PROJECT OVERVIEW

Sensors play an important part in our life—they provide many aspects of our work and home life, such as the automatic door, rice cooker, smoke detectors and remote control. They are mainly small in size and are at time even hardly perceivable by naked eyes. Nonetheless, they play an important role in collecting target object’s data and converting data to a useful reference. This data is then conducted with a multiplexer, encoder or center processor to form reliable information to the users.

In relation to the above applications, CMOS image sensors are the most popular and have the most general usage. The engineers have to develop lots of CMOS Image Sensor (CIS) for different functions usage. There has been a lot of focus on CMOS development recently. This is because their performance is relatively reliable when compared to CCD. The performance, functional capability and flexibility of CMOS image sensors have all been improved in recent years which have enabled them to fulfill a number of different uses.

OBJECTIVE

We aim to develop a schematic design for the CMOS image sensor: we focus three stages in the project:

1. Pixel circuit design
2. Amplifier circuit design
3. Converter circuit design

The objective is to demonstrate how signals operate and are generated within a CMOS image sensor. We used a software program named Cadence® Virtuoso® to design virtual components and circuit. And then we move on to conduct the simulation, analysis and modified our own schematic design.

SYSTEM BLOCK DIAGRAMS

As our goal, we are going to develop 1920*1080 pixels grayscale 3T-APS. The block diagram show how we will covered in project:

The green square at the middle right is a single 3T APS, it refers to 1 single-pixel (gray scale), totally 1880 rows and 1920 columns result to 2073600 pixels. Since the amplifiers in APS are not really “gain” (not >1). Thus, all of the 3T-APS are connected to row/column amplifier arrays. Collected all readout signals by multiplexer, and go for get the same gain and ADC become digital data. All blocks are followed by oscillator during processing.

METHODOLOGY

We need to install software in our computer to handle the Final Year Project as shown below.

1. Simulation: We simulate the circuit to test the circuit s correct and outputs.
2. Correction: When output is wrong, we correct the circuit and components in the circuit.
3. Replace: We use our own components to replace ideal components in the circuit.
4. Modification: We study the parameter in ideal components.
5. Testing and result: We simulate photocurrent in photodiode and integration its voltage and take voltage samples during readout phase. The signal transmitted through trace to VGA to take the sample and do amplification during sampling phase (sampling VGA turns on). after that, VGA will go into holding phase to hold the amplified signal before sampling the next signal phase (sampling VGA turns off). During VGA holding the output at VGA_out.

ADC will do quantization for digitizing the incoming analog signal (Quant_ADC). In quantization, Voltage generates an increasing voltage and do comparison with samples to detect its relative digital value, After quantization, ADC have it digital value representing the amplitude of the amplified signal, then ADC generate the relative sample from Q7 to Q0 (Q7 as the MSB). so should be a pulse width delay compare with sensor readout.

Sensor: designed a new 3T-APS and make 9 sensors as a column, don’t care the other rows.

Amplifier: Design a variable gain amplifier with 3 different gains (3.5, 7, 13).

Converter: Design a 8-bit analog to digital converter by our own.

IMPLEMENTATION

Phase 1 – Design: We design and edit our schematic circuit design by the ideal components.

Phase 2 – Simulation: We simulate the circuit to make sure the circuit s correct and outputs is what we are expected.

Phase 3 – Modification: We study the parameter in ideal components.

Phase 4 – Replace: We use our own components to replace ideal components in the circuit.

Phase 5 – Correction: When output is wrong, we correct the circuit until we get same result as ideal components.

Phase 6 – Design: We change the circuit and components into symbol for better arrangement.

Phase 7 – Combine: We compose all the circuit together for the Final testing and simulation.