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# Jovian impact flashes detection with DeTeCt software project

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## Abstract

Observations of Jupiter by a large number of amateurs have resulted in the discovery of three fireballs in its atmosphere produced by the impacts of small objects. The fireballs were detected on June 3, 2010, August 20, 2010 and September 10, 2012. There could be more impacts undetected on amateur videos. Hence we propose tools for detecting impacts on existing videos and a project for collecting information on these analysis in order to constraining the estimation of detectable jovian impacts rate (see [1])

## 1. Introduction

Prior to these 2010 and 2012 events, amateurs were not aware of the possibility of detecting the flashes of such impacts on their videos. Furthermore, for each of these events, one amateur detected the flash and issued an alert, leading other amateurs to detect the flash afterwards on their own videos. Given the fact that 3 fireball impacts have already been detected, there is a possibility of having undetected impacts in existing amateur videos.

A project called «DeTeCt» coordinating the search for such undetected impacts has been launched, with first preliminary results which could be used.

## 2. Data

### 2.1 Amateur participation

Planetary imaging amateurs use mostly reflectors with an aperture from 15 to 40 cm. Since 2001, their image coverage has been very good 6 months around Jupiter's opposition. There are several hundreds of amateurs regularly observing Jupiter and in contact with amateur associations like BAA, SAF, ALPO, …

The DeTeCt project already collected the analysis of 20 planetary imaging amateurs (see Table 1).

Table 1: List of amateurs participating the most to the "DeTeCt" project (as of May 2013)

| Name/ Country | Duration of videos analysed | Time frame |
|---|---|---|
| Trevor Barry (Australia) | 1d 14h 43m 54s (2424 videos) | 2009/07/07 to 2012/12/30 |
| Marc Delcroix (France) | 1d 9h 20m 0s (1393 videos) | 2006/04/14 to 2013/03/09 |
| Pascal Bayle (France) | 0d 16h 47m 54s (1006 videos) | 2012/11/30 to 2013/03/03 |
| Paul Rolet (France) | 0d 12h 43m 47s (442 videos) | 2012/09/07 to 2013/03/09 |
| Pascal Lemaire (France) | 0d 10h 46m 56s (573 videos) | 2012/08/01 to 2013/02/16 |
| Flavius Isac (France) | 0d 7h 47m 23s (546 videos) | 2011/08/12 to 2013/02/17 |
| Christophe Pellier (France) | 0d 7h 38m 54s (311 videos) | 2012/02/20 to 2013/01/16 |
| Manos Kardasis (Greece) | 0d 5h 12m 59s (323 videos) | 2010/06/09 to 2013/04/11 |
| Xavier Dupont (France) | 0d 4h 21m 57s (220 videos) | 2012/08/16 to 2012/11/14 |

### 2.2 Detection method

The software used , called "DeTeCt", can work on all different types of videos/individual files that amateurs use (avi, wmv, ser video formats; fits, tiff, bmp, jpg, … file formats). It runs in a batch mode for processing in a row all videos recursively found in a directory and its sub-directories, easing the processing of hundreds of acquisitions. Its' development has been launched by the professional planetary team in Bilbao but was extended for the project with additional supported formats, functionalities and logging capabilities by an amateur (MD).

It works by first registering the frames of the video images to align all frames canceling shifts due to turbulence or drifts of the planet on the sensor. Then it performs two operations. The first one attempts to detect impacts automatically by identifying zones on the planet getting sudden brightness increases which are limited in time and spread on several pixels. The

second one generates a detection image constructed by the difference between an image constructed with the maximum value for each pixel in all frames and a mean image constructed with the mean value for each pixel in all frames. The histogram of this detection image is stretched to the maximum to ease the detection of a potential impact by a quick 1-2s visual inspection by an amateur (see Figure 1).

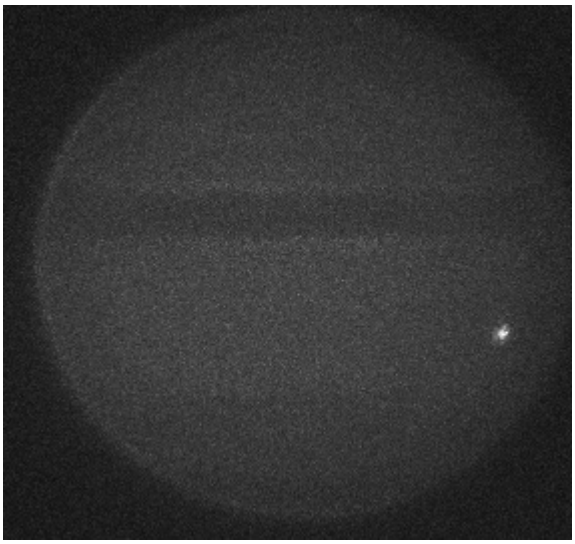

Figure 1: detection image generated by DeTeCt software (image with maximum value minus mean value for each aligned pixel) from an acquisition from Christopher Go on June 3rd 2010 with a ream detected impact

The amateur has to analyze all detection images generated (Complete and comprehensive English and French tutorials for running the software and analyzing the results are available in the website of this project, http://www.astrosurf.com/planetessaf/doc/project_detect.shtml ), then send to the author the log files generated listing all analyzes done signaling any potential positive result.

### 2.3 Additional information

Additional information is collected/processed for all videos processed: start/mid/end time, duration, frames per second. This information is derived either by the acquisition software used by the amateur (all common ones are supported: Lucam Recorder, Genika, Firecapture, PLxCapture, Avi felopaul, Genicap), or the file itself. This is used to calculate the total duration of all videos processed from all observers by a developed script analyzing all logs generated.

## 3. Results

### 3.1 Number of impacts detected

As of may 2013, no impacts were detected yet within this project.

### 3.2 Jupiter coverage analysed

As of May 2013, more 6h 1d 41m worth of videos, from 7826 videos from 20 observers, acquired between April 2006 and April 2013 were analyzed.

### 3.3 Rate of impacts

From this preliminary result we could estimate that the detectable jovian impacts rate should be lower than 1 per 60 earth days.

## 4. Summary and Conclusions

Amateurs can participate and run successfully by their own a project for impact detection leading to a first probable constraint to the estimation of detectable jovian impacts rate (<1 per 60 earth days). There is still a strong potential for getting more data from more observers (some participants did not analyze all of their available videos, and furthermore the French community participated well but only a few international amateurs participated yet). This should be continued for the upcoming apparitions to continue to actively contribute to impact detections studies and refine the flux of impacts in Jupiter estimation.

## Acknowledgements

We would like to thank all amateurs who have been participating to this project by analyzing their videos and providing the results.

## References

[1] Hueso R. et al.: The flux of impacts in Jupiter: From superbolides to large-scale collissons, EPSC2013-228, 2013