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Controller area network node reliability assessment based on observable node information

Key words: Controller area network (CAN); Transmit error counter (TEC); TEC value estimation; Bayesian network; Bus-off hitting time

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Introduction

- To ensure production safety and product quality, evaluating the CAN network reliability online is of great importance, which requires to estimate the node bus-off hitting time.

- Existing methods need to measure the bit error rate on the bus, which could not reflect the stochastic behaviors of the nodes upon each error.

- A novel node reliability assessment methodology for a CAN network using network traffic records and information from TEC accessible nodes has been presented in this work.

Method: node reliability assessment

- Estimate the node TEC value by segmented discrete time Markov chains after conducting the error identification.

- Construct the Bayesian network to learn the difference between the estimated and actual TEC values of the observable node.

- Predict the node bus-off hitting time by the random walk model based on the updated TEC value calculated by the Bayesian network.

Result: TEC value estimation

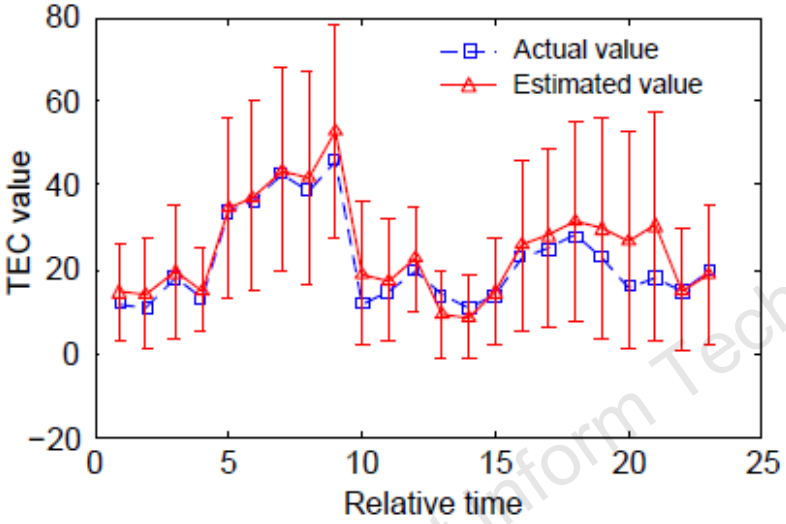


Fig. 1 Comparison of the estimated TEC value with the actual value

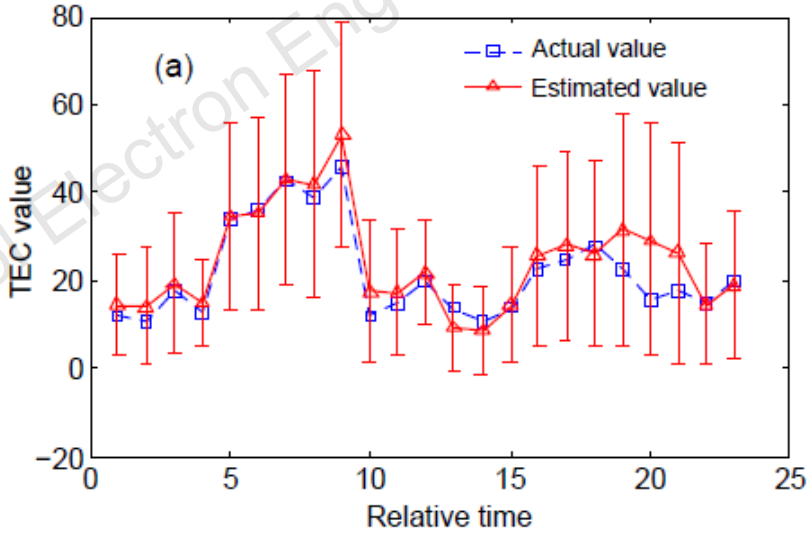
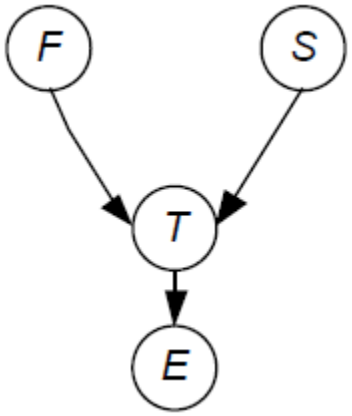
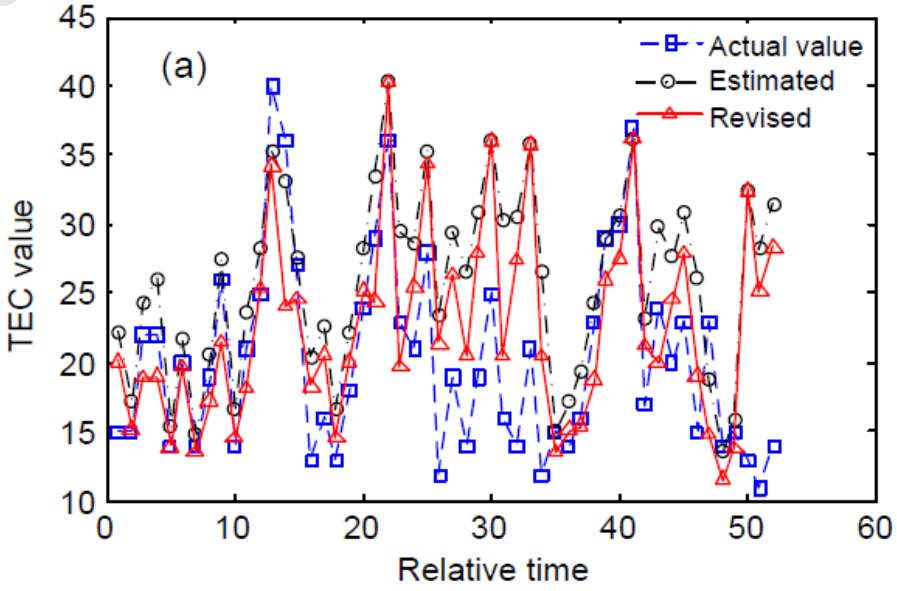


Fig. 2 Comparison of the estimated TEC value using all deleting strategy with the actual value when considering unidentified error information

Result: Bayesian network updating



◀ Fig. 3 Bayesian network structure in this work, where *F* denotes the number of errors, *S* denotes the number of successful transmissions in the last time window, *T* denotes the estimated TEC value, and *E* denotes the deviation between the estimated and actual TEC values



▶ Fig. 4 Updating result with condition *T*

Result: Bayesian network updating

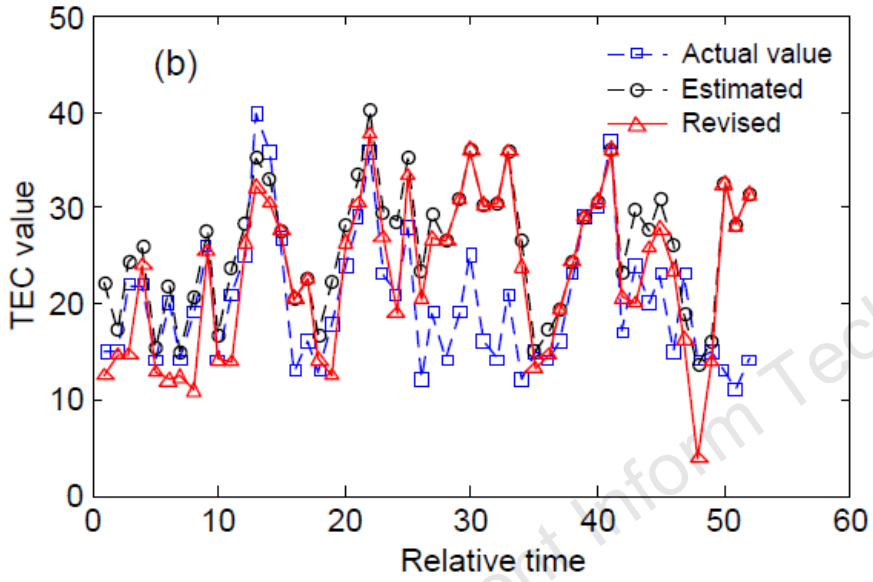


Fig. 5 Updating result with condition *F*

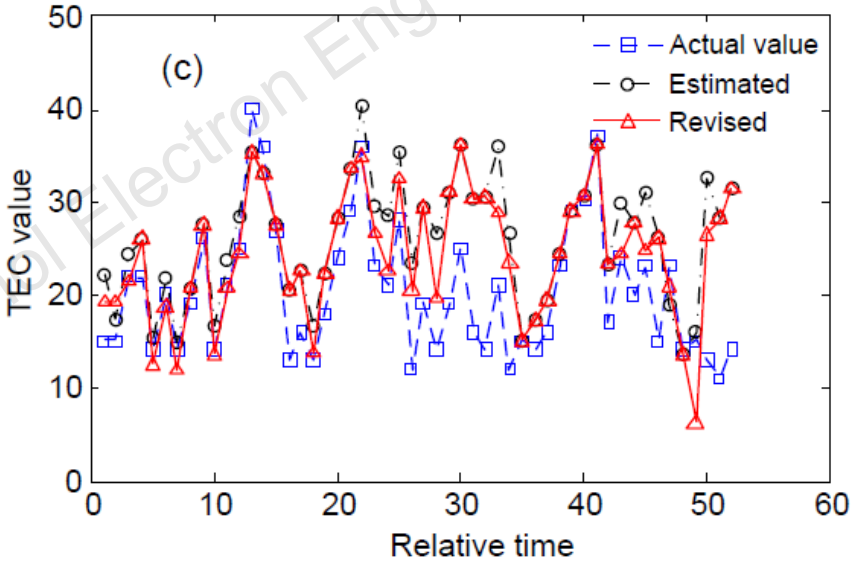


Fig. 6 Updating result with condition *S*

Result: bus-off hitting time

Table 5 Comparison of predicted bus-off time with actual time for different error log deletion ratios

Average fault injection interval (μs)	Actual hitting time (s)			Expectation of predicted hitting time (s)			Standard deviation of predicted hitting time (s)		
	R_E=25%	R_E=50%	R_E=75%	R_E=25%	R_E=50%	R_E=75%	R_E=25%	R_E=50%	R_E=75%
800	16.79	16.79	16.79	15.25	14.95	10.60	6.90	6.70	4.12
810	67.27	67.27	67.27	80.41	68.73	54.55	64.87	53.56	40.05
820	95.89	95.89	95.89	106.53	79.65	64.88	90.49	64.12	48.87

R_E: error log deletion ratio

Conclusions

- The proposed Controller Area Network node reliability assessment method is obtained by combining the network error log and the information provided by the observable nodes.

- Experimental results show that estimated TEC values obtained by the proposed method agree well with the actual observations, as well as the predicted bus-off hitting time of the nodes.