

CSEE 4840 Embedded systems Design

# Light Saber generator- *Return of the Jedi*

Anusha Dachepally (ad2657)

Raghu Binnamangalam (rsb2145)

Devesh Dedhia (ddd2121)

Roopa Kakarlapudi (rk2489)

# Overview

---

- Motivation
- Goals
  - ▣ Real Time Video Display
  - ▣ Color detection
  - ▣ Light saber generation
- Real time video processing
  - ▣ Processing at 60 fps

# Motivation

- To learn integration of hardware and software
- Real time video processing on the FPGA board
- Inspired by
  - ▣ Luke Skywalker (Star wars!!)

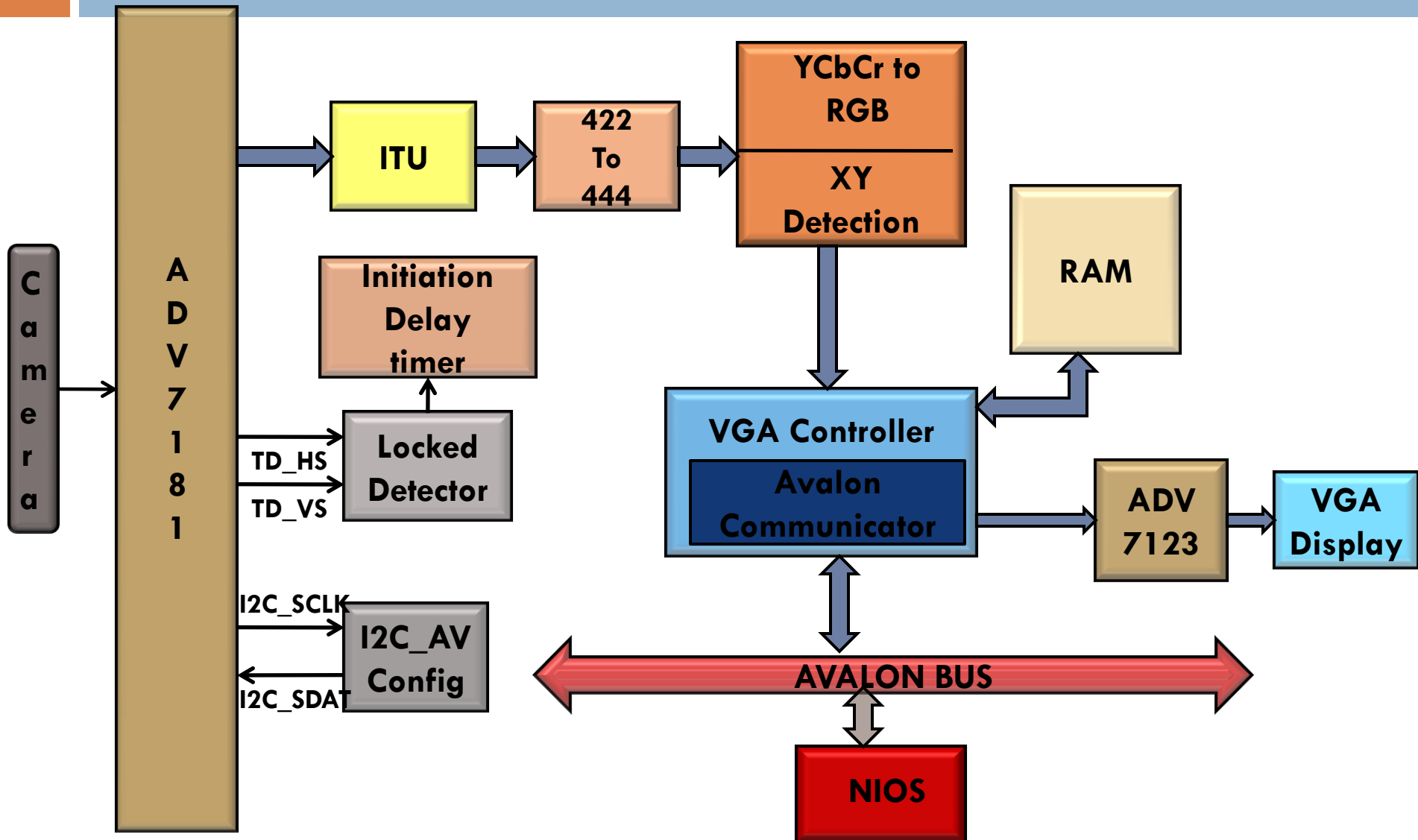


# Objectives

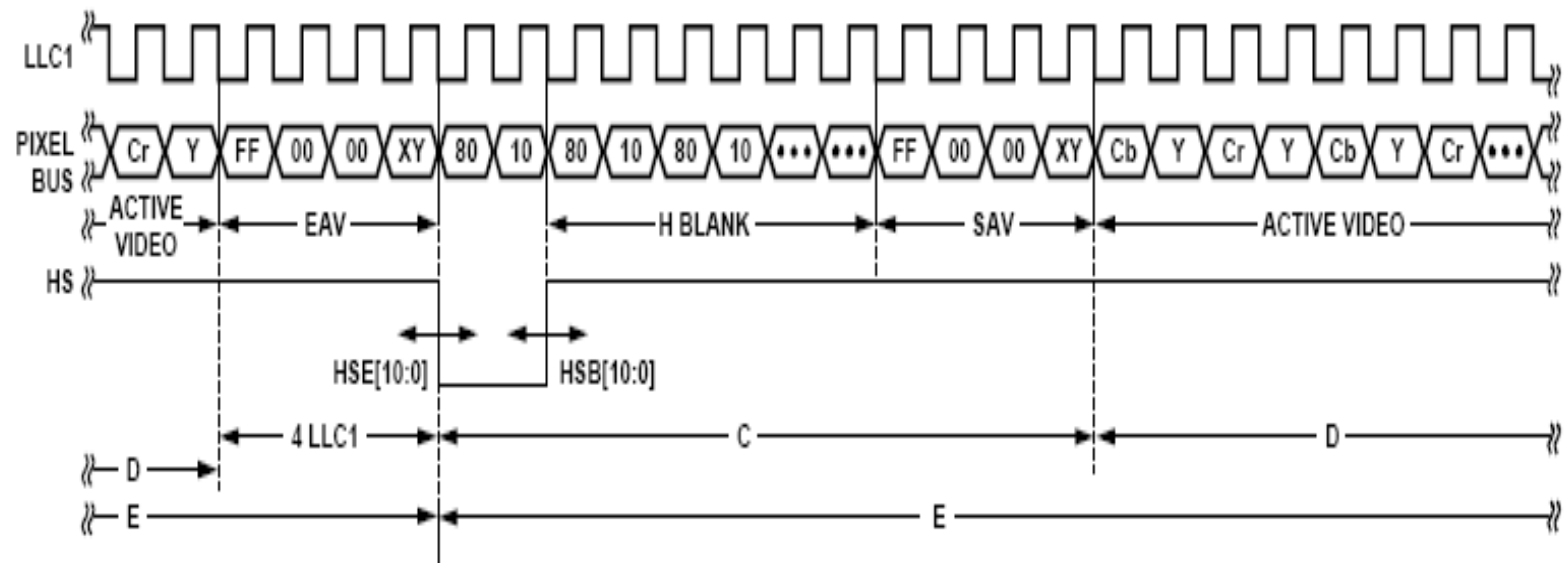
---

- To capture video in real time of a person holding a sword
- Do real time video processing at 60 fps
- Replace the sword with a light saber on the VGA display

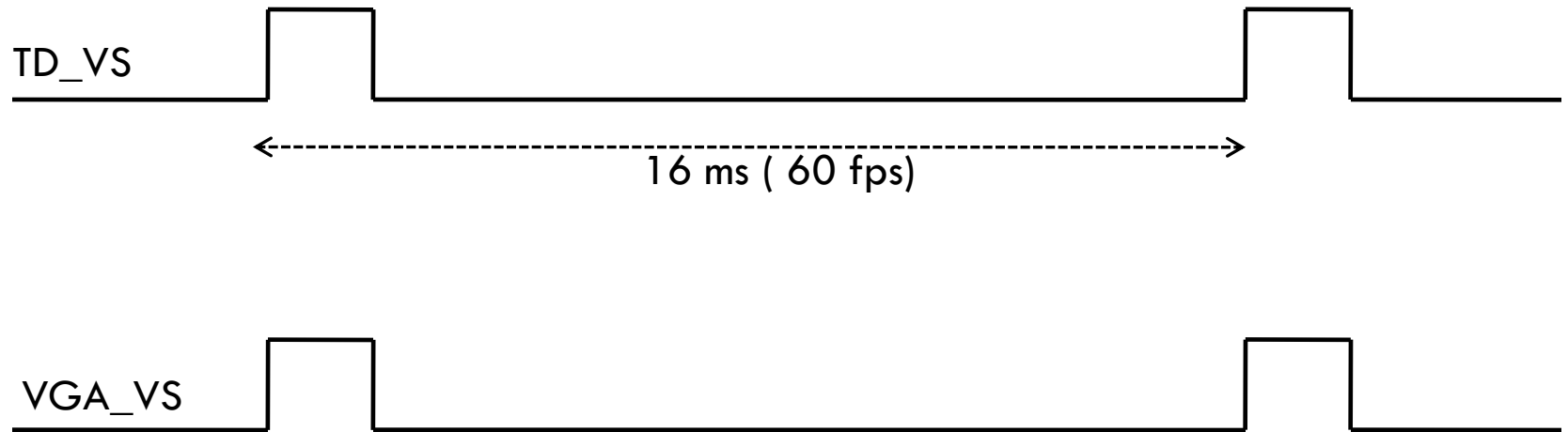
# System Architecture



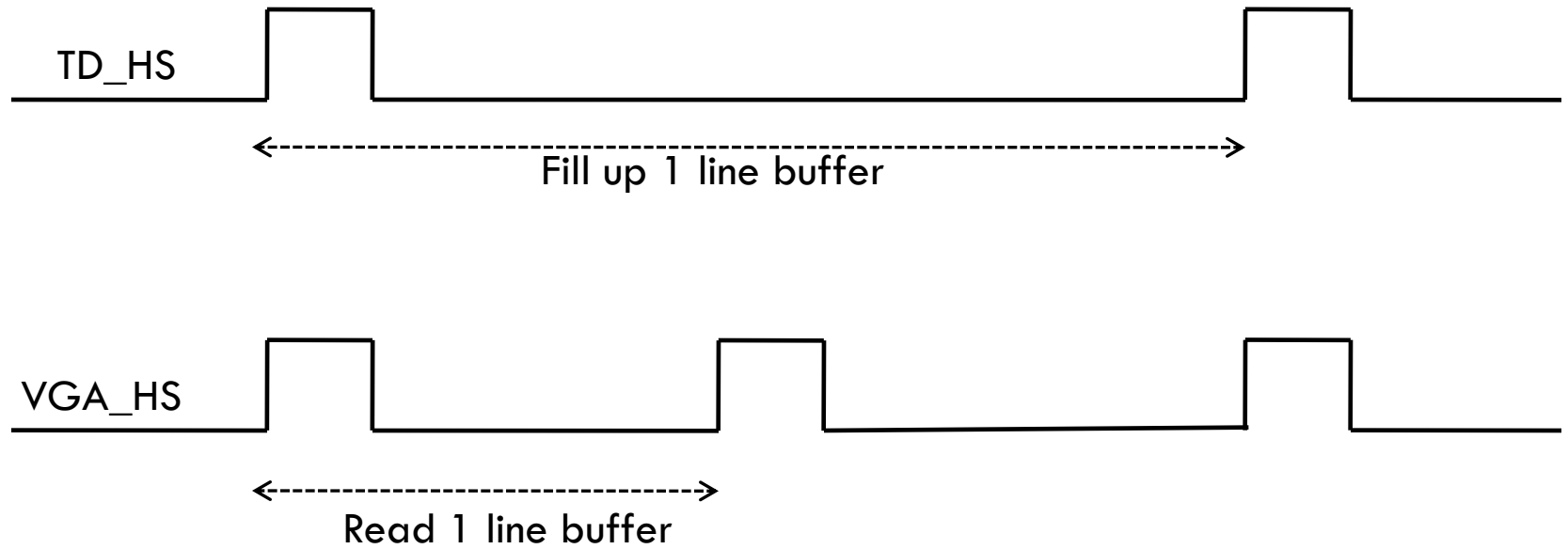
# Timing diagrams



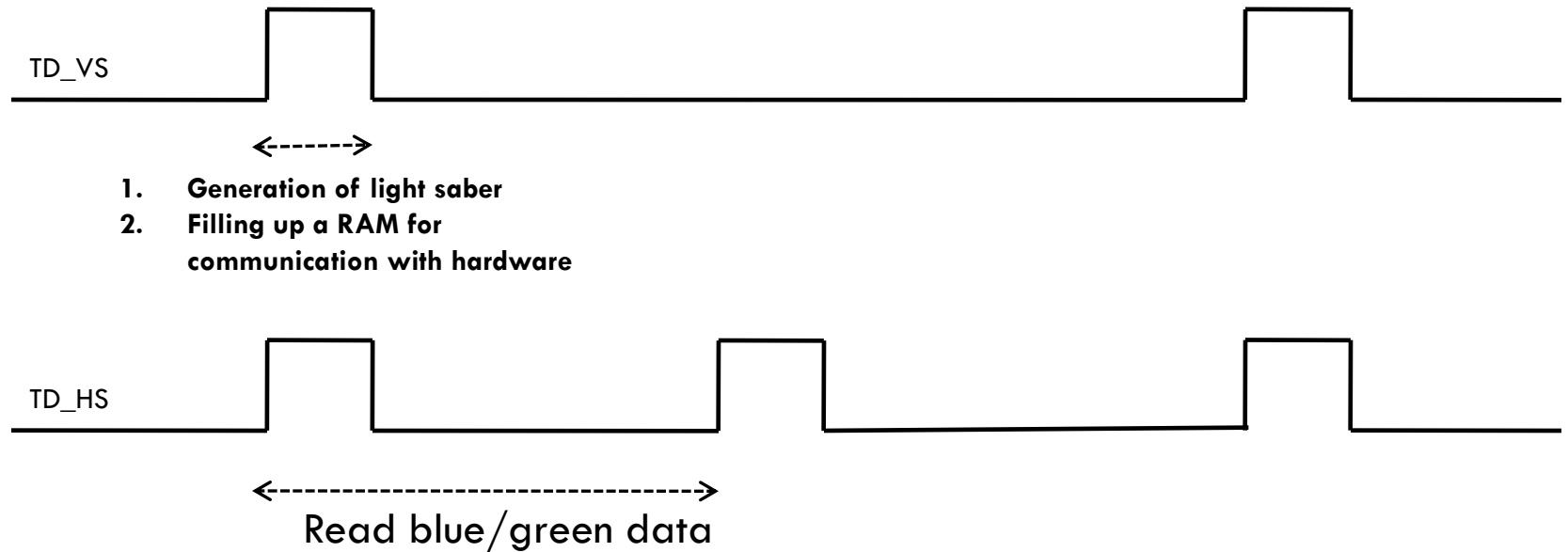
# Timing diagram 1



# Timing Diagram 2



# Timing diagram 3 (Software)



# Real time Video Display

- 60 fps display
  - ▣ To emulate real time video
- No frame storage
  - ▣ SRAM not dual ported
  - ▣ SDRAM is a time deterrent
  - ▣ Real time display on the fly
- Usage of 2 line buffers
  - ▣ Swap between the 2 line buffers
  - ▣ Avoids loss of information
- No interlacing
  - ▣ replicating even/odd frame

# Color detection

- Conventional approach
  - ▣ Euclidean distance
  - ▣ Intense computations hence delay
- Our approaches
  - ▣ RGB vs YCrCb
    - RGB has varying threshold with varying intensity of light
    - YCrCb has greater tolerance

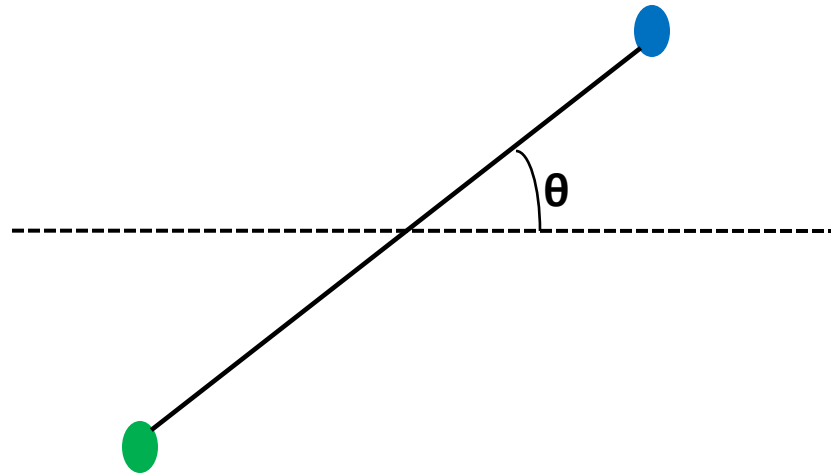
# Light saber generation



- Find centre of mass for ends of sword

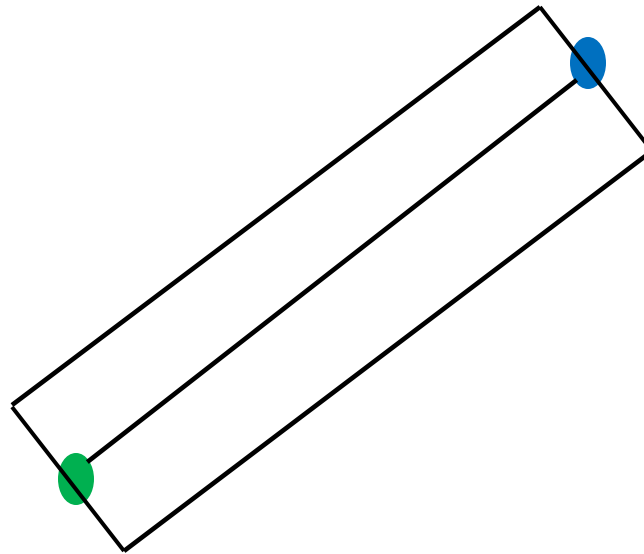
# Light saber generation

- Calculate the slope of the line



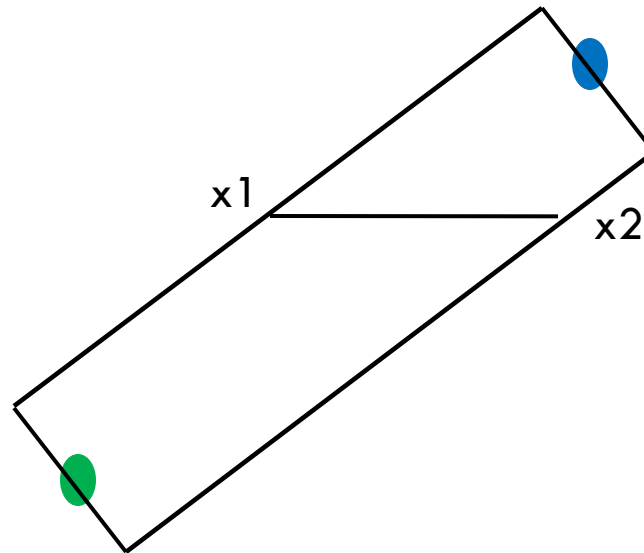
# Light saber generation

- Use a predefined sword width and halo width



# Light saber generation

- Filling the coordinate table



# Software Design

- Centre of mass calculation
- Using theta calculations find the four edge points of the light saber for a predefined width.
- Use a table to store the X1 and X2 for each line displayed by the VGA.

# Design challenges

- For real time video display
  - ▣ Horizontal sync and Vertical sync w.r.t incoming video from ADV 7181
- Achieving 60 fps
- Making the system work without frame buffers
- Deal with multiple clock domains

# Design challenges(contd..)

---

- Floating point calculations
- Line drawing algorithms
- Synchronization with the VGA module in hardware
- Hardware signals are sampled more than once

# Lessons learnt

---

- Start early
- DE2 Terasic real time video code is all junk
- Design timing diagrams before implementation
- Conventional measuring techniques like CRO are Life savers
- More time for debugging

# May the force be with you!!!





**Thank You**