Optical mixing with a half-transparent mirror and two monitors

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Introduction

In previous reports I discussed several configurations to mix a PAL and a VGA signal. Electronic mixing, using so-called video mixers, showed to give latency jitter and artefacts. Optical mixing using our iGlasses AR helmet showed to give too much distortion and too dim images. Here we tried mixing with a half-transparent mirror, a normal TV display and an LCD display. This shows to give little distortion, proper temporal behaviour and the images are sufficiently bright.

Setup

We have two signals to mix: the main input, which is a PAL interlaced 50 Hz video signal, and the VGA input, a VGA 60 Hz signal. The output is to be a 50Hz PAL video signal. Figure 1 shows the setup we used to mix these signals optically.

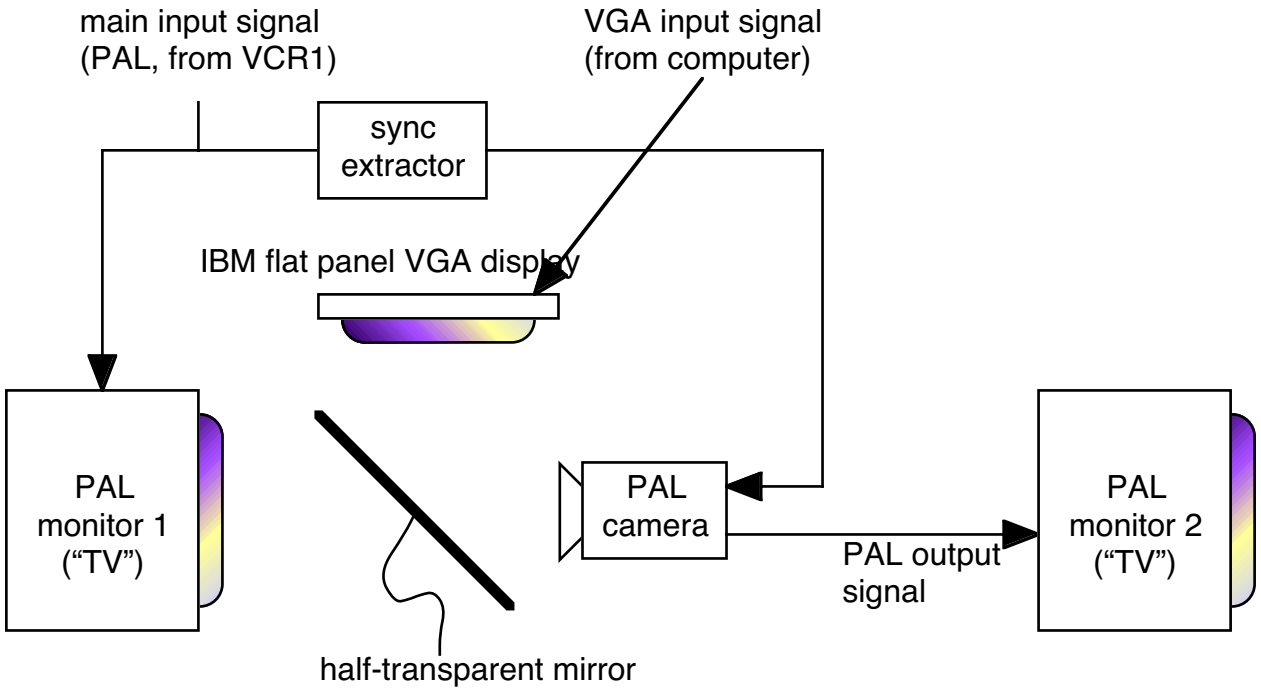

Figure 1. Optical mixing setup. See text.

To record the final optical image generated from our optical mixer, we used a professional Sony DCX-9100P 3CCD color video camera with a Fujinon wide zoom lens. This camera just about everything adjustable, which allows us to get optimal image quality. But more essential, it has a sync input and selectable shutter speed, which allows us to record from a normal color television (Sony Trinitron color TV, model KV-M1450D) displaying the main input PAL signal. To do this properly, the camera records in sync with the main input vertical sync pulses, and has a shutter

speed of exactly one field (1/50 s). The sync pulses were derived from the main PAL input signal with a custom sync extractor box.
If we would use a standard CRT monitor to display the VGA signal we would get thin bright stripes, because the VGA signal runs at 60 Hz and therefore a small part of the 50 Hz PAL image will be double exposed with the slightly quicker running VGA 60Hz signal. To avoid this, we use an IBM flat panel LCD panel to display the VGA signal. The PAL output signal from the camera was digitized with a JVC HR-DVS2 DV deck and spooled to a macintosh powerbook via firewire, for analysis.
Figure 2 shows a photograph of the prototype setup.

Figure 2. Prototype setup. On the left the PAL monitor. In the middle the half-transparent mirror, with the IBM VGA display behind it. At the right the Sony video camera. (The juice pack is just a safety measure in case the mirror might drop). Recording apparatus not shown.

Test input

To test the temporal behaviour of the system, we used the same test input as for the electronic video mixers in our earlier report (Figure 3). The VGA sequence consists of 5 images, played in a loop. As the VGA refresh rate is 60Hz, this loop is repeated 12 times per second. Each of the 5 images is blank but of different color: red, yellow, green, cyan and dark blue in this order.

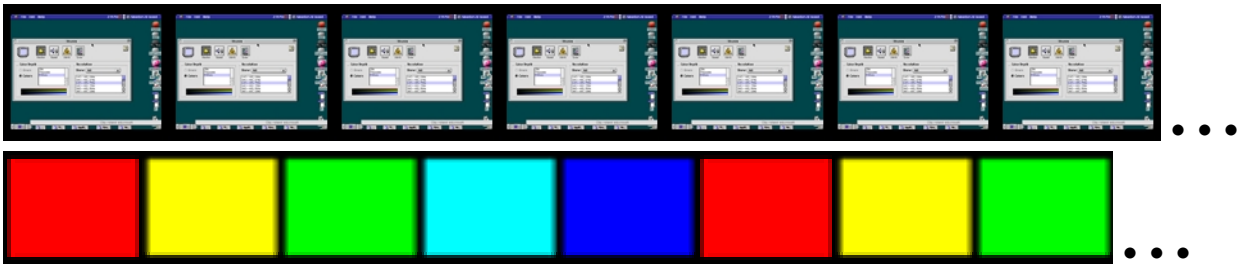

Figure 3. Two input signals. The top row shows seven fields (half-frames) at the main input (this figure shows a computer screen image, but we used a VCR player in the current setup). The bottom row shows 8

VGA frames. The width of the frames is proportional to the time taken to display them. After 6 VGA frames the two are in sync again, but then with the next color as starting color.

Results

The temporal behaviour is as expected. Figure 4 shows a few of the captured frames from the camera. The smooth blends from one color to the next is caused by the varying times the separate pixels are double-exposed: the lower in the image the shorter the new color is in view and the longer the older color is in view.

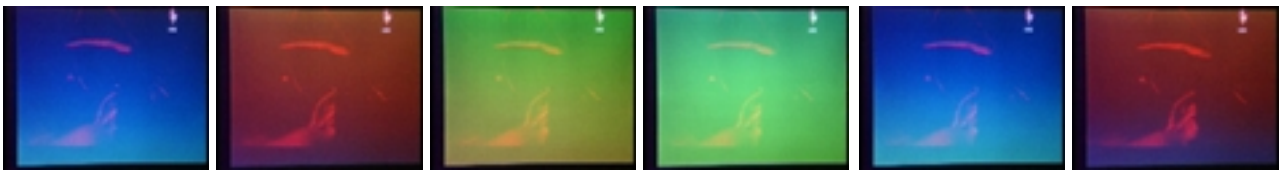

Figure. 4 subsequent halfframes. See text.

Figure 5 shows how the frames were related in time in this case.

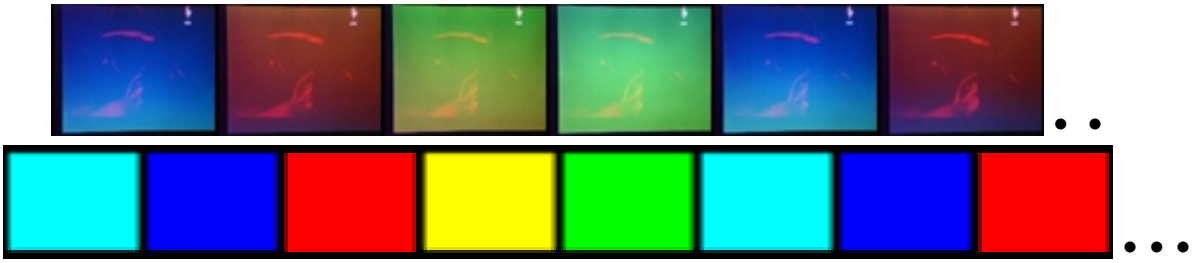

Figure 5. temporal relation between VGA and PAL inputs, corresponding to result shown in Figure 5.

To check the color, brightness, contrast, sharpness and distortion of the mixing output, we put some vivid colors on the two inputs and grabbed the output picture. Figure 6 shows the result. The colors are reasonably saturated, and the image looks quite sharp. Contrast maybe can slightly improved with a better LCD, but this looks acceptable. Barrel distortion is hardly present (but this is not shown properly in the figure).

Figure 6. The colors are properly saturated, the image looks quite sharp.

Conclusion

This mixing setup behaves nice: proper temporal behaviour and sufficient image quality. I propose to use this setup to mix the video signals for our statue video.