Chapter 13
Real-Time Digital Signal Processing-Based Algorithm for Universal Software Radio Peripheral to Detect GPS Signal

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ABSTRACT

Software-defined radios (SDR) are gradually becoming a practical option for implementing RF communication systems due to their low cost, off-the-shelf availability, and flexibility. Although the analog limitations of the hardware devices in these systems create barriers to some applications, creative algorithms in digital signal processing (DSP) can improve the results. In some cases, this improvement is essential to establishing a robust and reliable communication. The universal software radio peripheral (USRP) is a popular hardware that can be used alongside the SDR. Among many capabilities of USRP and its changeable daughter boards is receiving GPS signals. The GPS satellites transmit data on two main frequencies, L1 (1575.42 MHz) and L2 (1227.60 MHz). In this chapter, the focus is on describing a detailed implementation of the real-time DSP-based algorithm for USRP to detect GPS signal, namely the L1 band that transmits at 1575.42 MHz.

INTRODUCTION

This chapter details the steps taken to apply DSP algorithms to USRP. One should be able to follow these steps with the specified set of hardware and software to get the same configuration on the proper USRP device. These projects were implemented

DOI: 10.4018/978-1-5225-8188-8.ch013

under the supervision of NASA scientists and faculty advisors in dedicated NASA labs. Following lessons learned here and authors' previous experiences in data visualization and signal processing research and training relevant labs were designed to enhance the Computer Engineering program at the Virginia State University (VSU) (Sheybani, 1992, 2002, 2006, 2007, 2008, 2010, 2011, 2012, 2013, 2017; Javidi, 2008, 2010, 2014, 2015, 2017; Ouyang, 2010; Garcia-Otero, 2011; Badombena-Wanta, 2010; Ettus, 2014, 2015; Luttamaguzi, 2017; Mathworks, 2014).

The overall goal of this project is to retrieve the carrier signal of the L1 band from a GPS satellite signal using USRP. The USRP uses a daughterboard to tune to the radio frequency of the receiver interface or the transmitter interface. Daughter boards are selected based on the frequencies involved in the project. In many cases, the selection of an RF daughterboard is made solely on the application requirements for frequency coverage. Figure 1 shows the ranges of different daughter boards (Anon, 2014).

BACKGROUND

The Universal Software Radio Peripheral (USRP) is slowly becoming a very popular piece of hardware used in different universities and research labs across the world. It is inexpensive, flexible, and adaptive which attracts a lot of attention, along with its variety of applications and capabilities. The USRP connects to a host-computer through a high speed USB or Gigabit Ethernet interface. Another reason for the

Figure 1. Daughterboard frequency coverage