GRASP
(GRIPS Aspect Program) Requirements Document

A software requirements specifications (SRS) document for the aspect computer to be used on GRIPS

UC Berkeley Space Sciences Lab
GRIPS (**G**amma-**R**ay **I**mager/**P**olarimeter for **S**olar Flares)
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Updated as of: July 13, 2010

Abstract

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1 Introduction

GRASP (**GR**IPS **As**pect **P**rogram) is the onboard application to be used with the **GRIPS** (**G**amma-**R**ay **I**mager/**P**olarimeter for **S**olar Flares) test balloon.

- GRASP must start automatically and go into “ready mode”
- GRASP must always be enabled to receive:
  - commands; for example: START and STOP
  - parameters; for example: Δt, exposure time, analysis choice, strategy ID, values concerning phasing and cadence (1 to 10 Hz), QL (quick load) selection ($t_1 – t_2$, Δt, type)
- default parameters must be used if no options are taken
- timing input: TBD
  - NTP (network time protocol): synchronizes clock to a maximum accuracy of 200 μs in LANs
  - can NTP co-exist with other commands?
- images are acquired to “memory”
- output is analyzed/selected
  - “real time” pitch and yaw: (x, y) coordinate pairs
  - onboard storage: compressed data

2 Architecture

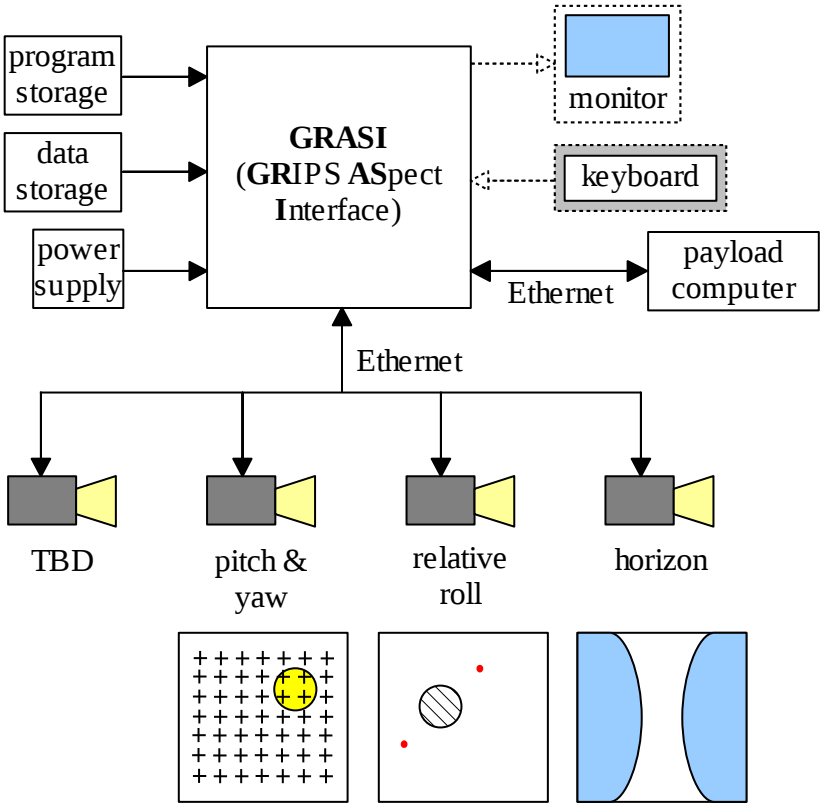


Figure 1: GRASI's Architecture

3 Application Flow Diagram

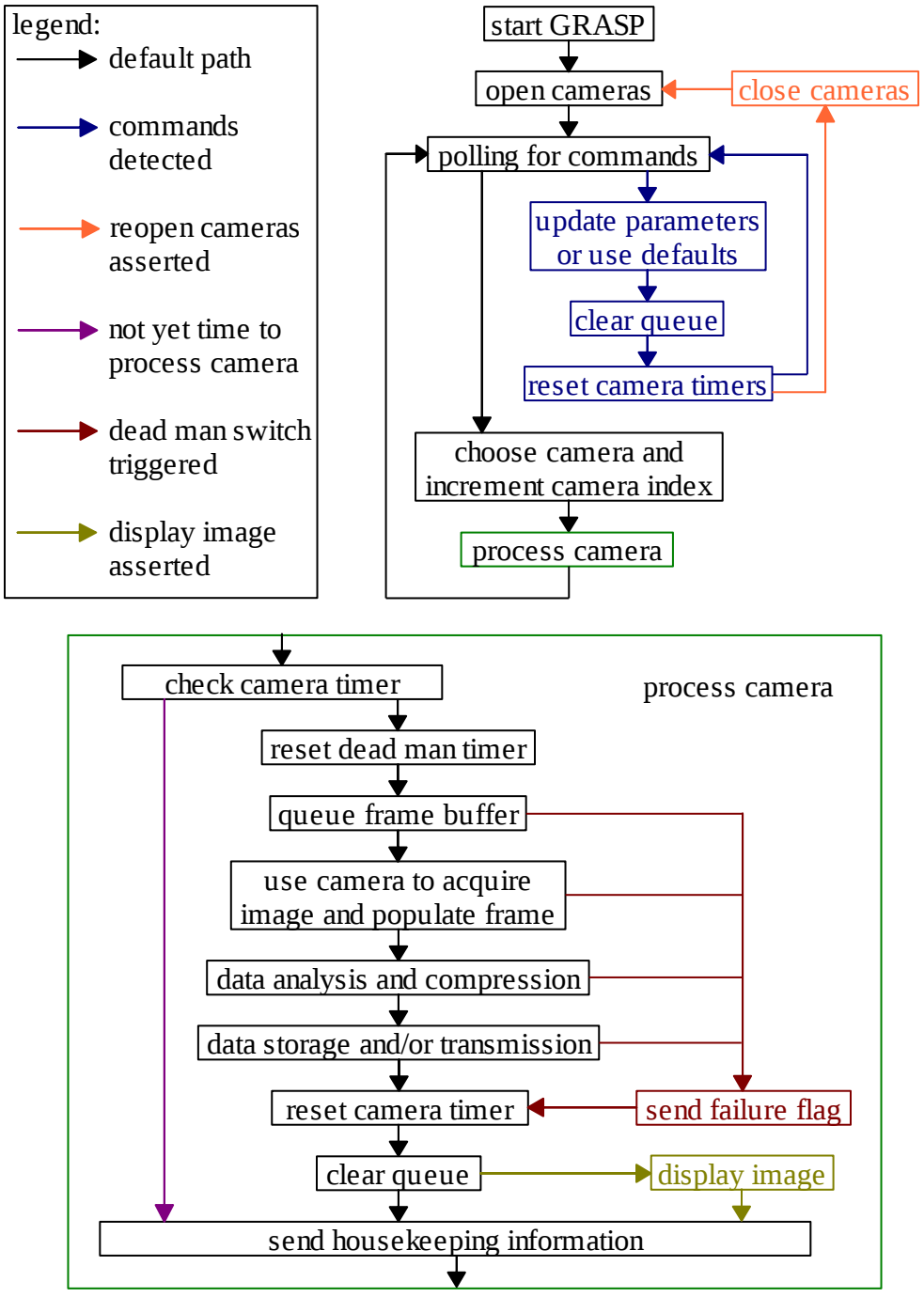


Figure 2: GRASP Flow Diagram

4 Commands List

5 Timing and Accuracy Requirements

5.1 Timing Accuracy Required for Relative Roll

Sample calculation:

given a diameter of 50 cm,

circumference ≈ 1500 mm

with a finest grid pitch of 1 mm and desired accuracy of 1/20 of a pitch,

pitch accuracy reaches 1/(20 * 1500) = 1/30000 rotation

supposing 4 seconds elapse per revolution,

timing accuracy reaches 4000 ms / 30000 ≈ 0.1 ms

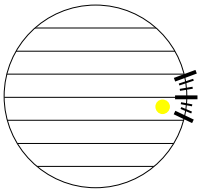


Figure 3: Sample Pitch Marks

6 Compression Schemes

Because GRASP will be working with a lot of data, compression schemes must be implemented to ensure that unimportant data is not stored.

6.1 Level 0

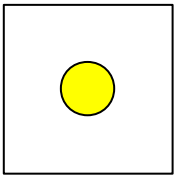
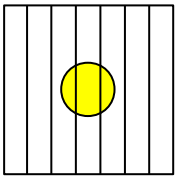


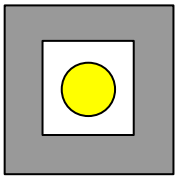
Figure 4: Level 0 Compression

Level 0 compression does not alter the data and sends full 1 MB pictures.

The remaining compression schemes first choose which part of the image to work with:



1) Use “scan lines” to determine where target area is.



2) Box target area and discard data of no use.

Figure 5: Choosing Which Part of the Image to Work With

Once the boxed area is acquired, a number of compression schemes can be further applied. These schemes vary in levels of compression.

6.2 Level 1

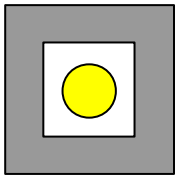


Figure 6: Level 1 Compression

Level 1 compression does not further compress the extracted box.

6.3 Level 2

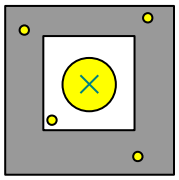


Figure 7: Level 2 Compression

Level 2 compression uses histograms to find the average background value, subtracts the value from the image, and then finds the centroid of whatever remains. Background noise is negligible.

6.4 Level 3

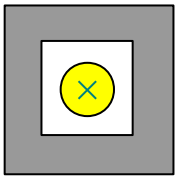


Figure 8: Level 3 Compression

Level 3 compression is similar to level 2 compression but finds a better estimate of where the center of the sun is.

6.5 Level 4

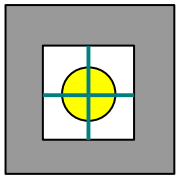


Figure 9: Level 4 Compression

Level 4 compression stores one or more vertical and horizontal strips of data.

6.6 Level 5

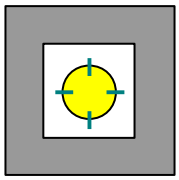


Figure 10: Level 5 Compression

Level 5 compression stores a few small strips of data, each with an estimated size of 2 bytes.

6.7 Level 6

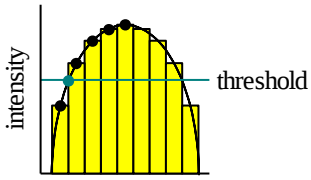


Figure 11: Level 6 Compression

Level 6 compression captures a choice of 2 to 6 points at each limb, fits the points to a polynomial, and then stores the x-position where the polynomial crosses a threshold. About 4 4-byte floating-point numbers are stored.

6.8 Level 7

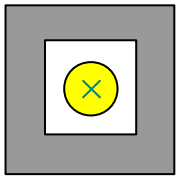


Figure 12: Level 7 Compression

Level 7 compression finds a very accurate estimate of the center of the sun.

7 GRASP Builds

7.1 Version 0

Uses only one camera and level 0 compression. Default parameters are used. The following parameters produced good results when the camera was tested in the summer of 2009:

exposure length (μs)	bit depth	filter	aperture
70	32	yes	1.6
220000	32	yes	16

Table 1: Parameters Used in Summer 2009

8 Assumptions

9 References