

# CMN\_ADAPT and CMN\_binViewer software

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As the main focus of the Croatian Meteor Network (CMN) shifted from data collection to data analysis, mainly discovering new meteor showers, it has been realized that the current data processing pipeline was slow and outdated. In this paper new software for fully automatic data acquisition and processing is presented. Furthermore, a new tool for viewing the data acquired with the CAMS capture and compression software is described and a link is given for free download from the CMN webpage.

## 1 Introduction

Since late 2009, when the first procedures for automatic CMN data processing were written (Vida et al., 2011), a constant further development of such tools was ongoing. Although the process of meteor detection, data calibration (astrometry and photometry) and orbit pairing was mostly a matter of running a few automated scripts, data processing was far from real-time. It is evident from the CMN publications of orbit catalogs (Šegon et al., 2012a; Korlević et al., 2013; Croatian Meteor Network, 2013) that in some cases data were not fully processed several years after their initial capturing. With the shifting of the main focus of the network from mere data acquisition to data analysis in 2012 and 2013 (Šegon et al., 2014), it has been realized that the existing procedures will not be sufficient any longer. The sheer work time required for both activities to be carried out at the same time was not available to the CMN staff. Thus it has been decided to develop a new tool which will provide a fully automatic way of data acquisition and processing.

In the second part of the paper a new tool for viewing files acquired by the CAMS capture, compression and detection software (Jenniskens et al., 2011), as well as Skypatrol, is presented.

## 2 Old data processing pipeline summary

### *Data acquisition*

Since the beginning of the Network, Skypatrol software was used for data acquisition, mostly because of its low

minimum system requirements. In the years of the Network’s expansion, finding a PC with a top-line configuration available only for the purpose of meteor capturing proved to be very difficult. Thus Skypatrol presented a good alternative to other more demanding solutions. With the further development of computer technology and wide availability of faster computer configurations, CMN could afford more advanced capturing solutions. Replacing Skypatrol was a high-priority task as it had certain drawbacks. Between capturing two images it had a 6 second pause used for internal processing procedures and writing the data on disk. This meant 10% loss of all meteors. In some cases of bright multi-station fireballs it has been found that several stations captured it properly, but often on one station it managed to coincide with the “6 second time hole”. Furthermore, it offered no automatic way to start and to stop the capturing process. Automatic scripts which moved the mouse pointer and clicked the buttons for starting and stopping were not very reliable as the Skypatrol window was often minimized and could not be automatically restored as it randomly changed the name of the window. Among other drawbacks, it also could not capture more than two concurrent events.

### *Meteor detection and image calibration*

Meteor detection was done using MTP\_MeteorDetector software (Gural et al., 2009) which was run by a script that allowed processing large volumes of data at once. The detection procedure was very time-consuming, often requiring more than 24 hours of processor time for a few months of data from only one station. That data had to be

further filtered of unwanted detections and calibrated with the CMN\_AutoCheckFit software which performed astrometry and photometry procedures. In cases where the PC at the station had no internet connection, an additional step of time synchronization had to be made with the CMN\_dTcommander software. It compared common events between two stations and calculated the most probable time difference between them for each day.

### **Orbit estimation**

UFOorbit software<sup>1</sup> was used for orbit estimation. It provided an easy to use user interface and a fair visualization of meteor orbits. But after some further research some of its limitations became apparent. The most obvious one is the assumption of a constant meteor velocity after entering the atmosphere, i.e. it does not take the deceleration of a meteor into account during the orbit calculation.

All orbits obtained by UFOorbit will be compared with orbits computed by the CAMS software application FTP\_Coincidence on the same data set in the near future.

## **3 New Data Processing Pipeline - CMN\_ADAPT**

CMN\_ADAPT (Automatic Data Acquisition and Processing Tool) was developed with all the data handling needs of the Croatian Meteor Network in mind. It provides a fully automatic way of data capturing, meteor detection, astrometry, photometry and data transfer to the central server, allowing for fully processed data ready for orbit estimation in less than 6 hours after sunrise. Although the full functionality requires an internet connection and a decent computer configuration, these requirements can be considered one of today's standards. A complete compatibility with the previous processing procedures is retained, enabling a seamless use of any old data like these obtained with CMN\_ADAPT software.

### **Initial setup**

A special consideration has been given to the ease of setting up the software, as it is sometimes difficult to educate new station operators only via e-mail or by phone. The software is distributed to individual station's computer via a compressed archive which the operator extracts to an appropriate location and runs the CMN\_ADAPT.exe file. The station operator is asked for only two pieces of information: station code and the availability of internet connection (Figure 1). If the internet connection is available, a configuration file containing all parameters of a specific station is downloaded from the central server and the setting up procedure is done. If the internet connection is not available, the station operator needs to choose an

appropriate configuration file which was specifically configured for that particular station with the software itself.

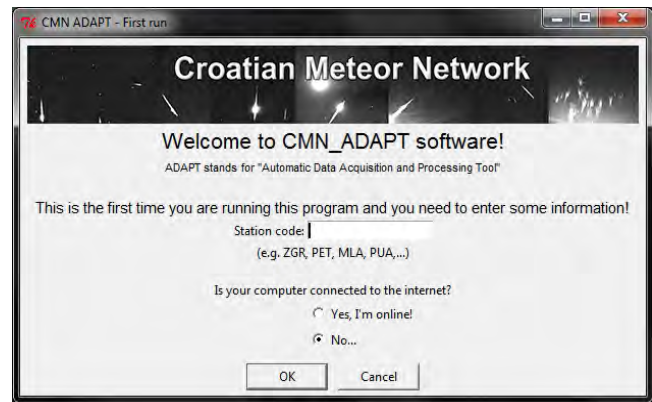


Figure 1– CMN\_ADAPT initial setup window.

During the initial setup some camera parameters such as brightness and contrast can also be adjusted. A configuration window opens and the camera operator can easily adjust the settings to achieve a proper look of the live feed from the camera itself. This step also serves as the last check of a proper hardware setup.

### **Pre-capturing maintenance**

At each software startup, a request is sent to the central server to check for a new software version. If it is available, the software is automatically updated. Before starting a new capturing session, any raw data older than a week is deleted. This prevents accumulation of raw data on the local computer as it would otherwise fill the hard disk in just a few weeks. After the cleanup, the starting time and duration of capturing is calculated with regard to the location of the station and the current date.

### **Capturing and meteor detection**

A decision has been made to fully replace Skypatrol with a more modern meteor capturing solution. Considering all available solutions, FTP\_CaptureAndDetect by Peter Gural was chosen as the most suitable one, as it retains several features from Skypatrol and it has an easily convertible data format, similar to one used by CMN. It also uses video capture via a frame grabber interface, which is compatible with all capturing devices currently used by CMN. FTP\_CaptureAndDetect is run at the calculated starting time and the duration of capture is passed to it. Parallel with the capturing thread, the meteor detection thread is running and detecting meteors on the captured images. These detections are written into a FTP\_detectinfo file.

### **CMN procedures**

When the capturing and detection process is finished, a script for making thumbnails of each captured image is run to create an easy way to see all events during the night on a single image. Also, it is necessary to convert the CAMS standard detection information format to the CMN format, in order to apply CMN procedures on the data. For this task

<sup>1</sup> [http://sonotaco.com/soft/UO2/UO21Manual\\_EN.pdf](http://sonotaco.com/soft/UO2/UO21Manual_EN.pdf) (SonotaCo, 2008)

a script named CAMS2CMN by Ivica Skokić is implemented in the CMN\_ADAPT. After the conversion all existing CMN standard procedures are applied on the data. First, detections are filtered using the MTP\_filter software which eliminates birds, bats, planes and other unwanted detections. The astrometry is done by running the AutoCheckFit software and the photometry is performed. To make the data compatible again with CAMS standard procedures, the final CMN file which contains meteor parameters is converted back into the CAMS standard detection information format.

### Archiving and transfer

All files containing detection and astrometrical data are archived to a compressed ZIP file and uploaded to the central server. Such files are often only a few megabytes in size. An archive of compressed raw image files which contain only detected meteors is kept locally and not transferred to the central server as these archives can reach up to several hundreds of megabytes in size. These files are sent by the station operators via portable hard drives or DVDs.

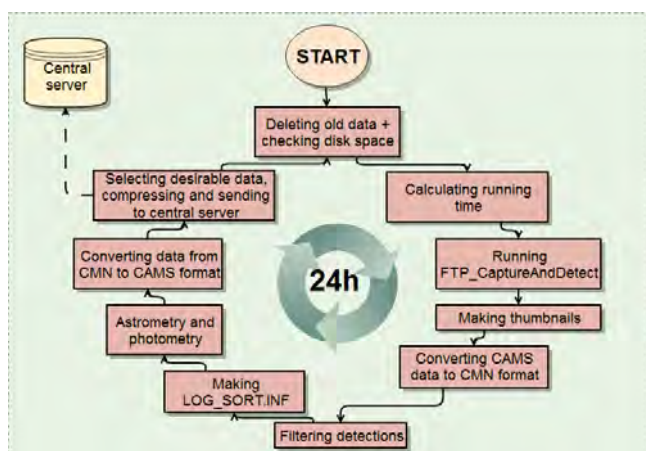


Figure 2 – CMN\_ADAPT flowchart.

### Orbit estimation

The multi-track coincidence and the orbits procedure is done by Peter Gural via the FTP\_Coincidence software. The data is downloaded from the CMN central server to his personal computer, the procedure is performed and the processed data is uploaded back to the server. From this point onwards the analysis can be done on the orbit data. A possibility of using UFOorbit for orbit estimation is also available, as all output data from the CMN\_ADAPT software are fully compatible with it.

## 4 E-mail alerts and thumbnails

To provide some way of supervision on the current status of the network and an early warning system for fireballs, a daily e-mail report is sent to several CMN members at 22<sup>h</sup>00<sup>m</sup> local time each day. This task is done by a script running on the CMN central server. The report contains a list of stations which failed to upload the data that day, a list

of detected fireballs and finally thumbnail images generated by CMN\_ADAPT are added as an attachment. Station operators are immediately contacted to resolve the issue with the station that failed to upload the data and the issue can be resolved or at least diagnosed via the remote desktop software. Listed fireballs are checked on the thumbnail images, and the thumbnail images themselves are thoroughly examined. If the detected event is determined to be a possible meteorite-dropping fireball, further steps are performed for its analysis.

## 5 CMN\_binViewer software

With the usage of new capturing software, a need for a more advanced solution for viewing captured data was created. Therefore it was decided to develop a new tool for viewing both CAMS standard and Skypatrol standard data. Its goal is to provide an all-around capability for easy data viewing, sorting, saving individual frames and images, making an animation, applying dark and flat frames and correcting image levels. As there are currently numerous networks working with CAMS standard software, CMN\_binViewer is given as freeware on the CMN website (<http://cmn.rgn.hr/binviewer/binviewer.html>).

### Filters

The main advantage of the CMN\_binViewer is its filters, special procedures applied to individual images that reveal meteor characteristics which would otherwise be invisible. There are 7 individual filters: Maxpixel image, Colorized image, Detection only, Average frame image, Odd field image, Even field image and Video.

The *Maxpixel image filter* displays the image composed of pixels which had the highest value during the recording period of 256 frames. On the Maxpixel image every recorded meteor should be seen, and thus it is set as the first and the default filter (Figure 3).

To get the general idea about the meteor's velocity, without looking at the video, the *Colorized filter* is used. It colors intermittent fields with cyan and red color. This is done by deinterlacing the image by odd field duplication. The resulting image is put into the red image channel, and the deinterlaced image by an even field duplication is put into the green and the blue channels. When all channels are viewed simultaneously, the image shows the desired effect. Fast meteors have nicely separated cyan-red detection points, while slow meteors often have detections very close to each other, thus odd field image and even field image are almost indistinguishable from each other. This results in an almost colorless white meteor on the final colorized image.

In Captured mode, the *Detection only filter* subtracts the Average pixel image from the Maxpixel image, which results in an image which shows only the detection, without background. The resulting image is usually darker than the Maxpixel. This filter is used when the background is very

bright, e.g. during the Full Moon, to better see faint meteors. In Detected mode, the image is constructed from individual frames of a detection, so only that particular detection is visible, in case when there are several detections on a single image.

The *Average pixel image* (Avgpixel in the GUI) depicts the average value of all pixels during the recording period of 256 frames. It shows background features like background sky brightness, CCD sensor imperfections (hot pixels), stars, the Moon, objects obscuring the field of view, etc. It is used to easily see the background conditions when the meteor was recorded.

*Odd field image* depicts the deinterlaced Maxpixel image by odd row duplication. The method consists of copying odd image rows (from top to bottom) to even rows. This filter is often used to see individual detections of a faster fireball to reveal the true nature of the fireball. With brighter events the phenomena such as wakes, trains and trails can be visible between the frames. *Even field image* depicts the deinterlaced Maxpixel image by even row duplication.

*Video filter* is used for viewing the video of a certain file or a detection. Image modifiers (deinterlacing, levels, dark frame and flat frame) are not applied during a video preview as they require a lot of processor time for each frame of the video. During the video preview the current frame number will be shown at the end of the timestamp (and change rapidly according to the FPS entry). When the viewer is showing a static image, the frame number will simply read “FFF”.

### Modes

In *Captured mode* every image in a certain folder is shown in the file list box, whether it has a detection (i.e. meteor) or not. It is useful to go through all images from a certain night. In this mode all filters are available for use. *Video filter* will show a movie from the first to the last frame (0 – 255 for CAMS). To narrow the temporal range, a new range can be specified in the Start Frame and the End Frame entries. When a GIF animation is generated in this mode, it will also produce an animation 255 frames long. To make an animation of the detection only, the *Detected mode* is used.

In *Detected mode* only images with detections are shown. All filters are disabled except *Detection only filter* which shows the specific event (Figure 4). The *Video filter* is also available in this mode, but it will show a movie only from the start to the end of a certain event. This can be used to quickly go through all recorded meteors and see their video clips.

### Image calibration and adjustments

CMN\_binViewer offers a possibility to apply two calibration images: *dark frame* and *flat frame*. It can

deinterlace the image by blending the odd and even fields. Also, it can apply levels adjustment. These options are used to enhance the final image. In several filters and in the Detection mode some of these features are disabled, as they would interfere with normal operation. When available, all options can be used to produce a combined effect.

### Saving images and animations

There is a possibility to save an image while it is shown on the screen in BMP and JPG formats. Also, it is often useful to have a short animation of a certain meteor that can be easily viewed across many platforms. The GIF format has been chosen because of the small final size of an animation, and the compatibility with many current web browsers. This provides easy sharing and viewing of the animations.

## 6 Conclusion

To fulfill the current needs of the Croatian Meteor Network, two software solutions have been developed. CMN\_ADAPT provides an automatic and care-free solution for data capturing, processing and transfer. In addition to the CMN\_ADAPT, a server-side script generates a daily e-mail report to warn CMN station operators of camera issues and fireballs. The CMN\_binViewer software, developed to view CAMS standard and Skypatrol standard data, provides an easy way of viewing and managing captured data. CMN\_binViewer is freeware and available to all meteor enthusiasts who are using the mentioned capture software solutions. A detailed user manual is provided with the software to help future users utilize all integrated features.

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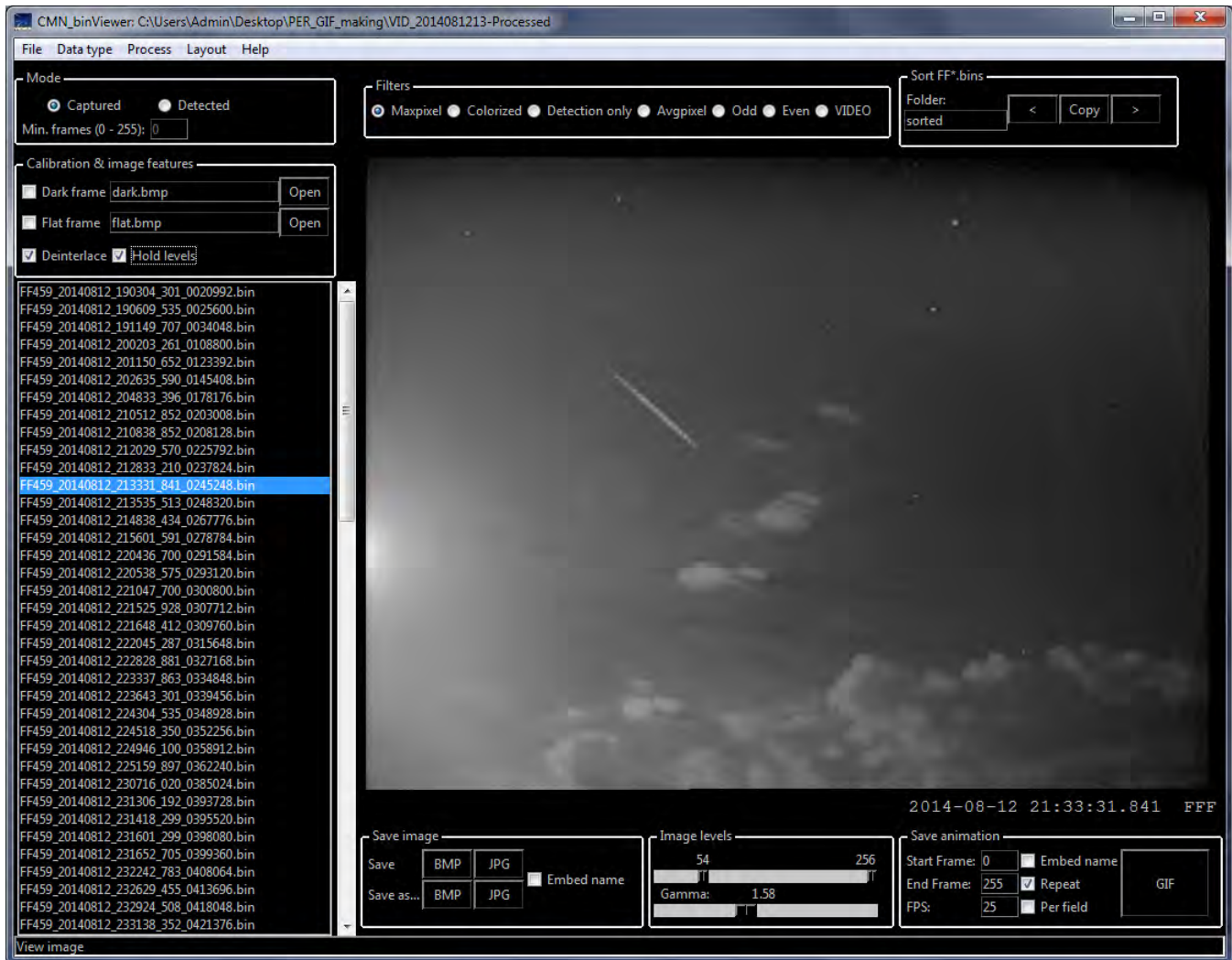


Figure 3 – CMN\_binViewer Maxpixel image filter in Captured mode.

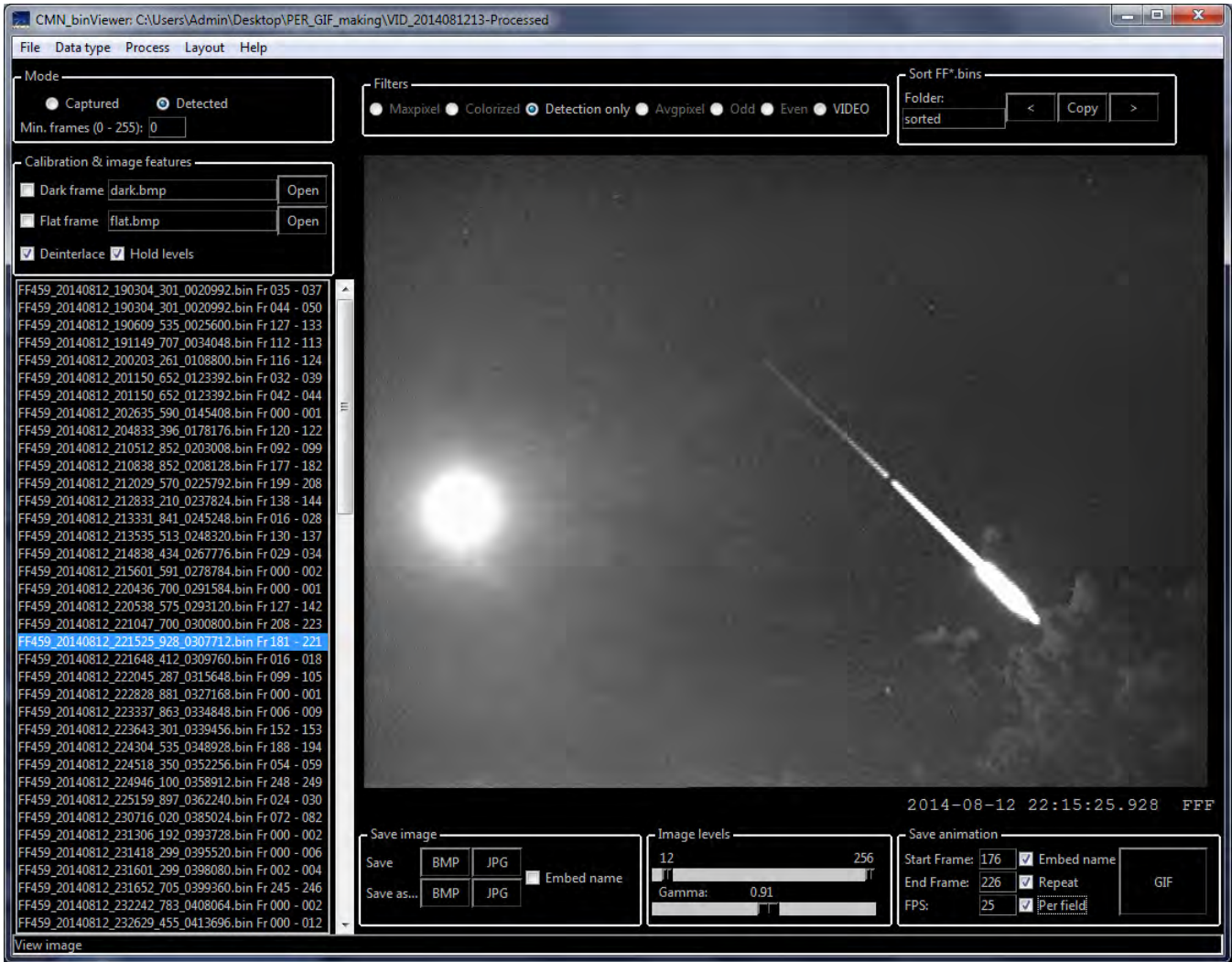


Figure 4 – Detection only filter in Detected mode, ready for saving GIF animation.