Computer Vision in Meteor Research

Ing. Bc. Eliška Anna Kubičková University of West Bohemia

What is computer vision

- Computer vision is group of methods, which try to duplicate the effect of human vision by electronically perceiving and understanding an image

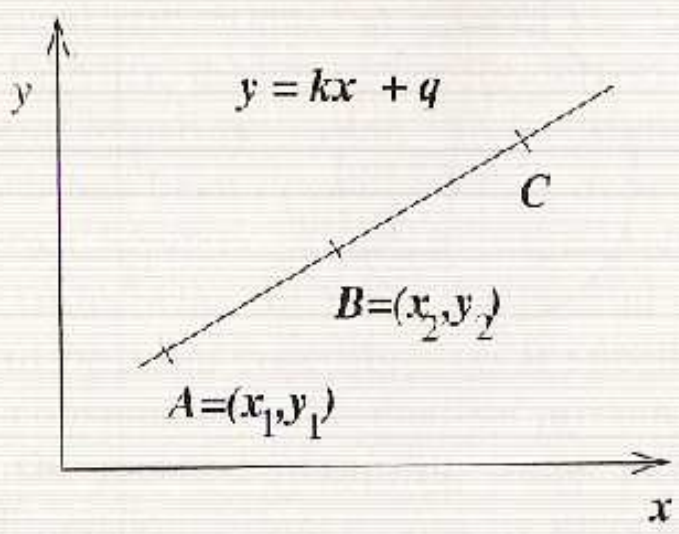
Main groups of computer vision methods

- Low-level processing methods
  - Image pre-processing (noise filtering)
  - Edge extraction
  - Image compression
  - Image sharpening
- High-level processing
  - Imitation of human cognition with use of artificial intelligence methods

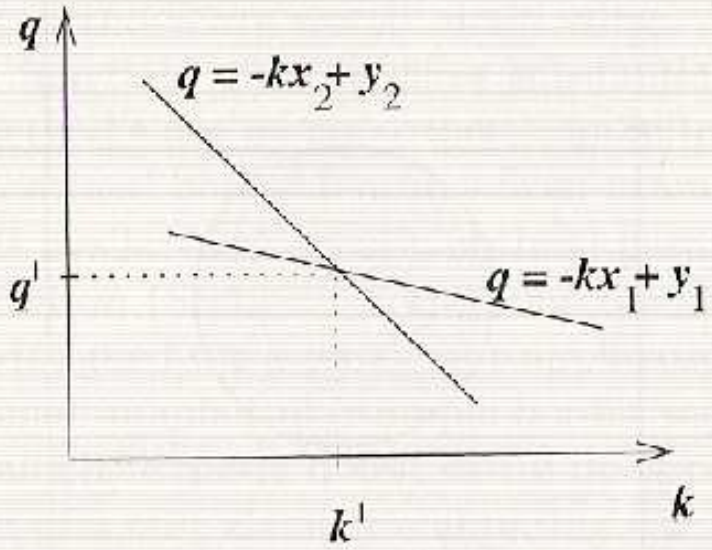
Methods used for meteor searching

- Image pre-processing methods
  - Gray-scale transformations
  - Geometric transformations
  - Image smoothing (median filtering)
- Segmentation
  - Hough transformation for straight lines detection

Principle of Hough transformation



(a)



(b)

Figure 6.33: Hough transform principles. (a) Image space. (b) k, q parameter space.

Figure from Sonka, Hlavac, Boyle: Image Processing, Analysis, and Machine Vision

Main steps of Hough transformation

- Edge detection in image (by some edge-based segmentation method)
- Parameter space creation
- Line detection

a) Original image b) Edge image c) Parameter space d) Deteted lines

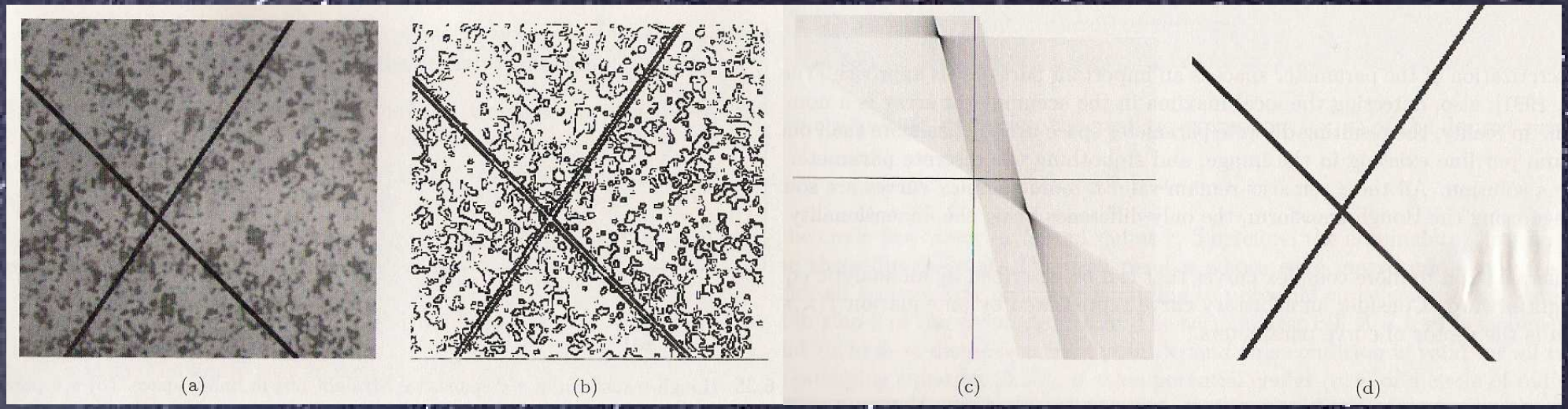
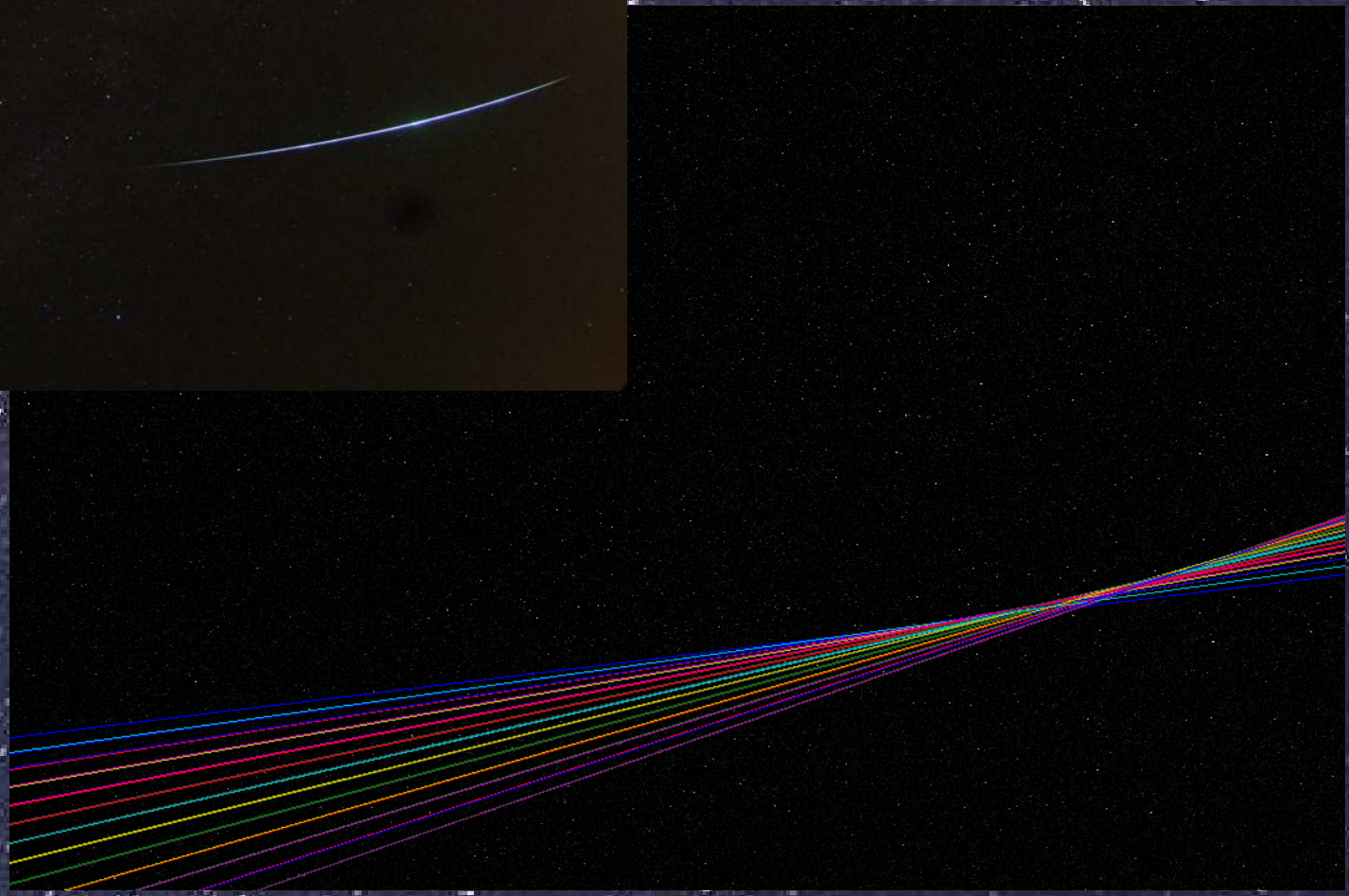
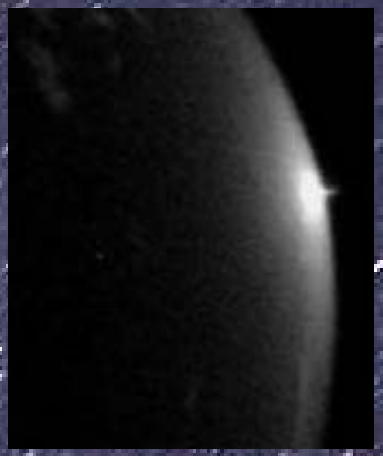


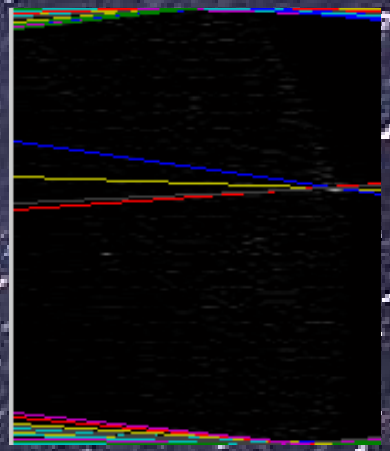
Figure from Sonka, Hlavac, Boyle: Image Processing, Analysis, and Machine Vision

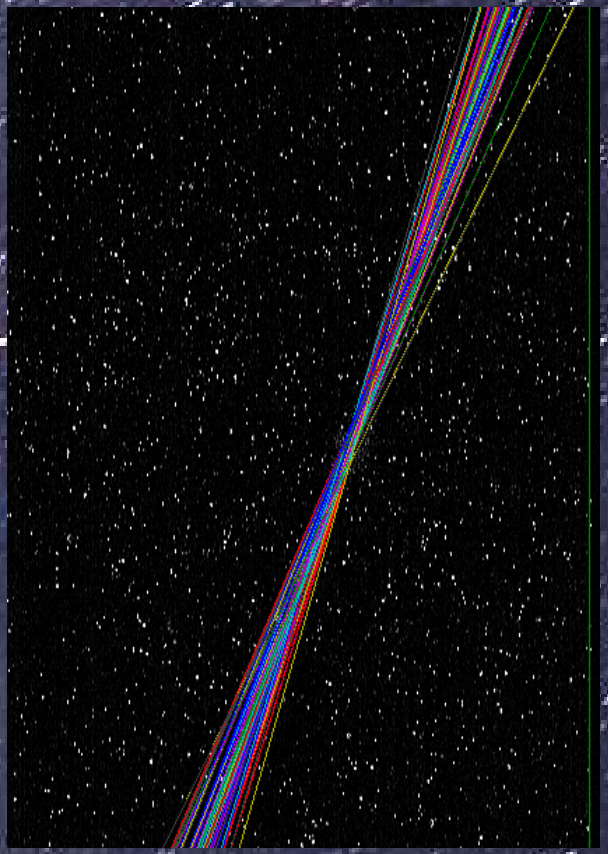
Very bright meteors are detected by the only basic function



Special cases of meteors…

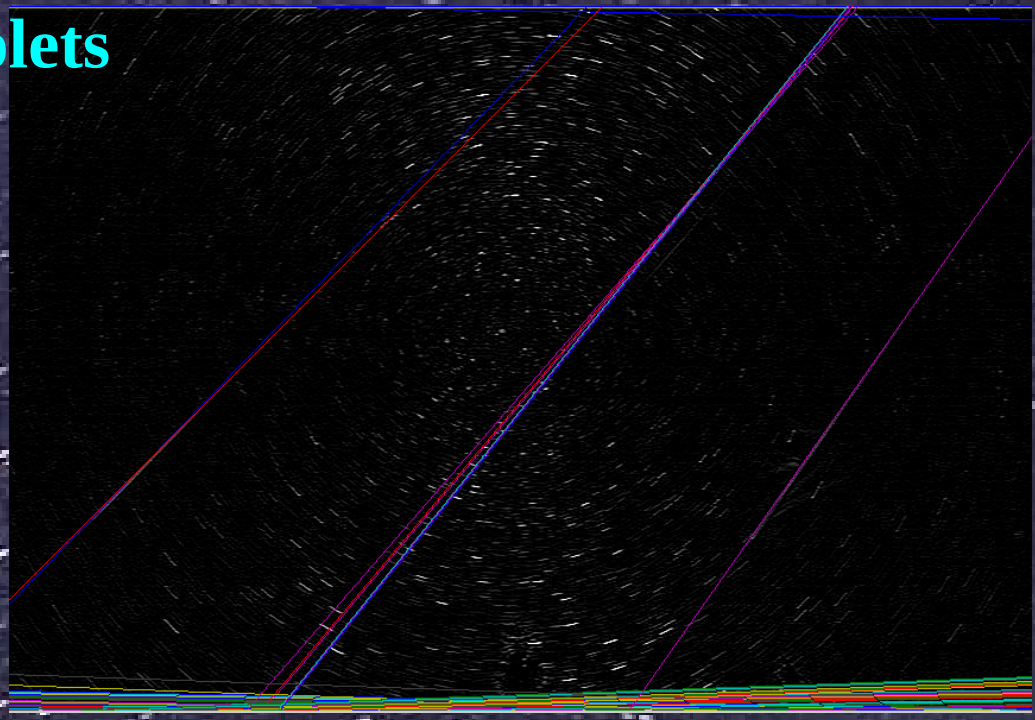


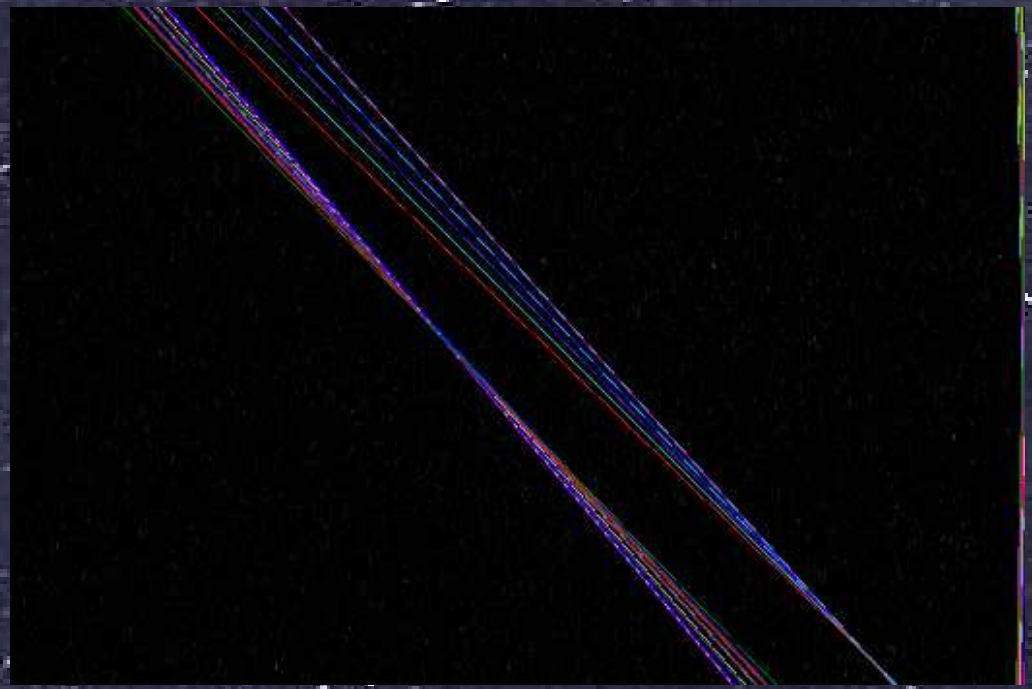




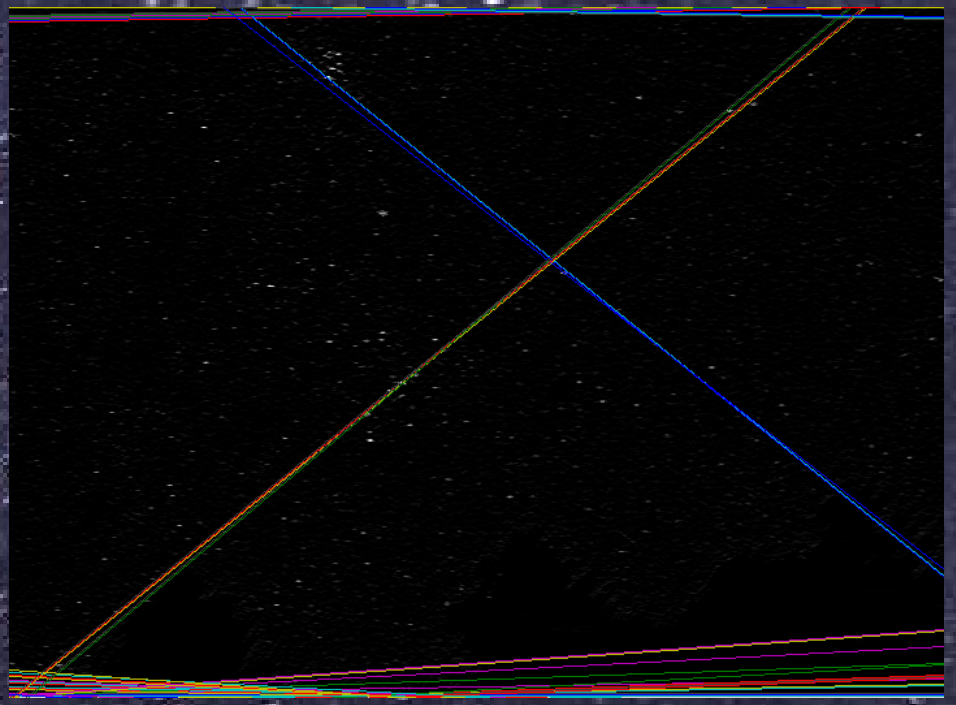
This is not meteor

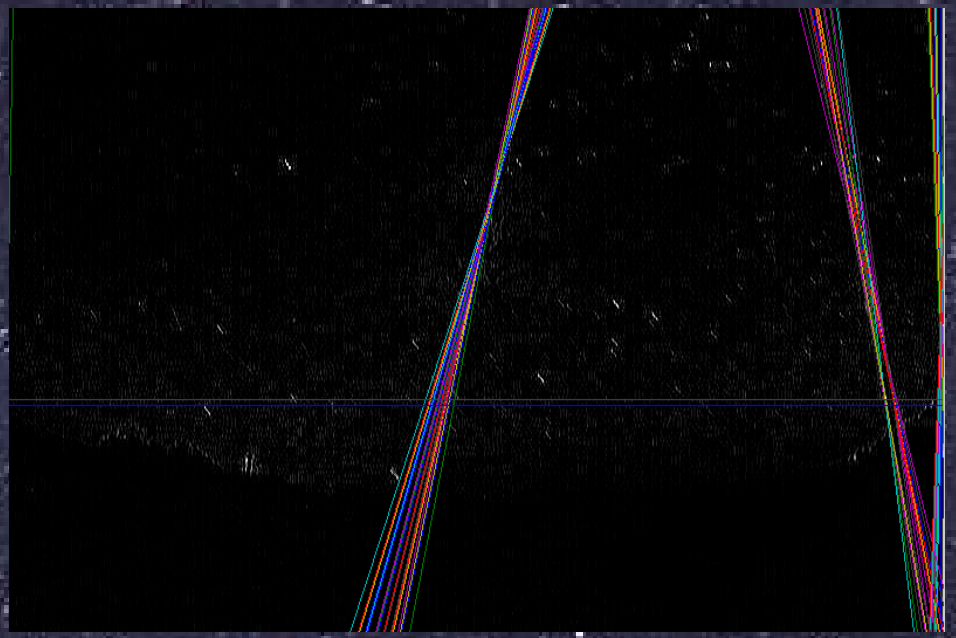
Triplets



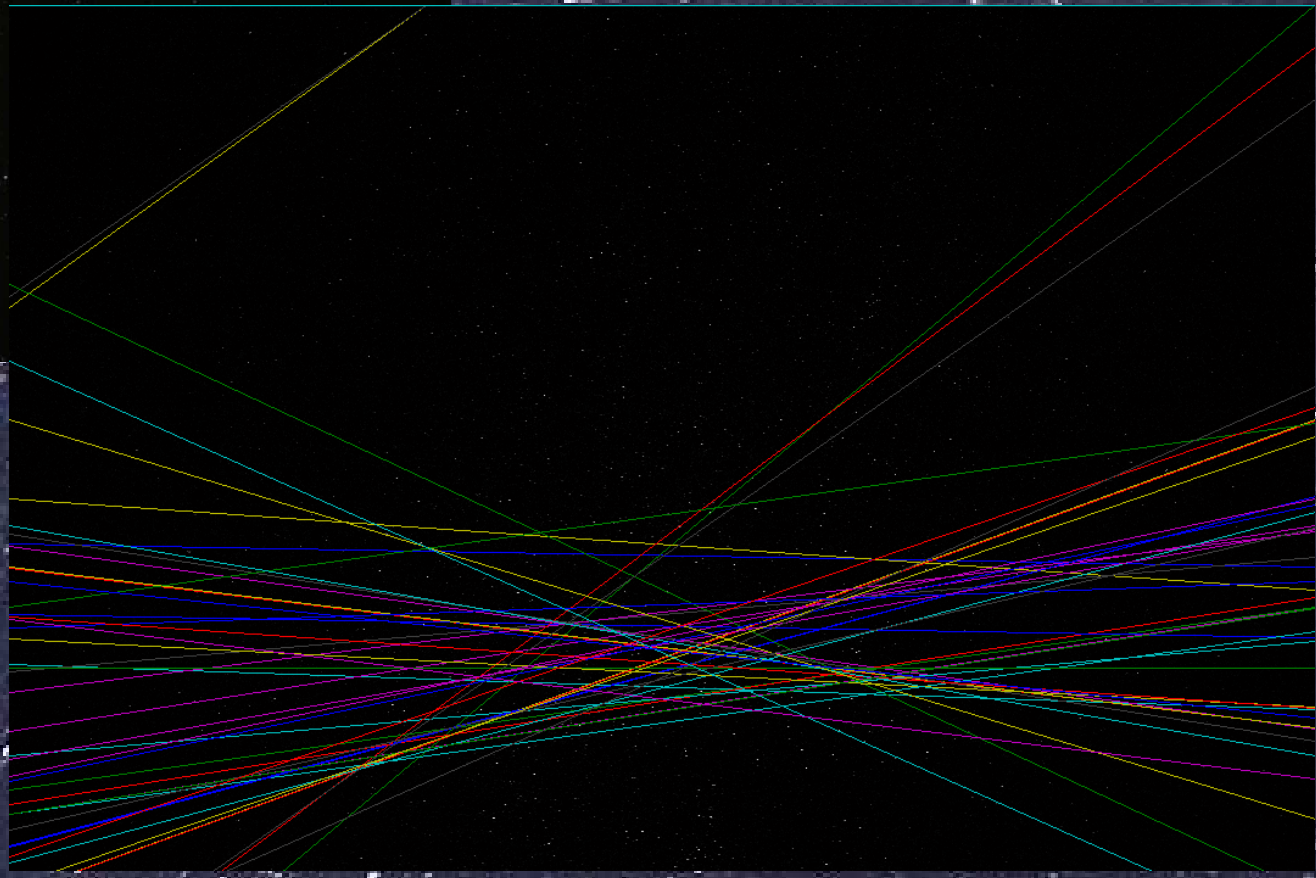


False lines

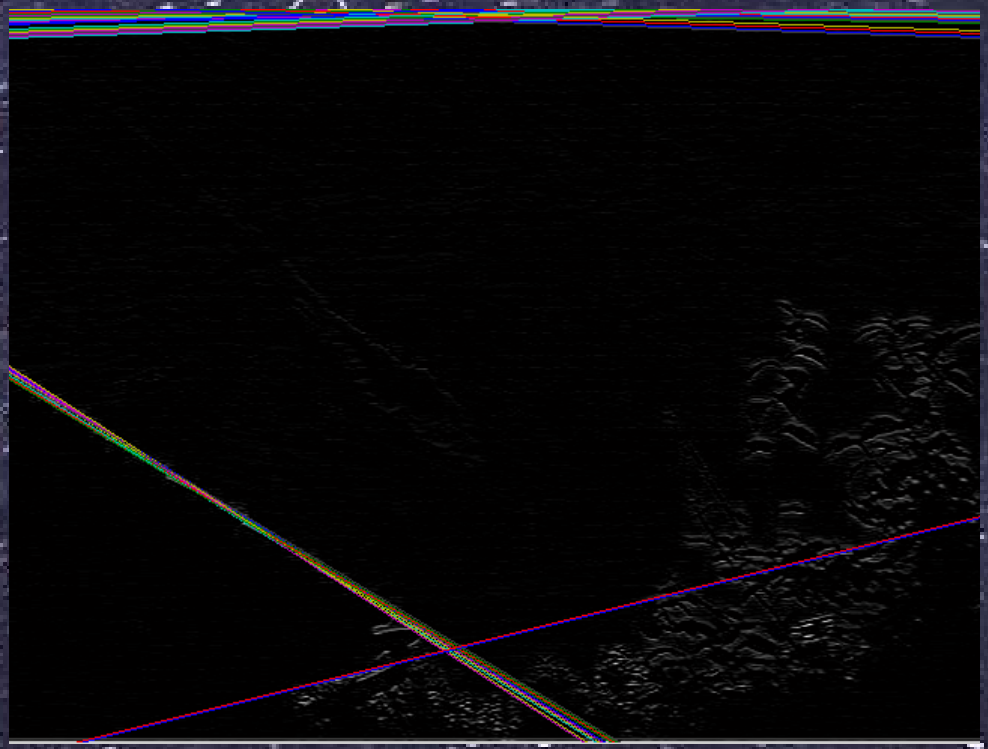


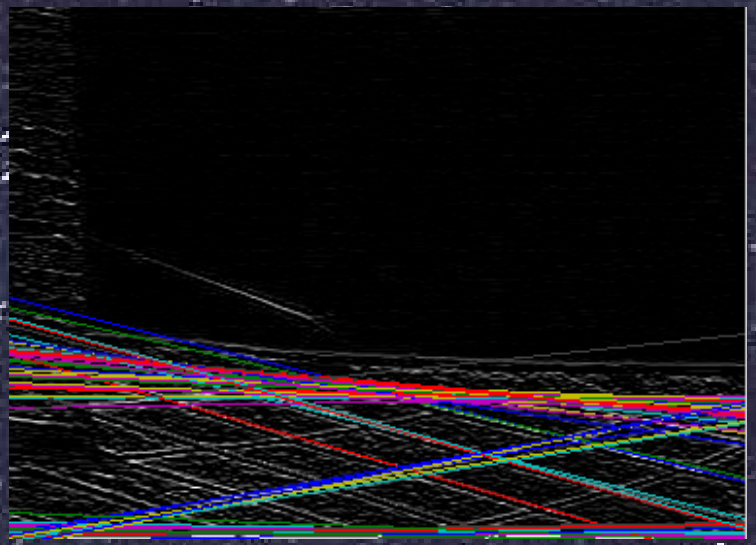


Too many false lines

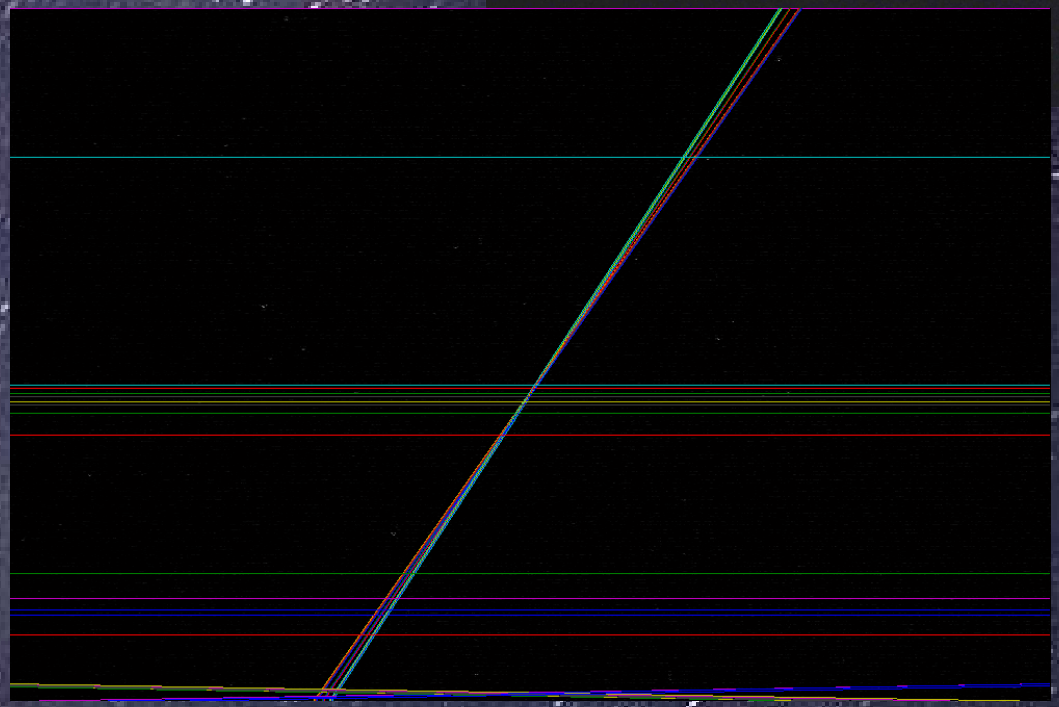


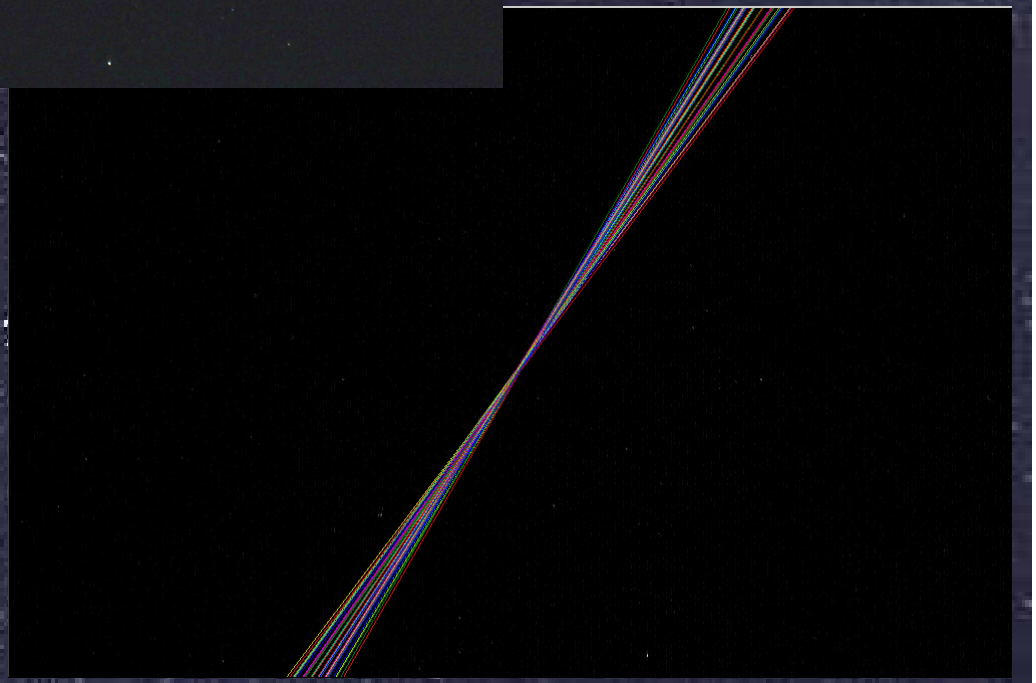
Meteors, which were not found

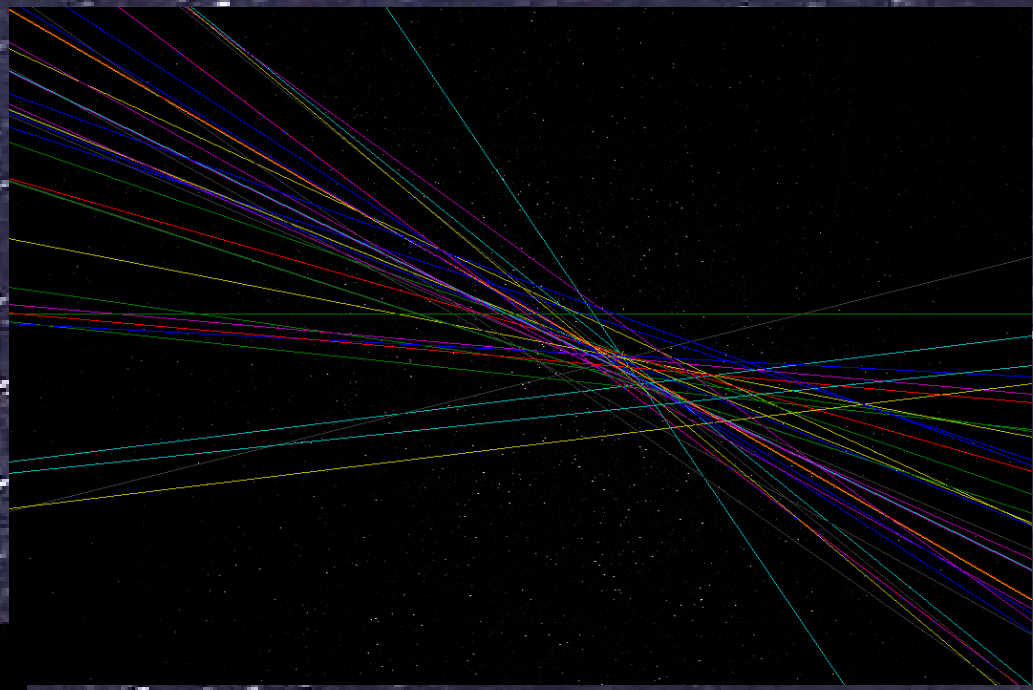


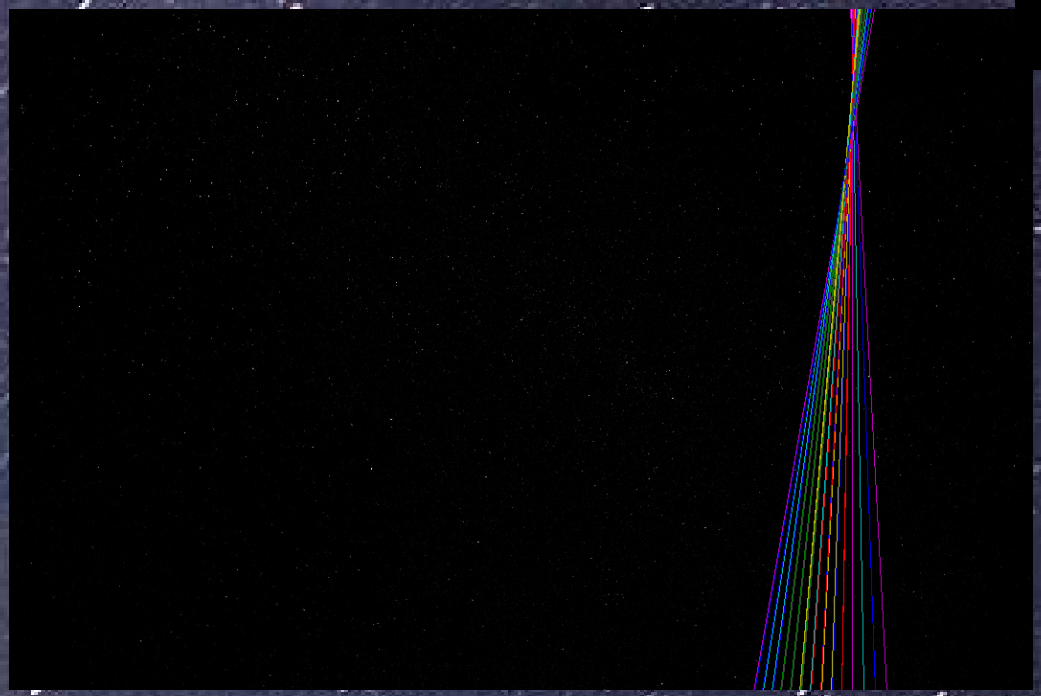


The meteors which were searched for by use of the rotation function



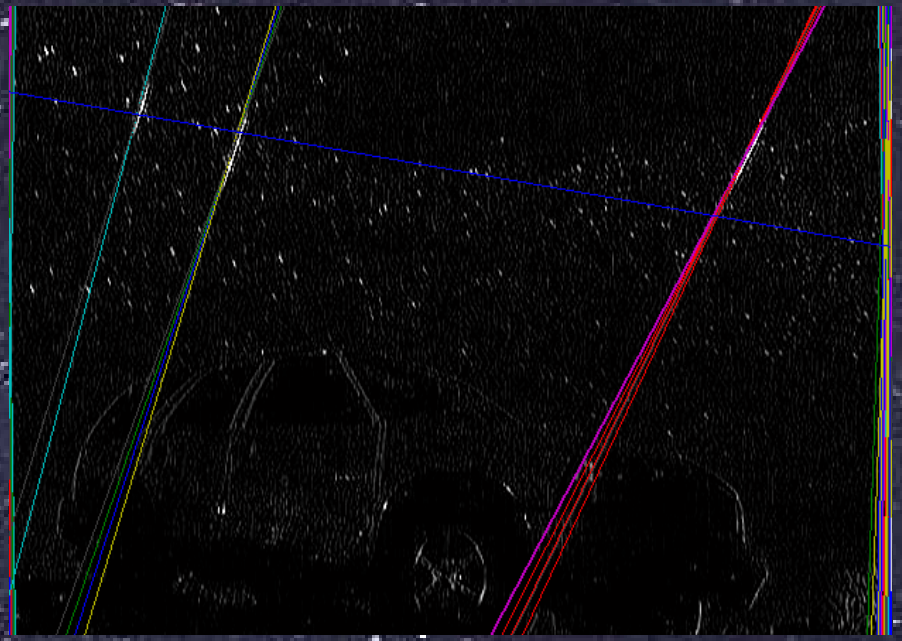




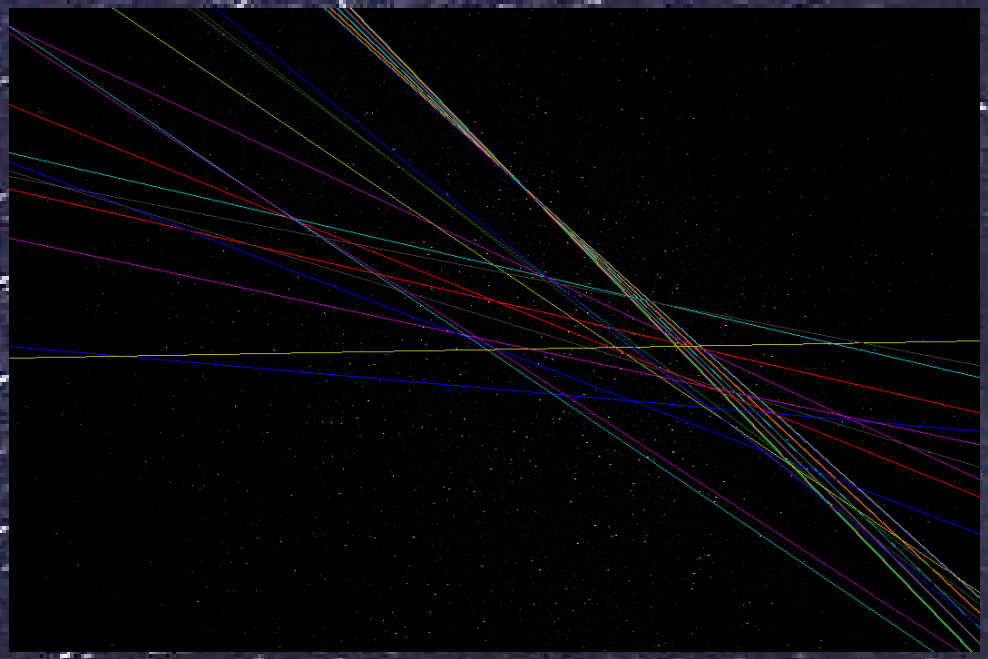


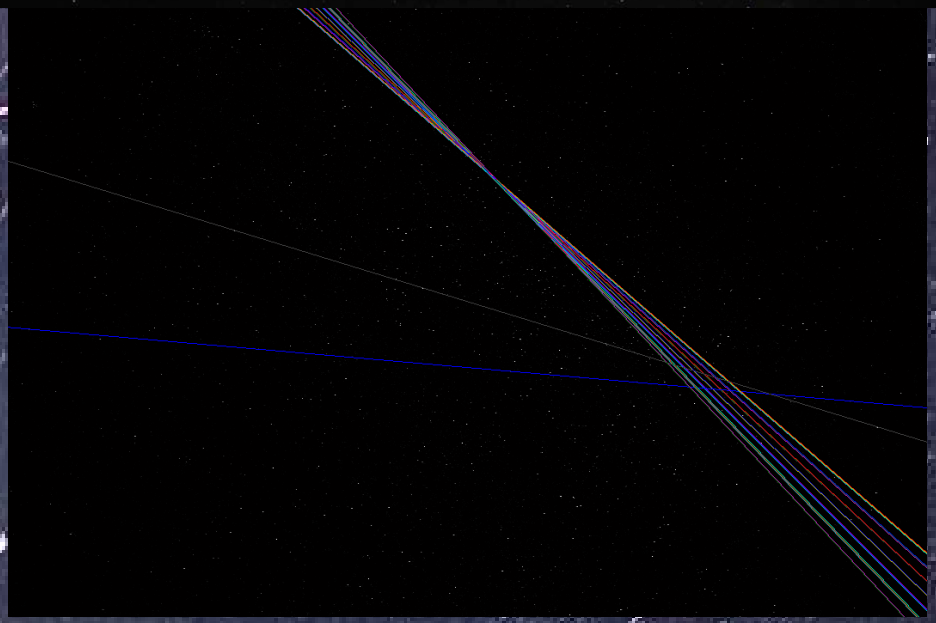
Searching for meteor without rotation (above) and with the rotation function

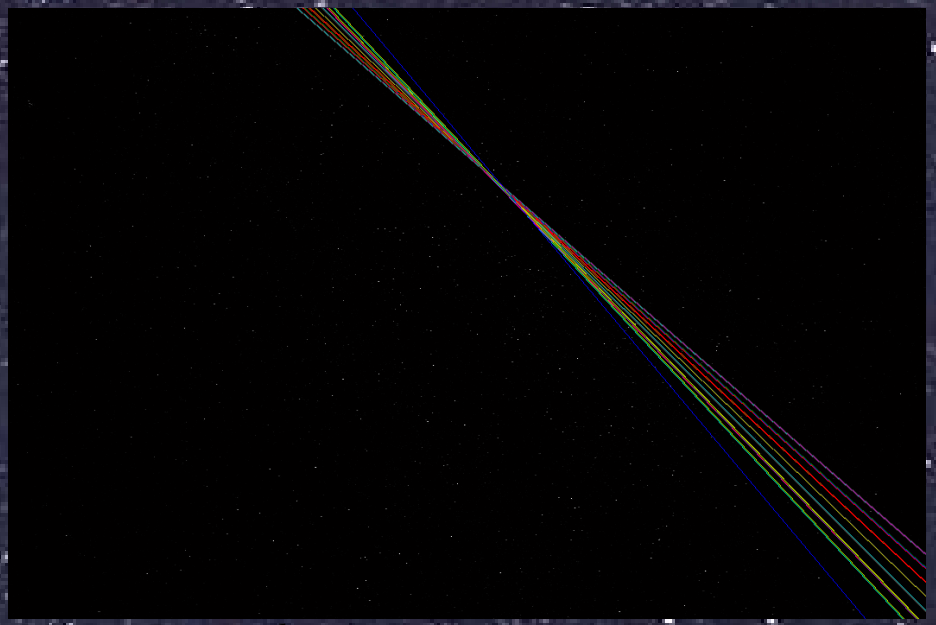
Unexpected good results



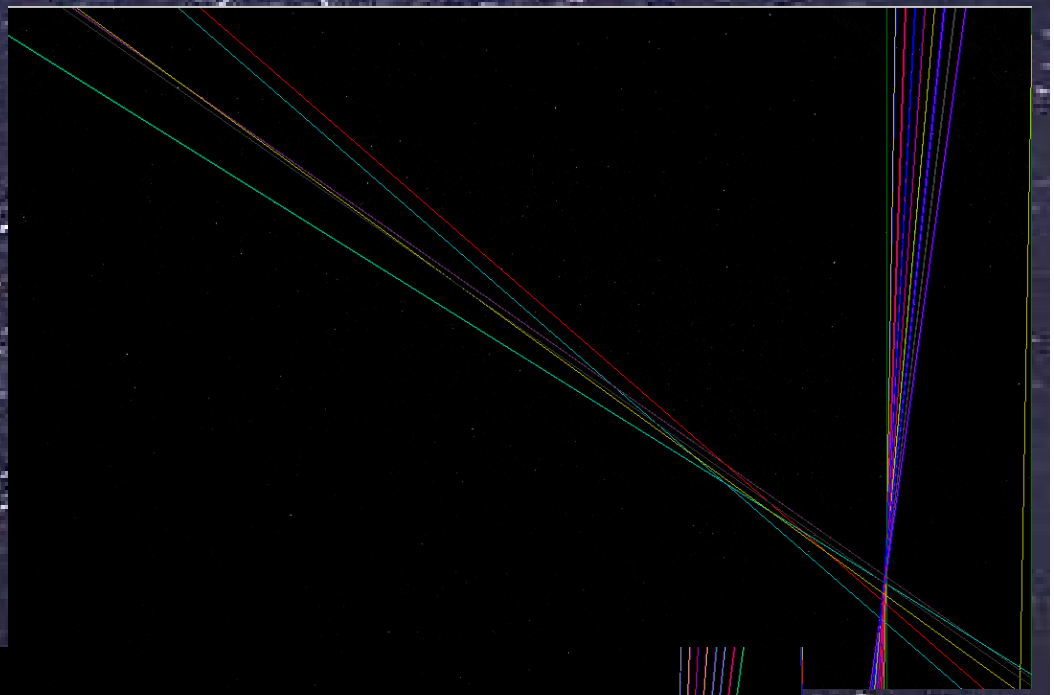
The meteors which were searched for by use of median smoothing (filtration) function

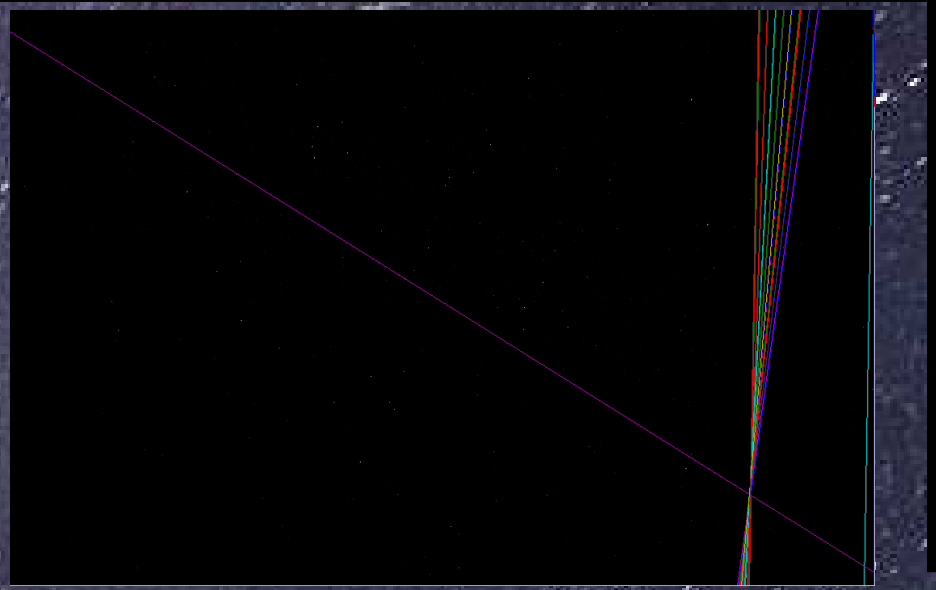




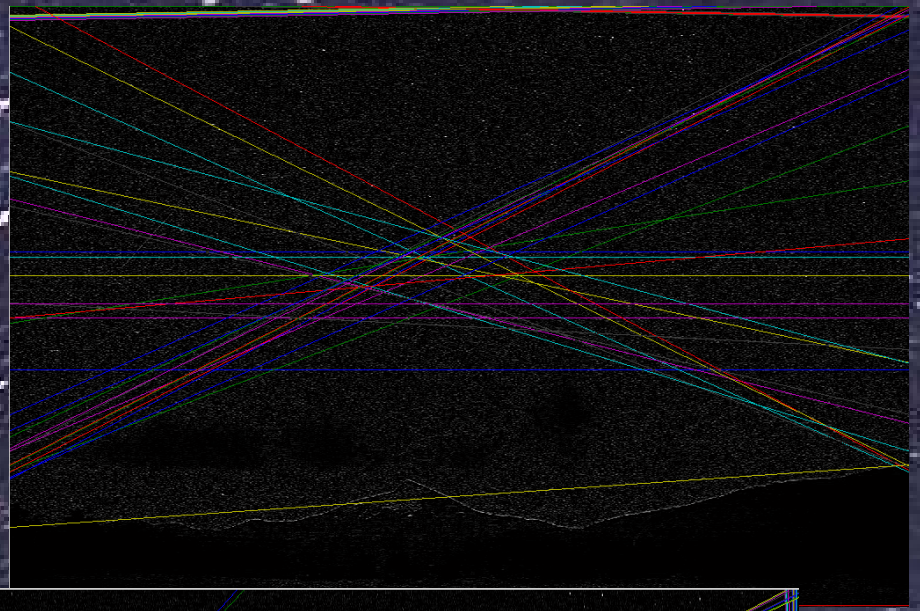


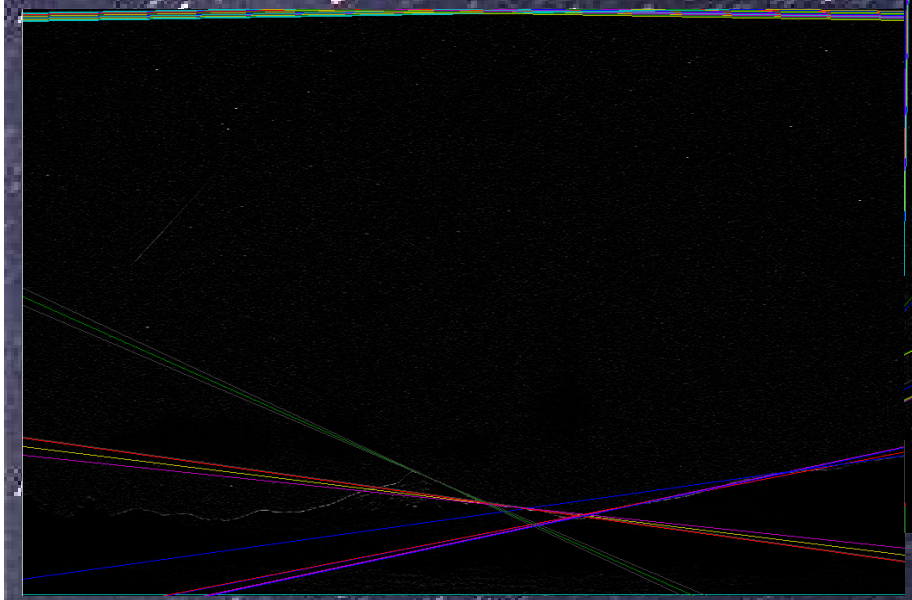
The meteors which were searched for by use of composed filtration and rotation functions

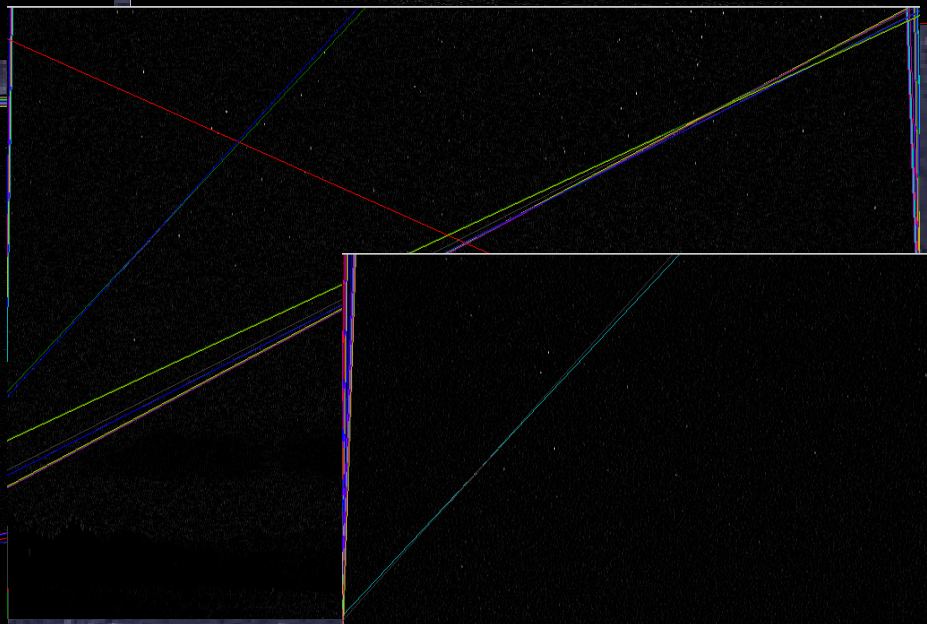


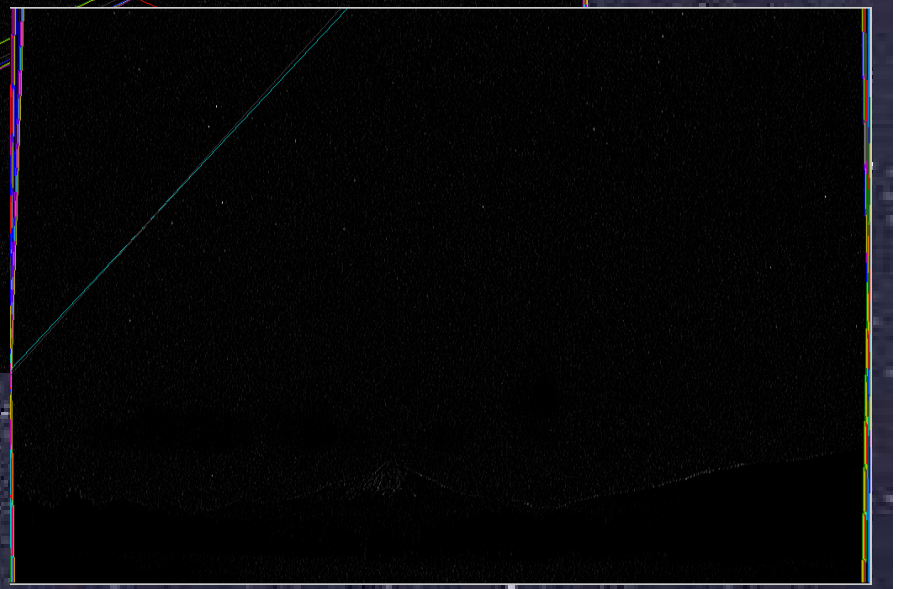


Seaching for very feeble meteor









Tasks for the future

- 80% of meteors in astronomical images were successfully searched
- For detection remaining 20% of meteors to improve used functions or created new functions and methods is necessary
- Automatize the process of meteor searching is desirable for easier work of astronomers