Software Development Using an Agile Approach for Satellite Camera Ground Support Equipment

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Abstract - This work presents the development of the software that controls a set of equipments, called Ground Support Equipment (GSE), which verifies requirement fulfilling and helps integration procedures of the CBERS-3 and 4 satellites’ Multispectral Camera (MUXCAM). The software development followed an iterative spiral model, with agile methods characteristics that were originally used at Opto Electronics in industrial and medical equipment’s projects. This approach allowed a small team, constituted by only four engineers, to fast create the first software version, even sharing time with GSE’s hardware development, and to keep the project on schedule, in spite of some requirement changes.

I. INTRODUCTION

Opto Electronics S/A won in 2004 the auction for developing and producing the Multispectral Camera (MUXCAM, Fig. 1) of the China and Brazil Earth Resource Satellites (CBERS) 3 and 4. The MUXCAM Ground Support Equipment (MUX-GSE) is a complex set of test equipments that also integrates the project. It is composed by several measurement equipments and an optical bench that allows evaluation of requirements and helps during assembly stage. The MUX-GSE is also the responsible for approving MUXCAM for launching, performing the last automated tests, after camera and satellite integration.

The MUX-GSE was specified to work in the most automated possible way, using an industrial computer as general controller. This computer should be equipped with the necessary software to command all the systems’ components and to perform all the specified test procedures. The development of this and other auxiliary software needed to be performed in the available short term, without prejudicing the quality and reliability of the system. As it was the first Opto’s aero spatial project, the development strategy applied to medicals’ and industrials’ areas products had to be adapted, however, it was avoided to perform big changes, since the practices were known for all the team and had already proved its performance in the past.

In this section we will briefly present the CBERS program and its importance. Section II contains some of the characteristics of the MUX-GSE. In Section III, we will present information about the agile methodologies of software development. Section IV shows the strategy applied to develop MUX-GSE’s software, comparing with the agile development’s techniques. Finally, we will show the obtained results and the conclusions about the performed work, emphasizing the qualities and flaws of the applied methods.

A. The CBERS Program

The China and Brazil Earth Resource Satellite (CBERS) is a cooperative pacific program signed in 1988, when was accorded the development of two advanced remote sensing satellites. Two satellites were produced in this first program stage. CBERS-1 was launched on October 14th 1999 and operated successfully until August 13th 2003, almost two years beyond its projected lifetime, which was only two years. The CBERS-2, for its time, was launched on October 21st 2003 and is working until now, in spite of some limitations. It was also projected for a two years lifetime.

These two satellites are identical, equipped with three cameras that together allow acquiring images in spectral bands’ ranging from blue to thermal infrared and four different spatial resolutions’, from 260m up to 20m. They allowed a large number of earth resource researches in Brazil. For example, only in the XII Brazilian Remote Sensing Symposium [1] more than seventy of the presented works applied CBERS images.

The Brazilian Government considers the CBERS’ images as a powerful instrument to scientific community developing

Figure 1. MUXCAM – Structural and Thermal Model

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1 Spectral band is the spectral electromagnetic range, comprising the set of frequencies (or wavelengths) for that each individual camera sensor operates.

2 Spatial resolution is the size that each image pixel represents in real world.
works about water quality, cartography, agricultural, deforestation, etc. Thereby, it decides to free distribute the images to national users and to charge only operational costs to international users, increasing significantly the number of viable applications. This strategy makes Brazil the bigger satellite’s images distributor in the world. Other countries have also demonstrated interests about the CBERS’ images. One proof is that the United States Geological Survey (USGS) has already accomplished reception tests to acquire the images of CBERS-2 and it is possible that they become users of the CBERS satellites in the next program stages, receiving its data directly.

Due to the great success obtained by CBERS-1 and 2 and the large number of users depending on its images, Brazil and China decided to continue the program, developing three new satellites. The CBERS-2B is a copy of CBERS-2, except by one of the cameras, the Infra-Red Multispectral Scanner, which will be replaced by a panchromatic camera with better spatial resolution (2.5m). The CBERS-3 and 4, however, will incorporate a lot of technological innovations. Besides those innovations, there is also other important change to Brazilian industry: The work share is now 50% to 50%. Brazil will produce more systems than did to the first three satellites. Improving the capabilities of spatial technology’s Brazilian industries was one of the main objectives of the CBERS program since its beginning.

The change in the work share brings to Brazil the opportunity of developing the MUXCAM. It is the first time that the Brazilian industry will produce a camera with its characteristics. Its success is necessary not only to the CBERS images’ users, but to the whole CBERS program and, specially, to the Brazilian spatial industry, to assure the continuity of government investments.

II. MUX-GROUND SUPPORT EQUIPMENT

The MUXCAM has rigid requirements to assure its reliability and image quality. It demands a lot of tests during the assembly stages and verification of several characteristics after the camera integration. These test procedures require a large set of specialized equipment that can accomplish optical, mechanical, electrical and logical evaluation. The MUX-GSE also contains cables, tools, mechanical cases and supports, software and accessories. Some of the MUX-GSE requirements, from [2] and [3], are:

- Generate optical patterns for calibration and test procedures.
- Perform quantitative measurements of specified optical, mechanical and electronic characteristics, as modular transfer function, focal plane, radiometric parameters and image distortion.
- Receive, decode, display in real-time and store the MUXCAM images, verifying the data format and rate.
- Obtain information about focus, collimation and centering of the MUXCAM optical system and about the CCD positioning, acting as auxiliary equipment during the integration procedures.
- Perform calibration procedures and stores its data.
- Evaluate mechanical parameters as dimensions, mass and mass center.
- Evaluate electrical parameters as power consumption, operational limits and circuit characteristics.
- Command and certify the MUXCAM working in all of its working modes.
- Check the properly working of all telemetries and telecommands.

Besides that, the MUX-GSE shall execute all the verification tests proposed to the MUXCAM. These tests are determined in the requirements definition and design stages and shall be executed during its manufacture, assembly and after the system integration, to assure that the desired characteristics are reached. The test procedures shall be as automated as possible, mitigating errors caused by the operator, however, all the MUX-GSE measurement equipments shall be available to manual control, so it is possible to accomplish measurements that were not originally planned. These necessities led the development team to choose virtual instruments, instead of real bench equipments.

This way, the MUX-GSE is composed by an industrial computer and several PCI boards that allows to emulate an oscilloscope, a multimeter, a digital waveform generator, a logic analyzer and make available a bunch of digital and analogical I/O ports, used to develop the necessary interface circuits to control the MUXCAM and acquire its data.

This approach is more flexible, making the system more adaptable to possible changes in its requirements. It also permits the automation of the system and the development of software interfaces to command the PCI boards emulating the bench instruments functions. However, the use of virtual instruments increases strongly the needed software development effort and the high level of system’s automatism demand more robust and reliable software, once that any measurement error can cause from project delays to damages to the MUXCAM. Worst than that, it can approve to launch a system that may have not reached the specified requirements.

III. AGILE DEVELOPMENT

The rise of the agile methodologies in the last years has shown that the production of less documentation, the transference of part of the management responsibility to developers, the creation of more simplified software, do not necessarily mean reducing the quality of the product. Even though it looks like the produced software will be less reliable and specialists are yet discussing the evolved issues [4], it was reported that, applying suitable methodology, the system could be produced faster, with complete reliability and more satisfaction for customers, developers and employers.

Agile methods as eXtreme Programming (XP), Scrum and Crystal have common characteristics, most of them summarized in the Agile Manifesto’s. These methods valorize...