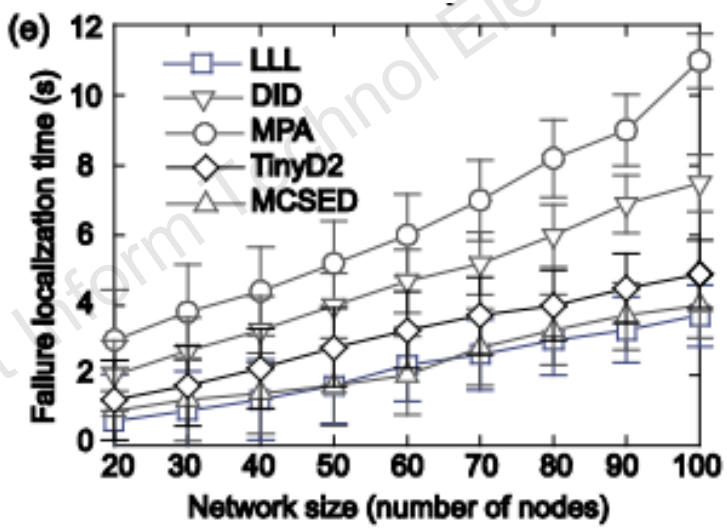

Conclusions

- We propose a probabilistic correlation based lossy link model that can express the association between failures.
- Our approach effectively represents the nondeterministic causal relationships between lossy links and symptoms due to the constructed PWBG model.
- CIERE removes the faults that are less likely to occur by adopting conditional information entropy.