

Whiteboard Capture and Processing For E-Learning

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ABSTRACT

This paper describes the Whiteboard capture and processing for E-Learning (WCPEL) system which captures video images, classifies the pixels into whiteboard background, pen strokes and foreground objects (e.g., people in front of the whiteboard), extracts newly written pen strokes, and corrects the color to make the whiteboard completely white. It improves captured content by correcting perspective distortion, by improving image contrast, and by compensating for changes due to light levels and for people moving through the field of view of the camera. This allows us to transmit whiteboard contents using very low bandwidth to remote meeting participants. Combined with other teleconferencing tools such as voice conference and application sharing, our system becomes a powerful tool to share ideas during online meetings. In this paper, we present a new system that combines the affordances of existing whiteboards with complementary digital tools that facilitate the retrieval, reflection removal, and use of whiteboard content long after its initial creation, whether or not it is still on the board. This system captures whiteboard content without explicit intervention from the user and stores content along with the modified video.

General Terms

E-learning, Image Processing

Keywords

Data capture, Processing, Playback, Key Frame Extraction, Color Enhancement, Filtering, White Board Color Extraction, Reference frame, Foreground objects.

1. INTRODUCTION

A whiteboard is an effective and easy to use tool for E-Learning and meetings, especially in scenarios such as brainstorming, lectures, project planning, and patent disclosure. Sometimes, meeting participants who are on conference call from remote locations are not able to see the whiteboard content as the local participants do. The same problem is found while playing the recorded videos of lectures used for E-Learning. The remote student are not able to see the whiteboard content clearly as the local students do who are present during the lecture due to various obstacles such as light reflections, the professor himself, his shadow, etc. E-Learning requires technologies such as high internet speed which may not be always possible. In order to enable this, the meeting sites and the classrooms often must be linked with expensive equipments and also the students or the employee requires high end technologies in order to view the videos. Expensive Equipment includes a pan tilt-zoom camera which can be controlled by the local participants. It is still not always satisfactory because of viewing angle, lighting variation, and image resolution, without mentioning lack of functionality of effective archiving and indexing of whiteboard contents. Other equipment requires instrumentation either in the pens such as Mimi o from Virtual Inker on the whiteboard such as SMART Board from

SmartTech[4]. The system presented in this paper allows the user to write freely on any existing whiteboard surface using any pen. To achieve this, our system uses an off-the-shelf high-resolution video camera which captures images of the whiteboard at 7.5Hz. From the input video sequence, our algorithm separates people in the foreground from the whiteboard background and extracts the pen strokes as they are deposited to the whiteboard. To save bandwidth, only newly written pen strokes are compressed and sent to the remote participants. Furthermore, the images are white balanced and color-enhanced for greater compression rate and better viewing experience than the original video[3].

2. EXISTING SYSTEM

There are a number of existing applications for screen capture.

1) Camtasia[7] make the most well known desktop solution; Camtasia Studio. This provides many features including mouse pointer highlighting, selection of recording area and video editing. There are also some free applications such as Cam Studio for Windows, which is available as open source software. Camtasia also produce an application called Camtasia Relay which is aimed at presentation capture. This uses client-server architecture to offload the processing from the capture client onto a central server. However this still have limitation such as it requires the client-side PC with capture application installed.

2) Web based screen capture is a much more recent development. However, due to the rapid development environment of the web, there are already a few applications available. Screencastomatic [8] is possibly the original. It is an entirely Java based application, which allows the user to select an area of the screen to record, and captures microphone input. It provides an export function to convert the video to QuickTime (MOV), Windows Media Video (WMV) or Flash Video (FLV) formats. One of its limitations is that it has a maximum recording duration of 15 minutes. However, Screen cast-o-Matic licenses their capture code to others, so there are a few similar applications which utilize their code.

3) Screen toaster[9] uses a combination of Flash and Java to deliver their application. Due to the use of Flash, their application can offer webcam capture in addition to desktop and audio capture. It also provides the ability to playback screen capture at a speed faster or slower than real-time. Screen toaster has, instead of a time limitation, a file size limit of 20 MB on the media which can be captured. As all video is stored on the client machine, it must therefore be uploaded after the recording has finished.

4) Interactive Whiteboard based application: Mimio[5] and eBeams[6]. Both the applications contain two hardware parts: One is to be stuck on the whiteboard which contains memory and receivers for receiving ultrasounds from the pen and Pen is another part of the applications. Both the applications of interactive whiteboard are based upon a combination of Ultrasound and Infrared. As hardware is involved, both the applications are expensive.

3. PROPOSED SYSTEM

This system is concerned primarily with the capture of whiteboard used in meetings or lectures. The project has been proposed for the purpose of recording a user screen, microphone and webcam, later on which can be viewed by anyone in enhanced way. Our system consists of three principle aspects data capture, processing and playback. In this system we have targeted effective use of white board capture system which is a part of our Distributed Meetings project, which aims at dramatically improving knowledge workers' meeting experience using

ubiquitous computing technologies to provide a rich experience for people who want to participate in a meeting from a distance. Our system does not require client side pc with capture application installed as required in camtasia. Unlike screen toaster, our system does not have any time or size limitation. Unlike mimio and eBeams, our system does not require any expensive hardware and without the need of special pens and erasers makes the interaction with our system much more natural.

3.1 Proposed Architecture

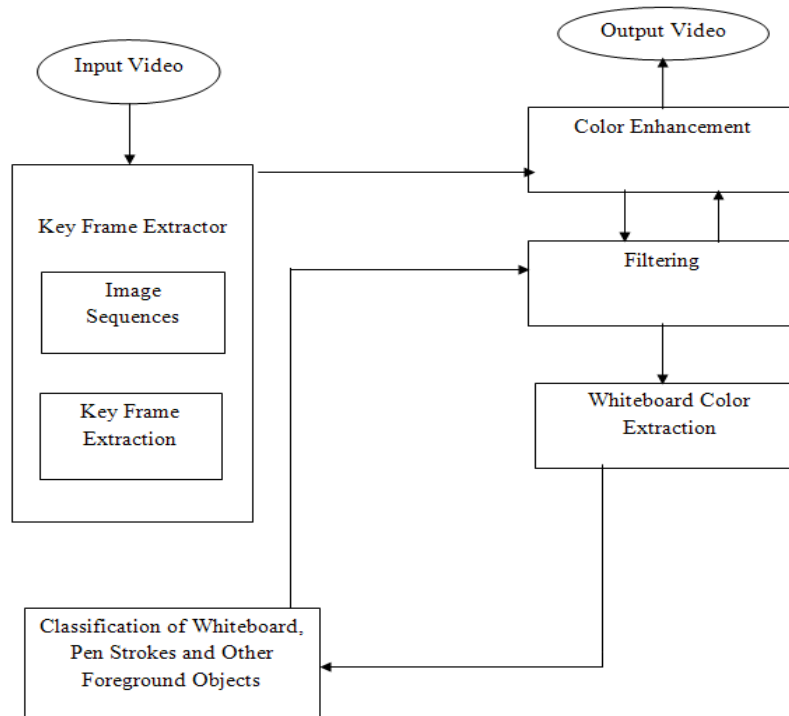


Fig. 1 :Block Diagram of Proposed architecture

As shown in the Fig.1[1], the proposed architecture of WCPEL consists of the following blocks:

3.1.1 Key Frame Extraction

It has two sub modules as:

3.1.1.1 *Image Sequence*- It reads avi file, get no of frames from selected video.

3.1.1.2 *Key Frame Extraction*- It gets frame rate i.e. key frame per second.

3.1.2 Color Enhancement

It will take the Key Frames and will process the individual red, green and blue values of the frame to enhance the color.

3.1.3 Filtering

It uses predefined 2D filter to sharpen the key Frames initially and N-D filtering of multidimensional images. Sharpening filters are used to enhance the edges of objects and adjust the contrast and the shade characteristics.

3.1.4 White Board Color Extraction

Reference frames are frames of a compressed video that are used to define future frames. We get reference frame & convert these reference frames (RGB) to reference frame (Gray). We retrieved Whiteboard by removing foreground objects and filling regions in it. Filling is a process that fills a region of interest by interpolating

the pixel values from the borders of the region. This process can be used to make objects in an image seem to disappear as they are replaced with values that blend in with the background area. We retrieved only Whiteboard pixels (RGB) and then we sharpened image objects. We converted reference frames to grey scale image which is then converted into binary image so that it can be processed. A grayscale or grey scale digital image is an image in which the value of each pixel is a single sample, that is, it carries only intensity information. Images of this sort are composed exclusively of shades of gray, varying from black at the weakest intensity to white at the strongest. We then add processed reference frame to output video file and continue this process till video is completely displayed.

3.2 Control Structure

As shown in the Fig.2[2], video consists of sequence of frames so we first retrieved number of frames present in that particular video which will be enumerated and then from these frames we find out key-frames. Key-frames are the principle component of the system, but the screen finding stage is the precursor to key - frame detection. Key-frames are then fed into key-frame grouping system in which all processing takes place such as extracting

whiteboard background color and removing foreground objects. The next module is rectifying key frames where filtering and color enhancement takes place. The same process continues till the last frames.

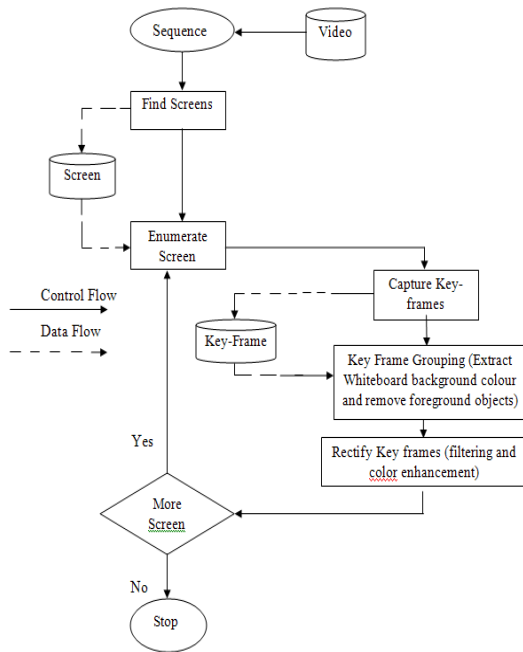


Fig. 2: Control Flow of System

3.3 Data Flow

As shown in the Fig.3[2], input video is accepted by WCPEL system and number of frames are identified which is then compressed for forming key frames that form the basis for filtering and color enhancement where all the processing take place including extracting whiteboard, region filling, sharpening, etc. After completion of processing, output video is produced by adding processed frames to the output video.

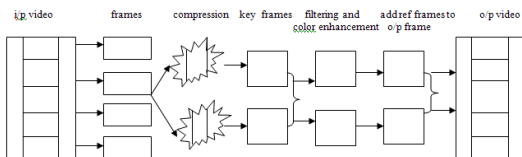


Fig. 3: Data Flow Diagram

4. EXECUTION RESULTS

Snapshot shown in Fig.4 represents main form of the GUI of WCPEL.

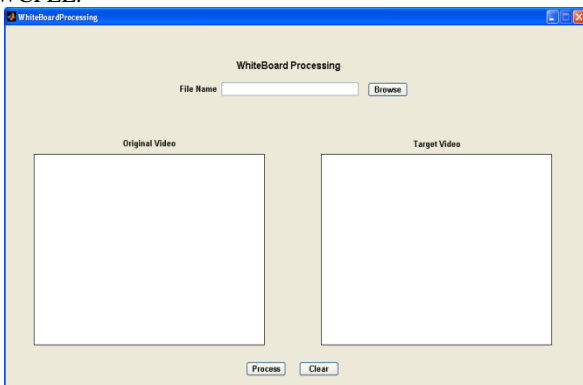


Fig. 4: GUI

Snapshot shown in Fig.5, represents the functionality of browse button that helps in giving video file as an input to the system.

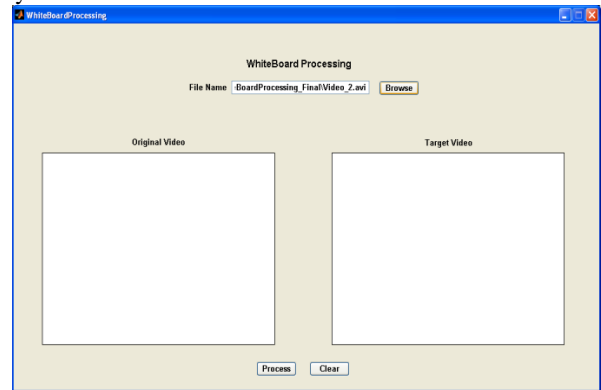


Fig. 5: Input to System

Snapshot shown in Fig.6, represents that processing has reached 65% and the corresponding output produced.

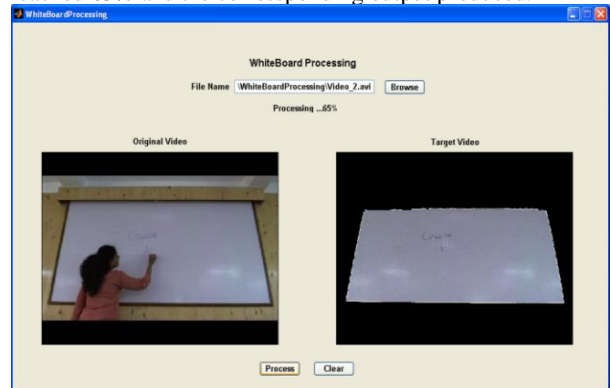


Fig. 6: In-between of Processing

Snapshot shown in Fig.7, represents that processing has been done completely & the completely processed output is shown in the Target Video.

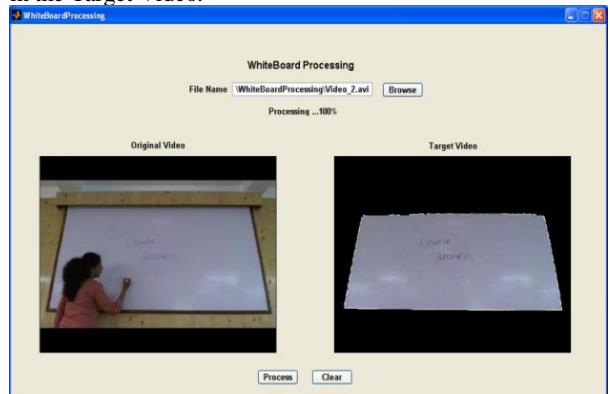


Fig. 7: Final Output

5. EXPERIMENTAL SETUP AND RESULTS

PC1 Configuration:

Microsoft windows XP Version 2002
Service pack 2
CPU 3.00GHz 2.99GHz, 0.99 GB of RAM

Fig. 8 shows test result of WCPEL system for configuration of PC1

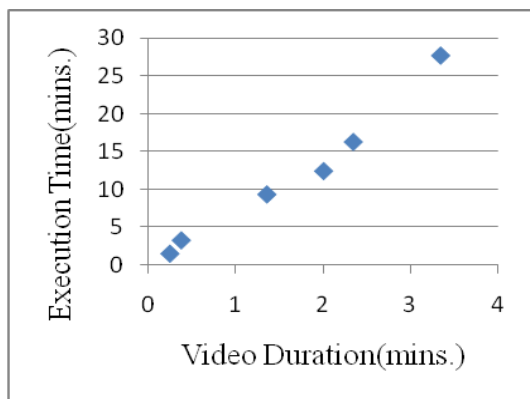


Fig. 8: Test Result of PC1

PC2 Configuration:

Windows 7 Home Basic

Service Pack 1

Processor: Intel® Core™ i3CPU M250 @2.27 GHz 3GB RAM

Fig. 9 shows test result of WCPCL system for configuration of PC2.

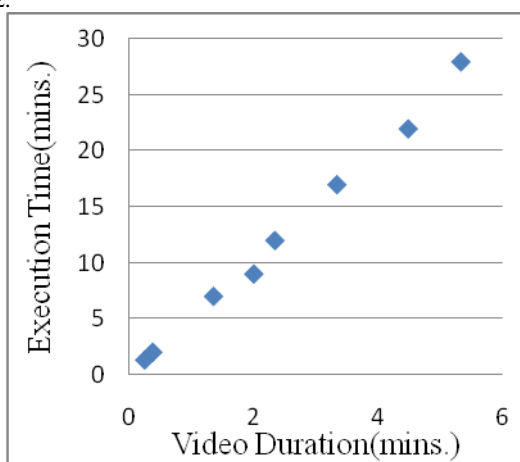


Fig. 9: Test Result of PC2

6. CONCLUDING REMARKS

Meetings constitute a large part of knowledge workers' working time so making more efficient use of this time translates to a big increase in their productivity as well as the videos of lectures taken by professors in the classroom are very much helpful for students during exams, revisions and for regular studies also. The work presented in this paper, the Whiteboard Capture And Processing For E-learning system, allows the users to share ideas on a whiteboard in a variety of teleconference scenarios. We have build a system that captures whiteboard images unobtrusively, without disrupting existing work practices along with content creation. With devices like electronic whiteboards, ebeams and mimio, the users are promised the ability to write freely in an all electronic mediums. But as the cost of those devices is still quite high, we believe that the combination of the omnipresent whiteboard and a low-cost video camera is a very promising solution, which is provided by our system.

7. REFERENCES

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