An Automatic, Robust, and EfficientMulti-User Breadcrumb Systemfor Emergency Response Applications

Abstract:

Breadcrumb systems (BCS) aid first responders by communicating their physiological parameters to remotely located base stations. In this paper, we describe the design, implementation, and evaluation of an automatic and robust multi-user breadcrumb system for indoor first response applications. Our solution includes a breadcrumb dispenser with a link estimator that is used to decide when to deploy breadcrumbs to maintain reliable wireless connectivity. The solution includes accounting for realities of buildings and dispensing such as the height difference between where the dispenser is worn and the floor where the dispensed nodes are found. We also include adaptive power management to maintain link quality over time. Moreover, we propose UF, a distributed cooperative deployment algorithm, to achieve longer breadcrumb chain lengths while maintaining fairness and high system reliability via selecting appropriate benefit and cost functions. We deployed and evaluated our system in real buildings with several different first responder mobility patterns. Experimental results from our study show that compared to the state of the art solution , our breadcrumb system achieves 200 percent link redundancy with only 23 percent additional deployed nodes. Our deployed breadcrumb chain can achieve 90 percent PRR when one node fails in the chain. In addition, by applying the UF coordination algorithm, the system can maintain connectivity for up to 87 percent longer distances than baseline greedy coordination approach while maintaining 96 percent packet delivery ratio.

Reliably transmitting this physiological data to a base station outside the building is a challenging problem. Existing solutions normally use one-hop communications and suffer from limited transmission range since it is sometimes difficult for wireless signals to travel through complex infrastructures.

We investigate whether there is a consistent and constant degradation in link quality between an existing breadcrumb and the dispenser or the newly deployed breadcrumb.

The existing breadcrumb and one dispenser is hooked on the waist of a first responder. RSSI values between them are recorded while their distance varies from 10 to 90 feet.

Proposed System:

We propose UF, a distributed cooperative deployment algorithm, to achieve longer breadcrumb chain lengths while maintaining fairness and high systemreliability via selecting appropriate benefit and cost functions.Wedeployed and evaluated our systemin real buildings with several different first responder mobility patterns.

We propose a new reliability model that consists of:

(1) An optimized redundancy degree for breadcrumbs,

(2) A decision support system for wireless link estimation that decides when to drop additional breadcrumbs,

(3) A height effect solver to handle the gap in link quality after breadcrumbs drop from the dispenser, and

(4) An adaptive transmission power control to handle link quality variation problems in harsh environments.

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We propose an approach tailored to this situation: adaptive power control.

Hardware Requirements:

- System : Pentium IV 2.4 GHz.
- Hard Disk : 40 GB.
- Floppy Drive : 1.44 Mb.
- Monitor : 15 VGA Colour.
- Mouse : Logitech.
- RAM : 256 Mb.

Software Requirements:

- Operating system : - Windows XP Professional.
- Front End : - DOTNET
- DATABASE : - SQL SERVER 2005