Recognition and Price Computation of Products from their Image

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Problem Statement:

Shopping is an essential part of life; Visiting grocery stores can be daunting at times during weekends when there is a large crowd, in turn, delaying the billing process due to a limited number of counters. The matter becomes worse for people with few items in their cart as the waiting time becomes an overhead. Expediting this process can save us a lot of time.
Current billing system uses barcodes to scan and identify products which acts as a unique identifier for each product type. Although every item has barcodes assigned, their detection requires them to be placed in a specific position and orientation resulting in wastage of time that could have been saved otherwise. Considering thousands of items sold per day, even seconds of extra time spent per item can lead to a huge loss of our valuable time. We intend to minimize the time spent with our solution.

Motivation:

The motive of our work is to improve the shopping experience by scanning products directly from the cart and automating the billing process; thus effectively avoiding long queues and reducing cashier overhead along with dynamically estimating total price based on the addition and removal of items.

State-of-the-art:

Woodman Store in Madison has a conveyor belt where each item is placed separately with barcode facing up. A sensor is placed facing the conveyor belt which reads the barcode. The price is displayed based on the corresponding entry in the database. Amazon has recently made a similar framework for billing purposes whose implementation remains private.
This would be the first project of its sort where Computer Vision is used to detect grocery items from their images instead of a simple barcode. This will help us in identifying multiple items in less time complexity than a sequential scan of the individual items.

Our Solution:

The proposed algorithm will take an image of one or more items present in a shopping cart, detect each of them and display the total price of the items as the output. This will not only reduce the long queues but maximize the efficiency by taking just one scan/picture per customer rather than experiencing an O(n) complex time for n items. Also, no one has worked on grocery items which don't have price tags.

Feature detection algorithms do not require huge training sets to work on and work perfectly under various lighting conditions and orientations. It can also help in detecting one brand from others even though the size/packaging is similar.

Our plan:

We intend to start with single object detection and work towards detecting multiple and overlapping items in images.

The plan is to complete the project in the following four phases -

1. Collection of labelled image data. The data includes images of grocery items along with their prices.
2. The initial phase will recognize individual shopping items and display its price.
3. The next phase will involve multiple items in the same image. It will detect all the items, segment them and recognize each of them giving their individual prices and the total price as well.
4. The final phase will test the algorithm with overlapping items. We will be comparing the percentage of overlap with the corresponding accuracy of the method. We would also do some other performance evaluation as mentioned later.

Timeline:

We would be following these steps into the phases -

1. Create dataset by storing the images of the grocery items and their price.
2. Take the image with one item and identify its SIFT features.
3. Apply geometrical mapping to the image.
4. Match this image with the dataset and retrieve the price of the matched image.
5. Return the original image with its price over the object.
6. Next, extend this to take images with multiple items in one image.
7. Segment the image so that each segment would have only one item.
8. Carry steps 2 to 4 on each segmented image.
9. Return original image with overlaid prices of corresponding items and the total price of all the items.

Mid-term report will contain step 1 to 5. Remaining steps will be included in final report, presentation and web page.

Performance Evaluation: We are planning to-

1. Evaluate the performance of the algorithm by finding its precision (number of correctly detected items as a fraction of the total number of items detected) and accuracy (number of correctly detected items as a fraction of total items in the image).
2. Study the precision and accuracy changes with an increase in the overlapping of the items.
3. Observe the behaviour of the algorithm when there is a change in the distance and the camera angles while taking the image of the items.
4. Check for significant changes in the performance of the algorithm for different combinations of items in the image.

References:

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