# Image Subsampling Strategies for Energy-Efficient Computer Vision

***SenSIP Algorithms and Devices REU***

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## 1. ABSTRACT


- Trend in industry: enable embedded and mobile platforms to become more energy-efficient
- To be more energy-efficient, machines performing a computer vision task utilize image subsampling
- We propose using a heuristic algorithm to determine the most energy-efficient subsampling for a given image.


## 2. MOTIVATION

- Efficient bandwidth usage
- Improved bit rate if transmission is required
- Reduce memory storage

- Specific application: self-powered cameras
- An array of photodiodes that can capture light intensity either to produce a pixel of an image or to harvest energy
- Objective: allow the self-powered camera to utilize more photodiodes for energy harvesting

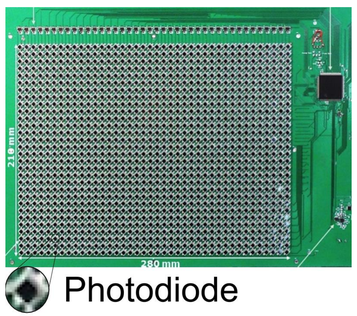


Figure adapted from [1]

## 3. PROBLEM STATEMENT

- Given an N-by-M image, how many pixels can be removed from said image such that a computer vision task can still be performed accurately?

## 4. METHODS OF IMAGE SUBSAMPLING

- Many methods of image subsampling have been developed already (e.g. downsampling the dimension of an image)
- We propose a simple method of image subsampling: removing pixels from an image

Original Image

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Random Pixelation

- Two image subsampling patterns:
  - Removing different numbers of pixels randomly
  - Removing pixels in a checkerboard pattern, varying the size of the alternating squares

## 6. BENCHMARK FOR COMPUTER VISION ACCURACY

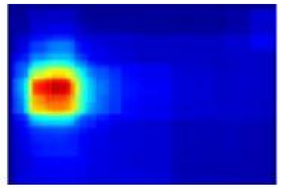
- Three benchmarks for computer vision:
  - Object Detection
  - Classification
  - Semantic Segmentation
- Determine the relationship between the benchmark's measure of error and MSE


Figure from [3]

## 5. MEASURING COMPUTER VISION ACCURACY

- Produce an importance map of an image that detects the likelihood of an object at a given region of the image

Original Image



Importance Map

- Produce an importance map of the image after subsampling
- Calculate the Mean Square Error (MSE) between the importance map of the ground truth image and the subsampled image



- Ground Truth Image



- Checkerboard Mask
- MSE: 0.0223



- Random Pixelation
- MSE: 0.0067

- Analyze relationship between subsampling pattern and MSE

## 7. REFERENCES

[1] S. K. Nayar *et al.*, "Towards self-powered cameras," in *Computational Photography* (ICCP), 2015. IEEE, 2015, pp. 1–10.
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[3] A. Vedaldi *et al.*, "Matconvnet: Convolutional neural networks for matlab," *in Proc. of the 23rd ACM international conf. on Multimedia*. ACM, 2015, pp. 689–692.

## 8. ACKNOWLEDGEMENT

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