Kristen Fernandez

Senior Design

Team Bridge Inspection Robot

Wireless Communication Protocols and Commercial Applications

Introduction

Research in the field of wireless communication has surged in recent years, which is largely due to the increase in cellular telephony and wireless data applications. The numerous advantages of wireless communications allow for several opportunities for commercial applications. This technical review paper will focus on the commercial applications of wireless communication along with different protocols for implementing wireless communication.

Commercial Applications of Wireless Technologies

Wireless communications are used in a wide range of commercial applications. In industrial settings, costs from cable and wired systems can be eliminated, and productivity can be improved through remote management and control. In the automotive industry, car-to-car communication is being developed to increase safety on the roads, and in-car integration of wireless technologies allows for smartphone and other electronics to be connected to the car [1]. The SimpleLink™ CC2650MODA device (~$13) from Texas Instruments is a wireless microcontroller that can support both Bluetooth, ZigBee, and other wireless standards. It uses a 32-bit ARM Cortex M3 architecture, 128 KB of Flash, 8KB of SRAM, and runs up to 48MHz [2]. The Atmel SmartConnect SAM W25 module (~$27) provides low-power Wi-Fi connectivity and allows support for Internet of Things applications. It is similar to the TI device in terms of memory and speed, but at an increased monetary cost the SAM W25 has a larger memory of 256KB embedded Flash and 32KB SRAM [3].

Technology Involved in Wireless Communication

Bluetooth

Also known as the IEEE 802.15.1 standard, Bluetooth was developed as a solution for short-range communications for portable, handheld electronics such as keyboards or printers [4]. Bluetooth devices are managed using a piconet topology [5]. A piconet is a group of Bluetooth devices that can communicate with each other; one device in the piconet is defined as the master while up to seven slave devices may be actively communicating at any one time, although there may be additional inactive slaves

connected as well. The master will assign a unique member address to each active slave, and it will also control which device is transmitting and when [4], [6].

Bluetooth operates on the unlicensed ISM band, which is centered at 2.4 GHz, and devices in a piconet follow a specific frequency hopping pattern of the 79 frequencies of the ISM band [5]. The time axis for the transmission and reception of data is subdivided into slotted time units, and each slot lasts for the duration of a frequency hop (about 625 microseconds). By using a frequency-hopping technique, this allows Bluetooth to function more effectively while there are non-hopping systems (such as Wi-Fi networks) in the same vicinity [4], [5].

ZigBee

ZigBee operates on the IEEE 802.15.4 standard and is also centered on the unlicensed 2.4 GHz band. It was developed to support simple devices, such as sensors and control devices, which do not need high-bandwidth but are reliant on minimal power consumption and low latency [7]. This protocol was also designed to be low cost, low maintenance and easy to implement [8].

The standard defines two types of devices: a full-function device (FFD) and reduced-function device (RRD). An RRD is intended for very simple applications, such as a switch or a sensor. It can send a small amount of data, and therefore only requires a minimal amount of memory. An FFD is capable of becoming a network coordinator and providing synchronization services to devices and other coordinators. A ZigBee network requires at least one FFD acting as a network coordinator, while other endpoint devices can be RRDs [7].

Wi-Fi

 Wi-Fi includes several IEEE 802.11 standards for wireless local area networks (WLAN) technology, such as 802.11b, 802.11a, and 802.11g. Although these standards share a number of characteristics, such as the same medium access protocol and frame structure, on the physical layer they operate on different frequency ranges and data rates [9], [10].

The basic building block of an 802.11 LAN is the basic service set (BSS), which is a set of mobile or fixed wireless stations and a central base station called an access point (AP). The AP in each BSS is connected to another device, such as a switch or a router, that connects the whole BSS to the internet. Wireless stations that are in proximity can also form an ad-hoc network, which does not require an AP [10].

Building Blocks for Implementing Wireless Communications

To set up wireless communication, protocol specific hardware is needed. The protocols define the standard for each type of wireless communication, so implementation level choices can be made in software.

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