

Multiresolution Image Sensor Using Switched Capacitor Circuits

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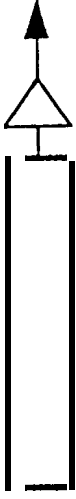
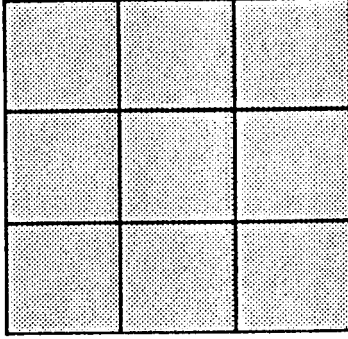
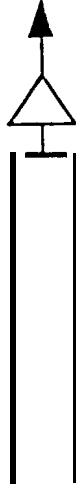
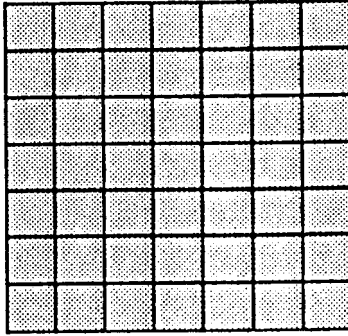
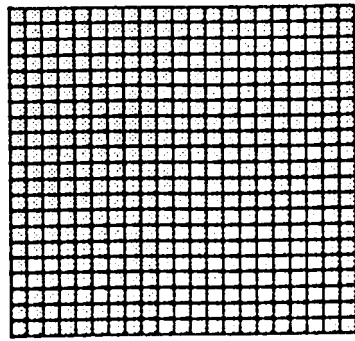
10-17-94

1994 International CMOS Camera Workshop

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Multiresolution APS

Multiresolution Readout Sensor: Pyramid Readout

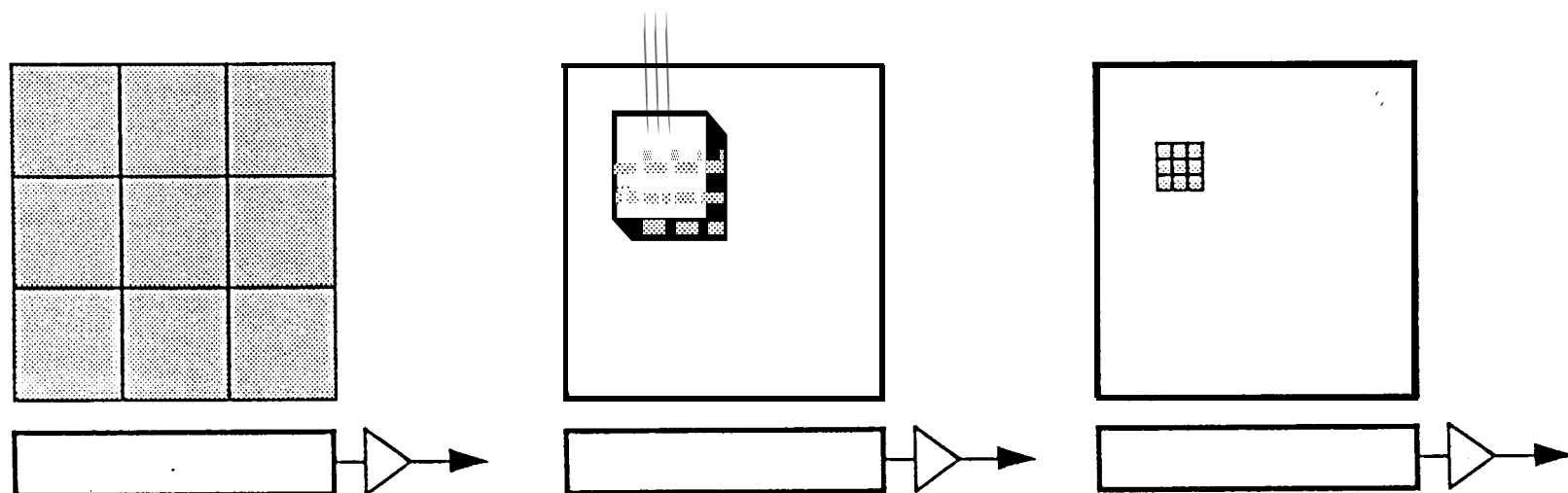


Read Out Array at Desired Resolution

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Multiresolution APS

Multiresolution Readout Sensor: Window Readout



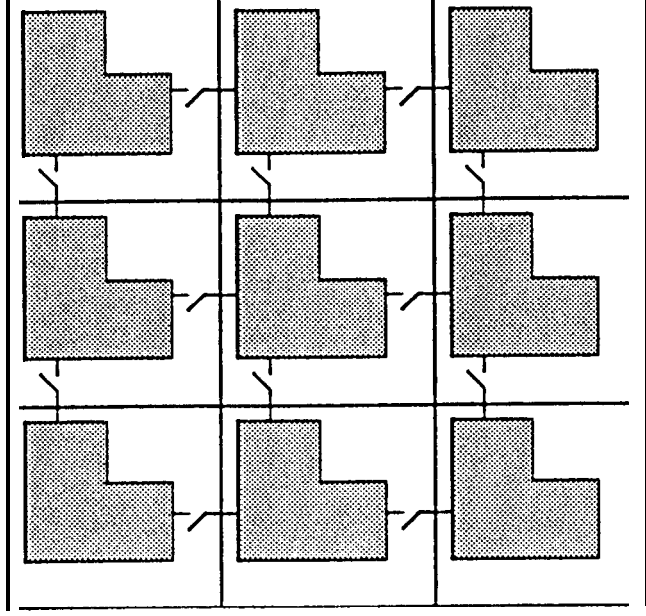
Applications

- Autonomous Navigation
- Pattern Recognition
- Target Tracking
- Progressive Transmission of Compressed Images
- Biological Vision Modeling

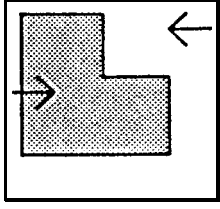
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Multiresolution APS

Spatially Programmable Approach



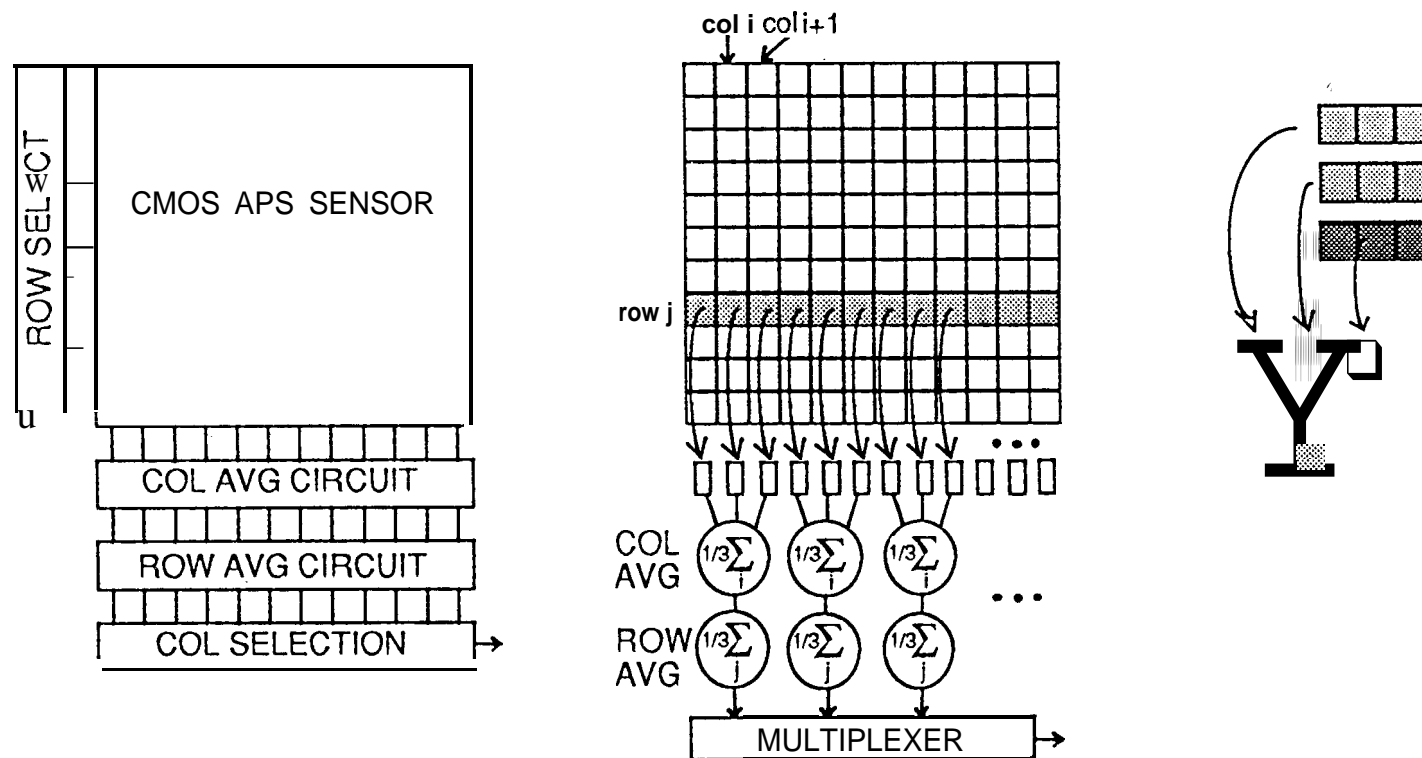
photodiode area



active circuit area

- Photodiodes interconnected through a set of programmable switches
- Capacitance scales nearly with increasing averaging

Column Parallel Approach

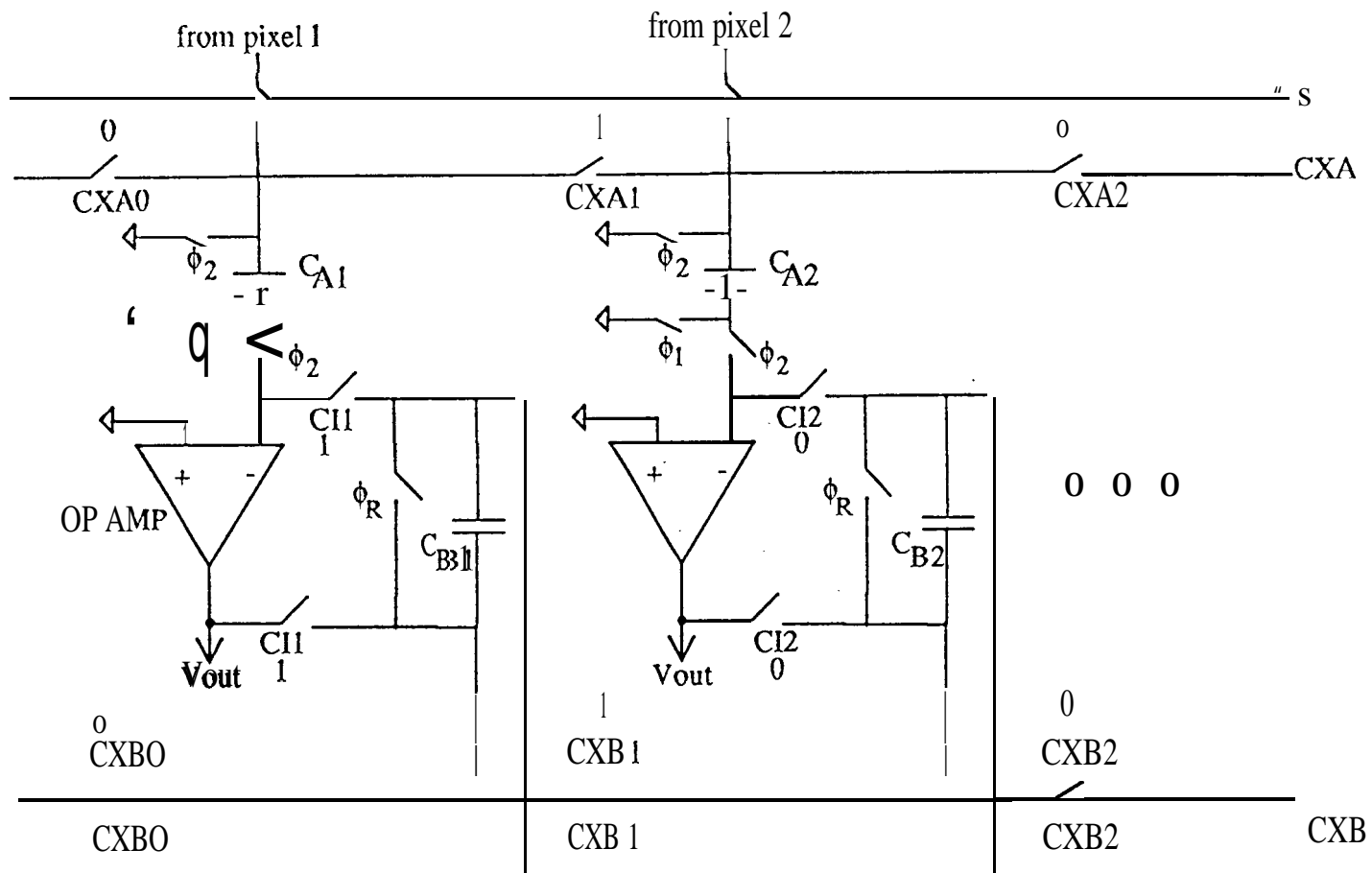


Parallel block averaging of kernels followed by serial readout



Multiresolution APS

Switched Capacitor Implementation



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Multiresolution APS

Project Specifications and Performance

Array Size:

256 × 256

Pixel size:

19.2 μm

Process:

.2 μm CMOS

Fill factor:

30 %

Programmable Window Size:

n rows × m columns

n, m = 1 ..., 256 m ≥ n

Frame Rate:

Full resolution

30 Hz ($T_f = 33.3\text{ms}$)

Lower resolution

$\{T_f/n + n(\text{smal overhead})\}^{-1}$

e.g. 64 × 64

$\{33.3\text{ms}/4 + 4(8\mu\text{s})\}^{-1} = 19.7\text{ Hz}$

Dynamic Range:

75 dB

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Multiresolution APS

Recursion Relation

$$V_{out}(k) = \frac{\sum_{i=1}^{k-1} C_{Bi}}{k} V_{out}(k-1) + \frac{C_{Ai}}{k} V_{in}(k)$$

$$V_{in}(k) = \bar{V}_{k,n}$$

$$\bar{V}_{k,n} = 1/n \sum_{j=1}^n V_{kj}$$

where k is the cycle index
and n is the kernel size

2 x 2 Example

$$V_{out}(2) = \frac{1}{2} V_{out}(1) + \frac{1}{2} \bar{V}_{2,2}$$

$$V_{out}(1) = \frac{0}{1} V_{out}(0) + \frac{1}{1} \bar{V}_{1,2}$$

$$V_{out}(0) = 0$$

therefore

$$V_{out}(2) = \frac{1}{2} \bar{V}_{1,2} + \frac{1}{2} \bar{V}_{2,2}$$

$$= \frac{1}{2} \left(\frac{V_{1,1} + V_{1,2}}{2} \right) + \frac{1}{2} \left(\frac{V_{2,1} + V_{2,2}}{2} \right) \\ = \frac{V_{1,1} + V_{1,2} + V_{2,1} + V_{2,2}}{4}$$

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Multiresolution APS

Switched Capacitor Timing

