The π of the sky project - software

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Part of M.D. Thesis

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What are Gamma Ray Bursts (GRBs)?

- GRBs are very short flashes of Gamma radiation, coming from random directions
- Orphan optical bursts are believed to follow every GRB

The only case of registered optical flash associated with GRB. What are the qualities of others?
Solution:

16 cameras coupled with computers, providing at least $\pi$ stereoradians of viewangle, 1’ sky resolution, ~5 sec. time resolution, online processing of incoming data.

ROTSE’s ‘hedgehog’-like design

Online processing of data

Remote controlling Via Internet
Software

- Complete automation of retrieving and processing pictures to increase detection rate of orphan optical flashes
- Processing must be performed online due to large stream of data (125MB/cycle) that cannot be stored
- Increase of sensitivity
- Recognition of optical flashes
- Interaction with triggers from GCN network (receiving and sending triggers)
- Controller hardware via Internet
USB Driver for Linux

 القومي Low level driver for kernel 2.6 –
tested & debugged features:

- Direct Memory Access using sg-lists
- Direct Memory Access using user_map_pages
- Specific sequence of loading and unloading drivers
- Timing requirements for commands
- Use of Vendor commands for Cypress EZ-FX protocol
- Watchdog refresh, using kernel timers
- Overriding timeouts
- New commands for camera

 القومي High level driver wrapper providing
functionality
New commands for Camera:

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>0xFD</td>
<td>„Artificial” RESET</td>
<td>EZ-FX2 does not provide normal reset</td>
</tr>
<tr>
<td>0xFC</td>
<td>Watchdog refresh</td>
<td>Refreshes watchdog in camera so that it does not reset</td>
</tr>
<tr>
<td>0xDD</td>
<td>Download firmware to Altera</td>
<td>Provides possibility of updates</td>
</tr>
<tr>
<td>0x0D</td>
<td>LNA gain control</td>
<td></td>
</tr>
<tr>
<td>0xEF</td>
<td>Get version of cam</td>
<td></td>
</tr>
<tr>
<td>0xE</td>
<td>Lens heating</td>
<td></td>
</tr>
<tr>
<td>Vendor – over control pipe 0</td>
<td>Download firmware to Cypress</td>
<td>Provides possibility of updates</td>
</tr>
</tbody>
</table>
Data compression for storage

• Lossless – Rice-Golomb codes; differential coding using linear predictors
  ✓ The library was completely rewritten to be compatible both with Windows and Linux

• Statistics

Compression ratio: 2.094
% of not compressed pixels: 7 %
Rice protocol overhead: 13%
Better adjusted sets of predictors: 5%

=> The size of the compressed file can be 25 % smaller

Diagram of length of compression codes
White pixels ~ 29 bits, black pixels ~ 7.7 bits
• **Linear Predictors**

If \(((A==B) \& (A==C))\)  

Predictor\(_D\) = \((A+B+C)/3\)

Predictors can be better adjusted eg. statistically to obtain smaller standard deviation of differential signal

• **Lossy compression**
  - JPEG format is not well suitable because it deforms the objects of interest
  - Stars must be compressed losslessly
  - Background can be compressed in a lossy way, not stored at all, or stored as rough gradient
Plans

- Further development of data compression – lossless and lossy
- Further development of USB driver
- Final preparation of thesis

Project deadline: February 2005
Thank you for your attention