Chapter 9
Hyperspectral Microwave Atmospheric Sounder (HyMAS) Graphical User Interface Design

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ABSTRACT

The hyperspectral microwave atmospheric sounder (HyMAS), for weather and climate missions, is capable of all-weather sounding equivalent to hyperspectral infrared sounders (in which clouds decrease the accuracy of the results) in clear air with vertical resolution of approximately 1 km. This will improve both the vertical and horizontal resolutions of the atmosphere. Through the use of independent RF antennas that sample the volume of the Earth's atmosphere through various levels of frequencies, thereby producing a set of dense, spaced vertical weighting functions, hyperspectral microwave is achieved. This yields surface precipitation rate and water path retrievals for small hail, soft hail, or snow pellets, snow, rainwater, etc. with high accuracies. One of HyMAS requirements is a graphical user interface (GUI). Hyperspectral measurements allow the user to determine the Earth's temperature with vertical resolution exceeding 1km (1093.61 yards).

INTRODUCTION

This chapter details the steps taken to design a graphical user interface (GUI) for a Hyperspectral Microwave Atmospheric Sounder (HyMAS) climate mission satellite. One should be able to follow these steps with the specified set of hardware and

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software to get the same configuration on the proper USRP device. This project was implemented 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 idea of HyMAS is to improve temperature and moisture measurement accuracy compared to non-hyperspectral microwave sounding systems. Non-hyperspectral microwave Sounding systems accuracy are challenged when high water vapor and clouds are present. HyMAS uses a processor to gather frequencies, which is analyzed and recorded. The recorded frequencies can be any precipitation or temperature in the atmosphere. The frequencies can range within 118-183 GHz. The HyMAS Emulator is an intermediate frequency generated by a radio frequency. The emulator amplifies, filters, channelizes, and detects each channel using a detector. An Explorer 16 board can be used to interface with the emulator.

Some of the most recent advances in microwave hyperspectral radiometry are due to the new developments in high-speed integrated circuits developed in digital signal processing as well as radio frequency (RF) and microwave technologies. One of the primary microwave hyperspectral radiometry prototypes was developed by Beihang University (BHU-Hyper). This prototype worked in the frequency range of 50~70GHz for the atmospheric temperature sounding. It would split 50~70GHz signal into up to 2048 hyperspectral channels with identical bandwidths. Simulation studies of this prototype to study its performance from an information perspective in the space-borne platforms show noticeable improvements compared to AMSU-A. The Degree of Freedom for Signal (DFS) of the simulated sounding data with respect to different channel numbers and sensitivity as well as the temperature retrieval performance of BHU-Hyper also show noticeable improvements compared to AMSU-A, suggesting favorable possibility of future space-borne applications (Zhao, 2012).

The new developments in high-speed integrated circuits in digital signal processing as well as radio frequency (RF) and microwave technologies have aklso lent themselves to new hyperspectral microwave remote sensing modality for atmospheric sounding. These advances permit receiver arrays that can multiplex multiple broad frequency bands into more than 100 or 1000 spectral channels, thus improving both the vertical and horizontal resolutions of the retrieved atmospheric profile. Several simulation studies over ocean and land in clear and cloudy atmospheres using three different atmospheric profile databases have been conducted that assess the temperature, moisture, and precipitation sounding capability of several notional hyperspectral