

# ECE532 Digital Systems Design

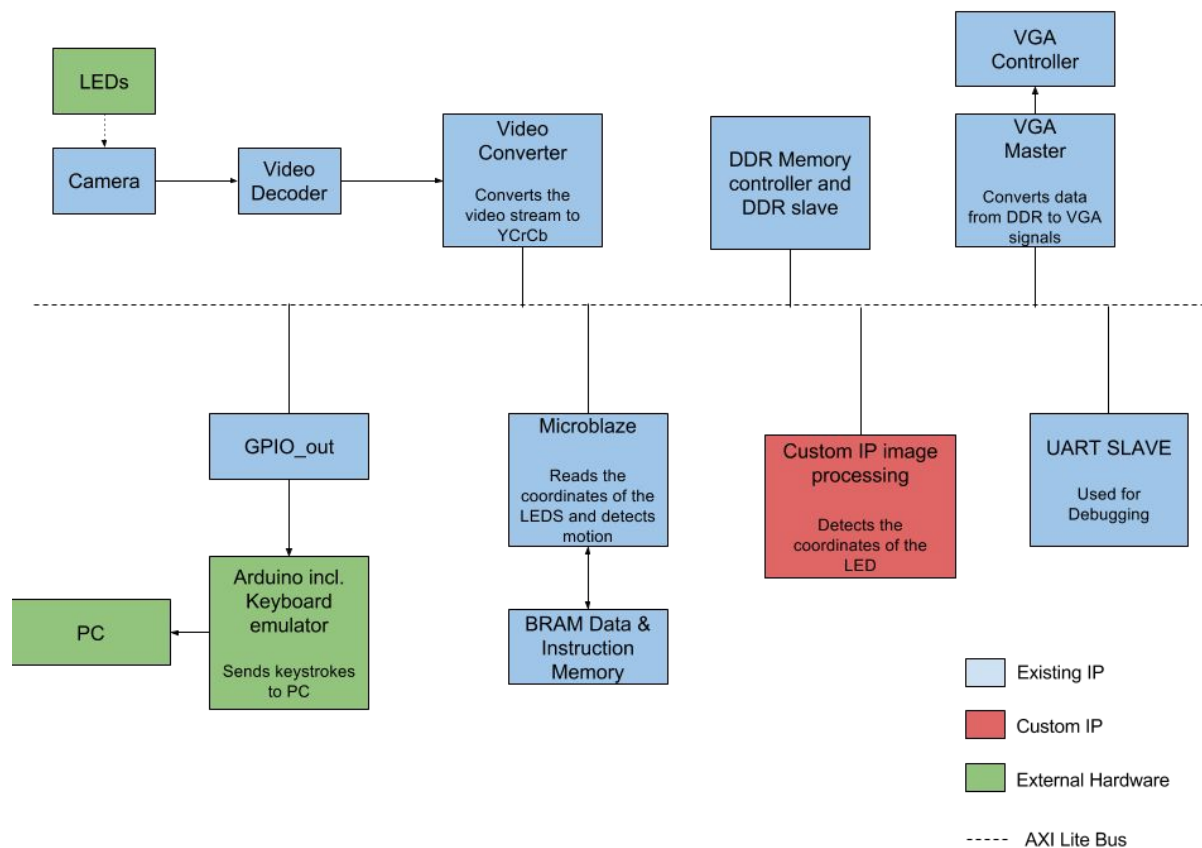
## Hand Gesture Computer Interface

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# Background & Motivation

- World is looking for new ways to interact with our devices
- Hand gestures are very intuitive and non-intrusive
- One application is presentations
- Could potentially be extended to allow doctors to interact with 3-dimensional models of organs

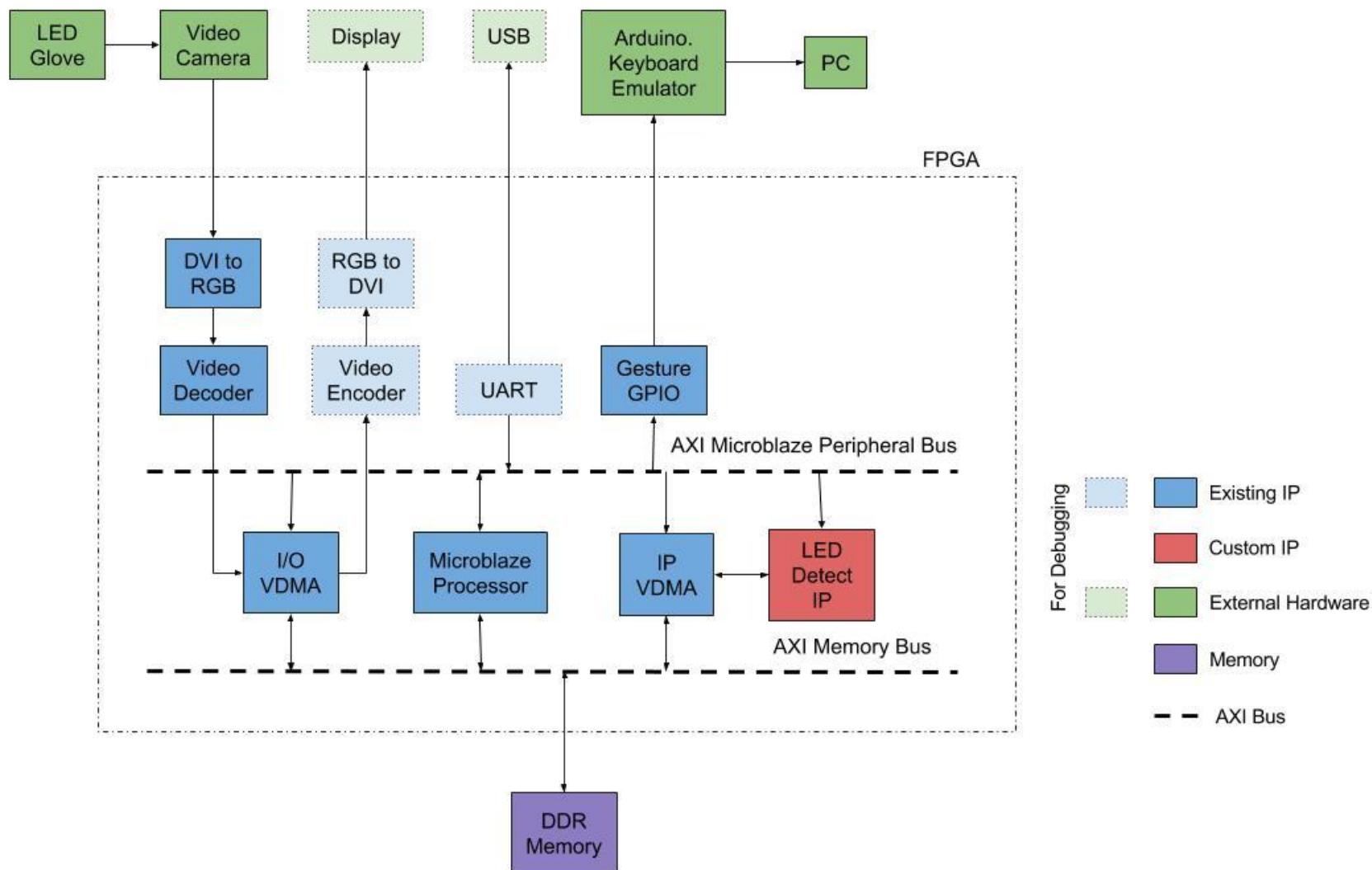
# Proposed Architecture



# Final Design

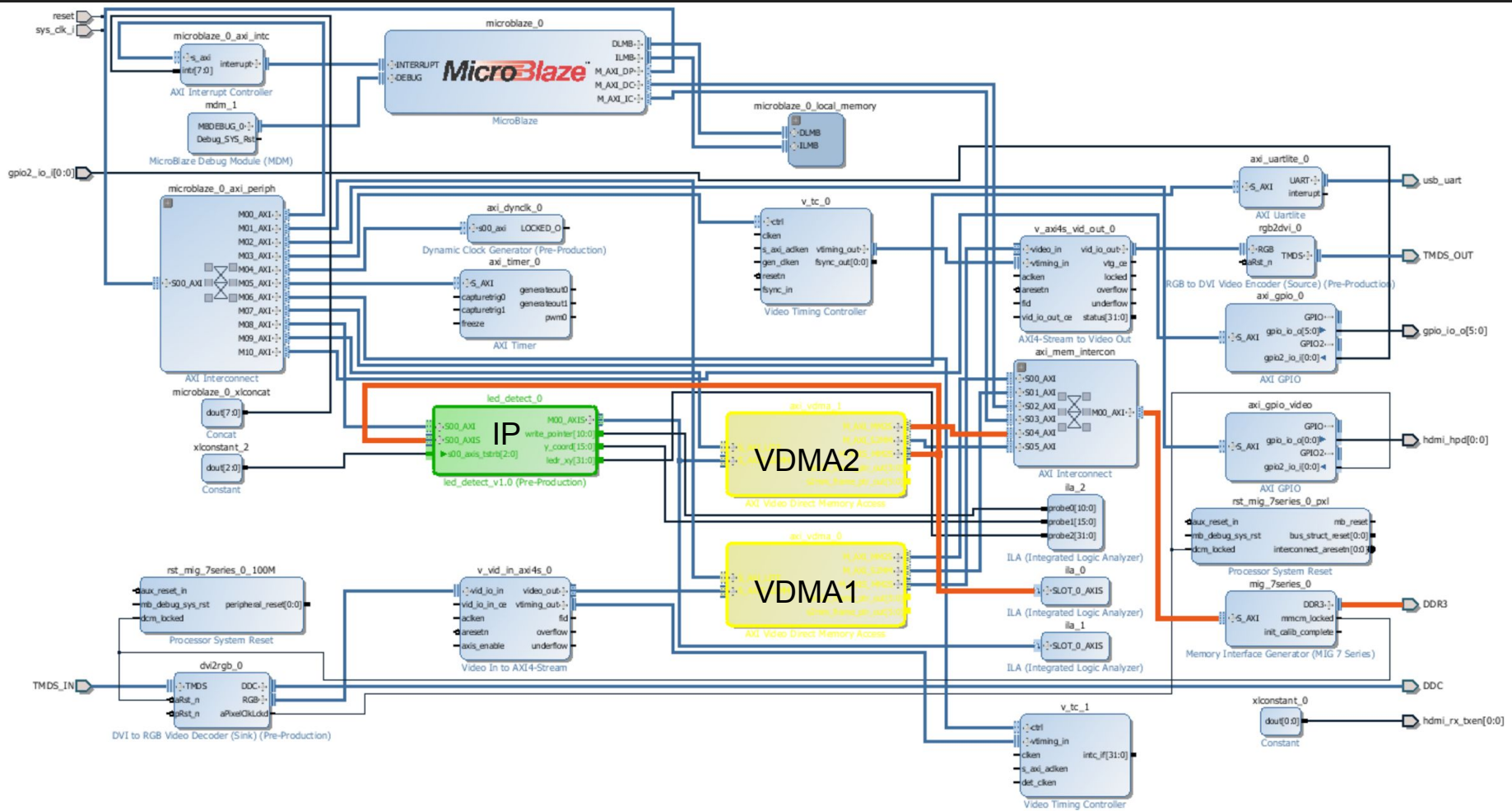
- Final design largely fulfilled initial proposal
- Use of red/green LEDs in place of IR LEDs
- One LED on each hand
- HDMI output instead of VGA for debugging
- RGB analysis instead of YCrCb

# Final Architecture

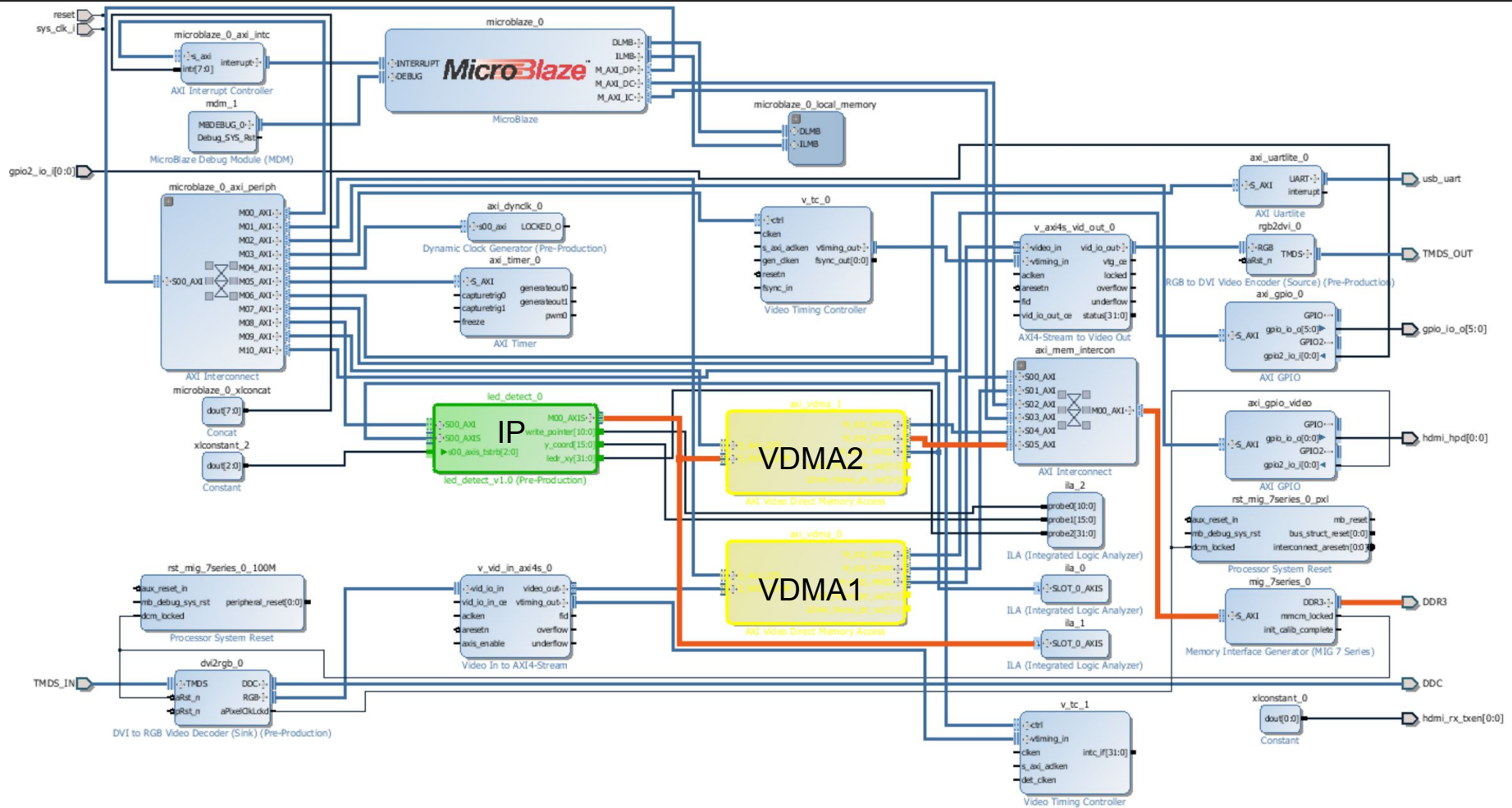




# Information Flow

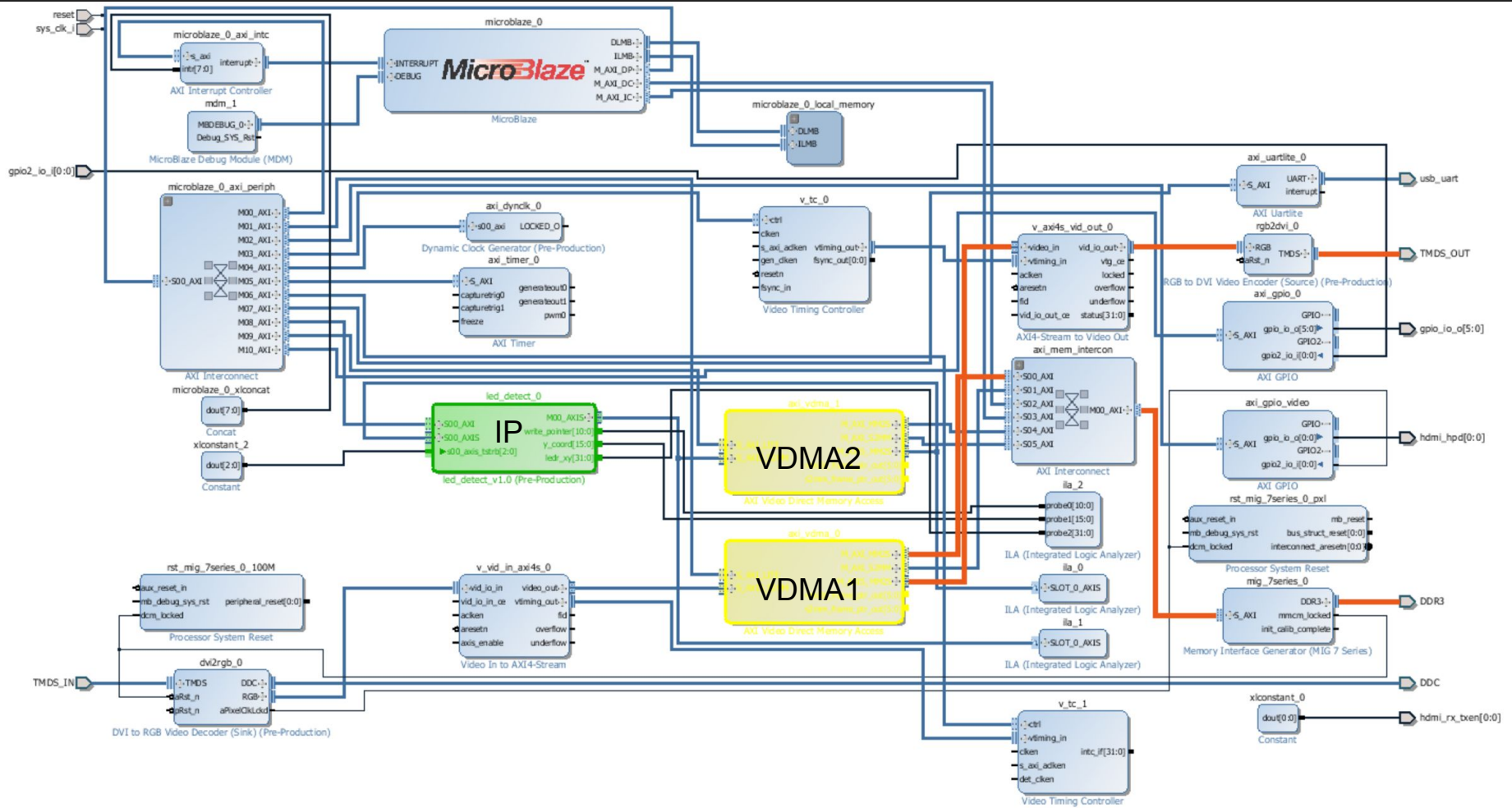


# Information Flow

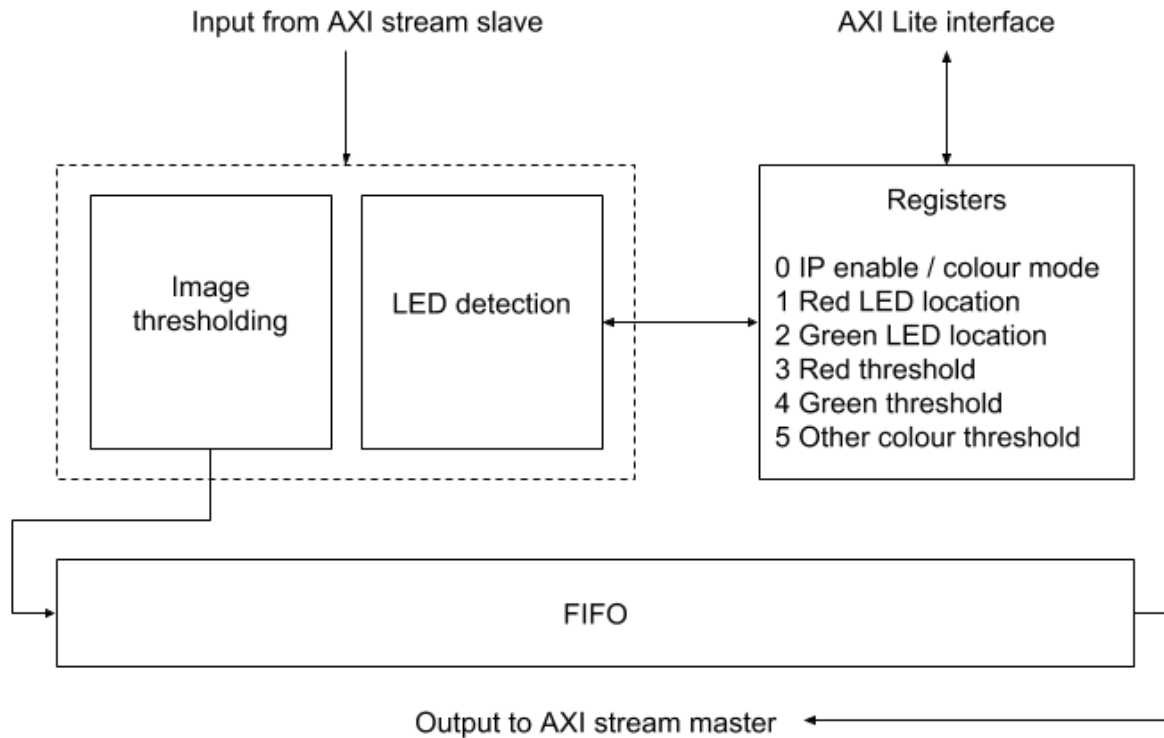




# Information Flow



# Image Processing IP



# VDMA2

- Read one row from frame 1 in DDR
- Write one row to frame 2 in DDR
- Timing issues with VDMA and IP
  - Poll IP for valid output

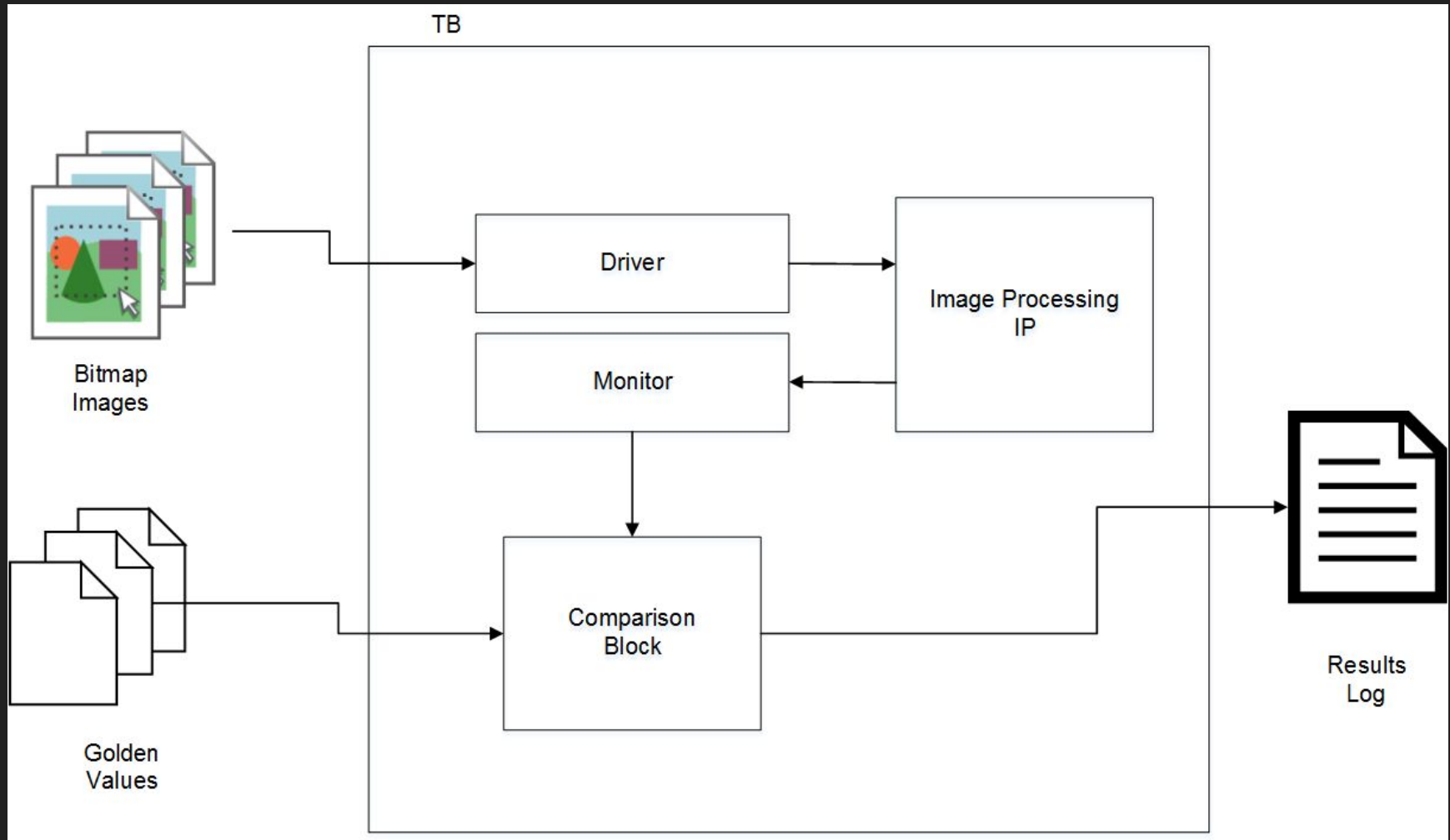
# Gesture Detection

- Scroll & Swipe Detection
  - Threshold absolute distance of 1 point
- Zoom Detection
  - Threshold ratio of 2 points
- Both based on history of points
- Use deltas

# Peripherals

- Arduino provides keyboard emulation
- FPGA sends signals via GPIO to Arduino input pins
- Arduino sends keyboard commands over USB (e.g. CTRL and '-' for zoom out)
- Gloves

# Testbench



# Design Process

- Flexibility in initial proposal
- Started IP early, ahead of schedule, to provide debugging time which was critical
- Kept IP relatively simple and use Testbench simulation to verify functionality
- Used ILAs for debugging, especially process of elimination
- Developed and verified software algorithms before coding

# Design Process

- Version control for backup and collaboration
- Some aspects compartmentalized and prototyped by one person, integration as a team
- Debugging largely with more than one member present



# What We Learned

- Unrealistic to synthesize IP regularly - use registers to allow updating of functionality/parameters in software
- Timing signals/writes correctly critical
- How to access hardware using software drivers
- The importance of handshaking
- How thresholds can be used to filter images

Thank you