Chapter 75
Ad Hoc Communications for Wireless Robots in Indoor Environments

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ABSTRACT

This chapter presents a theoretical and experimental comparison of electromagnetic propagation models for indoor robot communication using mobile ad-hoc IEEE802.11 and IEEE802.15.4. The analysis includes the behavior of the electromagnetic signal using the abovementioned standards in two scenarios, both located inside the building of the College of Telematics of the University of Colima. The results of the propagation of the electromagnetic signals in the two scenarios were then compared with the mathematical model.

INTRODUCTION

The mobility and convenience that wireless networks provide has contributed to the increased number of people using them; however, the required infrastructure cannot be provided in all scenarios(Luu, O'Brien, & Baran, 2007). An ad-hoc wireless network is a collection of mobile elements that form a temporary network without an established infrastructure (Bracka, Midonnet, & Roussel, 2005). Advances in wireless technology and the miniaturization of robots have allowed the formation of ad hoc networks that can maintain communications in disaster and other important situations.

Ad hoc networks formed by mobile robots equipped which can communication among themselves through wireless transmission capabilities is mainly determined by the communication technology and the specific scenario.

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RELATED WORK

The mobility of wireless networks has been widely investigated. However, most of these papers focus more on random rather than controlled mobility (Jardosh, 2003). Controlled mobility is now a research area of mobile ad hoc networks (Bracka, et al., 2005). In the following research, the network communication has been addressed from different perspectives, without following any of these characteristics of mobility would be expected to have in our proposed scenarios.

In 2005, nine Lego Mindstorms robots equipped with an infrared interface used classic algorithms such as RIP or OSPF to form an ad hoc robot network, allowing robots to maintain communications with each other or with a fixed base (Bracka, et al., 2005). In 2006, the Army Research Laboratory of the United States (ARL) implemented a Mobile Ad Hoc Network (MANET) that allowed communication between an Operated Control Unit (OCU) and a robot. The ARL implementation employed IEEE 802.11g Linksys routers with 100mW internal amplifiers without high gain antennas. Test results show they were able to communication 400 meters, with the possibility of communicating longer distances (Luu, et al., 2007). In that same year, in a collaborative effort, the State of Mexico Technological Institute's Robotics Lab and the University of California at Santa Cruz's Internetworking Research Group formed a league of robots that allow multi-robot collaboration beyond the football field. The local robot control was managed by a single Digital Signal Processor (DSP) chip that was optimized for digital motor control. The DSP receives remote communications from the Artificial Intelligence system through a TX/RX Radiometrix radio[1] using the 914MHz and 869MHz frequency bands at a transmission rate of 64Kbits/seg. In this experiment, all robots were very close to each other, meaning that all the robots were within the transmission range of each other. This makes message routing between any two network nodes very simple as any robot can send a message to any other robot in a single transmission. However, for other applications would require a multi-protocol routing hop in order to maintain communication (Weitzenfeld, Martinez-Gomez, Francois, Levin-Pick, & Boice, 2006).

As mentioned above, another technology that has gained a field of application is based on IEEE 802.15.4. Due to its characteristics (low power consumption, cost and frequency), it is ideal for small applications where power consumption is minimized. In 2009, the Australian Research Council Center of Excellence for Autonomous Systems, in cooperation with the Australian Centre for Field Robotics (ACFR) and the University of Sydney, New South Wales, Australia, worked on an ad hoc wireless network based on ZigBee mesh. They employed JENNIC JN5139 as part of a prototype system consisting of 15 nodes. This device allowed them to run simple applications in the ZigBee module without an internal processor. Simulated and experimental tests concluded that ZigBee-based systems are good choices in networks consisting of many small robots (Fitch & Lal, 2009).

THE EVOLUTION OF ROBOT WIRELESS COMMUNICATION

Technology has advanced along with the electromagnetic propagation models used in mobile robots. An important design consideration for mobile ad hoc networks must consider not only the signal range, but also the power consumed by the devices and their size. Aspects such as these can be definitive in choosing a communication technology. Unlike a WAN where you have a robust physical infrastructure to support it, ad hoc networks are infrastructure less and its components must function both independently and in conjunction with each other during the packet routing procedure (Wang, 2003). Consequently, it is important to know how the signal propagates

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