INTERACTIVE IMAGE FOREGROUND/BACKGROUND SEGMENTATION USING NETWORK FLOW

(daVinci Group)

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Agenda

- ★ Introduction
- ★ Algorithm Description
- ★ Implementation
- ★ Feature Description
- ★ Results & Evaluation
- ★ Demo
- ★ References

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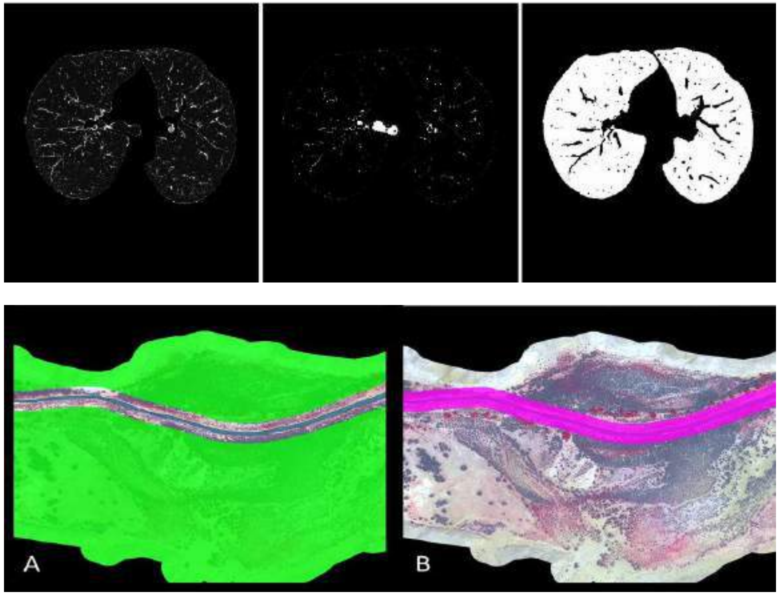
Introduction

★ Image segmentation is a method of **partitioning an image into multiple segments**.

★ The simplest form of image segmentation can be separation of **foreground and background** regions.

★ Aim of segmentation is to get a **simplified and a meaningful representation of an image**, which in turn, can be utilized by other applications for its better analysis.

Image segmentation Applications



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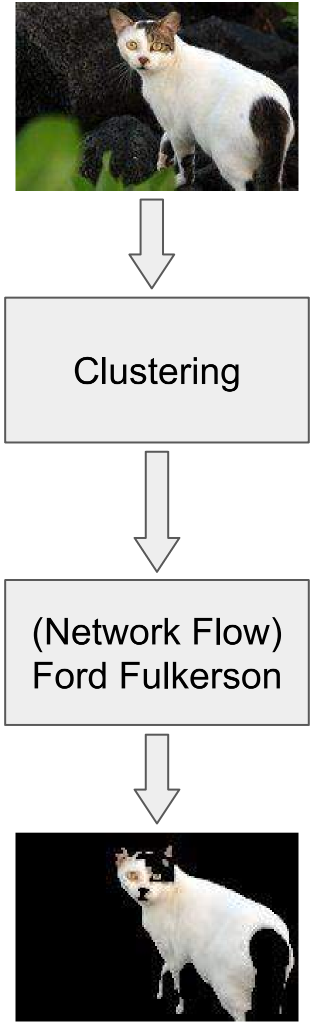
Introduction

★ Image segmentation can be performed by **supervised or unsupervised learning.**

★ Various techniques are used for Image segmentation - we first perform **Clustering**.

★ We use **K-means** vector quantization technique to perform clustering.

★ For our project, we implemented image segmentation using **Ford Fulkerson Network Flow algorithm.**



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Algorithm Description

K-Means

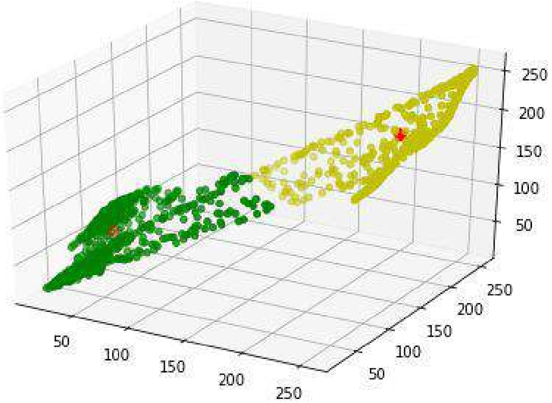
- ★ K-means is an algorithm that is used to cluster the input data points, i.e. pixels in an image, into multiple classes based on the respective distances between one pixel to another.
- ★ To perform K-means we assume that the number of clusters are given as ‘k’, each cluster is represented by its center C_i.

Extension from K-means centroid value:

- ★ D is the distance measurement computed as euclidean value. We calculate the label, L_k for each pixel as:

$$L_k(x_k) = \mathit{arg}\ \min_i D(x_k - C_i) = \mathit{arg}\ \min_i ||x_k - C_i||^2$$

Result from K-means



Algorithm Description

Ford-Fulkerson

- ★ The algorithm builds an undirected graph from the given input image that has 'V' vertices and 'E' edges.
- ★ The edges are all pairs of neighboring pixels and edges connecting source to pixels/pixels to sink.
- ★ For every pixel, “i”, we have a likelihood a_i that it is a part of foreground and a likelihood b_i that it is a part of background.
- ★ We label a single pixel in such a way that if a_i is greater than b_i, then the pixel belongs to foreground else background.
- ★ The likelihood decision about the current pixel depends on its neighbor. For each pair of neighboring pixel, the algorithm assigns the separation penalty p_{ij} that must always be greater than or equal to zero. The algorithm tries to minimize the quantity.

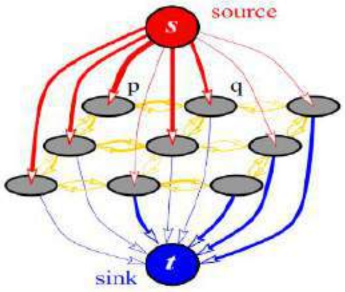
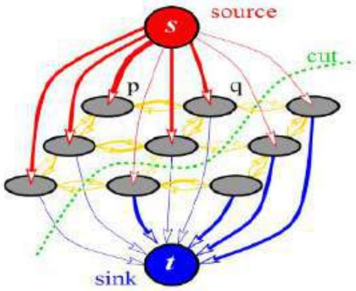


Image representing Graphs used for graph cuts.



A representation of Minimum cut

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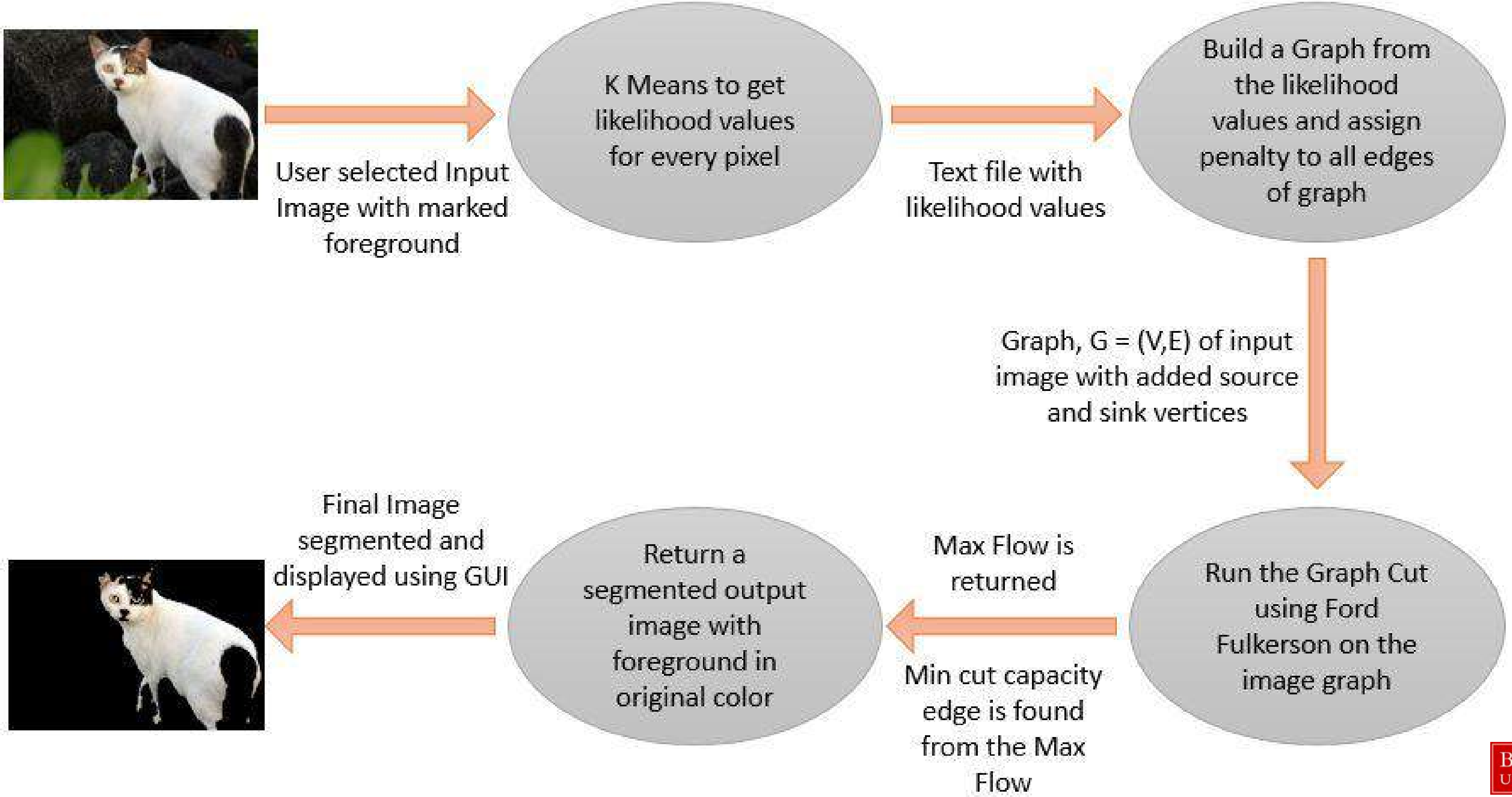
Implementation



Implementation

KMEANS

- ★ K means is implemented using **OpenCV library in Python**.
- ★ Image clustering with the value assigned to **K = 2** is performed.
- ★ **Likelihood values** are generated for each pixel and **saved in a text file**.
- ★ **Range** of likelihood values is from **0 to 10.**

FORD FULKERSON

- ★ Implemented Ford Fulkerson using **Breadth First Search** in **C++.**
- ★ Initialize a **Binary Image** using OpenCV matrix command.
- ★ With the help of two segments and **Adjacency matrix** we assign pixel values **'0' to background (black) and '255' to foreground (white).**
- ★ **Penalty** value can be varied but must be **greater than or equal to 0**.

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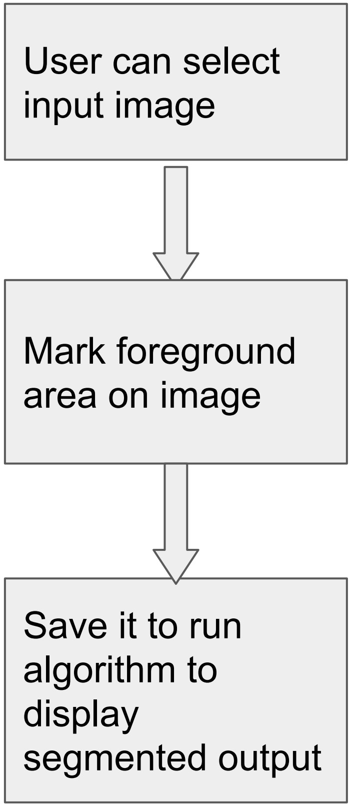
Feature Description

- Interactive **Image browsing feature.**
- **Image marking** to demarcate the regions of foreground and background.
- **Clustering** into two regions using K-means with k value set to 2.
- **Ford-Fulkerson** algorithm to segment the image.
- **Display & save** the segmented Image.

Interactive GUI Implementation flow



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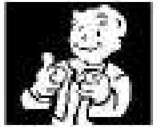
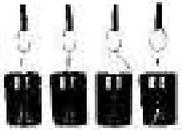
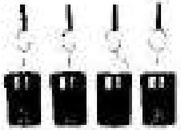
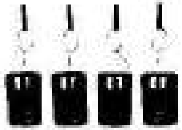
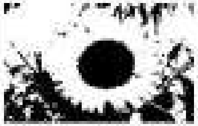
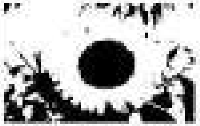
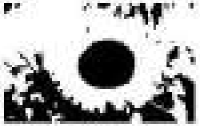
Results & Evaluation

Input image & dimensions	*Segmentation for Penalty = 0*	*Segmentation for Penalty = 1*	*Segmentation for Penalty = 2*
 100 x 100 pixels (format: png)	 Running time = 11 seconds	 Running time = 20 seconds	 Running time = 31 seconds
 250 x 250 pixels (format: jpg)	 Running time = 245 seconds	 Running time = 780 seconds	 Running time = 1054 seconds
 150 x 113 pixels (format: png)	 Running time = 149 seconds	 Running time = 175 seconds	 Running time = 184 seconds

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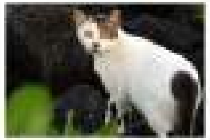
Input Image & dimensions	*Segmentation for Penalty = 1*	*Number of Pixels/Format/Running Time*
		33 x 44 pixels Format: png 0.1 second
		120 x 160 pixels Format: jpg 178 seconds
		200 x 133 pixels Format: jpg 384 seconds
		150 x 150 pixels Format: png 210 seconds
		150 x 113 pixels Format: png 196 seconds

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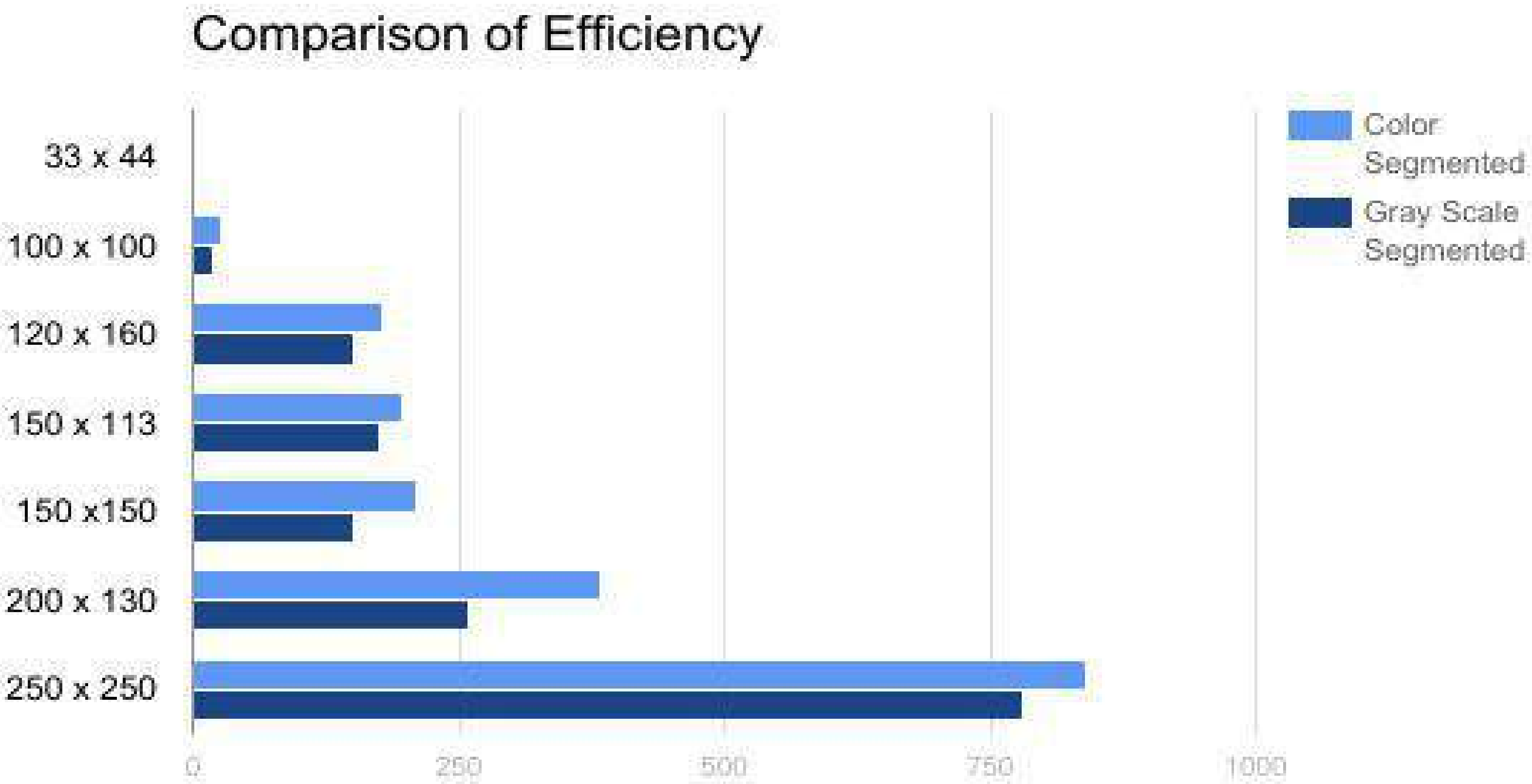

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Why is segmentation using Network flow not ideal?

Input Image	*Segmentation*
	
	

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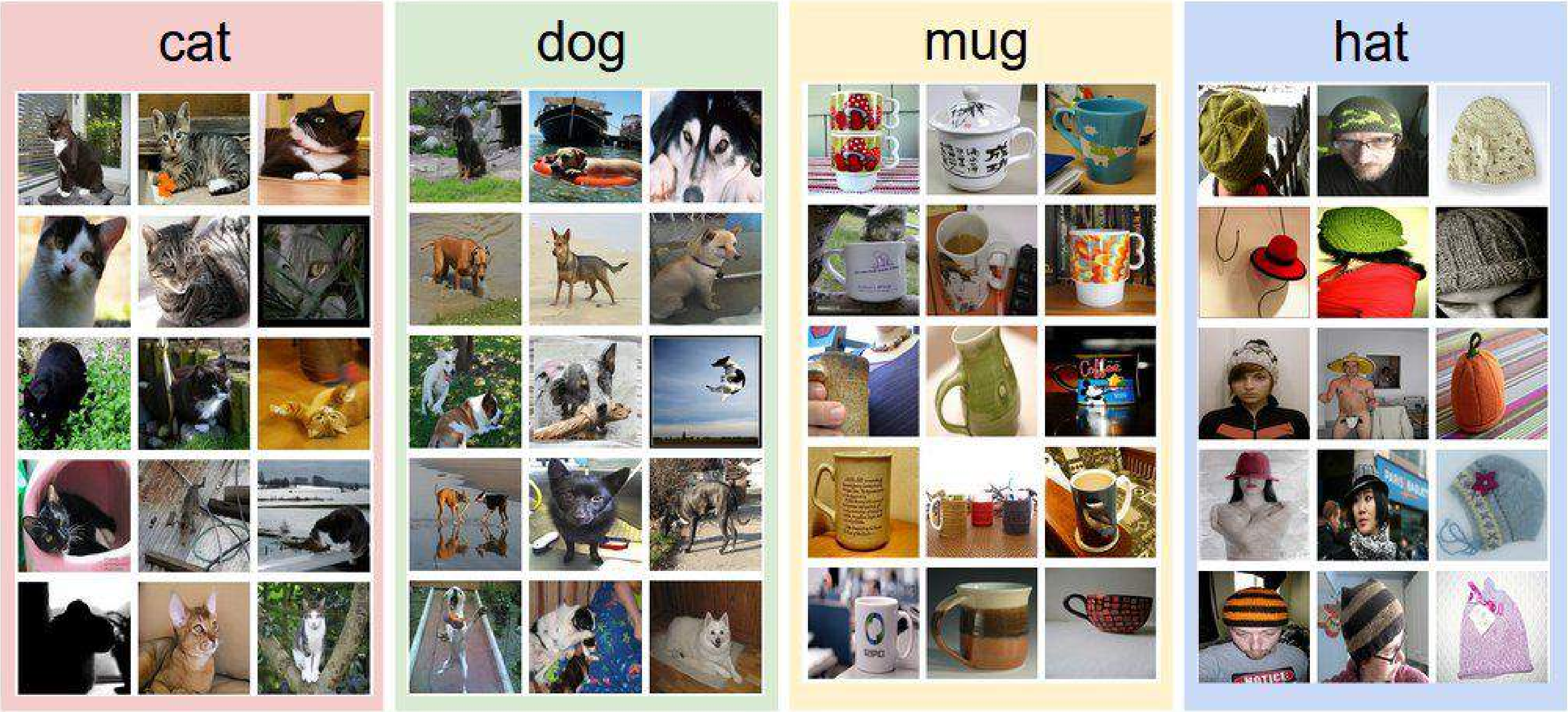
Learning from training set



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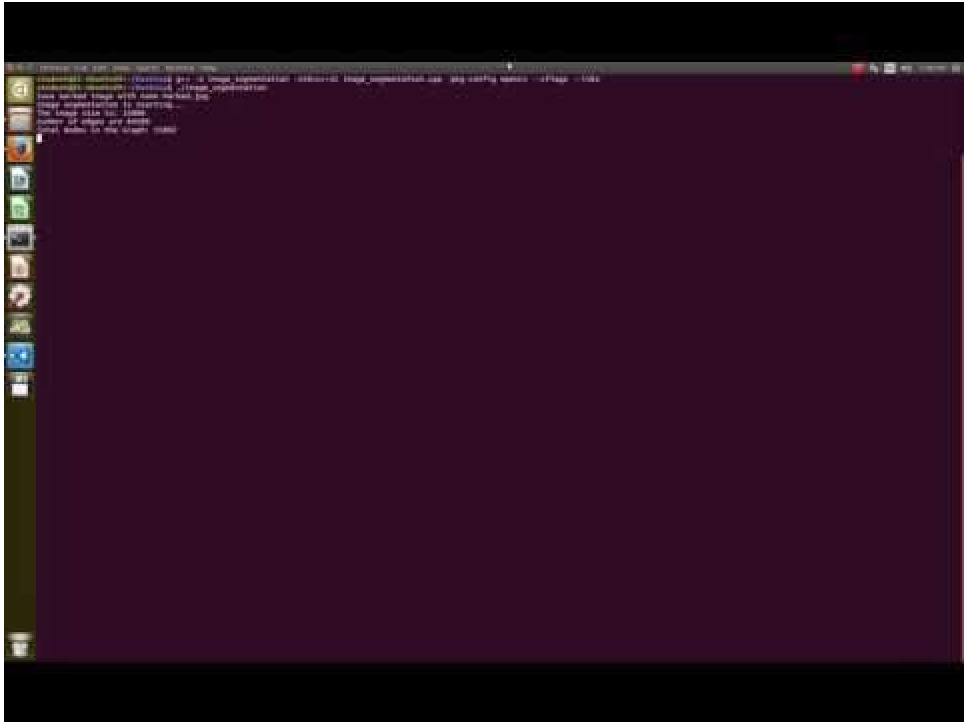
Demo

https://youtu.be/d785ZHLubEM



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References

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[3] *Graph Cuts Approach to the Problems of Image Segmentation* - Ross Whitaker, University of Utah

[4] *Algorithm Design* - Jon Kleinberg and Eva Tardos, Cornell University

[5] *Markov Random Fields for Binary Image Segmentation* - Chris Whiten University of Ottawa

[6] *K Means Cluster Analysis for Image Segmentation* - S.M Aqil Burney and Humera Tariq

[7] *Web References*:
http://docs.opencv.org/3.0-beta/doc/py_tutorials/py_ml/py_kmeans/py_kmeans_opencv/py_kmeans_opencv.html

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SUPER
THANK
YOU