Coloured-Object Tracking Camera

ECE 492 Group 4 Design Project

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Motivation

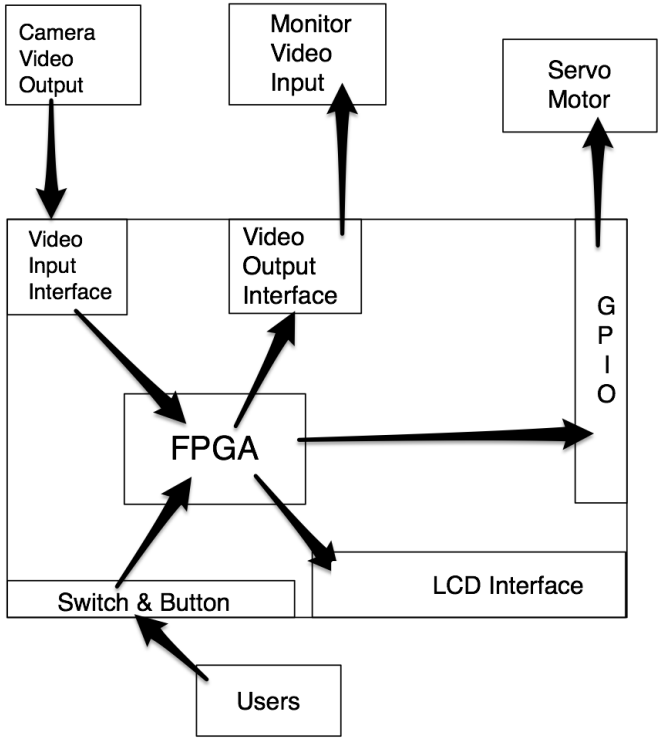
- Original idea came from this video
  - Optimal to see the individual throughout turn
- Can be used for many other things
  - Security and surveillance
  - Lacking a cameraman
  - Track targets in unsafe environments

Video is cited from Vincent Lee, “Jank Edit 2.0”
https://www.youtube.com/watch?v=jfmxrR4WlBg

Functionality

- Analyze image frames from a camera video stream
- Threshold the image for the predefined colour we wish to track
- Calculate centre of the object after the threshold and it’s position
- Output appropriate signals to servos to reorient camera so that target object is centred in the frame
- Two dimensional tracking system (horizontal and vertical pan)
- Change the colour being tracked on the fly

Hardware Design

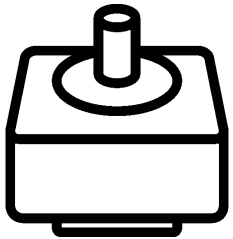


- Image Processing:
  - NTSC input signal —— FPGA
  - Colour space conversion (RGB to HSV)
  - Threshold colour
  - Find the centre
  - FPGA —— RGB output signal
- User Interfacing:
  - Threshold value control (Switches)
  - Operations indication (LCD)
- Servo Motor Control:
  - Custom Pulse Width Modulator (PWM)

Software Design

1. User Interface (Switches)
   - Manipulating settings
   - Setting colour to be tracked

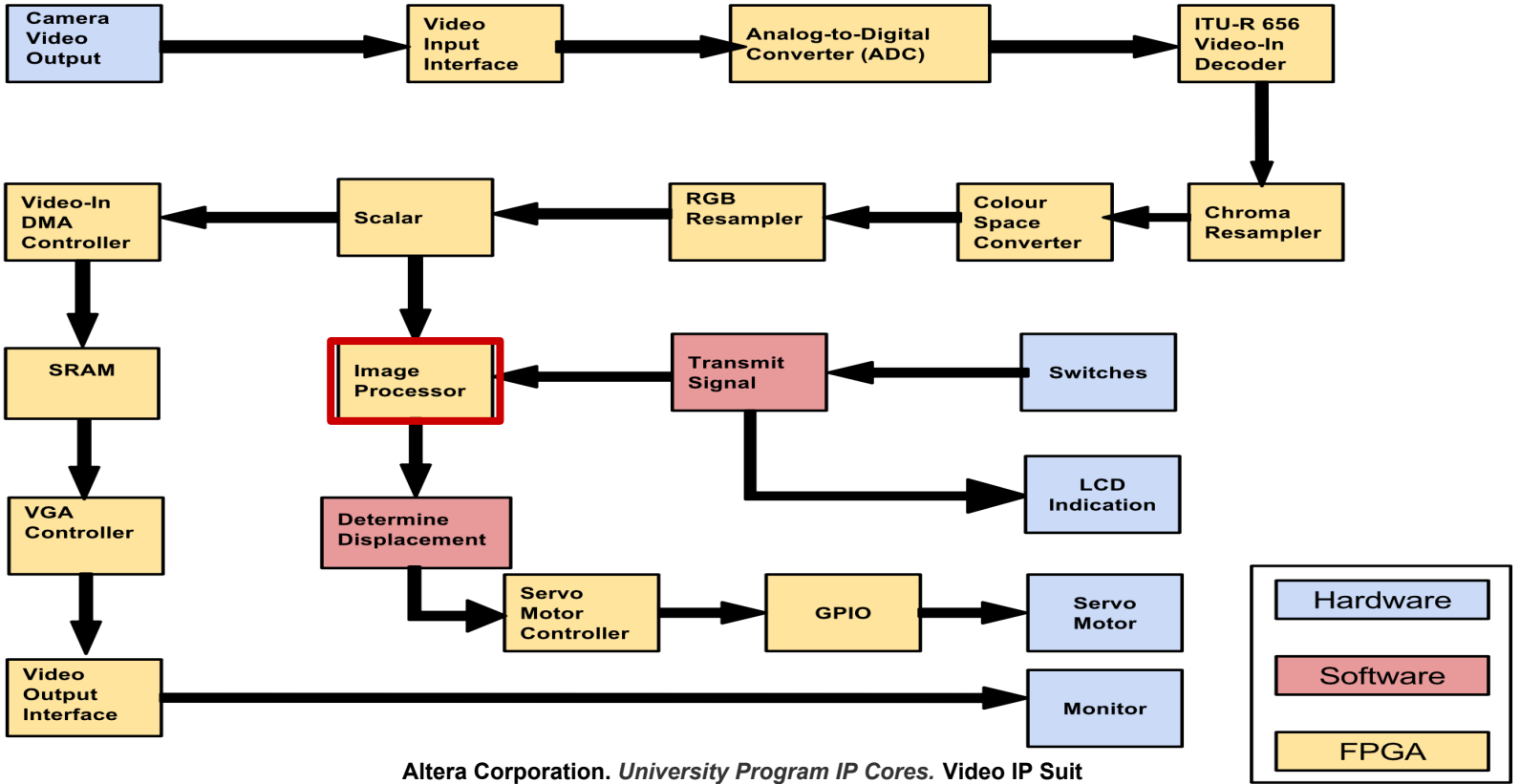
2. Calculate Direction of Object and Displacement
   - Reads in centre coordinates calculated in hardware layer
   - Compares coordinates with center of the frame (where the camera is pointing)
   - Calculate and convert displacement from number of pixels to number of degrees



3. Generate signal for PWM for rotation
   - Calculate new pulse width from the calculated displacement
   - Send new pulse width to PWM

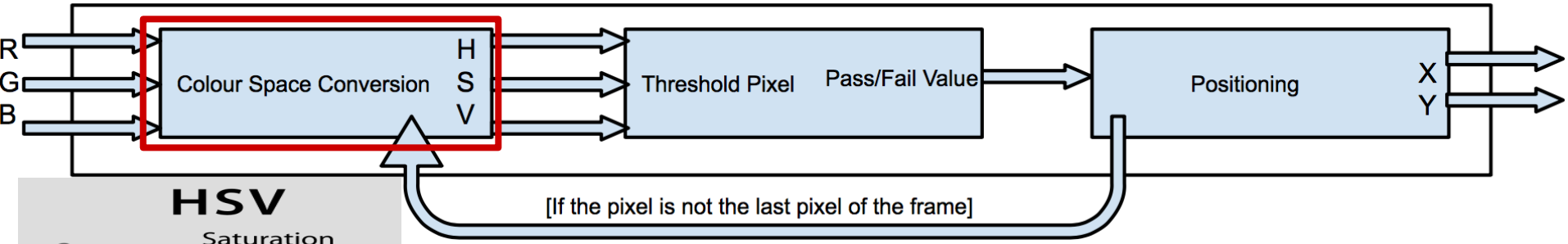
1.http://www.iconarchive.com/show/windows-8-icons-by-icons8/User-Interface-Nui-2-icon.html 2.http://www.iconpng.com/icon/48480 3.http://www.iconpng.com/icon/24323

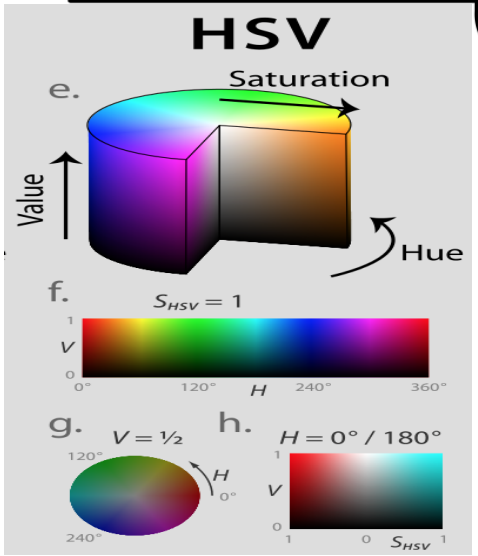
Data Flow



Altera Corporation. *University Program IP Cores.* Video IP Suit

Image Processor





Picture is cited from http://en.wikipedia.org/wiki/HSL_and_HSV#/media/File:Hsl-hsv_models.svg

$$S = MAX(R,G,B) - MIN(R,G,B)$$

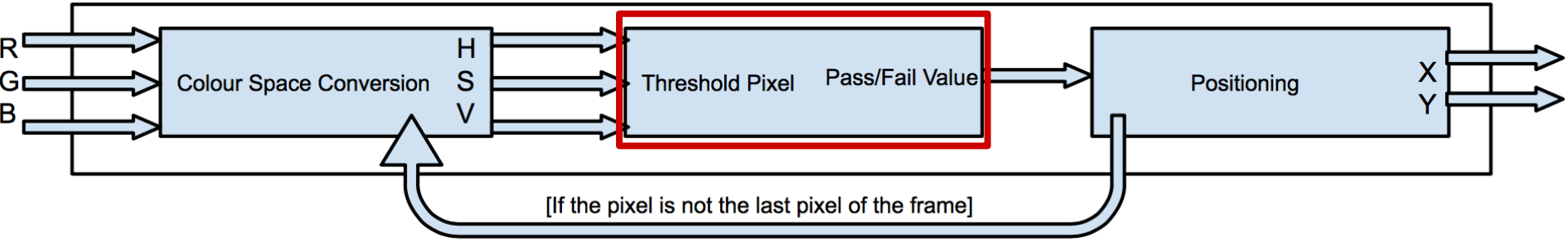
$$V = MAX(R,G,B)$$

$$H = \begin{cases} \dfrac{G - B}{S} \times 60^\circ & \text{if } MAX = R \\ \dfrac{B - R}{S} \times 60^\circ + 120 & \text{if } MAX = G \\ \dfrac{R - G}{S} \times 60^\circ + 240 & \text{if } MAX = B \\ 0 & \text{if } S = 0 \end{cases}$$

HSV is simpler to threshold than using RGB

- Image format that separates light intensity and colour
- Able to track colours during lighting changes

Image Processor



- Each pixel is compared to HSV threshold
- Threshold ranges determined by the HSV values of the colour user is tracking

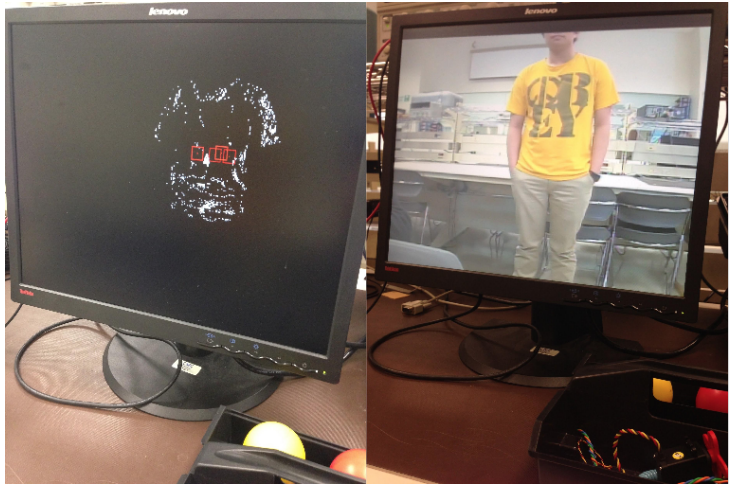
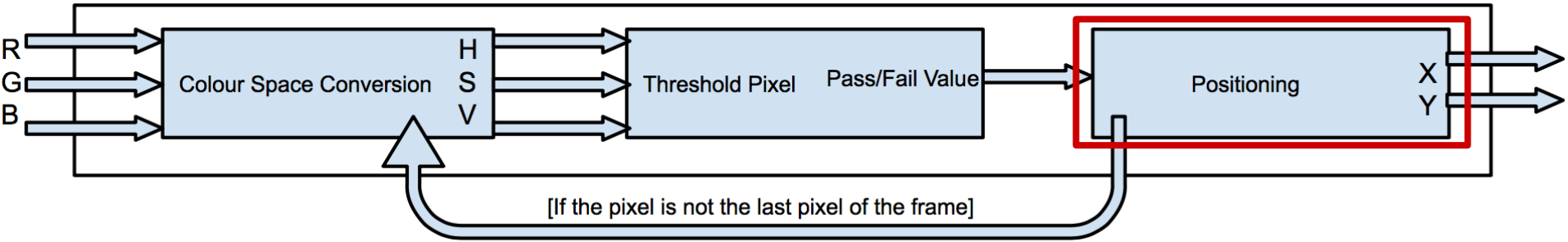


Image Processor



- Stores coordinates of the first and last pixel that passed the threshold
- After last pixel of frame, calculate the centre by averaging the x and y coordinates of the first and last pixel.

$$centre_x = \frac{first_x + last_x}{2}$$

$$centre_y = \frac{first_y + last_y}{2}$$

DEMO

Future Work

- Custom Settings
  - Offsetting tracked object
  - Boundary threshold
- Minimize form factor
  - Accessible, transportable
- Modernize it
  - HDMI
- Improve tracking algorithm
  - Accuracy
  - Minimize/Ignore noise