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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.

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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.

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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.

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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.

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Major results

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

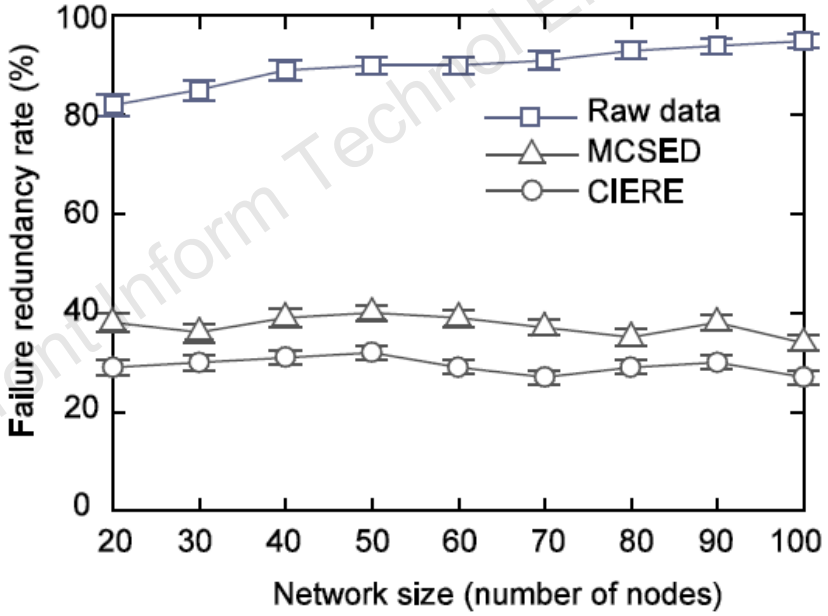

Fig. 5 Comparison of the failure (lossy link) redundancy rates with algorithms MCSED and CIERE

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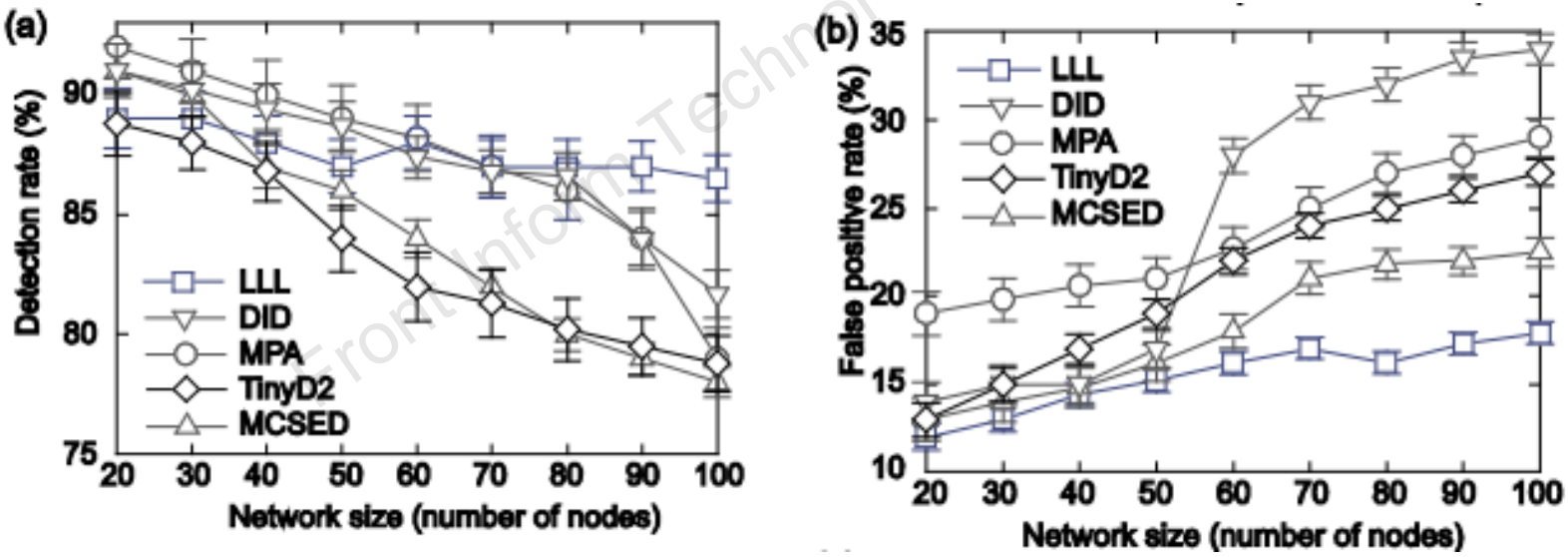
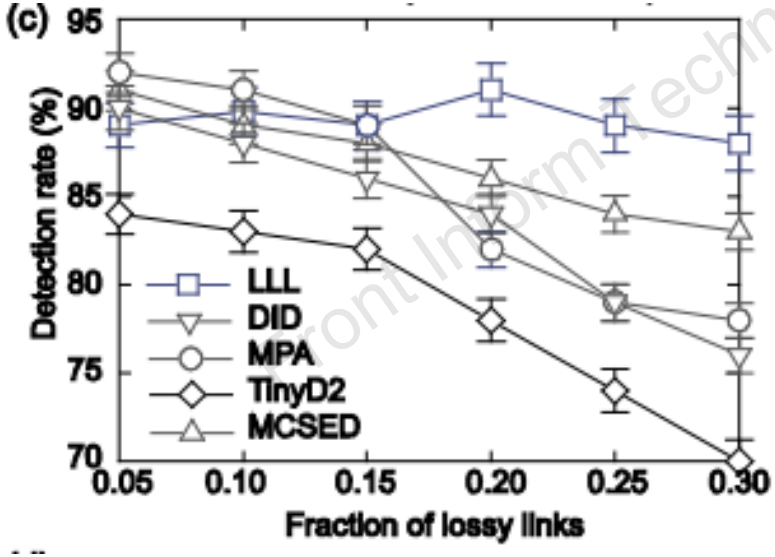
Major results (Cont'd)

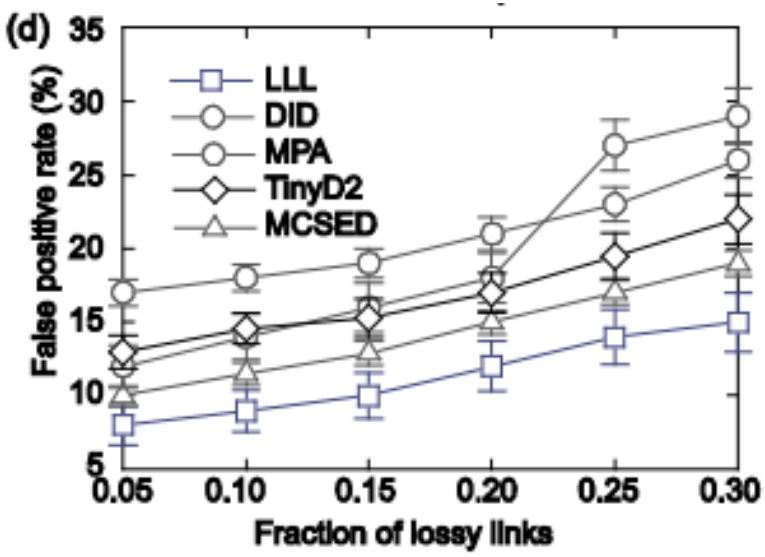
- LLL has high localization accuracy and low localization time.



Major results (Cont'd)

- LLL has high localization accuracy and low localization time.





Major results (Cont'd)

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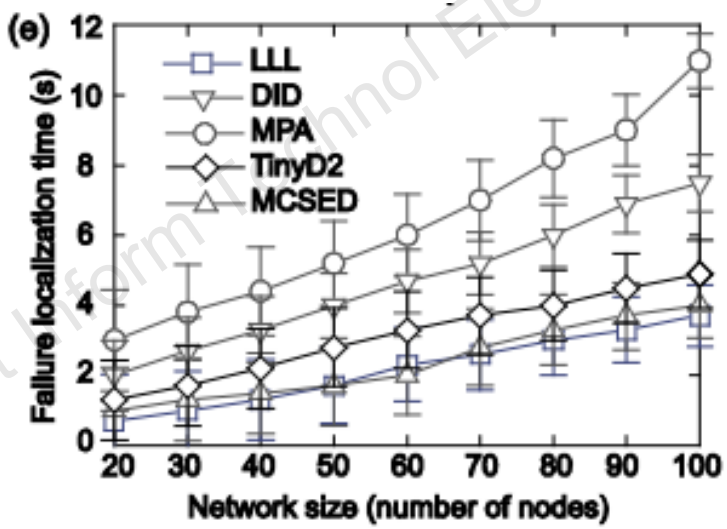

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Conclusions

- 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.

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