

# 6.111 Final Project

## Project Checklist

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21 November 2011

**projective\_transform**: processes a stream of incoming pixels, skewing, rotation, and scaling the image by generating new  $(x, y)$  coordinates for each pixel corresponding to the four corners of the frame. (Logan)

- Correctly calculates distances and iterator incrementors, using the `sqrt` and `divide` submodules.
- Sends a signal to `LPF` to request new data when initial frame calculations have been done.
- Generate one new set of coordinates per clock cycle and transmit to `memory_interface`.
- Pipelines square root and division calculations so that there is no delay for each new line.
- Pauses appropriately when `memory_interface` cannot handle new data.
- Can handle “unexpected” new frame events.

**object\_recognition**: average the  $(x, y)$  tuples for each pixel that matches one of four Cr/Cb regions of interest. (Logan)

- Sums the coordinates of each color that it receives.
- Correctly averages each coordinate.
- Outputs the list of coordinates and a flag immediately after `ntsc_capture` has finished processing a frame and the `divide` submodules have finished their averaging operations.
- Output “fake” downsampling coefficients based on linear estimates of distance.
- (Time permitting:) Generate and output  $M_x$  and  $M_y$  downsampling coefficients after a frame has been captured.

**memory\_interface**: efficiently interfaces with the memory and all of the modules that have to write to and read from ZBT memory. (José)

- Writes to memory data from `ntsc_capture`.
- Reads from memory an image to `vga_display`.
- Outputs to and captures data from `LPF`.
- Captures data from `projective_transform`.
- Shifts data locations when `ntsc_capture` starts providing a new image.
- (Time permitting:) Reads an image from flash memory and stores it in RAM for use as the transformed image.

**LPF**: applies lowpass filters, vertically and horizontally, on the image that is to be warped, in order to prevent aliasing at the output. (José)

- (Out of time:) Just fetches pixels from memory and feeds them to `projective_transform`. LPF does not filtering.
- Loads appropriate filter coefficients based on the coefficients  $M_x$  and  $M_y$  from `object_recognition`.
- Reads data from memory vertically and horizontally, and has the necessary data for the calculation of each output pixel in its buffers.
- Mirrors the data appropriately in its buffers when processing near an edge.
- Outputs to `memory_interface` a pair of pixels that correspond to the convolution sum of the corresponding data.

**ntsc\_capture:** process the incoming video stream and send pixels in sets of two to `memory_interface` (Logan)

- Capable of reading the incoming video stream from the video ADC.
- Can transmit pixels to `vga_display` for immediate display.
- Saves full color data.
- Lumps pixels into groups of two to transmit to `memory_interface`.
- Recognizes pixels matching specific regions of the Cr/Cb plane, and transmits that information to `object_recognition`.

**vga\_display:** fetches data from memory and displays it on the screen. (José)

- Displays a predefined pattern on the screen.
- Requests a pixel one video clock cycle before it is needed.
- Reads an image from memory, through `memory_interface`, and correctly displays it on the screen.