nano-tera.ch
swiss scientific initiative in health / security / environment systems

WiseSkin RTD 2013

FNSNF

Improving the Self-Healing in Skin Sensor Networks

C. Rojas[1,2], D. Piguet[1], J.-D. Decotignie[1,2] and J. Farserotu[1,2]

[1]Centre Suisse d'Electronique et de Microtechnique (CSEM), [2]École Polytechnique Fédérale de Lausanne (EPFL)

csem

EPFL ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

Abstract

WiseSkin contains a Wireless Sensor Network that collects the tactile information over the artificial skin. As any wireless system, failures are possible and can result in the patient not feeling a region of the skin. The typical mechanisms for healing the network require an overhead in delay, energy and packet losses. This work proposes reducing the overhead through a novel mechanism for extracting link quality information from the packet repetitions used by preamble sampling MAC layers.

Introduction

WiseSkin [1] relies on a routing protocol to define the paths for the tactile information, which could break due to the failure of a node or changes of the link quality (LQ) when bending the skin. This would result on the patient not feeling a region of the skin (fig. 1).

State of the art routing protocols [2,3], relay on transmitting (TX) multiple beacons to gather information about the LQ and choose a new route, at the expense of delay, energy and packet losses, while the network adapts.

Contribution

This work aims to reduce the healing overhead through a novel approach for extracting useful statistics for link estimation (LE), such as the Packet Success Ratio (PSR) and the average LQ Indication (LQI), from a single packet in preamble sampling MAC protocols, such as WiseMAC [4] or ContikiMAC [5].

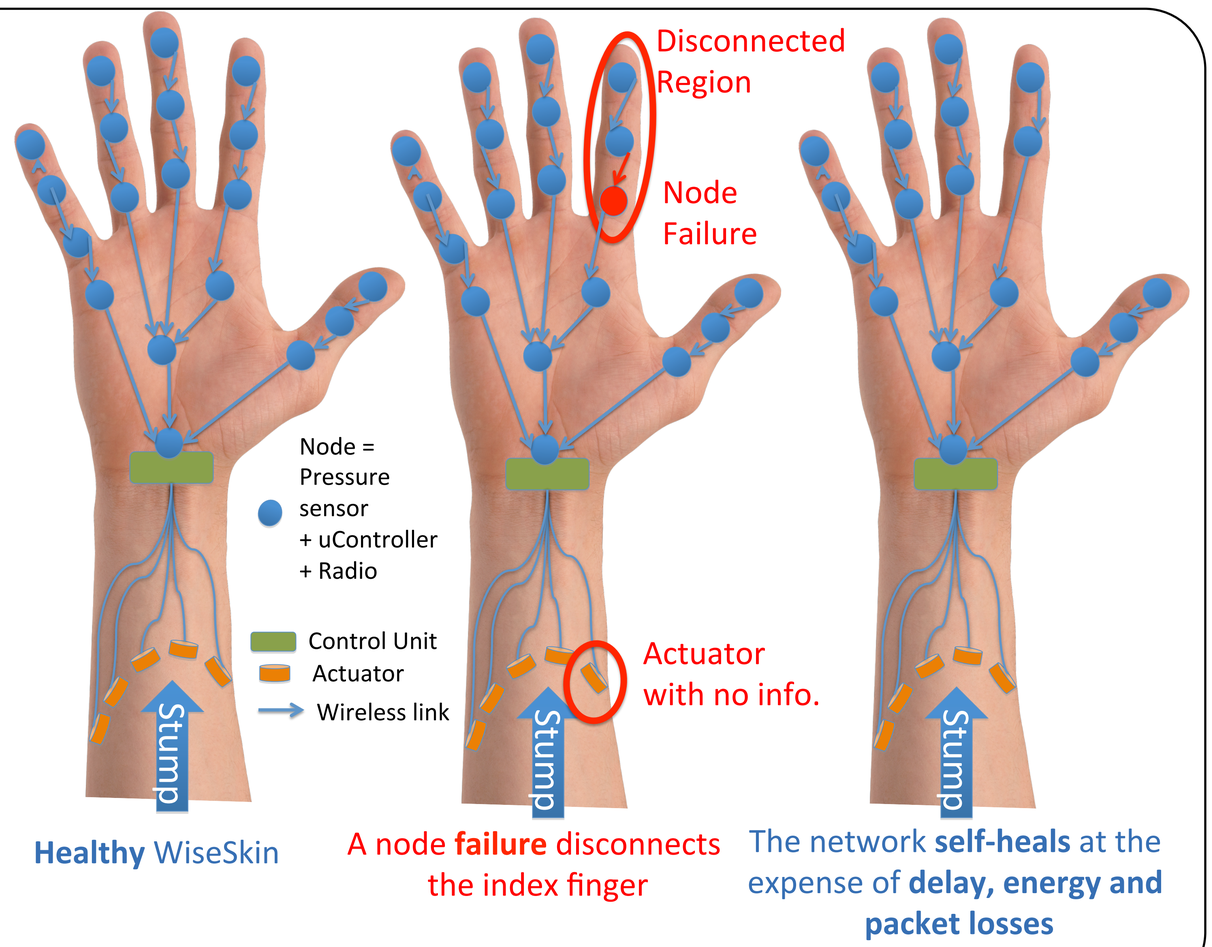

Figure 1. A wireless network can be self-healed at the expense of an overhead [6].

Design

This work proposes ContikiMAC-Repetitions (ContikiMAC-R), which is based on ContikiMAC (W_1) modified as follows:

i) upon reception (RX) of a broadcast MAC repetition, the radio keeps listening during a time window W_m so that it listens to m repetitions (fig.2. A and B)

ii) the broadcast TX must be extended by W_m to ensure that a receiver will always listen for m repetitions from each broadcast (fig.2. C)

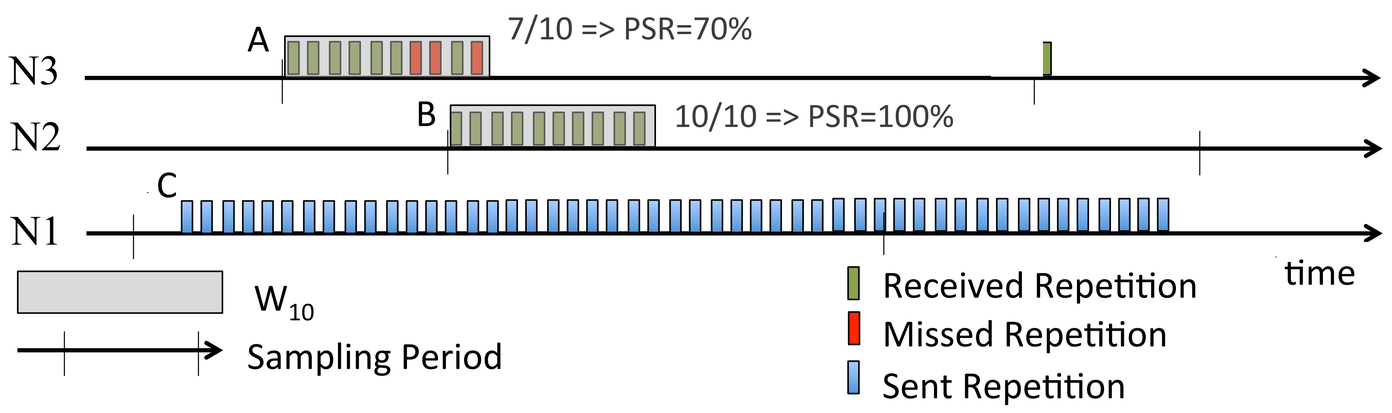

Figure 2. LE from the MAC repetitions

Results

The simulations in COOJA [7] to estimate the overhead of ContikiMAC-R, without taking advantage of its LE information, show that ContikiMAC-R can perform a LE:

i. with an overhead in RX energy that does not increase with the density of the network (fig. 3)

ii. without impacting the reliability

iii. with a negligible cost in TX energy

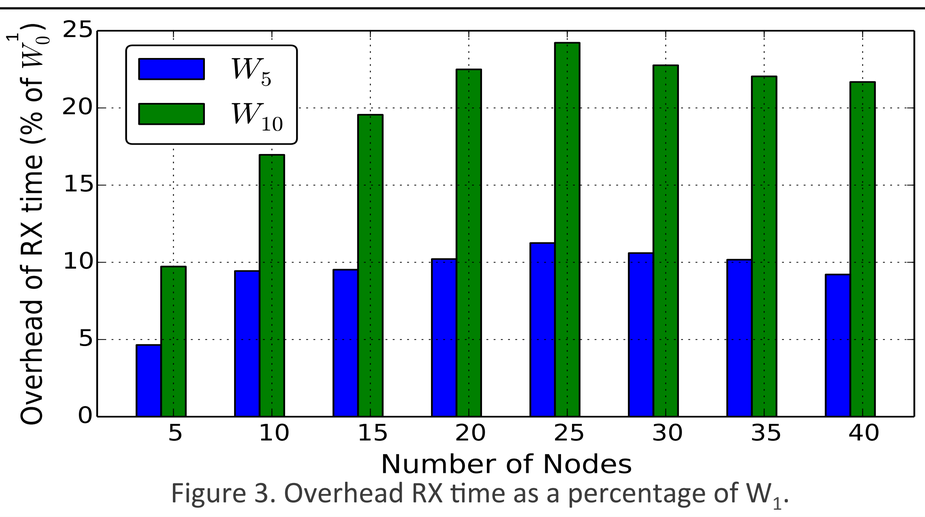

Figure 3. Overhead RX time as a percentage of W_1.

Conclusions

The results suggest that ContikiMAC-R:

i. has an energy overhead that could be compensated with the savings of the routing, if it uses the new LE information to reduce the TX

ii. could reduce the delay, energy and packet losses during the "healing", by reducing the packets required for LE

iii. could result in a better accuracy of the LE due to the fine-grain estimation from the MAC repetitions, hence improving the reliability

References: [1] C. Antfolk, V. Kopta, J. Farserotu, J.-D. Decotignie, and C. Enz, "The WiseSkin artificial skin for tactile prosthetics: A power budget investigation," in *2014 8th International Symposium on Medical Information and Communication Technology (ISMICT)*, pp. 1–4.
[2] O. Gnawali, R. Fonseca, K. Jamieson, D. Moss, and P. Levis. Collection tree protocol. In *Proceedings of the 7th ACM Conference on Embedded Networked Sensor Systems*, pages 1–14. ACM, 2009.
[3] A. Dunkels, F. Osterlind, and Z. He. An adaptive communication architecture for wireless sensor networks. In *Proceedings of the 5th international conference on Embedded networked sensor systems* 335–349. ACM, 2007.
[4] A. El-Hoiydi and J.-D. Decotignie. Wisemac: An ultra low power mac protocol for multi-hop wireless sensor networks. In *Algorithmic Aspects of Wireless Sensor Networks*, pages 18–31. Springer, 2004.
[5] A. Dunkels. The contikimac radio duty cycling protocol. 2011.
[6] PNGIMG. hands_PNG929.png [Image]. Retrieved from http://pngimg.com/upload/hands_PNG929.png
[7] F. Osterlind, A. Dunkels, J. Eriksson, N. Finne, and T. Voigt. Cross-level sensor network simulation with cooja. In Local Computer Networks, Proceedings 2006 31st IEEE Conference on, pages 641–648.