Test/ Debugger: imgCropMULTI

Summary: Works through step by step the preprocessing and cropping stages. Useful for code debugging and investigating preprocessing quality of a particular frame.

User notes:

1) Make sure relevant function files, videos and individual video frames are located in the same folder as this live script. So far, only works on horizontal flow videos.

2) There are some user-defined inputs, particularly video/ image file name. Other processing parameters can also be adjusted as see fit.

V2.0. SWC, 19 Feb 2021.

```
close all
clear
```

1) Load video

```
vid_file_name = 'SDS001_SO5cSt 12 uL_23 uL SDS_50 mM 062.avi'; %<-------- user-defined input!!
% vid_file_name = 'DYE003_52%Gl_W_0.003_Ink_SO_SPAN80_0.003_2kfps_.avi';
vid = VideoReader(vid_file_name); %read video
totframes = vid.NumFrames %check total num of frames in video
```

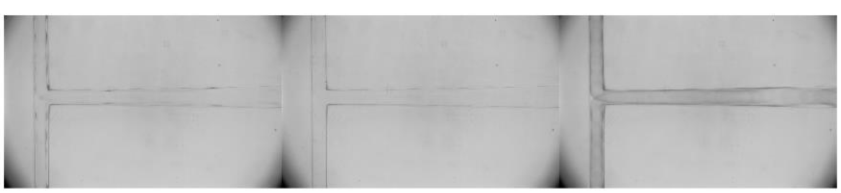
```
totframes = 724
```

2a) Background generation - 'Basic' Statistical Approach

Shows 3 methods: i) Median, ii) Mode and iii) Mean

```
n = 200;    % number of frames to use for background generation  <--------
user-defined input!!

[med_bg mod_bg avg_bg] = bgGenBasic(vid_file_name,n); %custom function
```

```
Processed video: SDS001_SO5cSt 12 uL_23 uL SDS_50 mM 062.avi
Median; Elapsed time = 35.28
Mode; Elapsed time = 149.61
Mean; Elapsed time = 80.70
```



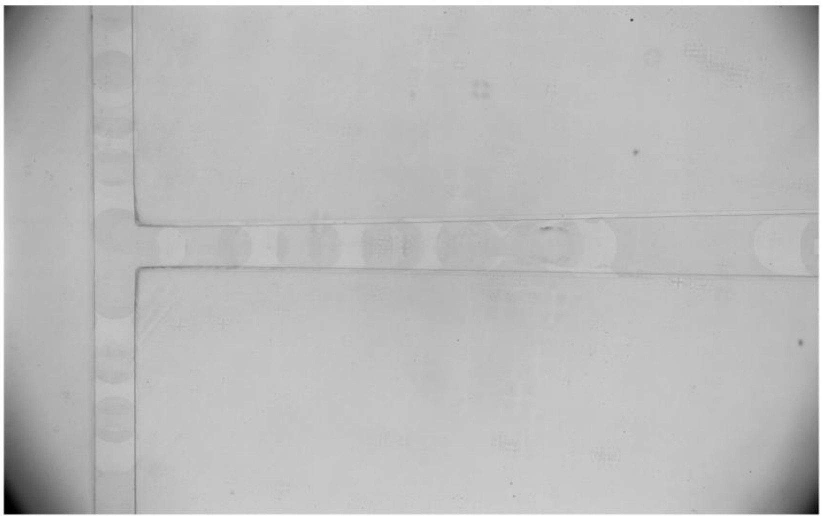
2b) Background generation - 'Complex' Statistical Approach

(Adapted from ADM method)

```
n = 40;    % number of frames to use for background generation <-------- user-defined input!!

bg = bgGenCmplx(vid_file_name,n,'original'); %custom function
```

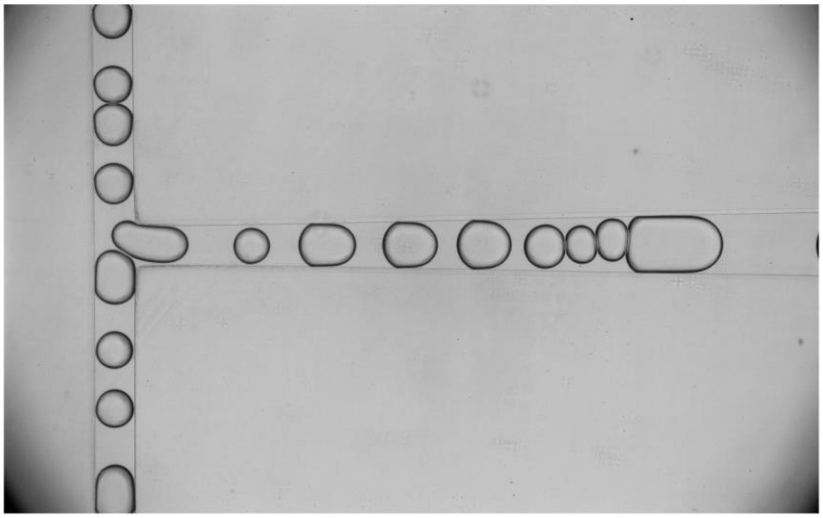
```
Processed video: SDS001_SO5cSt 12 uL_23 uL SDS_50 mM 062.avi
Using standard algorithm...
Elapsed time is 85.914387 seconds.
```

```
% 'original': for WAT, TRI, SDS, DYE.
% 'modified': for C12Tab.

figure; imshow(bg);
```



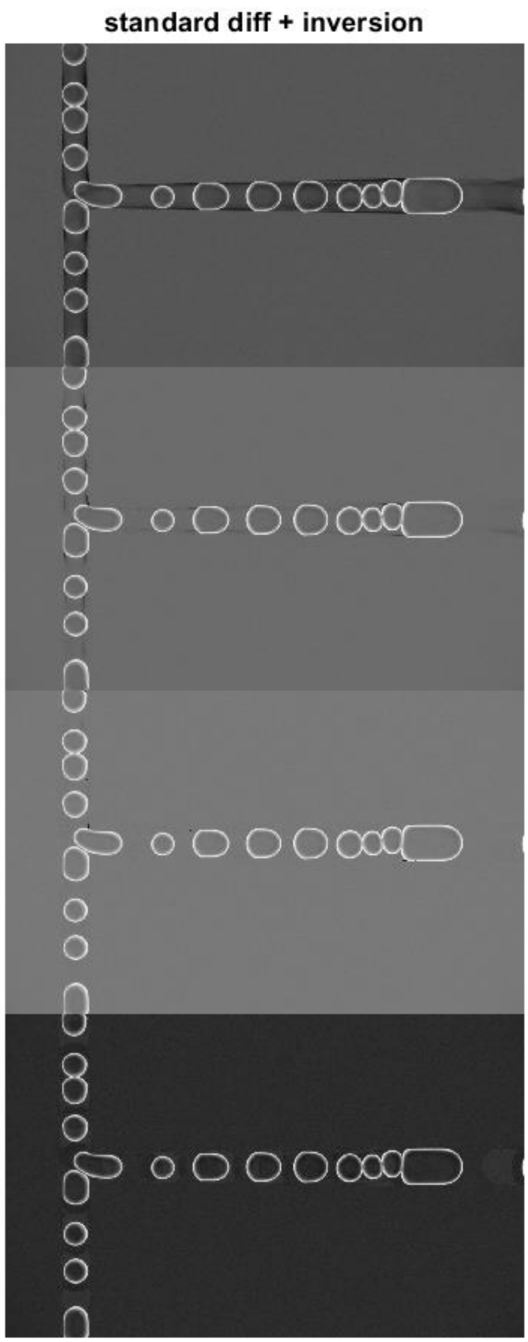
3) Load test image

```
% Load images
I = imread('SDS001_687.jpg');   %<-------- user-defined input!!

% check images loaded correctly
figure; imshow(I);
```



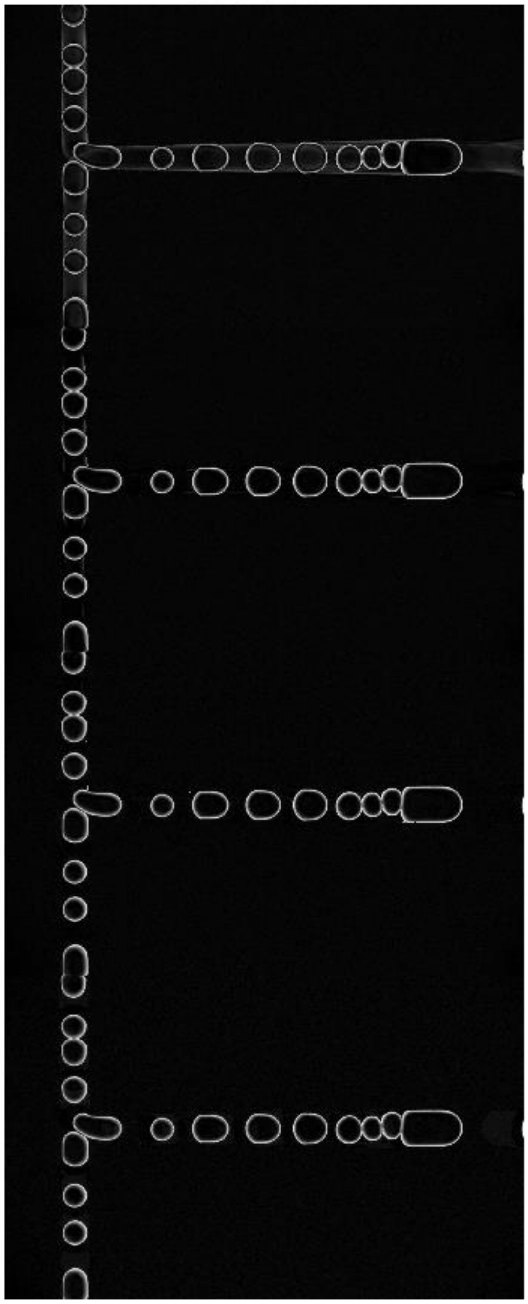
4) Background Subtraction

```
%% From Mean background generation
subMean = rescale(1-(double(I) - double(avg_bg))); % std diff with inversion
subMean2 = rescale(abs(double(I) - double(avg_bg))); % abs subtraction

%% From Median background generation
subMed = rescale(1-(double(I) - double(med_bg))); % std diff with inversion
subMed2 = rescale(abs(double(I) - double(med_bg))); % abs diff

%% From Mode background generation
subMax = rescale(1-(double(I) - double(mod_bg))); % std diff with inversion
subMax2 = rescale(abs(double(I) - double(mod_bg))); % abs diff

%% From complex background generation method
subCom = rescale(1-(double(I) - double(bg))); % std diff with inversion
subCom2 = rescale(abs(double(I) - double(bg))); % absdiff

figure;
montage({subMean subMed subMax subCom}, 'Size', [4 1]); title('standard diff +
inversion');
```




```
 figure; montage({subMean2 subMed2 subMax2 subCom2}, 'Size', [4 1]);
title('absolute diff');
```

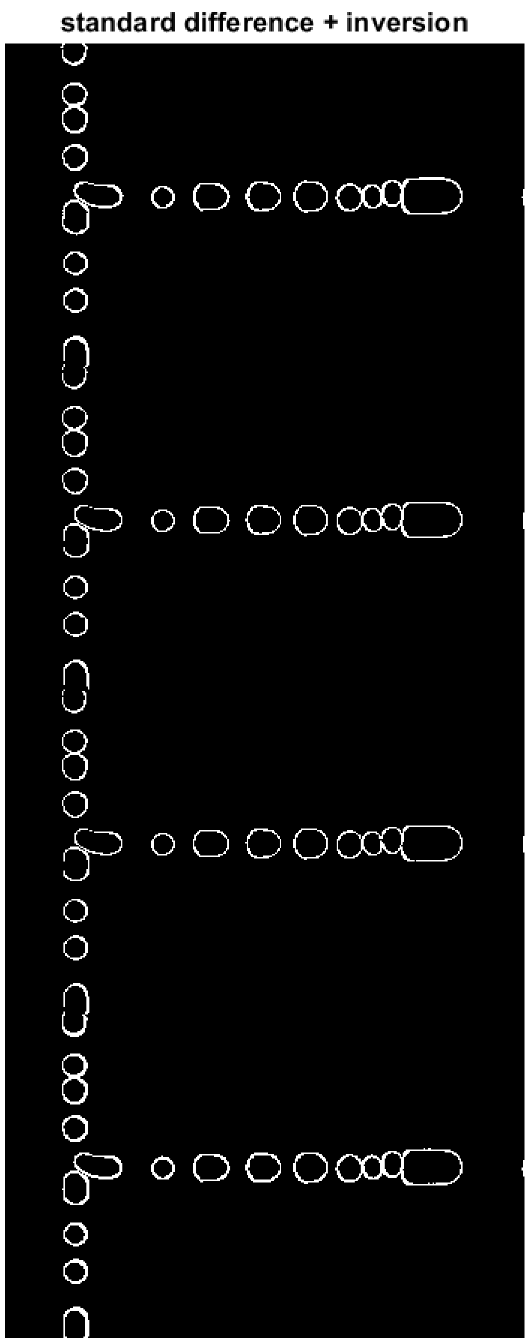
absolute diff



```
% figure; imshow(subMean); title('mean')
% figure; imshow(subMed); title('median')
% figure; imshow(subMax); title('mode')
% figure; imshow(subCom); title('complex')
```

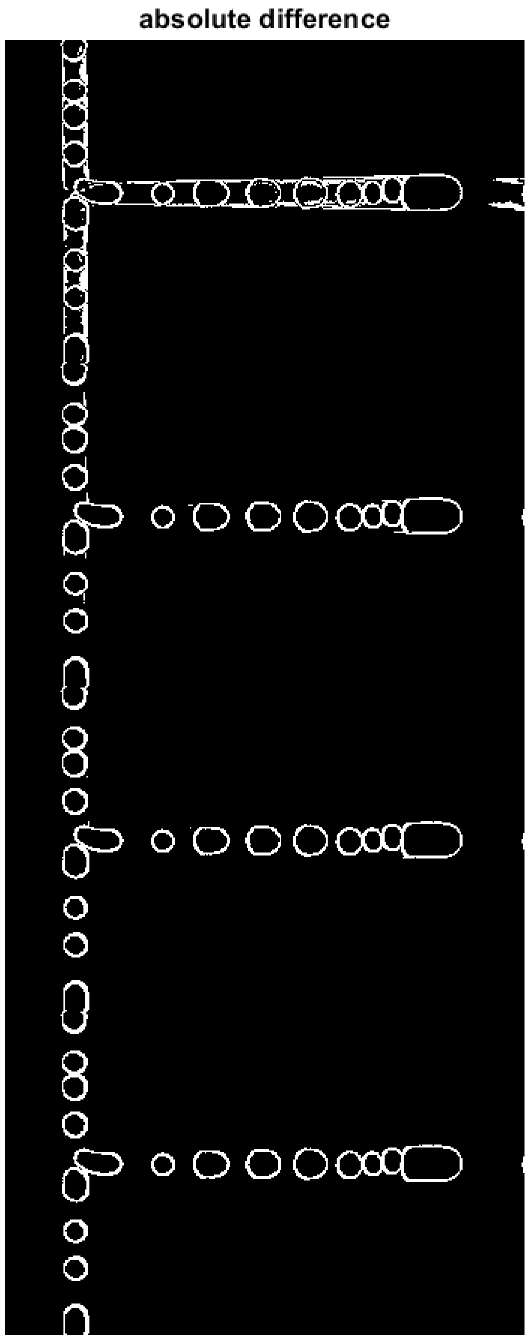
5) Convert to binary image

```
 bin1 = imbinarize(imadjust((subMean)), graythresh(subMean));  %graythresh uses
Otsu's Method
 bin2 = imbinarize(imadjust((subMed)), graythresh(subMed));
 bin3 = imbinarize(imadjust((subMax)), graythresh(subMax));
 bin4 = imbinarize(imadjust((subCom)), graythresh(subCom));

 figure; montage({bin1 bin2 bin3 bin4}, 'Size', [4 1]); title('standard
difference + inversion');
```



```
bin21 = imbinarize(imadjust((subMean2)), graythresh(subMean2));
bin22 = imbinarize(imadjust((subMed2)), graythresh(subMed2));
bin23 = imbinarize(imadjust((subMax2)), graythresh(subMax2));
bin24 = imbinarize(imadjust((subCom2)), graythresh(subCom2));
```

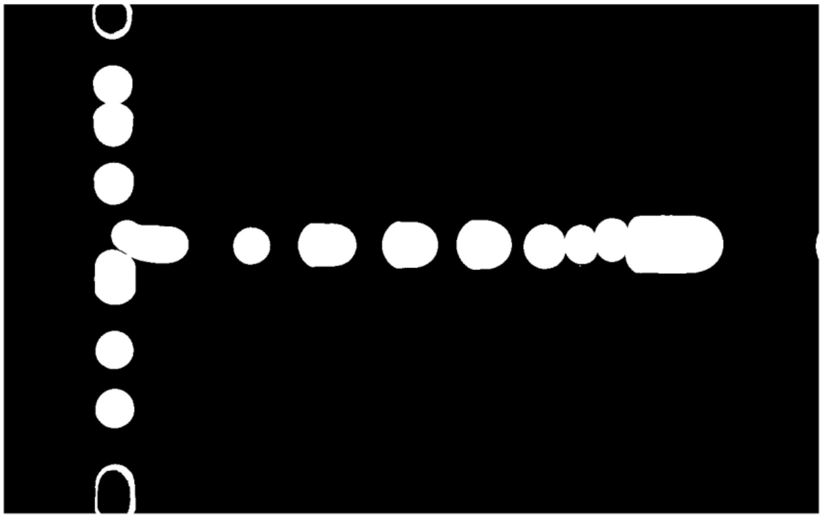
```
figure; montage({bin21 bin22 bin23 bin24}, 'Size', [4 1]); title('absolute difference');
```



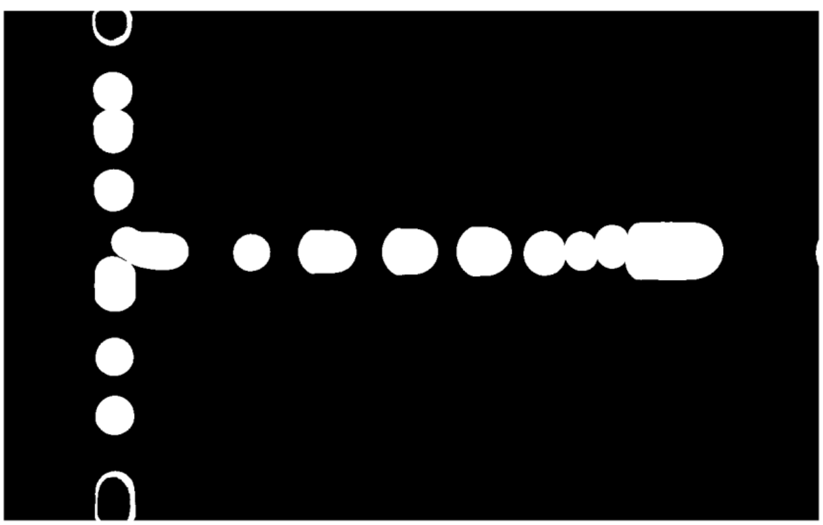
6) Morphological fill

- only use best result from previous parts

```
Img = bin4; % choose a  binary image to process

fill1 = imfill(Img, 'holes'); %fill fully closed drops
figure; imshow(fill1)
```



```
minA = 50; % anything with area less than this will be treated as noise object
cfill1 = bwareaopen(fill1,minA); %noise object removal
figure; imshow(cfill1);
```



```
rg = regionprops('table',cfill1,'Area') %detect ROI
```

rg = 13×1 table

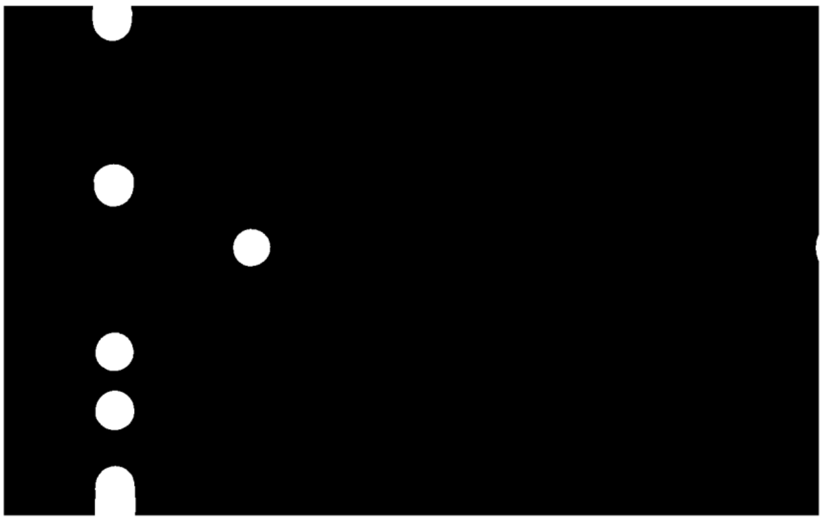
	Area

	Area
1	1030
2	6552
3	3340
4	10979
5	1358
6	2835
7	2985
8	2674
9	5312
10	5347
11	5518
12	21744
13	136

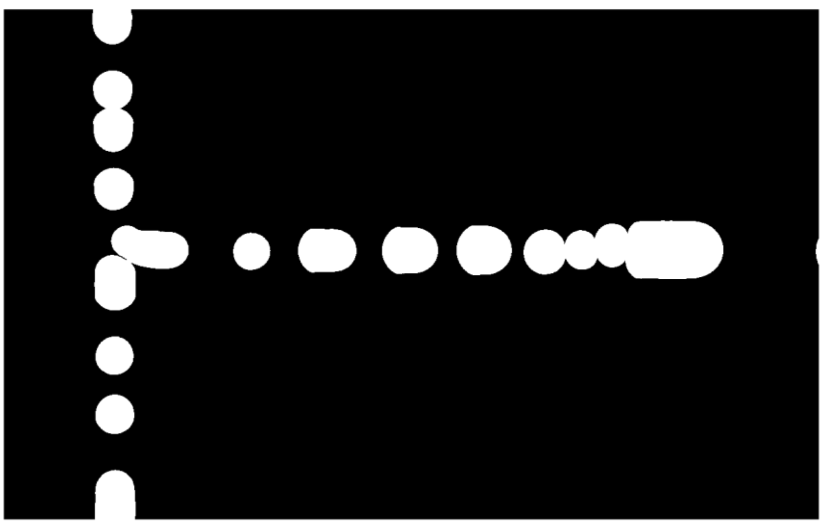
```
[bwl n] = bwlabel(cfill1,8); %assign label to each detected ROI
minA = 0.2*max(rg.Area)
```

```
minA = 4.3488e+03
```

```
pos = find(rg.Area < minA); %find ROIs that have holes so have not been filled;

bwl2 = ismember(bwl,pos); %segment out ROIs that need further manipulation
(morphological close)
% figure; imshow(bwl2);

bwl2 = imclose(bwl2,strel('disk',15)); %morphological close
fill2 = imfill(bwl2,'holes'); %fill fully closed drops (drops at border not
filled!)
% figure; imshow(fill2)

fill2_bord = fill_border_drops(bwl2); % fill objects at border (custom
function)
% figure; imshow(fill2_bord)

fill2 = fill2 | fill2_bord; %resulting filled image
figure; imshow(fill2);
```



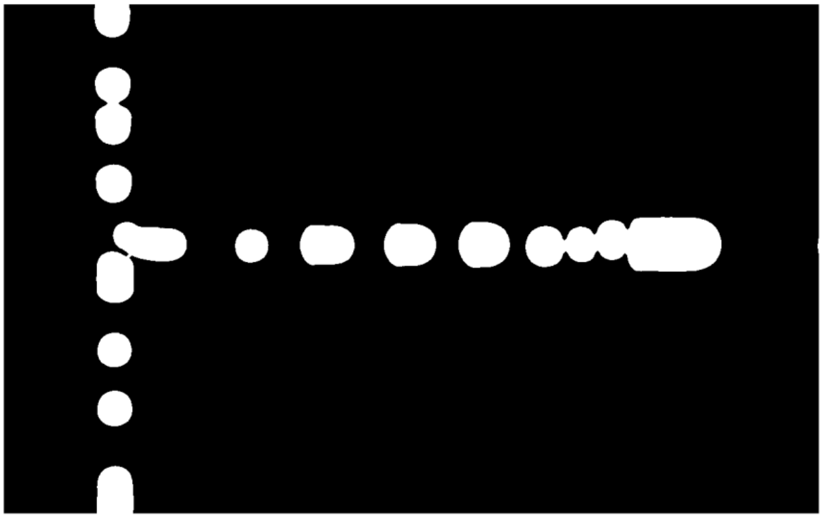
```
L = cfill1 | fill2; %combine to form a final mask
figure; imshow(L);
```



7) Drop Segmentation

- attempt to separate drops that were wrongly fused together from previous steps

```
L2 = imerode(L, strel('diamond',3));
figure; imshow(L2)
```



8) Identify Bounding Box of ROI

```
ROI = regionprops('table', L2)
```

ROI = 13×3 table

	Area	Centroid		...
1	2566	170.7459	24.0312	
2	5593	172.1244	160.3776	
3	2799	173.2262	281.8703	
4	9484	206.3501	398.4884	
5	3889	175.3762	766.1718	
6	2342	174.3143	543.7882	
7	2481	174.8057	635.8142	
8	2197	389.6208	380.1379	
9	4599	507.4895	378.6912	
10	4645	637.6366	378.5522	
11	4813	754.0143	378.2595	
12	19507	988.7090	377.3733	
13	31	1.2797e+03	380.1290	

```
% first entry in ROI table is the drop nearest to left frame border
leadEdge = ROI.Centroid(1,1) + 1.4*(ROI.BoundingBox(1,3) /2)  % estimate point of entrance to main channel
```

leadEdge = 210.6459

```
% remove any drops outside of main flow channel
```

```
ROI(ROI.Centroid(:,1) < leadEdge, :) = []
```

ROI = 6×3 table

	Area	Centroid	
1	2197	389.6208	380.1379
2	4599	507.4895	378.6912
3	4645	637.6366	378.5522
4	4813	754.0143	378.2595
5	19507	988.7090	377.3733
6	31	1.2797e+03	380.1290

```
% remove small objects
ROI(ROI.Area < 200, :) = []
```

ROI = 5×3 table

	Area	Centroid	
1	2197	389.6208	380.1379
2	4599	507.4895	378.6912
3	4645	637.6366	378.5522
4	4813	754.0143	378.2595
5	19507	988.7090	377.3733

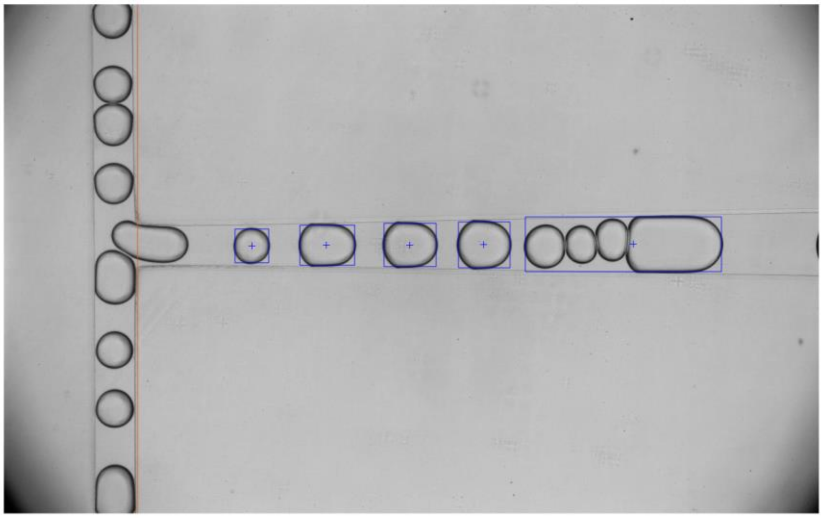
Assumptions:

- horizontal flow in main channel
- entrance region is captured in video (i.e., video does not just purely show a segment of main flow)
- drop identified as that nearest to left frame border is not a random noise object (and thus the width is not representative of a regular drop)

9) Plot results

```
figure; imshow(I);
hold on

% visualise centroid
plot(ROI.Centroid(:,1), ROI.Centroid(:,2), 'b+')

% visualise bounding box
for i=1:height(ROI)
    rectangle('Position',ROI.BoundingBox(i,:),'EdgeColor','b')
end
```

```
% visualise estimated leading edge for analysed region
plot([leadEdge leadEdge], [0 vid.Height])
```



6) Crop and show individual drops

```
roiTable = ROI.BoundingBox;
cropSize = [128 128];

for i = 1: height(roiTable)
    dim = 1.4*max([roiTable(i,3:4)]); % this will be the width/ height of
square cropped area

    % x-coord of centroid of cropping region
    cx = roiTable(i,1) + roiTable(i,3)/2;
    % y-coord of centroid of cropping region
    cy = roiTable(i,2) + roiTable(i,4)/2;

    % coordinates of bottom-left vertex of intended crop region
    xmin = cx - dim/2 ;
    ymin = cy - dim/2 ;

    % crop region defined as [x-coord of bottom left point, y-coord of
    % bottom left point, width, height]
    Img = imcrop(I, [xmin, ymin, dim, dim]);

    % resize cropped image
    Img = imresize(Img, cropSize);

    %show image
```

```
    figure; imshow(Img)
end
```