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Engineering Project

Chana Chadad | 316094101
Adi Kobi | 316034347

Advisor: Prof. Shmuel Peleg

The algorithm

base on the article

“Interactive Digital Photomontage“

We use graph-cut optimization to create a composite that satisfies the image and seam objectives specified by the user

Suppose we have n source images $S_1,...,S_n$.

To form a composite, we must choose a source image S_i for each pixel p.

We call the mapping between pixels and source images a **labeling** and denote the label for each pixel L(p) We say that a seam exists between two neighboring pixels p, q in the composite if L(p)!=L(q).

alpha expansion

This is an iterative algorithm

The t'th iteration of the inner loop of the algorithm takes a specific label α and a current labeling L_t as input and computes an optimal labeling L_{t+1} such that L_{t+1} (p)= L_t(p) or L_{t+1} (p)=α.

we choose this value according to a cost function.

The outer loop iterates over each possible label.

The algorithm terminates when a pass over all labels has occurred that fails to reduce the cost function

Cost function

we define the cost function C of a pixel labeling L as the sum of two terms: a data penalty C_d over all pixels p and an interaction penalty C_i over all pairs of neighboring pixels p, q:

$$C(L) = \sum_{p} C_d(p, L(p)) + \sum_{p,q} C_i(p, q, L(p), L(q))$$

Cost function

$$C(L) \quad = \quad \sum_{p} C_d(p, L(p)) + \sum_{p,q} C_i(p, q, L(p), L(q))$$

C_d: Designated image: 0 if L(p)=u, where Su is a user-specified source image, and a large penalty otherwise.

Cost function

$$C(L) \quad = \quad \sum_{p} C_d(p, L(p)) + \sum_{p,q} C_i(p, q, L(p), L(q))$$

C_i : We define the seam objective to be 0 if L(p)=L(q). Otherwise, we define the objective as:

$$C_i(p, q, L(p), L(q)) = \begin{cases} X & \text{if matching "colors"} \\ Y & \text{if matching "gradients"} \\ X + Y & \text{if matching "colors \& gradients"} \end{cases}$$

where

$$X \quad = \quad \|S_{L(p)}(p) - S_{L(q)}(p)\| + \|S_{L(p)}(q) - S_{L(q)}(q)\|$$

$$Y \quad = \quad \|\nabla S_{L(p)}(p) - \nabla S_{L(q)}(p)\| + \|\nabla S_{L(p)}(q) - \nabla S_{L(q)}(q)\|$$

Max flow-min cut

In optimization theory, maximum flow problems involve finding a feasible flow through a flow network that obtains the maximum possible flow rate.

The maximum value of a source to destination flow is equal to the minimum capacity of an source to destination cut, as stated in the max-flow min-cut theorem.

Max flow-min cut

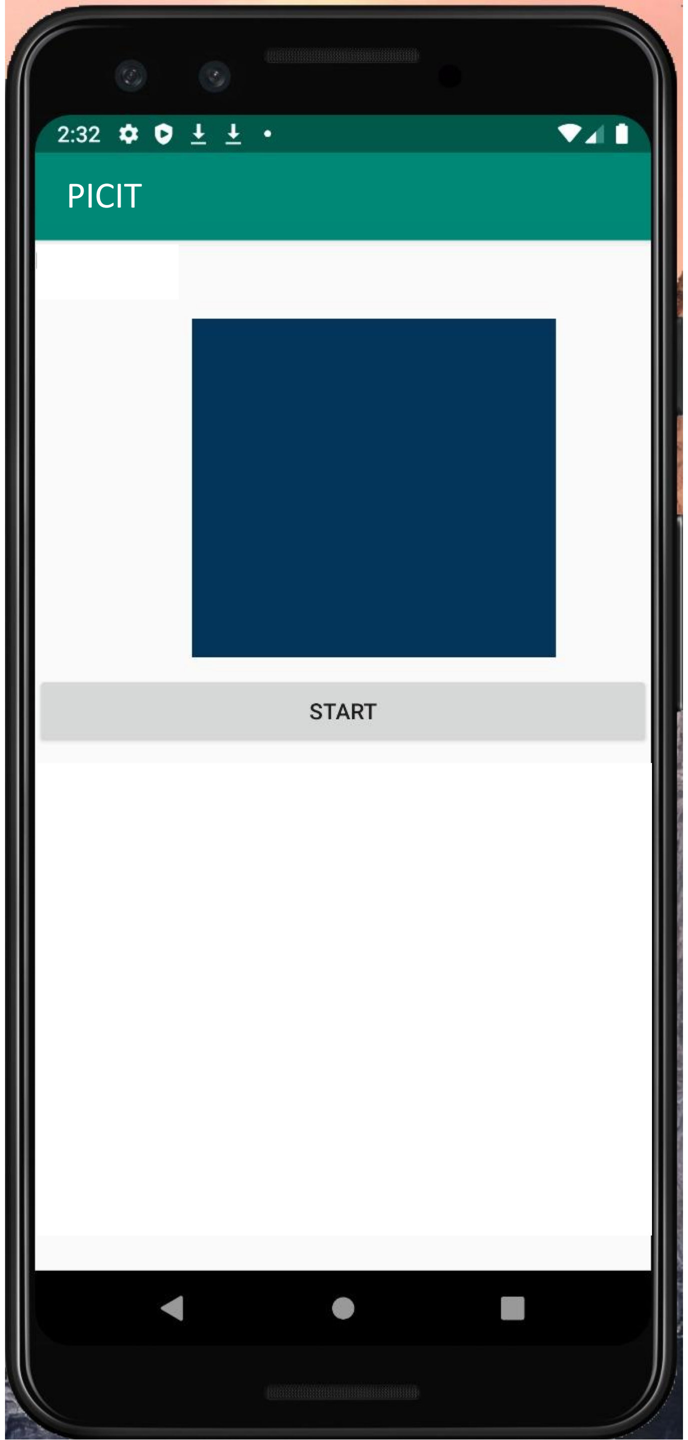
In each iteration for each alpha, we calculate a graph that represents the label selection so that the graph edges describe the cost for each labeling.

On this graph we run the max flow algorithm and check whether the flow we received is smaller than the minimum min-cut we have received so far.

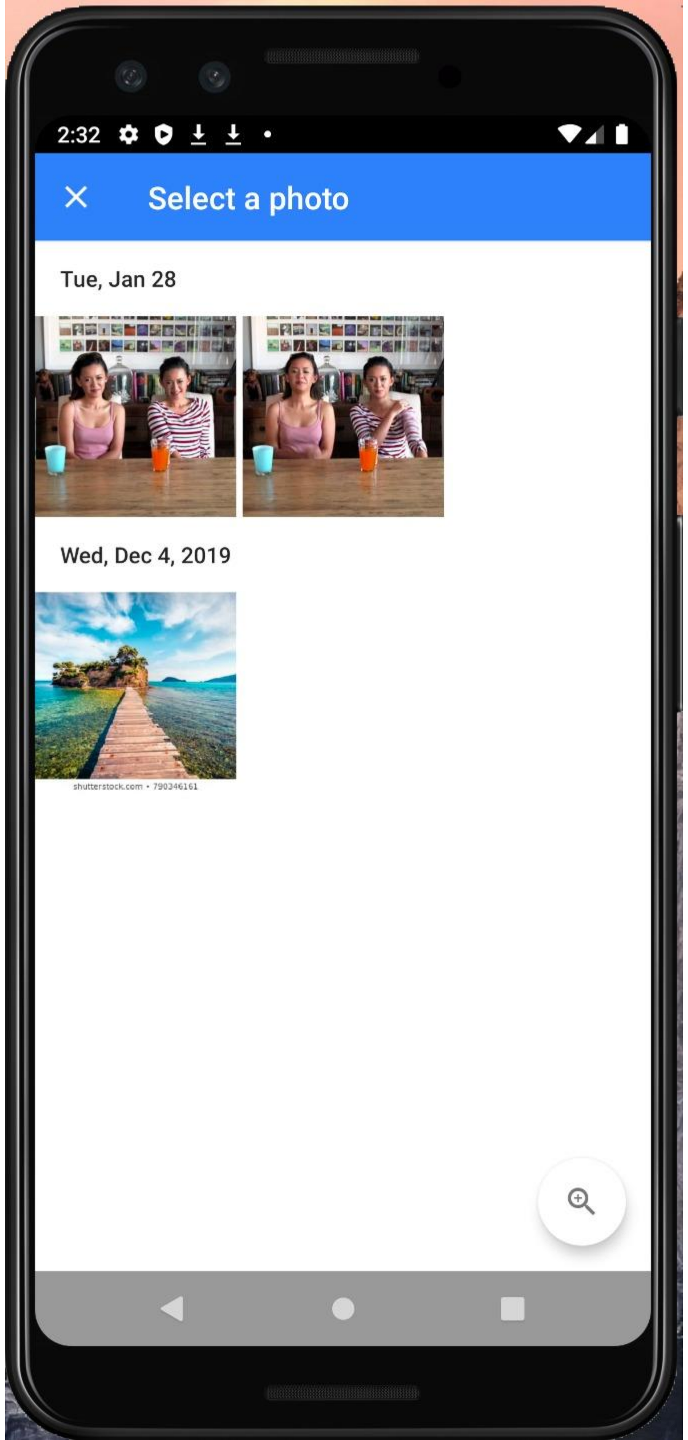
If so, there is improvement and we will do the whole loop over all the possible alpha again.

else, it means that we have already found the best min cut and have not improved any more, so we can stop the algorithm.

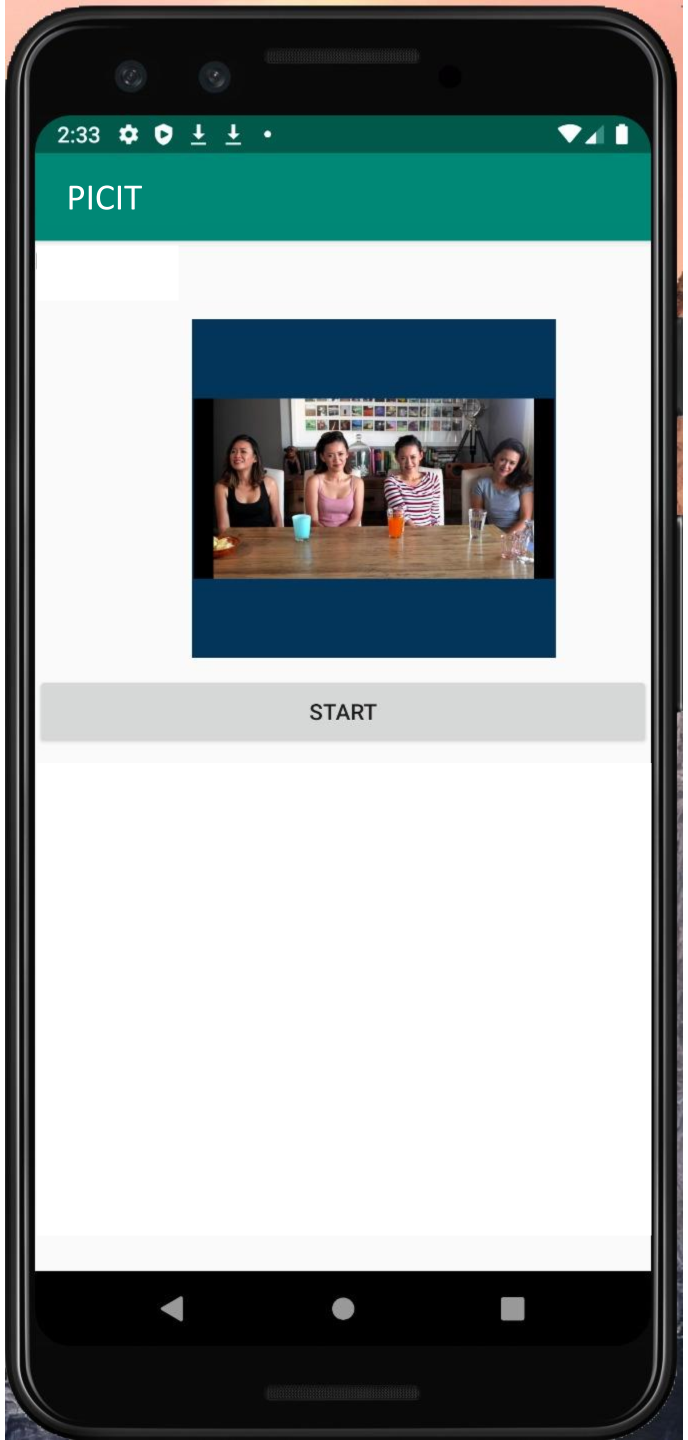
When we finish the algorithm, we can set the value of each pixel according to the optimal label for it.



Press the blue square to open the gallery

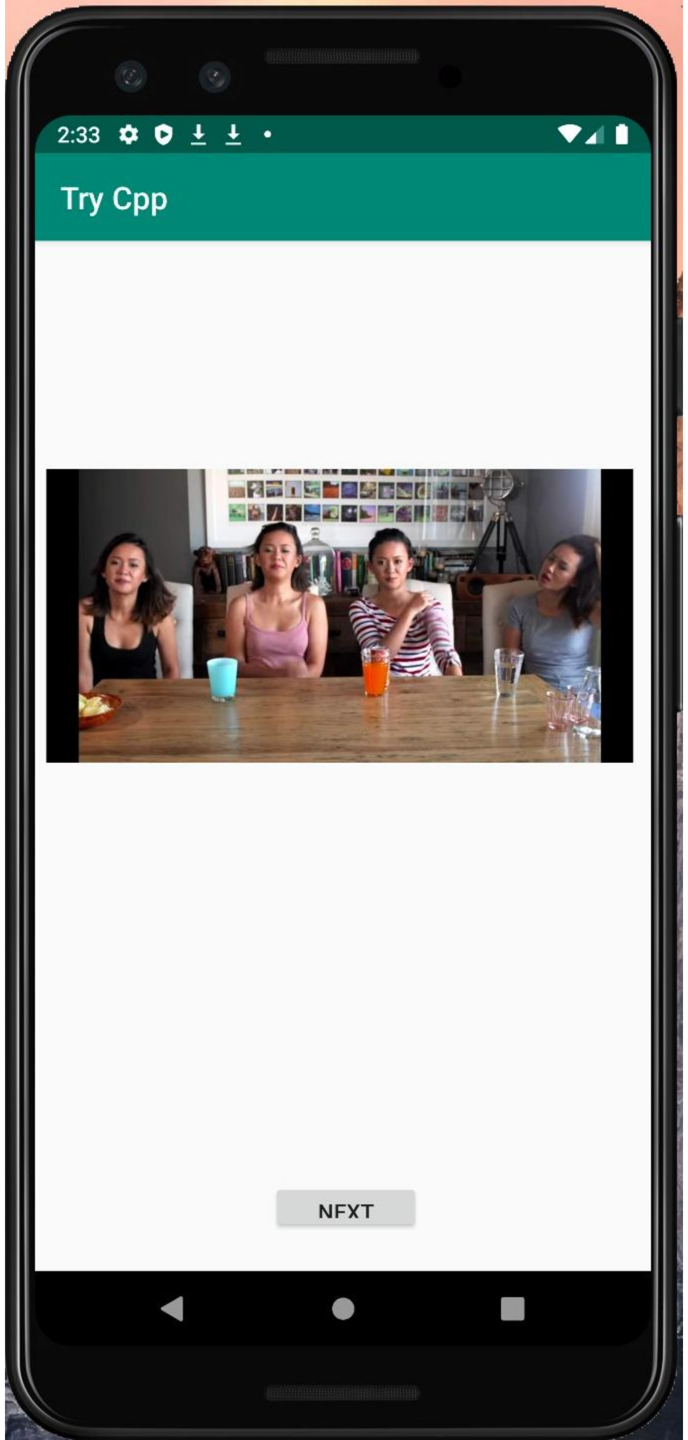


Choose the first image



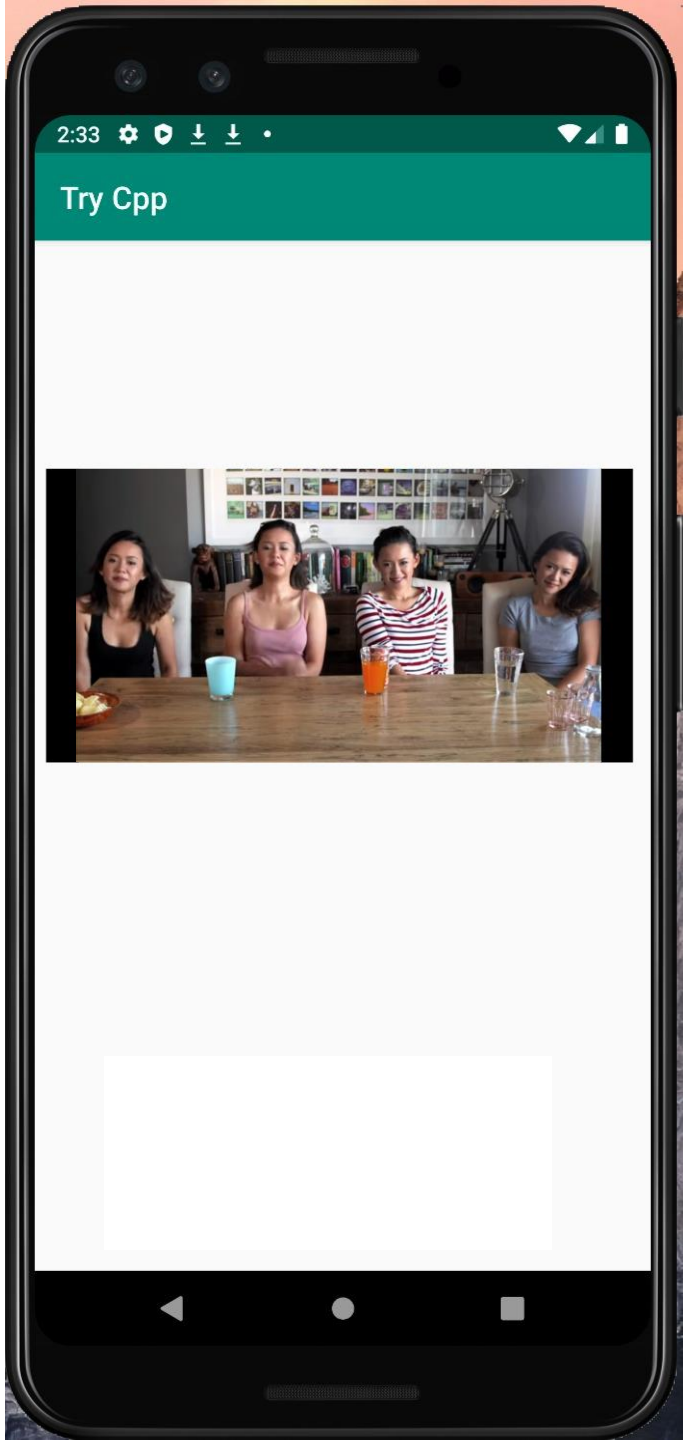
Choose the next images.

Press start



Mark the part that you want from each image by touching the screen in the relevant area.

Press next to pass to the next image



Get the final image


1


2


result


1
2
3