

Slide Synchronization

Authorization software

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Abstract

The lectures, particularly the academic lectures, are mostly based on slides presentation. The slide identification in particular time in the lecture video is useful not only as the important cue when navigating the lecture recordings but also for providing the user with high-quality version of the projected slide. The Slide Synchronization tool detects the slide position in the video, extracts and refines its visual content and removes moving objects partially covering the slides. When original high-quality slides are available, the tool also matches the extracted slides with original ones.

Algorithm

The initialization pre-processing step analyzes the video and search the video frames for the most probable area of projected slide¹. Having the area, the slides are extracted and unwrapped into normalized size. The consecutive extracted slides are compared and slide changes are detected. The comparison is based on analysis of approximated spatial distribution of slide differences; when the difference is high and the vertical and horizontal distributions of changes are more-or-less uniform, the slide change is detected. The sequence of the extracted images of particular slide is combined using per-pixel median in temporal domain. The median approach partially removes the objects moving in front of slide projection such as the lecturer, students, etc. Stored extracted slides serves as the index to the video and as the source of enhanced slide images provided to the user.

¹ The slide position detection algorithm is based on work of Ing. Igor Potůček, Ph.D. and Ing. Stanislav Sumec, Ph. D. The method was developed at DCGM FIT BUT.

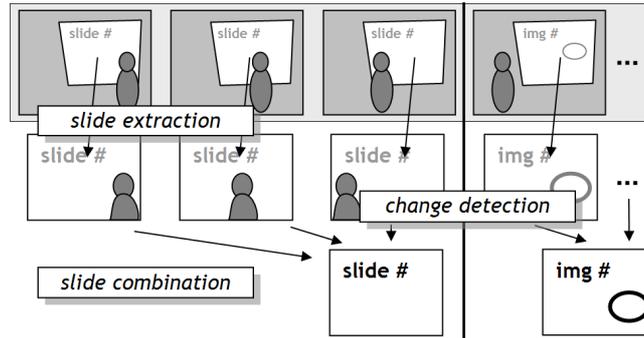


Figure 1. Slide extraction and change detection schema.

When the original slides are present, instead of displaying the extracted slide images, the original ones can take place. The matching between extracted and original slides is based on dense gradient features extracted on image pyramid (see Figure 2.). At the very beginning, the features are extracted from the set of original slides. During the lecture processing, each extracted slide is described by the set of features. Each feature then votes for k-best slides from original slide set and the most frequently voted original is chosen.

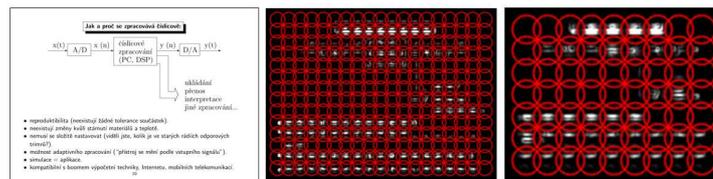


Figure 2. Slide image and first two levels of dense gradient features.

The matching results are stored together with extracted slides referencing the original slides. When the matching fails, the extracted slide is used instead.

Tool

The algorithm is realized in *slide_sync* command line tool. The parameters of the tool are:

-i input_video

recording of the presentation containing the projected plane,

[-o output.xml]

name of the output file where detection results are stored in XML format (see next section for more details),

[-c config.xml]

name of the input file containing algorithm parameters and configuration (when not provided, default setting is used),

[-p images_path]

directory name where the detected slides are stored,

[-s slidesOriginals]

directory where the original slides are available.

Data Formats

Input

The original slides are described as a list of images. Based on XML, the format is as follows:

```
<data>
  <slides>
    <slide
      id="01"                identifier of the original slide
      start="0"             unused attribute
      src="originals/001.bmp" source of the original slide
    />
```

Output

The tool exports the information about detected and matched slides in following format:

```
<sources>
  <video
    src="input.avi"          name of the video source
  />
  <originals
    src="originals.xml"     List of images of original slides
  />
</sources>
<slides>
  <slide
    id="0"                  slide identifier
    start="0"              frame number of the slide first occurrence
    end="149"              frame number of the slide last occurrence
    confidence="0.000000"  detection confidence
    src="/detected/00000000.jpg" name of the stored detected slide
    match_id="1"           identifier of original slide
    match_src="originals/001.bmp" source of the original slide
  />
  ...
```

Implementation

The tool is implemented in C/C++ and utilizes *OpenCV 2.0*² library, *libxml*³ and *ffmpeg*⁴ library.

² <http://opencv.willowgarage.com/wiki/>

Conclusion

The developed software was successfully used for web based on-line lecture browser at <http://www.lectures.cz/about.php?lang=cz>.

³ <http://xmlsoft.org/>

⁴ <http://ffmpeg.org/>