Background Subtraction for Moving and Stationary Object Detection

Tilak Nanavati, Charmy Patel

201811001, 201811013

Dhirubhai Ambani Institute of Information and Communication Technology

Computer Vision

21 November 2019

Points to be covered

Continue...

Background Subtraction

- **Background subtraction** is a technique which allows an image's foreground to be extracted for further processing (object recognition etc.).
- Particularly used in the systems where the region of interest are objects such as humans, cars, chair, etc.
- **Applications of Background Subtraction:**
  1. Video surveillance
  2. Optical motion capture
  3. Human computer interaction
  4. Content-based video coding
  5. Traffic monitoring
  6. Real-time motion gesture recognition

Ref: Foreground detection (*https : //en.wikipedia.org/wiki/Foreground$_d$etection/Applications*)

Continue...

Problem Statement

Problems in the current scenario!

- Object shadows are mistakenly considered as the object parts.
- Light switches or local gradual changes of illuminations may lead to wrong object detection.
- Higher false positive rate in conventional approach.[1]

Ref: [1] Lucia Maddalena and Alfredo Petrosino. Background subtraction for moving object detection in rgbd data: A survey. page 27, April.-May. 2018

Continue...

Proposed Approach

Taking depth as a new dimension!

- **Depth** data has opened new ways of dealing with the problems addressed above.[1]
- RGBD Data is collection of **RGB images** with the corresponding **depth images**.
- The proposed approach is to use the depth data as the fourth dimension of the pixel vector and use it to mitigate the above listed problems.

Ref: [1] Lucia Maddalena and Alfredo Petrosino. Background subtraction for moving object detection in rgbd data: A survey. page 27, April.-May. 2018

Continue...

Overview of Dataset - abandoned2

The dataset contains:

- **RGB Images**
- Corresponding **Depth Images**
- Corresponding **Ground Truth Images** (For selected images)
- **Dataset used:** SBM-RGBD/IntermittentMotion/abandoned2
- **No of frames:** 250
- **Image Size:** 640*480



Link : Dataset (*http : //rgbd2017.na.icar.cnr.it/SBM − RGBDdataset.html*)

Overview of Dataset - sleeping-ds

The dataset contains:

- **RGB Images**
- Corresponding **Depth Images**
- Corresponding **Ground Truth Images** (For selected images)
- **Dataset used:** SBM-RGBD/IntermittentMotion/Sleeping-ds
- **No of frames:** 300
- **Image Size:** 640*480



Link : Dataset (*http : //rgbd2017.na.icar.cnr.it/SBM − RGBDdataset.html*)

Continue...

Stationary Object Detection

Frame differencing for stationary object (Without depth dimension) [2]

Procedure:

1. In this we are converting our frames to gray-scale image.
2. Then we subtract background frame from current frame which gives RGB differecnce image.
3. After that we perform thresholding on RGB difference image.

Ref: [2] G. Rao and Ch.Satyanarayana.Object tracking system using approximate median filter, kalman filterand dynamic template matching.International Journal of Intelligent Systems and Applications, 6, 042014.

Results

Confusion Matrix (Dataset: abandoned2)

Confusion matrix for abandoned2 dataset image shown in previous slide without considering depth parameter and using frame differencing method.

Actual Values

Predicted Values

Total: 307200	Positive (1)	Negative (0)
Positive (1)	TP 77207	FP 67862
Negative (0)	FN 7310	TN 154821

Frame differencing for stationary Object (With depth dimension)[1]

Procedure:

1. In this again we are converting our frames to gray-scale image.
2. Then we are subtracting background frame from current frame as well as subtracting background depth from current depth frame.
3. After that we perform thresholding on RGB difference image as well as depth difference image.

Ref: [1] Lucia Maddalena and Alfredo Petrosino.Background subtraction for moving object detection in rgbd data: Asurvey.page 27, April.-May. 2018.

Confusion Matrix (Dataset: abandoned2)

Confusion matrix for abandoned2 dataset image shown in previous slide, considering depth parameter using frame differencing.

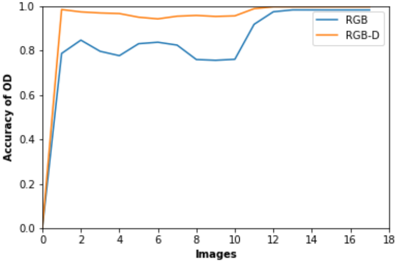
Actual Values

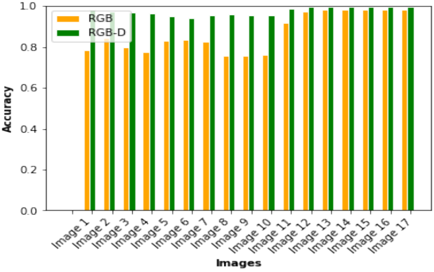
Predicted Values	Total: 307200	Positive (1)	Negative (0)
	Positive (1)	TP 75811	FP 5862
	Negative (0)	FN 8706	TN 216821

Results

Accuracy graph - abandoned2

Comparing the results with their respective groundtruth for RGB and RGBD image for abandoned2 dataset.[3]



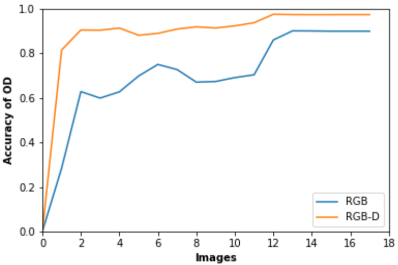


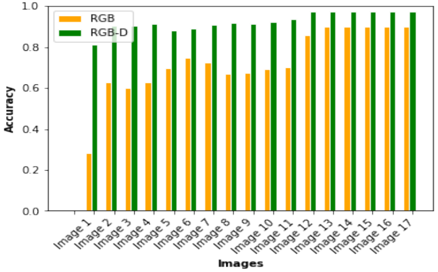
Ref: [3] Shireen Elhabian, Khaled El-Sayed, and Sumaya Ahmed.Moving object detection in spatial domain using background removal techniques.Recent Patents on Computer Science, 1:32–54, 01 2008.

Results

F-score graph - abandoned2

comparing the results with their respective groundtruth for RGB and RGBD image for abandoned2 dataset





Average filtering for moving object (Without depth dimension)

This includes the result from sleeping-ds dataset without considering depth parameter

1. In this we are converting our frames to gray-scale image.
2. Then we are averaging the previous 20 frames and subtracting it from current frame.
3. After that we perform thresholding on RGB difference image.

Results

Confusion Matrix (Dataset: sleeping-ds)

Confusion matrix for moving object dataset image shown in previous slide without considering depth parameter and using average filtering.

Actual Values

Total: 307200	Positive (1)	Negative (0)
Predicted Values: Positive (1)	TP 22633	FP 12532
Predicted Values: Negative (0)	FN 41635	TN 230400

Moving Object Detection

Average filtering for moving object (With depth dimension)[1]

Procedure:

1. In this again we are converting our frames to gray-scale image.
2. Then we are subtracting average of previous 20 RGB frames from current RGB frame. We apply the same procedure for depth frames as well.
3. After that we perform thresholding on RGB difference image as well as depth difference image.

Ref: [1] Lucia Maddalena and Alfredo Petrosino.Background subtraction for moving object detection in rgbd data: Asurvey.page 27, April.-May. 2018.

Results

Confusion Matrix (Dataset: sleeping-ds)

Confusion matrix for moving object dataset image shown in previous slide considering depth parameter and using average filtering.

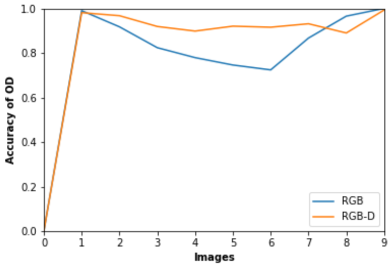
Actual Values

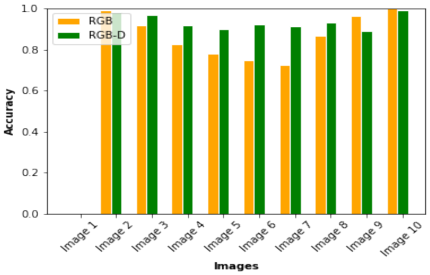
Total: 307200	Positive (1)	Negative (0)
Predicted Values: Positive (1)	TP 48398	FP 9069
Predicted Values: Negative (0)	FN 15870	TN 233863

Results

Accuracy graph - sleeping-ds

Comparing the results with their respective groundtruth for RGB and RGBD image for sleeping-ds dataset.[3]



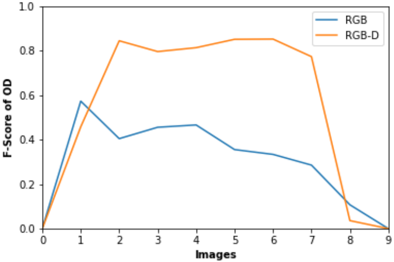


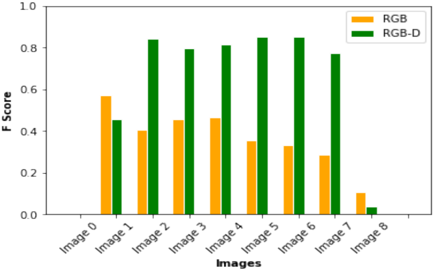
Ref: [3] Shireen Elhabian, Khaled El-Sayed, and Sumaya Ahmed.Moving object detection in spatial domain using background removal techniques.Recent Patents on Computer Science, 1:32–54, 01 2008.

Results

F-score graph - sleeping-ds

Comparing the results with their respective groundtruth for RGB and RGBD image for sleeping-ds dataset





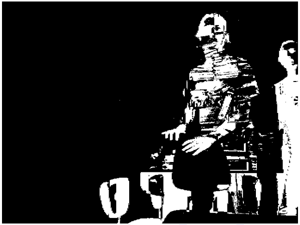
Mixture of Gaussians (MoG)

Gaussian filtering for moving object

Procedure:

1. In this we are using MOG inbuilt method.
2. It uses a method to model each background pixel by a mixture of K Gaussian distributions (K = 3 to 5).
3. The weights of the mixture represent the time proportions that those colours stay in the scene.
4. The probable background colours are the ones which stay longer and more static.





Results

Confusion Matrix(Dataset: sleeping-ds)

Confusion matrix for moving object dataset image shown in previous slide considering depth parameter and using “Mixture of Gaussian” filtering.

Actual Values

Predicted Values	Total: 307200	Positive (1)	Negative (0)
	Positive (1)	TP 8319	FP 25019
	Negative (0)	FN 34496	TN 239366

Continue...

Future Work

Exploring further techniques for Background subtraction

- To Study Mixture of Gaussian considering depth parameter.[4]
- To study deep architectures for learning the background subtraction.
- To study novel approach discussed in class and given in paper which uses the rule $|x_{i,j,k} - \mu_{i,j}| < 3 * \sigma_{i,j}$.[5]

Ref: [4] Y. Song, S. Noh, J. Yu, C. Park, and B. Lee.Background subtraction based on gaussian mixture models using colorand depth information.InThe 2014 International Conference on Control, Automation andInformation Sciences (ICCAIS 2014), pages 132–135, Dec 2014.

Ref: [5] P. Kumar, S. Ranganath, Huang Weimin, and K. Sengupta.Framework for real-time behavior interpretation from traffic video.IEEE Transactions on Intelligent Transportation Systems, 6(1):43–53,March 2005.

Continue...

References I

Lucia Maddalena and Alfredo Petrosino.
Background subtraction for moving object detection in rgbd data: A survey.
page 27, April.-May. 2018.

G. Rao and Ch.Satyanarayana.
Object tracking system using approximate median filter, kalman filter and dynamic template matching.
International Journal of Intelligent Systems and Applications, 6, 04 2014.

Shireen Elhabian, Khaled El-Sayed, and Sumaya Ahmed.
Moving object detection in spatial domain using background removal techniques-state-of-art.
Recent Patents on Computer Science, 1:32–54, 01 2008.

References II

Y. Song, S. Noh, J. Yu, C. Park, and B. Lee.
Background subtraction based on gaussian mixture models using color and depth information.
In *The 2014 International Conference on Control, Automation and Information Sciences (ICCAIS 2014)*, pages 132–135, Dec 2014.

P. Kumar, S. Ranganath, Huang Weimin, and K. Sengupta.
Framework for real-time behavior interpretation from traffic video.
IEEE Transactions on Intelligent Transportation Systems, 6(1):43–53, March 2005.

Continue...

Appendix

$$\textbf{Accuracy} = \frac{TP + TN}{TP + TN + FP + FN}$$

$$\text{Precision} = \frac{\text{True Positive}}{\text{Predicted Positive}}$$

$$\text{Recall} = \frac{\text{True Positive}}{\text{Actual Positive}}$$

$$\text{F1} = 2 \cdot \frac{\text{Precision} \cdot Recall}{\text{Precision} + \text{Recall}}$$