

Using OpenGL and 3D to Manage Large Numbers of Video Conferencing Streams



EVO



ViEVO

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for

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From VIC (VRVS) to ViEVO (EVO)

with developing of video application
to **develop a new video application**
EVO

vievo: Team Meeting

CAMERA DESKTOP PICTURE

SIZE SHOW SETUP HELP

<input type="checkbox"/> Marek Domaracky (VRVS SK) CAM 23 f/s 631 kb/s (CIF)	
<input type="checkbox"/> Viktor Michalcin CAM 4.8 f/s 64 kb/s (4CIF)	
<input checked="" type="checkbox"/> Viktor Michalcin CAM 24 f/s 602 kb/s (CIF)	
<input type="checkbox"/> Pavel@158.197.12.230 CAM 20 f/s 333 kb/s (CIF)	
<input type="checkbox"/> Pavel Farkas CAM 5.0 f/s 143 kb/s (4CIF)	

5 participants 1.7 Mb/s

Setup

DESKTOP PICTURE

SHOW SETUP HELP

SETTINGS

2.30 Mb/s

9 f/s

6

vievo: Team Meeting

CAMERA DESKTOP PICTURE

SIZE SHOW SETUP HELP

<input type="checkbox"/> Pavel Farkas PIC 9.0 f/s 7 kb/s (CIF)	
---	--

7 kb/s 1 participant

Close



Display facilities of VIC (VRVS)

- each **video** displayed **in separate window**, what leads to following negative consequences:
 - **crowded taskbar** in case of larger number of video streams
 - **management of display windows** on a computer screen **is uncomfortable** – has been partially solved with automatic display modes
- **strong linkage between physical video resolution and display size** of video source
 - video source can be displayed **only** in its **original size**, or in **two re-sampled versions**: $\frac{1}{4}$ of original resolution (every second sample is taken) and 4x of original resolution (samples are duplicated in each direction) - main reason is **to save maximum CPU resources** for video encoding and decoding
 - computer **screen is covered** very soon **by video windows** in case of larger number of video streams
- **limited possibilities** to create visually attractive display functionality

XGA
(1024 x 768)

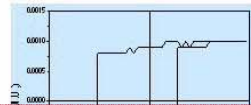
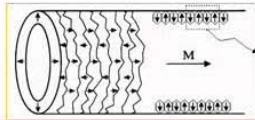
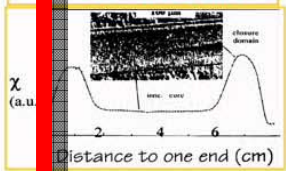
CIF
(352 x 288)

CIF
(352 x 288)

Bistable Loops

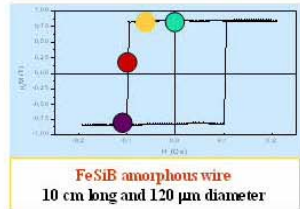
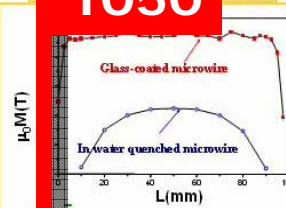
Amorphous Microwires FeSiB (Large and Positive Magnetostriction)

Susceptibility Profile

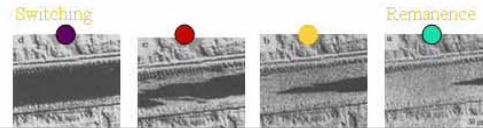


1050

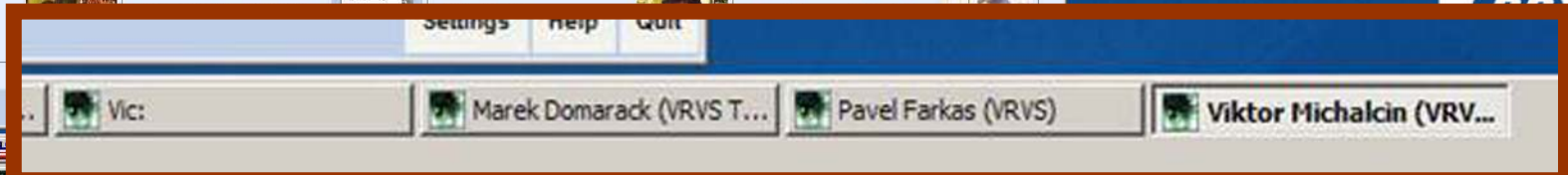
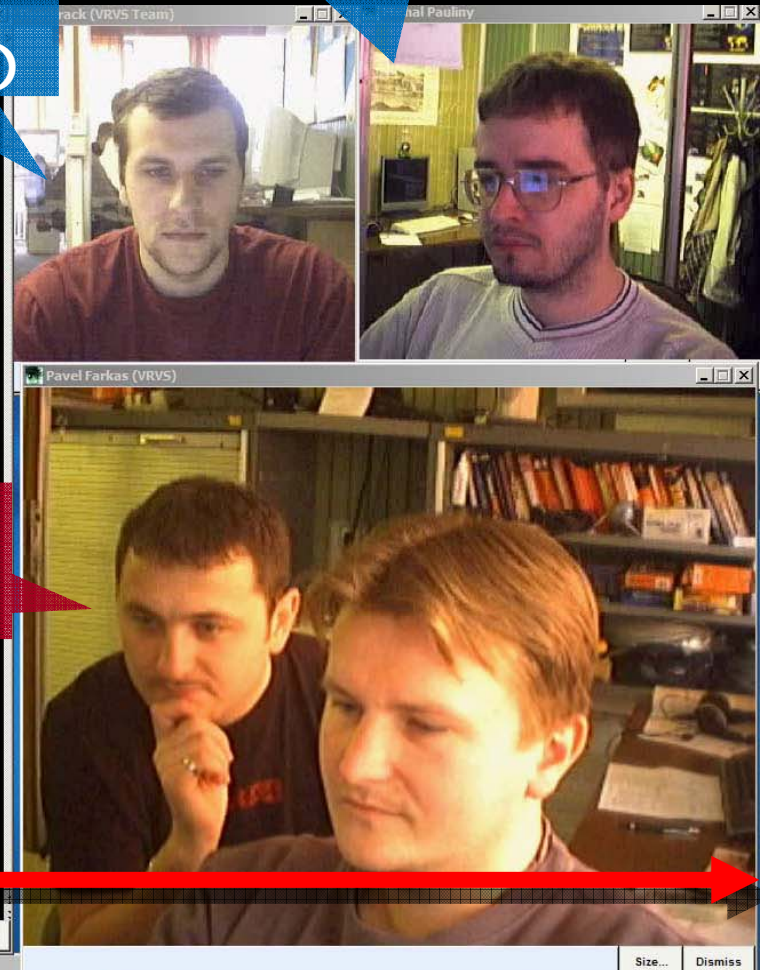
VGA
(640 x 480)



Tiny Dimensions:
2 mm long
5 μm diameter



1680



VIC

17 participants displayed
("Speaker + all" mode)

Vic: Headquarters Virtual Room

137.138.26.8

Display Dock Display modes Transmit

Michal Pauliny
137.138.26.8
Pavel.Farkas@vrvs
Dave (VRVS)
Pavel Farkas (VRVS SK)
158.197.12.228
Nicholas Kankula (VRVS SK)
Marek Domaracky (VRVS Te
Dennis (VRVS Team)
Dave - Caltech Mac
Gregory DENIS (VRVS Team)
Juraj Sucik (CERN)
Joao (vrvs@CERN)
158.197.12.228
Viktor Michalcin VRVS-SK
G5 SLOVAKIA
Joao (SC Linux)

Total Received: 4.2 Mb/s

Mini mize Settings Help Quit

RAT: Headquarters Virtual Room

Listen Talk

Michal Pauliny
Marek Domaracky(VRVS Team)
Viktor Michalcin VRVS-SK
kankula
Dennis (VRVS Team)
Juraj Sucik (VRVS)
Dave A (XP)
Gregory Denis (VRVS Team)
Joao (Fedora Core 3)
499602d2
158.197.12.228
Nicholas Kankula (VRVR SK)
VRVS gregory

Minimize Dock Settings Help Quit





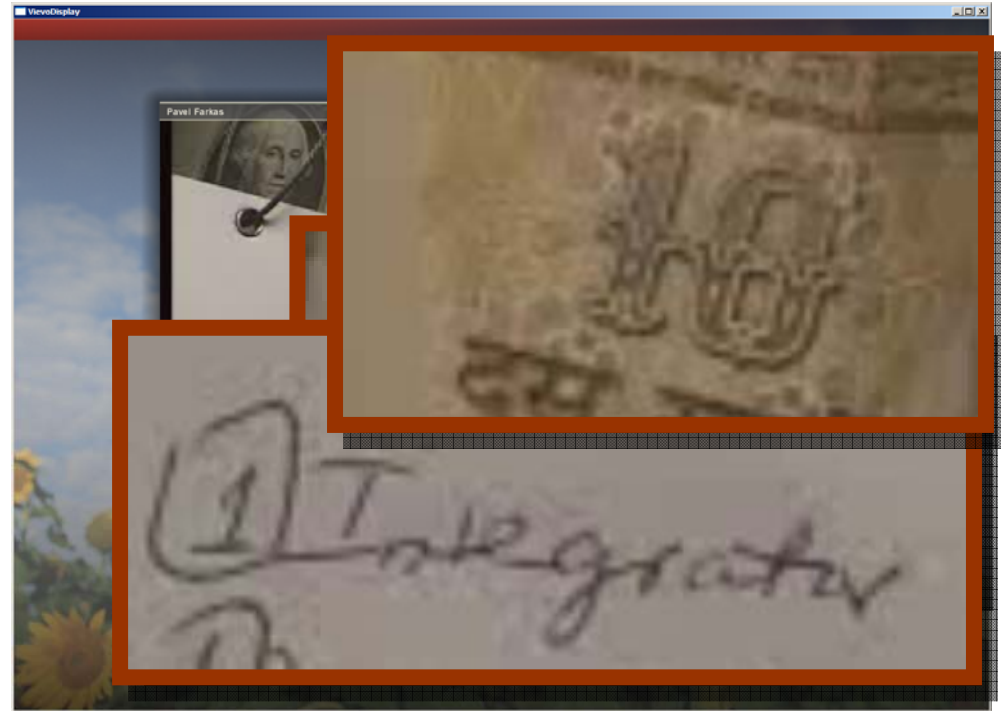
ViEVO (EVO) and OpenGL solution

- ~~easy and straightforward solution is to display all video sources in one common display window managed by OpenGL~~
 - ~~only one display window on the taskbar~~
 - ~~user can place the window on arbitrary position on the screen with arbitrary window size – content will be managed automatically by OpenGL in accord with selected display mode~~
- video resolution and display size are not linked anymore
 - texture is created from each decoded video frame and then it is mapped to rectangle of selected (arbitrary) size. Textures are stretched or shrunked by OpenGL as necessary and this is applied using the current texture filter (performed by graphic hardware, CPU is not used)
 - space on the screen can be used effectively
- OpenGL allows us to create any display mode in 3D which is hardware accelerated – many possibilities to create visually very attractive content

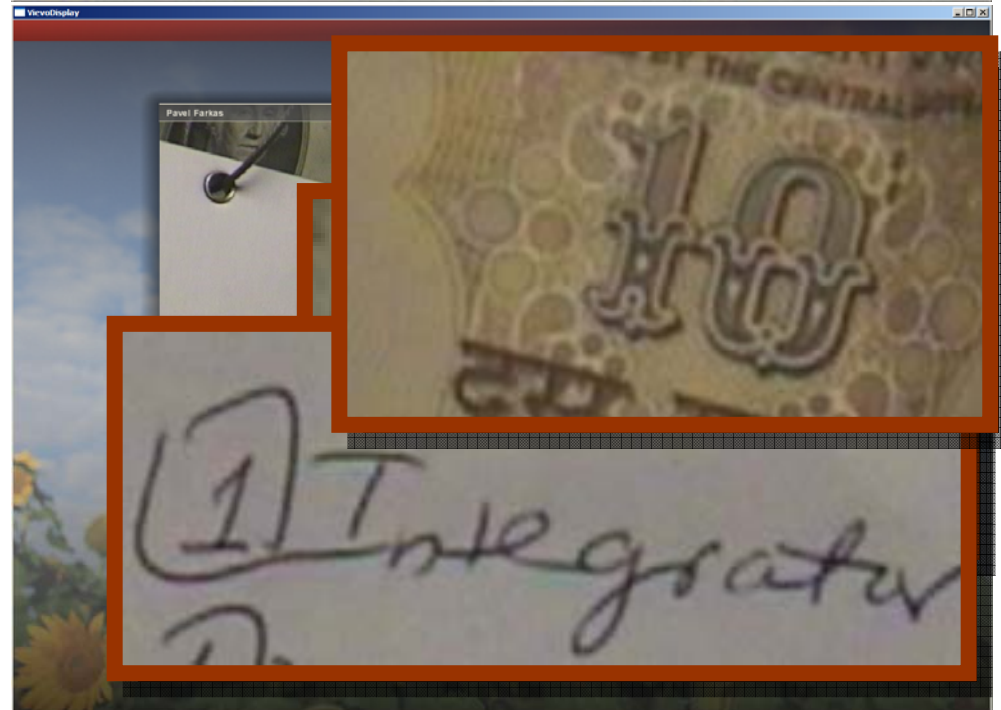


Comparison No. 1

**Video with
CIF resolution**
(new OpenGL solution)



**Video with
VGA resolution**
(new OpenGL solution)





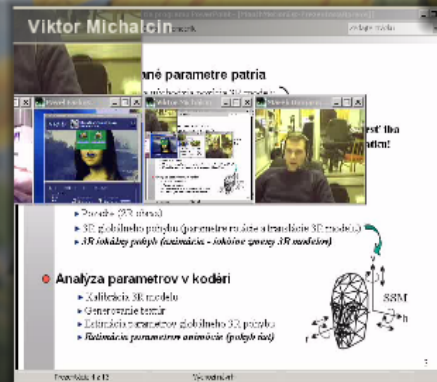
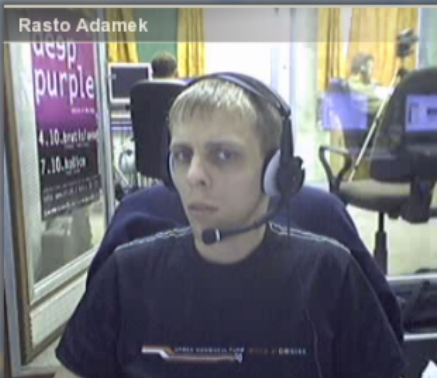
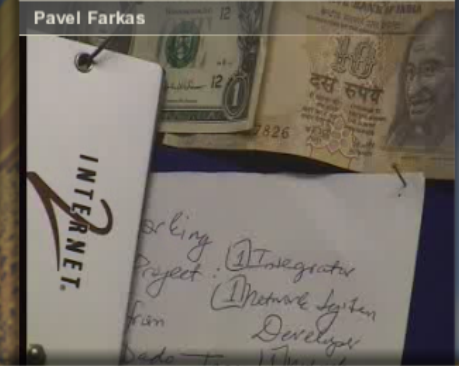
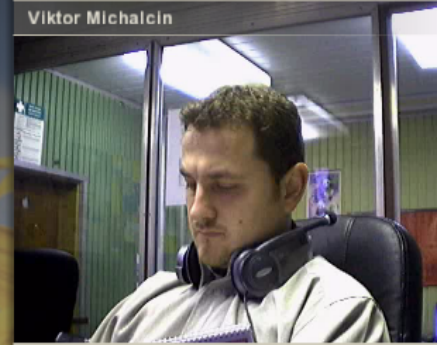
Comparison No. 2

**Video with
CIF resolution
enlarged to 4CIF
(old VIC solution)**

**Video with
CIF resolution
enlarged to 4CIF
(new OpenGL solution)**



OpenGL based display mode

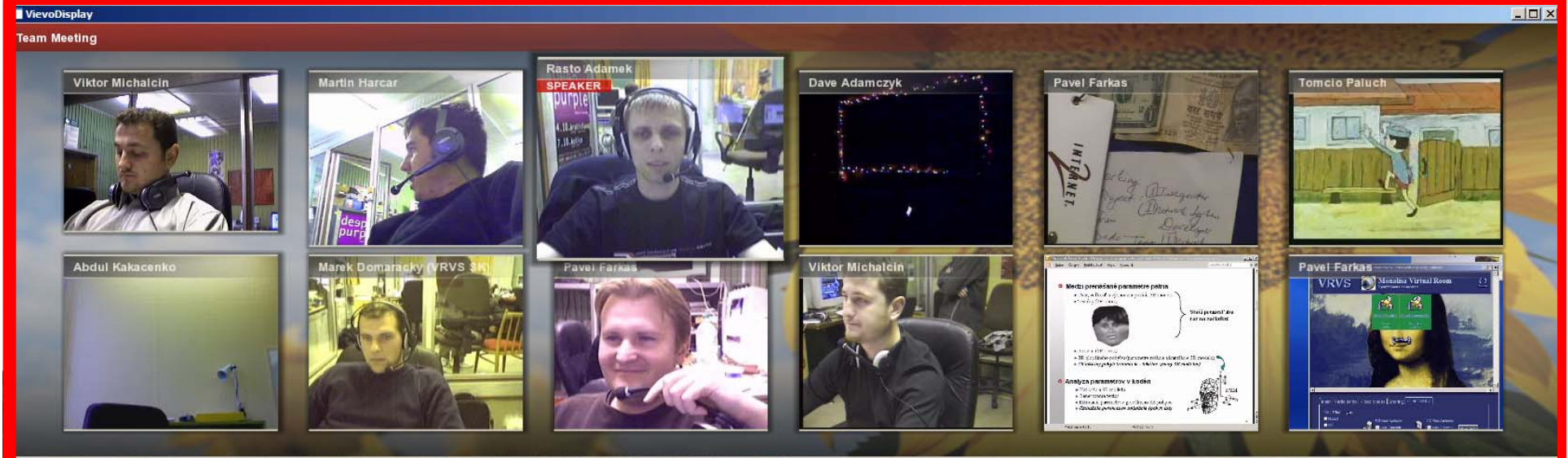


OpenGL based display mode

The screenshot displays a team meeting interface with a background of a 3D-rendered forest scene. The interface is divided into several sections:

- Top Bar:** Shows the meeting title "Koala - Pavel Farkas in Team Meeting" and various controls like "Language" and "Search".
- Participant List:** A horizontal row of small video thumbnails for participants: Marek Domaracky, Phil Galvez, Pavel Farkas, Dave Adamczyk, Count Dracula, EVO TV, Viktor Michalcin, Rasto Adamek, Abdul Kakacenko, and Martin Harcar.
- Chat Window:** A chat area with a scrollable list of messages. Recent messages include: "[Dec 6 16:03] Abdul Kakacenko ok. I have to go on section meeting", "[Dec 6 16:03] Abdul Kakacenko see you later", "[Dec 6 18:41] Count Dracula Marek?", "[Dec 6 18:43] Gregory Denis http://www.tandberg.net/products/video_system/standberg_1700_mxp.jsp", "[13:45:03] Rasto Adamek joined", "[13:46:21] Abdul Kakacenko joined", and "[13:48:24] Martin Harcar joined".
- Participant Grid:** A grid of larger video thumbnails on the left side, showing individual participants like Viktor Michalcin, Martin Harcar, Rasto Adamek (SPEAKER), Dave Adamczyk, Pavel Farkas, and Tomcio Paluch.
- System Windows:** Several windows are open, including "Total Commander 6.55 - NOT REGISTERED" showing file lists in two panes, and "VievoDisplay" showing a grid of participant thumbnails.
- Taskbar:** The Windows taskbar at the bottom shows the Start button and several open applications: Total Commander 6.55, Doručená pošta pre Pav..., Adobe Photoshop, Vic: Team Meeting, Pavel Farkas, EVO, the future of the..., Java Console, and Koala - Pavel Farkas in T... The system tray shows the time as 13:59 and the user as štvrtok.

OpenGL based display mode



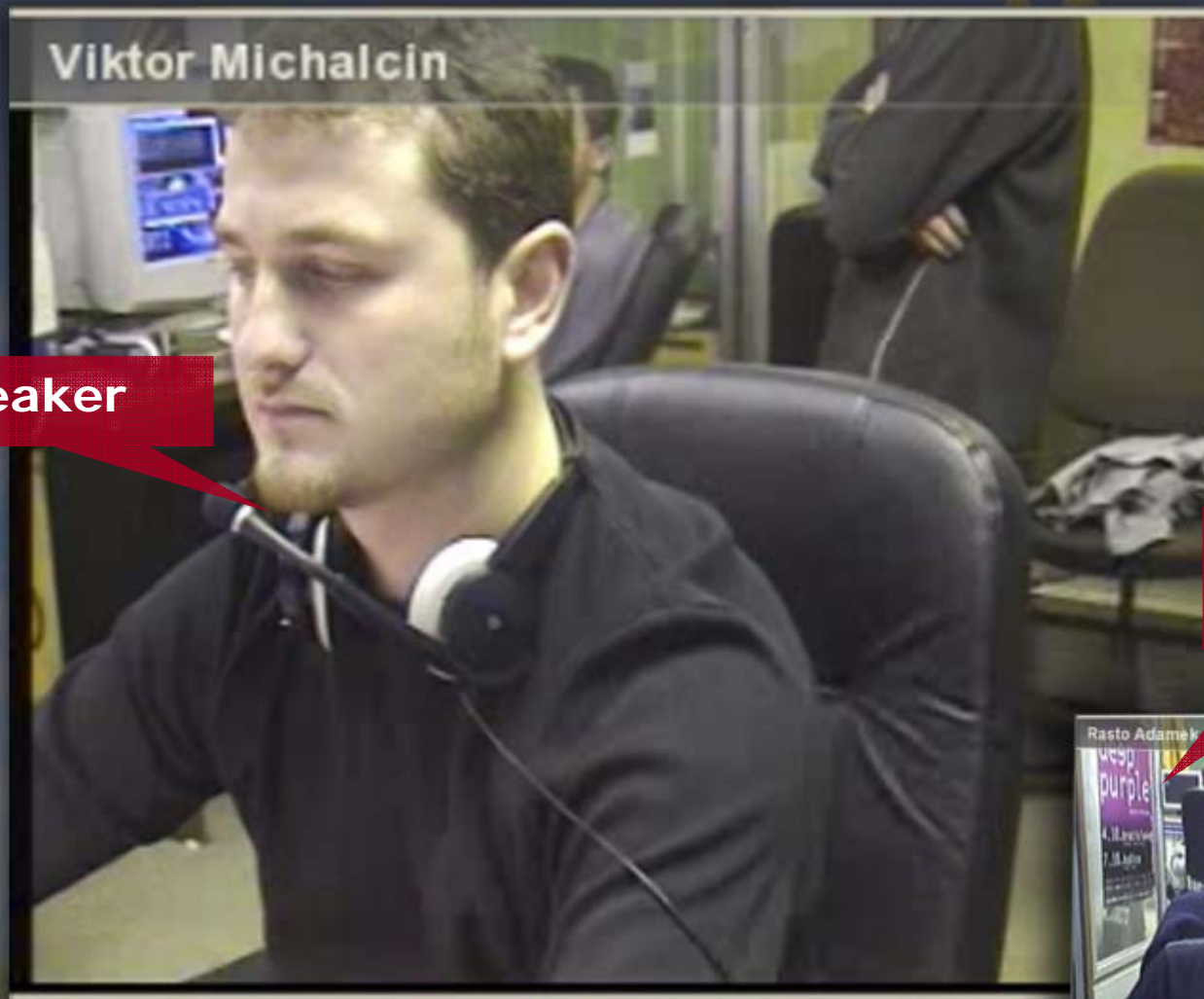
The screenshot shows the Koala application interface, which is a team meeting client. The main window displays a "Team Meeting" with a grid of video feeds for participants: Marek Domaracky, Phil Galvez, Pavel Farkas, Dave Adamczyk, Count Dracula, EVO TV, Viktor Michalcin, Rasto Adamek, and Abdul Kakacenko. Below the video feeds are controls for video and audio. The interface also shows a chat window with messages from participants and a list of available buddies.

On the right side, the Total Commander 6.55 file explorer is open, showing the contents of the directory "d:\W O R K\Streams*.*". The file list is as follows:

Meno	Ext	Veľkosť	Dátum	Atrib
[.]	<DIR>		19.10.2006 15:41	—
[RTP]	<DIR>		19.09.2006 14:52	—
bin	zip	1 908 825	14.06.2006 19:59	-a-
cimtoje	rtp	8 108 608	19.01.2006 16:52	-a-
playme	bat	107	07.12.2006 13:49	-a-
stream2	rtp	13 134 461	07.12.2005 10:36	-a-
viewo	exe	5 357 568	19.10.2006 15:41	-a-
viewo	zip	1 660 698	28.07.2006 16:53	-a-

The taskbar at the bottom shows the Start button, several icons, and the taskbar itself with the following open applications: Total Commander 6.55..., Doručená pošta pre Pav..., Adobe Photoshop, Vic: Team Meeting, Pavel Farkas, EVO, the future of the c..., Java Console, Koala - Pavel Farkas in T..., and VievoDisplay. The system tray shows the time as 14:00 and the user as štvrtok.

Ongoing and future work



Speaker

Local user's video



"Speaker" display mode

Ongoing and future work

Current speaker



Recent speakers




“Debate” display mode

Presentation

Microsoft PowerPoint - [Prezentácia programu PowerPoint - [MouthMotionEsc-PrezentaciaDprava]]

Súbor Úpravy Prehľadávač Okno Pomocník Zadať otázku

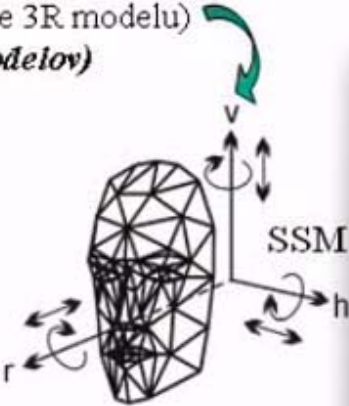
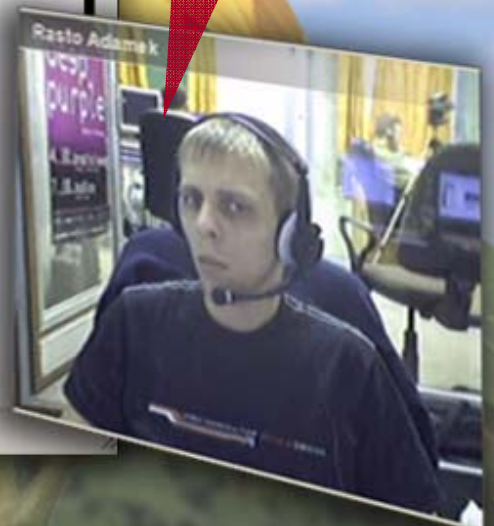
- **Medzi prenášané parametre patria**
 - ▶ Tvar, veľkosť a východzia pozícia 3R modelu
 - ▶ Textúry (2R obraz)



Staci preniesť iba raz na začiatku!

- ▶ Pozadie (2R obraz)
- ▶ 3R globálneho pohybu (parametre rotácie a translácie 3R modelu)
- ▶ *3R lokálny pohyb (animácia - lokálne zmeny 3R modelov)*

- **Analýza parametrov v kodéri**
 - ▶ Kalibrácia 3R modelu
 - ▶ Generovanie textúr
 - ▶ Estimácia parametrov globálneho 3R pohybu
 - ▶ *Estimácia parametrov animácie (pohyb úst)*

Prezentácia 4 z 13 Výchozí návrh

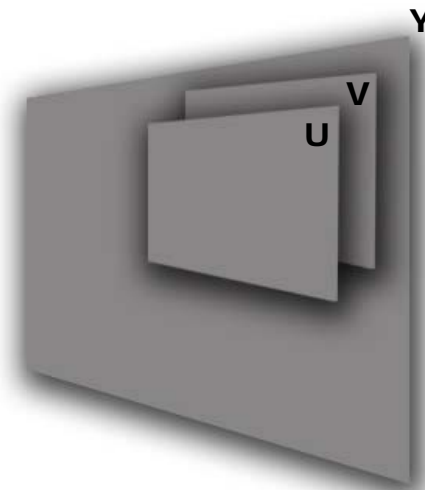
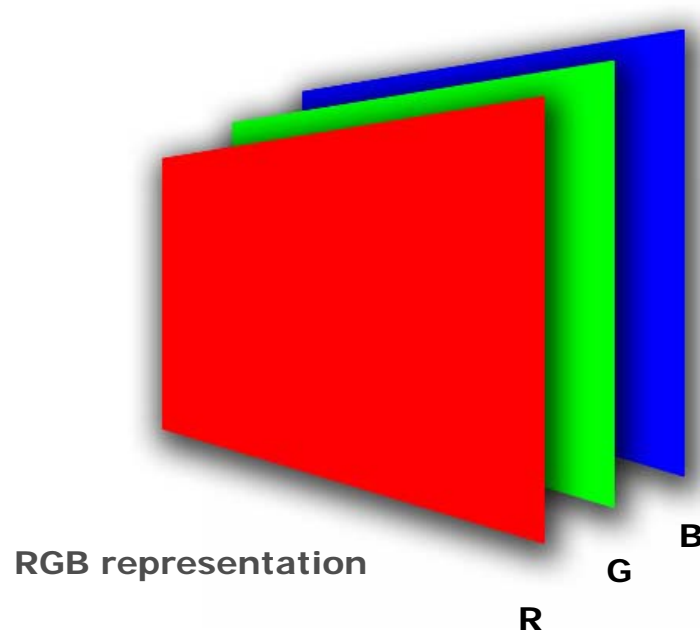
Presenter

"Presentation" display mode



RGB and YUV color spaces

- the human visual system is **less sensitive to color** than to luminance (brightness)
- in RGB color space **all three colors are equally important** and all stored at the same resolution



- more efficient way is to separate luminance from color information and **represent luminance with higher resolution than color information** – YUV (YCrCb) color model



RGB versus YUV textures

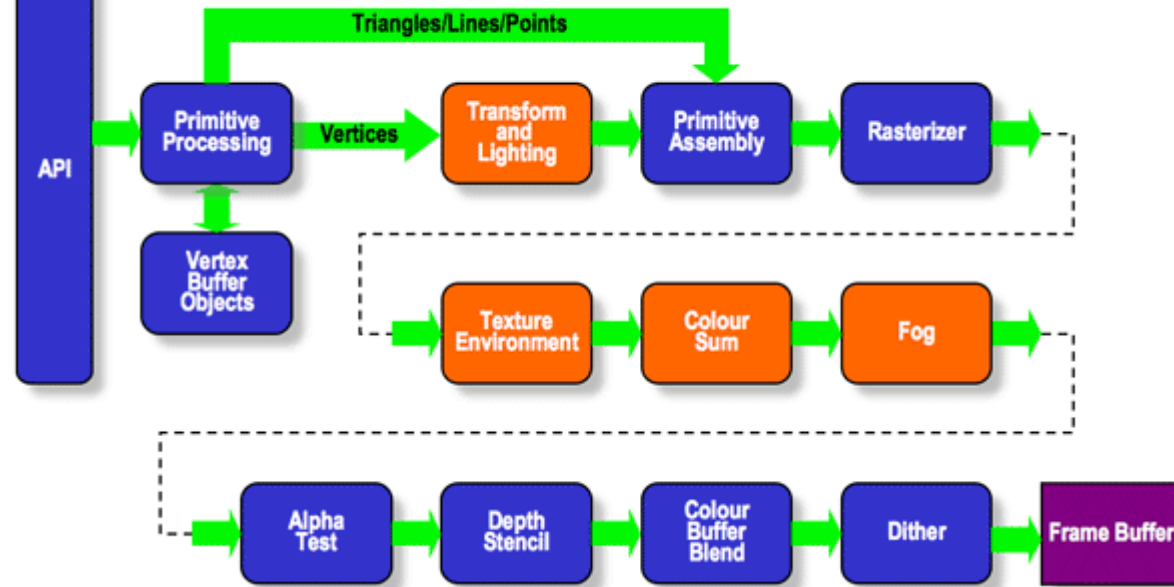
- video displaying application requires **continuous updating of video textures** (unlike, for example, games, where textures can be preloaded at the beginning of the level)
- **copying** of large amount of **data from PC memory to the graphic hardware memory** can have negative impact on application performance

Can we speed up this process or make it more effective?

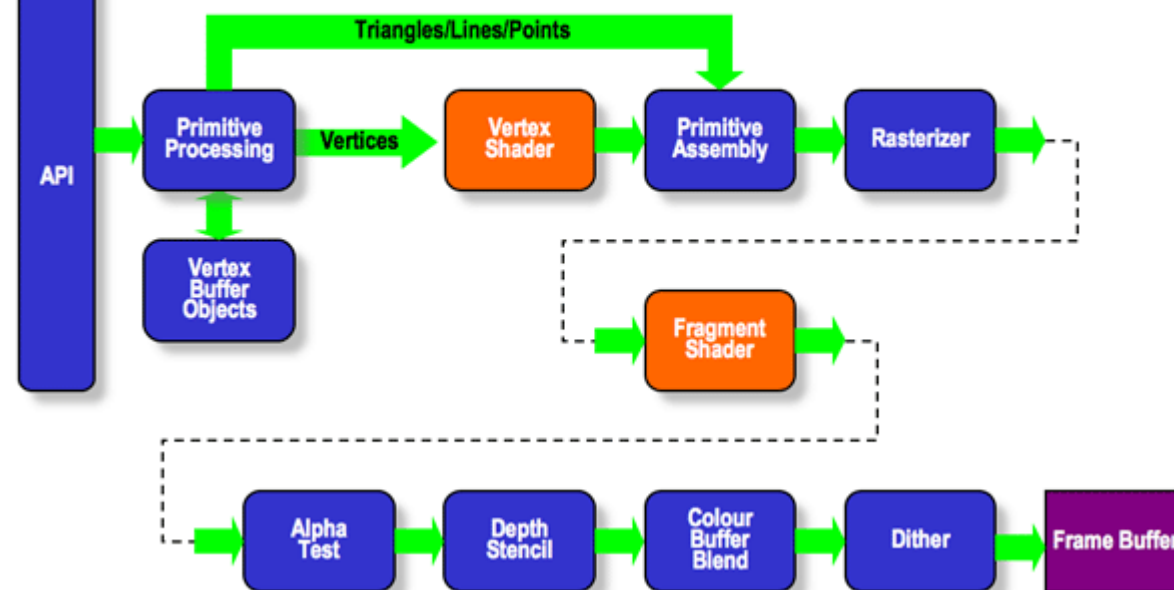
- **solution are YUV textures** (not natively supported by OpenGL) + **utilization of programmable OpenGL pipeline (vertex and fragment shaders)**
- **benefits:**
 - only **half amount of data is transferred** from PC memory to graphic card memory compare to RGB textures
 - saves the graphic card memory, **3x less memory usage compare to RGB textures**
 - more **effective memory utilization**
 - YUV -> RGB conversion is **performed by GPU** – saves CPU!!



Fixed OpenGL rendering pipeline



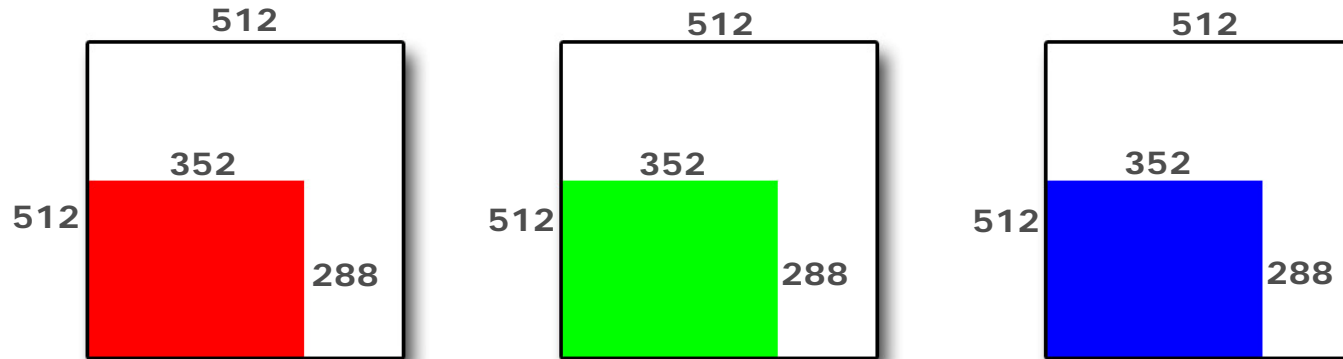
Programmable OpenGL rendering pipeline





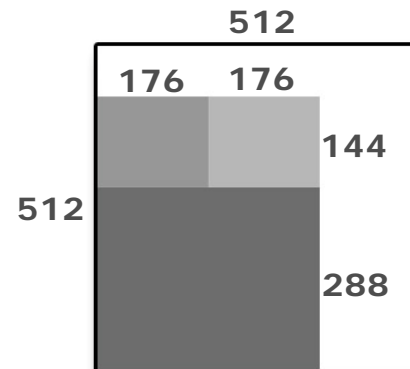
RGB versus YUV textures

```
glTexImage2D(GL_TEXTURE_2D, 0, GL_RGB, 512, 512,  
0, GL_RGB, GL_UNSIGNED_BYTE, textureData);
```



RGB texture

```
glTexImage2D(GL_TEXTURE_2D, 0, GL_LUMINANCE, 512, 512,  
0, GL_LUMINANCE, GL_UNSIGNED_BYTE, textureData);
```



YUV texture

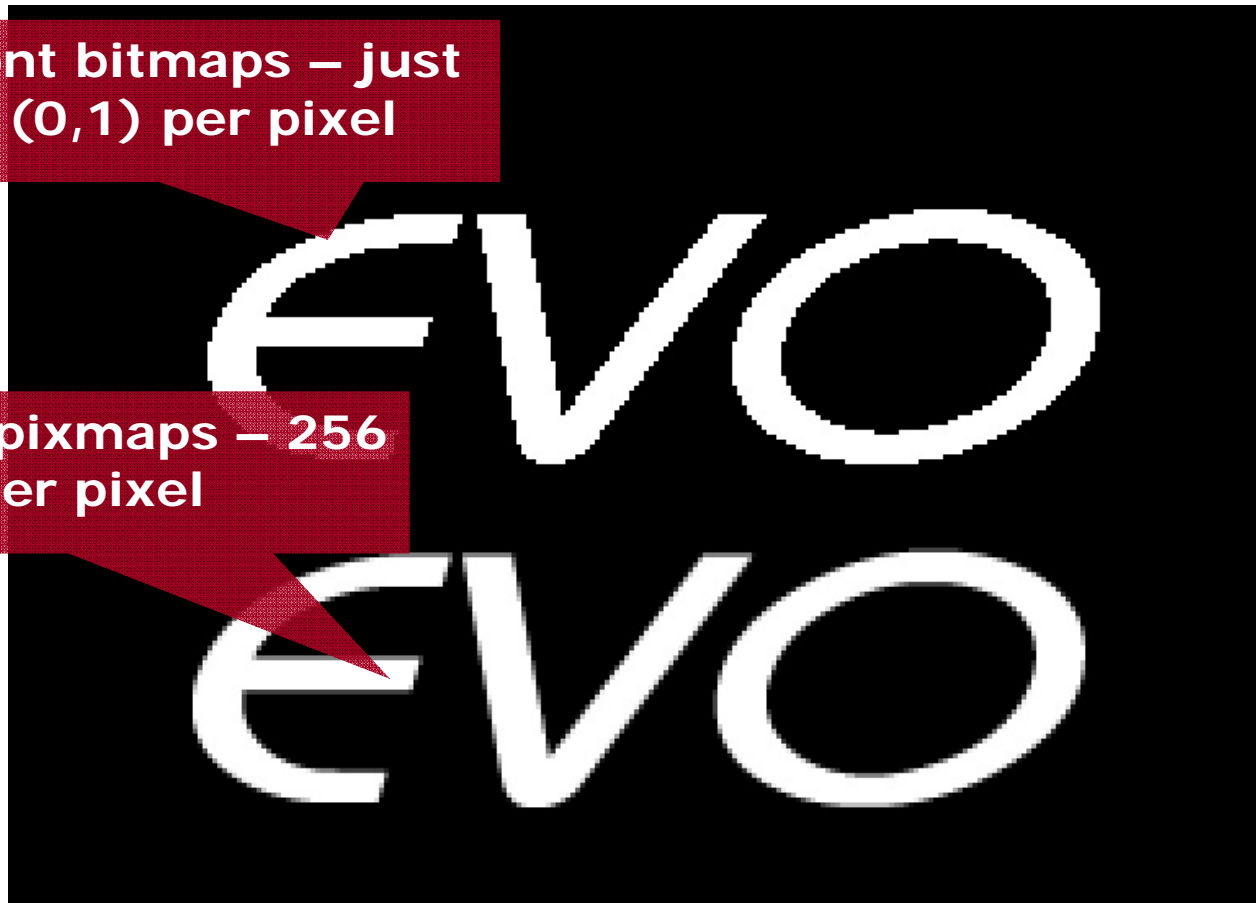


Font engine for OpenGL

- FreeType library (Win32, Mac OS, Linux) - a **software font engine** that is designed to be small, efficient, highly customizable, and portable while capable of producing high-quality output - www.freetype.org

WGL 2D font bitmaps – just 2 levels (0,1) per pixel

Freetype font pixmaps – 256 levels per pixel





Conclusions

- **interactivity** with OpenGL content – buttons, controls
- allows us to **remove old** Tcl/Tk based **GUI**
- next step - **porting the solution to MAC and Linux** platforms
- implement **advanced 3D models** of real meetings/conferences (audience in auditorium, participants sitting around a table, etc)
- all is valid also for MS Direct3D technology, OpenGL has been chosen for its multiplatform support

Thank you for your attention