DEVELOPMENT OF ROI PROCESSING SYSTEM USING QUICK LOOK IMAGE

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ABSTRACT: Due to its inherent feature of high-resolution satellite, there is strong need in some specific area to minimize the processing time required to get a standard image on hand from downlink signal acquisition. However, in general image processing system, it takes considerable time to get image data up to certain level from raw data acquisition because the huge amount of data is dealt sequentially as input data.

This paper introduces the high-speed image processing system which generates the image data only for the area selected by user. To achieve the high speed performance, this system includes Quick Look Image display function with sampling, ROI selection function, Image Line Index function, and Distributed processing function.

The developed RPS was applied to KOMPSAT-2 320Mbps downlink channel and its effectiveness was successfully demonstrated. This feature to provide the image product very quickly is expected to promote the application of high resolution satellite image.

KEY WORDS: ROI, QUICK LOOK IMAGE, KOMPSAT-2, RECEIVING SYSTEM

1. INTRODUCTION

As the space system and its technologies evolves, the high-resolution earth observation satellite like IKONOS, QuickBird, SPOT-5 and KOMPSAT-2 provide the very accurate high-resolution images for panchromatic and multi-spectral bands, which can be widely used in crop monitoring, land and environment management, map generation, military application and so on.

Due to its inherent feature of high-resolution satellite, there is strong need in some specific area to minimize the processing time required to get a standard image on hand from downlink signal acquisition. However, in general image processing system, it takes considerable time to get image data up to certain level from raw data acquisition because the huge amount of data is dealt sequentially as input data. That means there is a constraint that all received downlink data should be processed even though very small Region of Interest (ROI, hereafter) in entire image data acquired is required to be processed in a very timely manner for urgent application.

This paper introduces the high-speed ROI Processing System (RPS, hereafter) which generates the image data only for the area selected by user for quick processing. To achieve the high speed performance, this system includes Quick Look Image display function with sampling, ROI selection function, Image Line Index function, and Distributed processing function.

In this paper, the data level defined in RPS, software and hardware configuration and data flow, and main features in RPS are discussed and its application to KOMPSAT-2 are presented.

2. RPS DEVELOPMENT USING QUICK IMAGE

In this paper, RPS development was based on the general data because the physical sensor model and sensor characteristic are various and dependent to satellite and some ancillary data for image processing is not available to end user.

2.1 Data Definition

In general, the high-resolution satellite applies both the compression technology due to its massive data generation rate and encryption technology for its data security during downlink to ground. In this study, we assumed the data from satellite is compressed and encrypted reflecting this general high-resolution satellite. The data handled in this RPS consists of Raw Data, Image Link Block, Image Line Index, Level 0, Level 1R, Level 1G.

Raw Data was defined to be the data received through serial telemetry receiving card from X-band antenna via demodulator. Image Line Block consists of sets of Image Lines which are normally acquired after processing like frame synchronizing, de-randomizing, Channel decoding and decryption. Image Line Index includes image line location information in image line block and this index information is used in displaying the data selected for ROI accurately in Image Line Block. Level-0 is data decompressed for ROI and its image format is raw. After

radiometric correction, the Level 1R data is obtained. Level 1G is the re-sampled data after geometric correction using physical sensor modelling. The standard data for user is Level 1R or Level 1G. Figure 1 shows processing flow for each data level from acquisition to delivery.

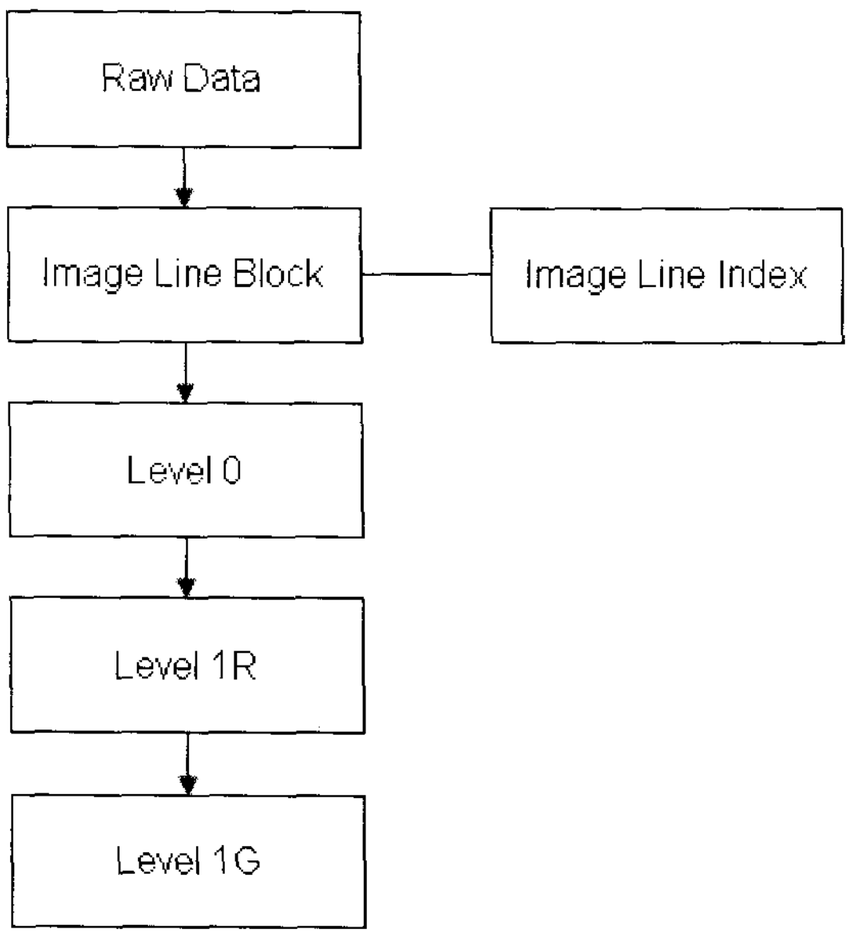

Figure 1. Processing Flow

2.2 System Configuration

The RPS consists of 3 hardware; Demodulator, Channel Workstation, MWD PC. The number of channel workstation depends on the on-board data CCSDS processing and transmission scheme like modulation, polarization, and number of channels. In this paper, 2 channels for I and Q were assumed and two workstations were allocated for each channel. For fast processing, threading technology in software design and implementation is widely used, therefore the workstation's CPU was selected to be Intel Multi-Core Processor.

Figure 2 shows the hardware configuration and its associating software deployment in each system. Demodulator receives IF modulated signal and performs demodulation, bit sync and provides data and clock output for I and Q channel. The data and clock from I and Q channel are connected to dedicated channel Workstation. Channel Workstation has Receiving processor software and ROI Provider software.

Receiving Processor software performs (1) Image Line Block and Image Line Index generation through processing the data obtained though serial card from I or Q channel (2) MWD channel extraction and transmission to MWD viewer software for real-time MWD. These two activities are done simultaneously.

ROI Provider software extracts accurately the data corresponding to ROI from the stored Image Line Block data, and then performs de-compression and finally provides the processed output to ROI Processor. MWD PC consists of RPS Controller, MWD viewer, and ROI processor software. RPS controller provides the overall RPS control functionalities like scheduling, channel workstation control, and M&C GUI provision. MWD viewer processes the one of multi-spectral channel selected and display the Quick Look Image in real-time during downlink reception and provides the interface to select the ROI from Quick Look Image. ROI processor generates 1R or 1G from the data which ROI provider in channel workstation provides for ROI.

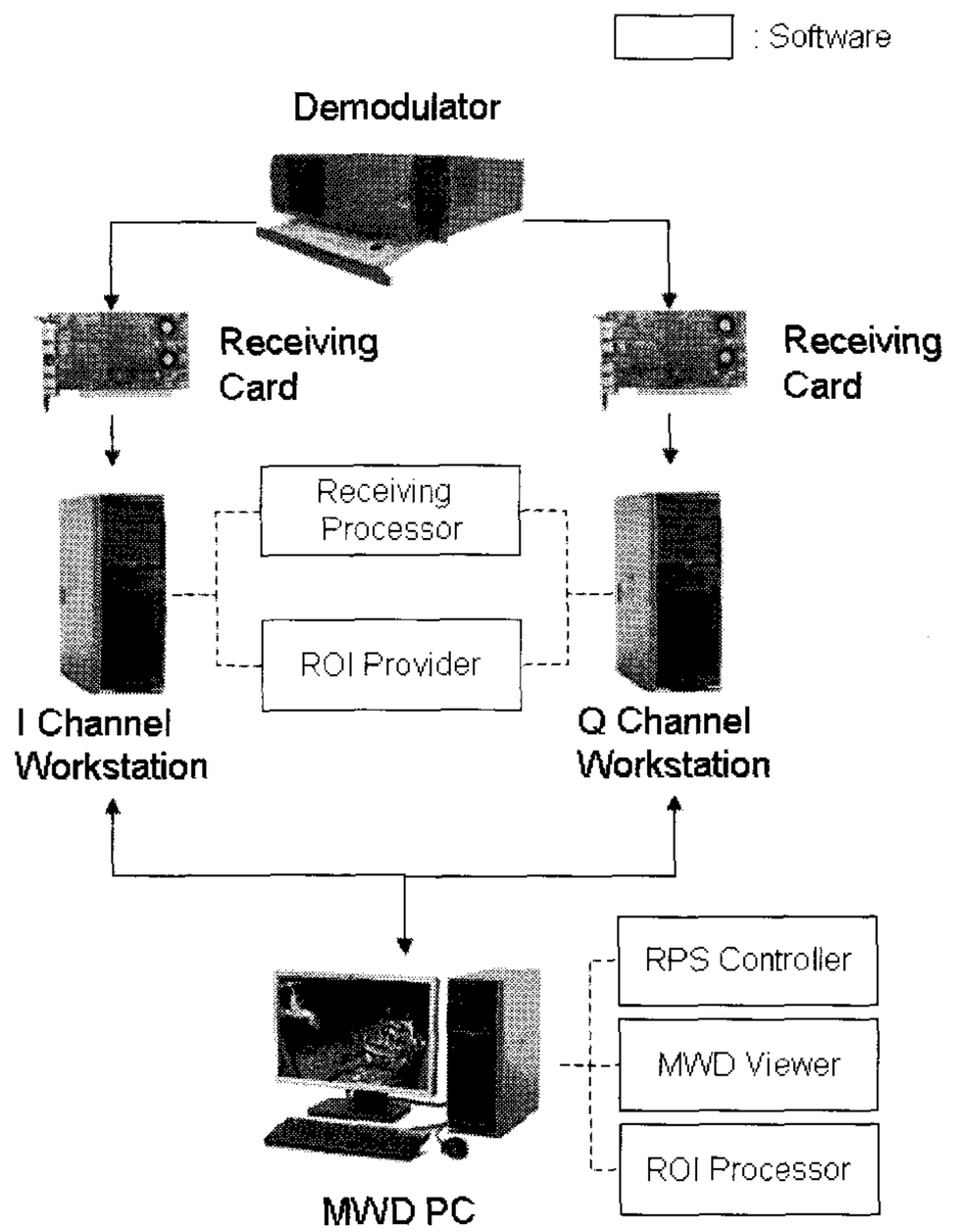

Figure 2. RPS Configuration

2.3 Processing Flow

RPS processing flow can be divided by 2 cases based on processing time frame. Each step can be treated separately. This section covers data flow between software modules during each processing flow.

2.3.1 Flow during acquisition

During acquisition, RPS performs data processing, data recording, and quick look image display. Figure 3 shows the data flow between software modules.

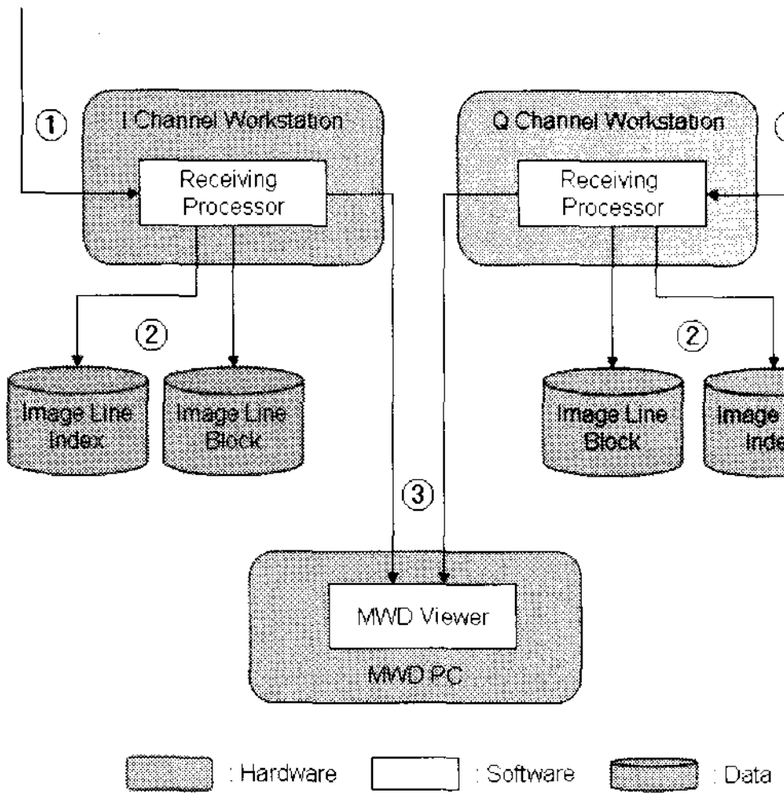

Figure 3. Data Flow during Acquisition

① Raw Data obtained via serial telemetry receiving card are transferred to Receiving Processor in each channel Workstation.
② Receiving Processor performs Frame Synchronizing, De-randomize, Channel Decode, Decryption and generation/storage of Image Line Block and Image Line Index.
③ For operator/user to observe real-time moving window display, the Receiving Processor transfer Image Line Block Data to MWD Viewer and MWD viewer performs decompression for Image Line Block data provided, sampling the image data, and displaying the Quick Look Image.

2.3.2 Flow after acquisition

After image data acquisition, user selects the ROI via Quick Look Image, and then RPS performs level processing up to certain level like 1R or 1G for selected ROI. Figure 4 shows sequential data flow between software modules.

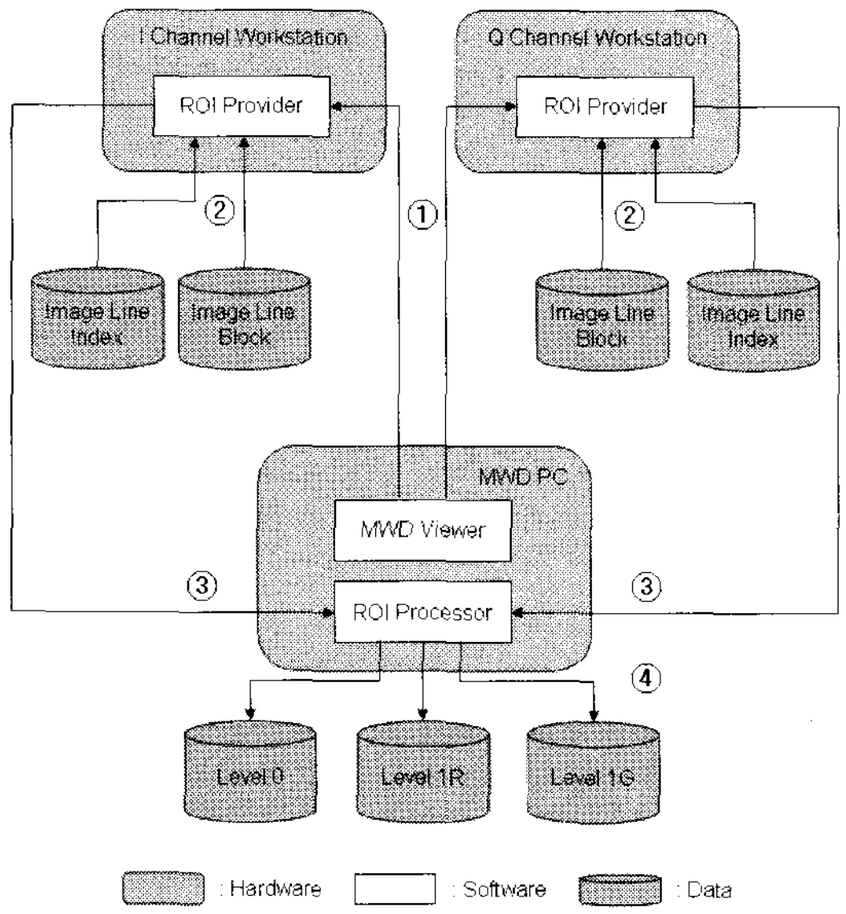

Figure 4. Data Flow after Acquisition

① User selects ROI via Quick Look Image in MWD Viewer and request image product for selected ROI.
② ROI Provider display the ROI data from Image Line Block data based on Image Line Index data.
③ ROI Provider first performs de-compression for displayed ROI data and sends the output results to ROI processor.
④ ROI Processor receives the output results and process the data for ROI to certain level.

2.4 Main functionalities of RPS

In this study, for fast processing for selected ROI, 4 functionalities were developed. These 4 functionalities cover Quick Look Image display function, ROI selection function, Image Line Index function, and Distributed processing function.

2.4.1 Quick Look Image Display

RPS provides in Quick Look Image aka MWD for one pre-selected MS channel in real-time, which is directly used for searching ROI after acquisition. For this, high-resolution image was sampled for entire swath display. Figure 5 shows the MWD display viewer showing the Quick Look Image display. Quick Look Image is stripe image of which size is too big to use memory to display entire region. Therefore, the all input data is file cached and then only the region user wants to see is loaded into memory for display.

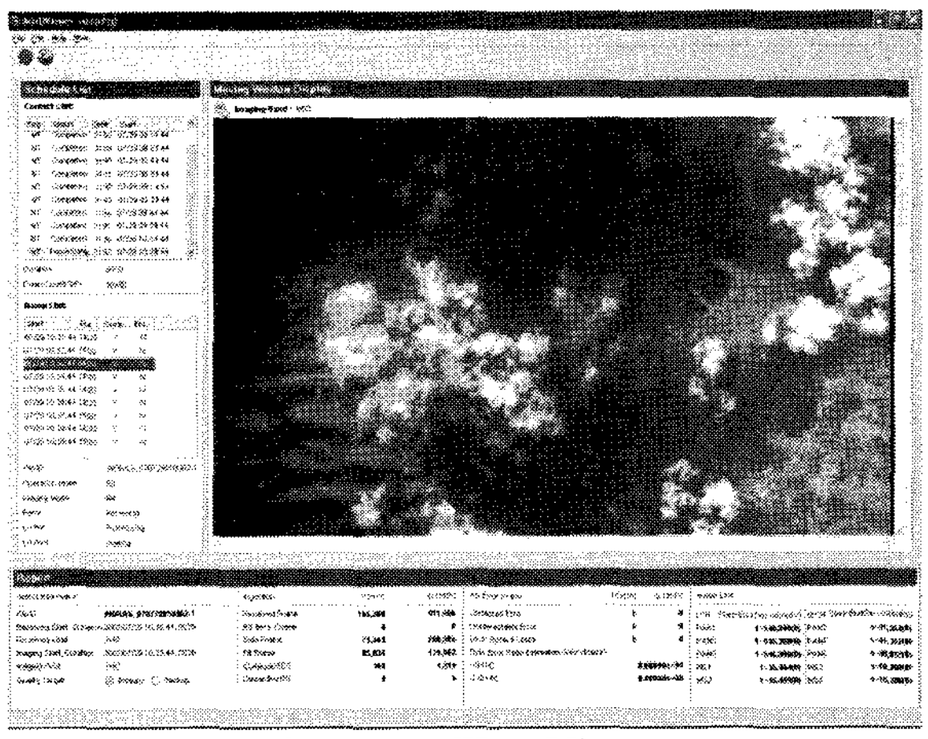
Figure 5. MWD Viewer

2.4.2 ROI Selection

RPS provides the functionality to select the ROI using Quick Look Image. After data acquisition, the green bar is displayed to define the start line and end line of ROI on the Quick Look Image. This green line can be moved through simple mouse roll-over action. The image line number corresponding to green line is displayed in left above of green line. Figure 6 shows the ROI selected by

selecting the start line and stop line of ROI using simple mouse clicking.

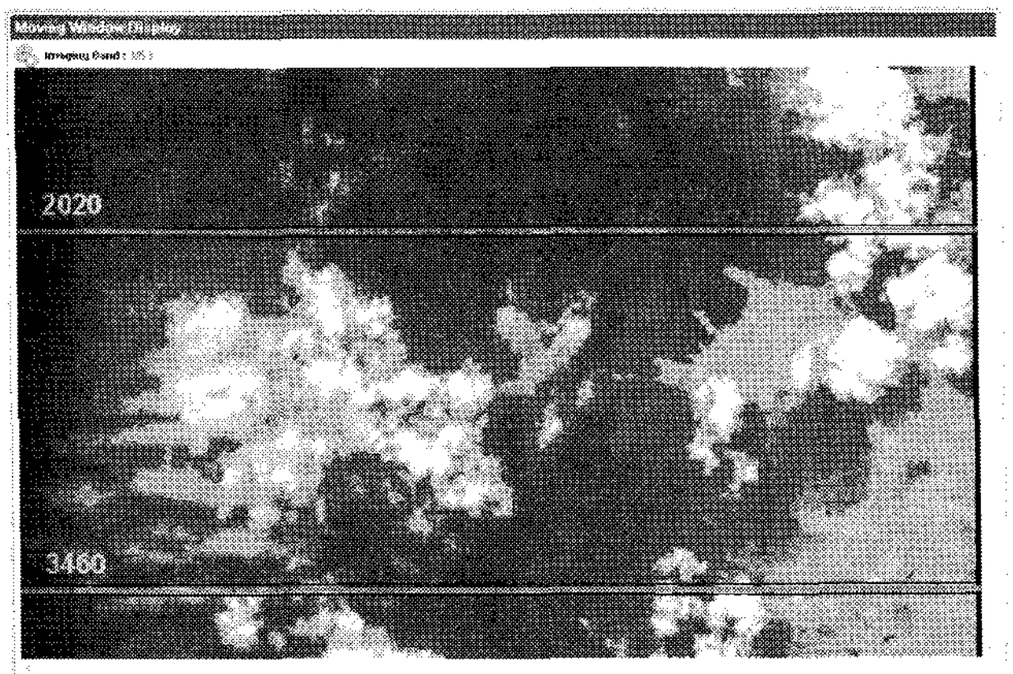

Figure 6. ROI Selection

2.4.3 Image Line Indexing

In general, the Image Line Block is compressed data, therefore, the size of image line is not uniform and also the simple calculation like image line multiplication by line size can not meet the extracting the ROI data in all band data. To handle this kind of problem, the software of Receiving Processor stores not only Image Line Block data but also Image Line Index data after extracting the Image Line information from Image Line Block data during data acquisition. Since the Image Line Index data records the physical location information of Image Line Block corresponding to the image line number, the physical location of Image Line Block to ROI can be easily extracted.

2.4.4 Distributed Processing

The ROI Provider software in each channel workstation extracts the Image Line Block data based on selected ROI and performs de-compression and sends them to ROI Processor in MWD Viewer. This concept employs distribution processing in each channel workstation which makes faster processing to be possible for selected ROI. .

2.5 RPS Implementation

RPS was applied to KOMPSAT-2 X-Band image data. The frame synchronization card was used for serial telemetry card; therefore, receiving processor performed CCSDS processing after ingesting the frame aligned data. Multi-Spectral band was used for Quick Look Image display. RPS for KOMPSAT-2 showed its effectiveness by providing processed image very quickly for ROI compared with normal KOMPSAT-2 image processing system.

3. CONCLUSIONS

RPS was introduced in this paper. RPS processes and generates the image product quickly for the ROI selected by user. Also the quick look image display function, ROI selection function, Image Line Indexing function, and Distributed processing function were described.

The developed RPS was applied to KOMPSAT-2 320Mbps downlink channel and its effectiveness was successfully demonstrated. This feature to provide the image product very quickly is expected to promote the application of high resolution satellite image.

But due to its high resolution feature, when the displayed area is not much familiar to user, it was not easy to select the ROI. Additional ROI selection methods based on time information for ROI or Lat/Lon information or ROI are expected for user to define the region for further processing.

4. REFERENCES

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