

# ExPixel FPGA: multiplex hidden imagery for HDMI video sources

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Figure 1: ExPixel FPGA hardware (a) Core diagram, (b) Hardware (c) Public testing using game consoles.

## 1 Motivation: multiplex beyond stereo 3D

In recent years, 3D technology has become so widespread that the technology alone no longer fascinates the viewers. To achieve further technical innovations on display experience, we should explore the limitations of 3D devices.

We developed a new technology called multiplex which can add secondary images onto the current display. The early prototype was realized using two or more projectors to combine multi-channel images. The most valuable discovery from our project was the "hidden imagery" technique which can cancel an image using the other channel. It can realize multiplex simultaneously and improve the current 3D theater into a hybrid 2D+3D which are reported by "ScritterH"[1] and "2x3D"[2]. Hopefully with field testing we can incorporate this technique into wider spread consumer flat 3D panels and other devices.

## 2 ExPixel: generic multiplex hidden algorithm for 3D flat panel

"ExPixel"[3], which realizes hidden images and prior natural images for naked eyes, allows the user to see both the hidden and original image using polarization filters. This technique is based on past research but was also tested on wide spread consumer 3D flat panels with HDMI interface.

ExPixel provided various solutions for developers and consumer users. (1) ExPixel Generator is an exporter tool for Microsoft PowerPoint. (2) ExPixel for Unity is a shader asset package for Unity rendering engine. These solutions are focused to professional users. In this proposal, we contribute to end user side. (3) ExPixel FPGA, a black box hardware which can make multiplex-hidden imagery by simply attaching 2 HDMI input and 1 HDMI output.

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## 3 Implementation On FPGA Hardware

Proposed hardware which is named "ExPixel FPGA" supports HD digital video sources (mainly designed as 1920×1080/60p). ExPixel core algorithm had been implemented by look up table (LUT) to obtain inversed gamma on ATLYS Spartan-6 XC65LX45 with 2 inputs and 1 output (figure a,b). Plugged sources are decoded and combined to a striped image for line-by-line 3D. The image is performed by ExPixel core then encoder put a HDMI output signal with correct period signal. The core just needs 1 frame buffer to perform entire process. It had been implemented by FPGA internal BlockRAM as a line buffer and Xilinx's Memory Interface Generator (MIG) with DDR2 SDRAM as a frame buffer.

## 4 Demonstration

We can show various demonstration using proposed hardware. In the public testing, we have succeeded in creating multiplex for Xbox 360 and Wii U game consoles. Parents and their children can play different games on the same screen simultaneously. The game channel had been chosen by glass wear on or off. Our concept and method were easily understood by them. Audio should be controlled but they had explored simultaneous play field. No hardware issues occurred within 42 hours of testing.

## References

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