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 = 'WAT004_SO5_17umL-13Wat_umL-10kfps x4mag_sh50_C001H001S0016.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 = 1434
```

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: WAT004_SO5_17umL-13Wat_umL-10kfps x4mag_sh50_C001H001S0016.avi
Median; Elapsed time = 19.86
Mode; Elapsed time = 40.28
Mean; Elapsed time = 33.90
```

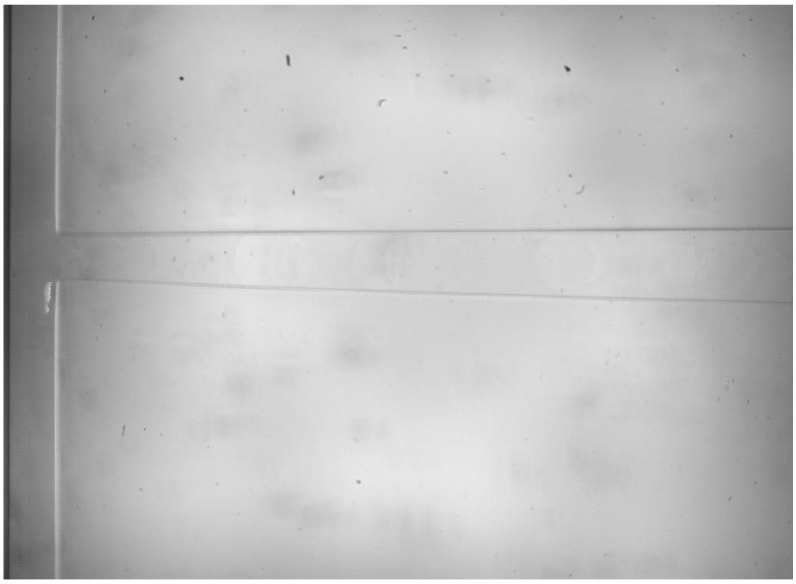
2b) Background generation - 'Complex' Statistical Approach

(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: WAT004_SO5_17umL-13Wat_umL-10kfps x4mag_sh50_C001H001S0016.avi
Using standard algorithm...
Elapsed time is 41.598548 seconds.
```

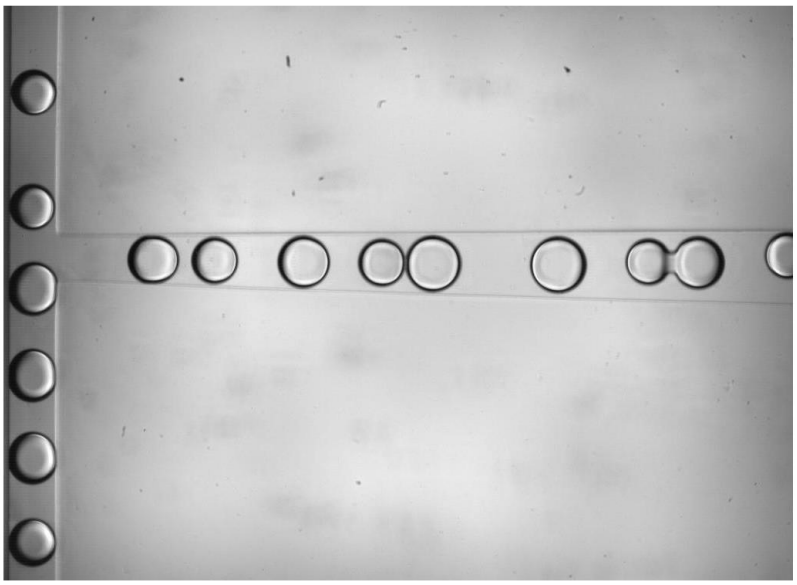
```
% 'original': for WAT, TRI, SDS, DYE.
% 'modified': for C12Tab.

figure; imshow(bg);
```



3) Load test image

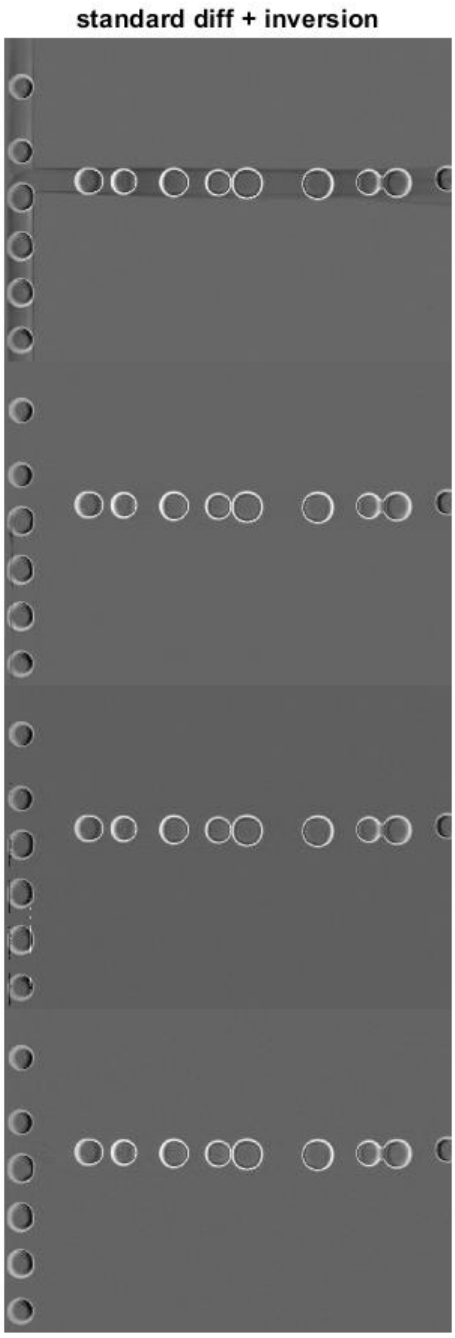
```
% Load images
```

```
I = imread('WAT004_1360.jpg');   %<-------- user-defined input!!

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

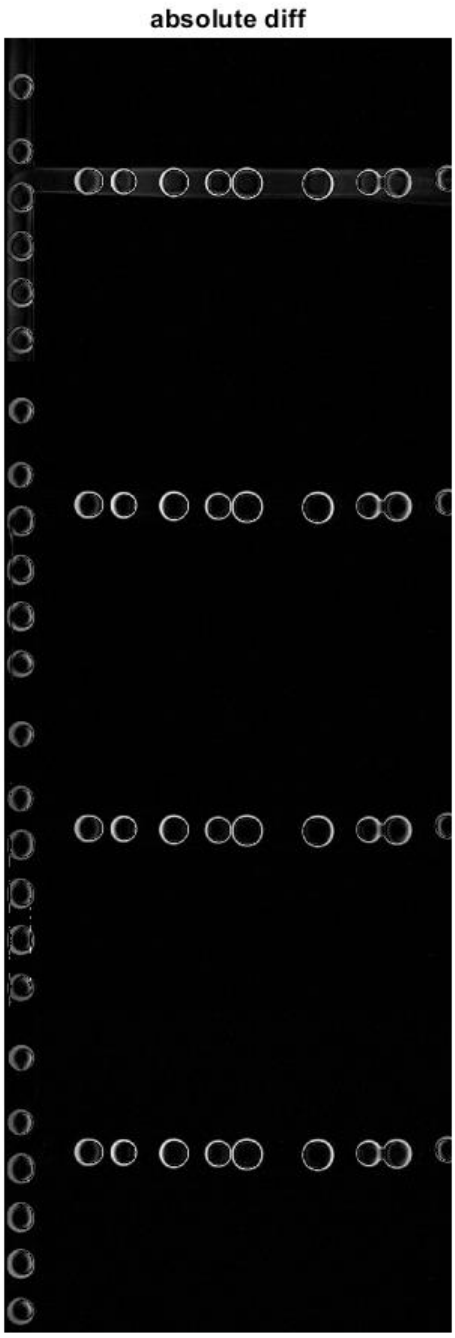


4) Background Subtraction

```
%% 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');
```



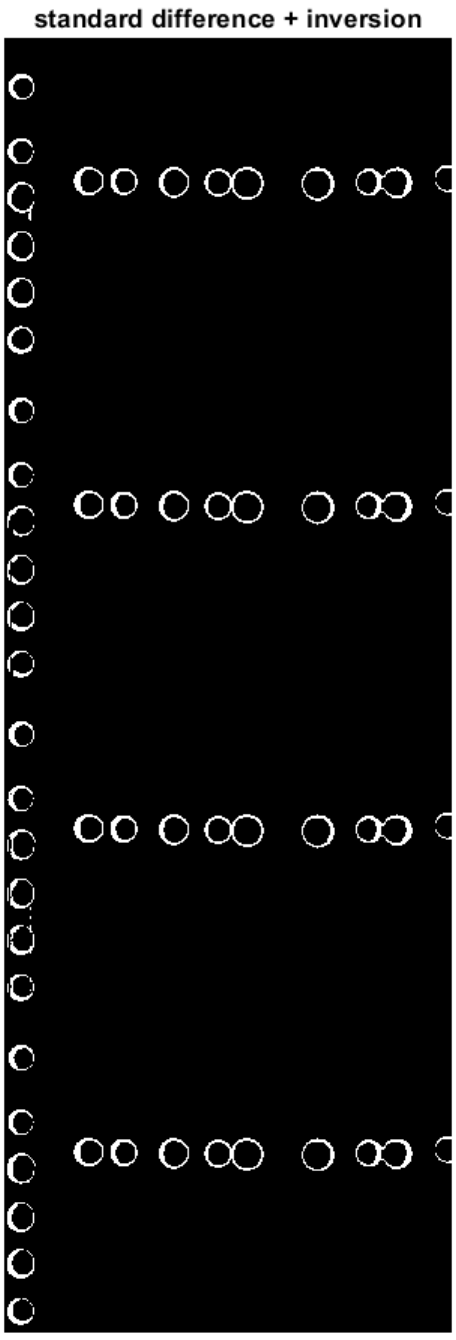

```
 figure; montage({subMean2 subMed2 subMax2 subCom2}, 'Size', [4 1]);
title('absolute diff');
```




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

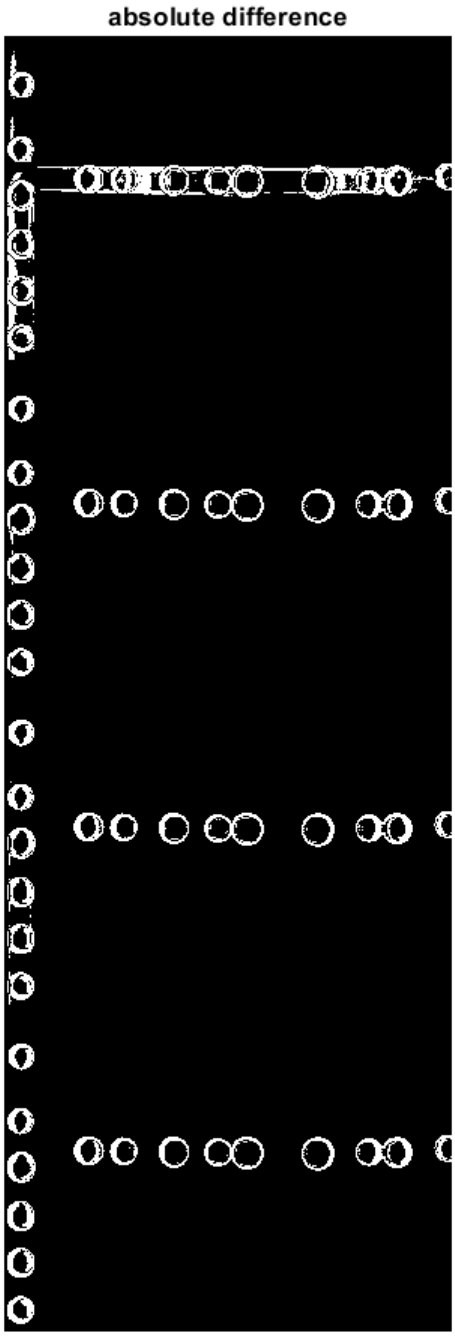
5) Convert to binary image

```
 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));
```

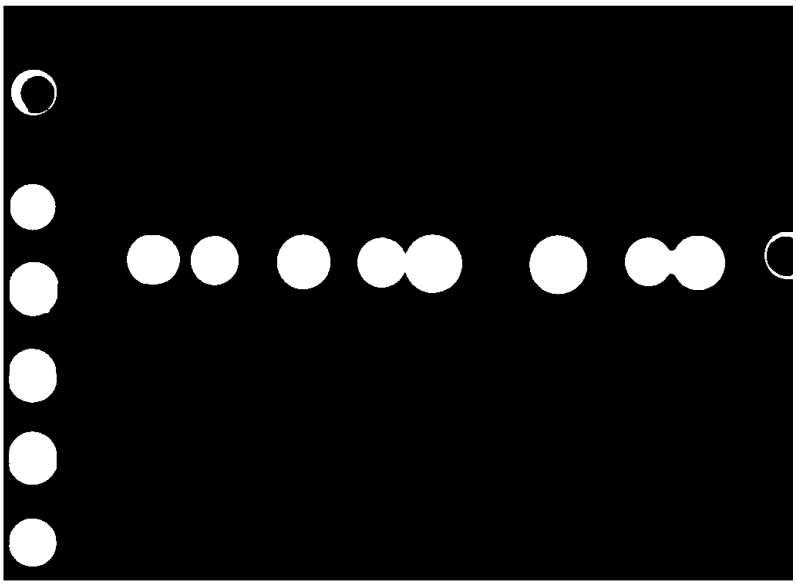
```
 figure; montage({bin21 bin22 bin23 bin24}, 'Size', [4 1]); title('absolute
difference');
```



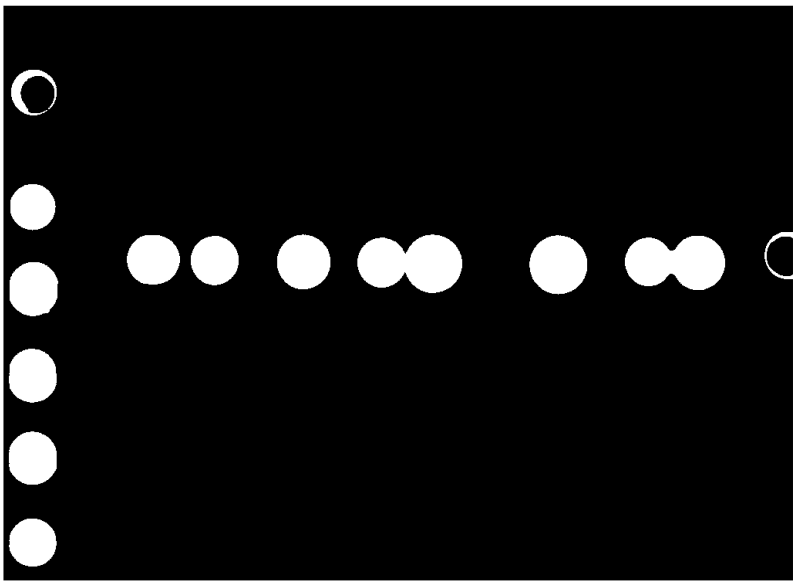
6) Morphological fill

- 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

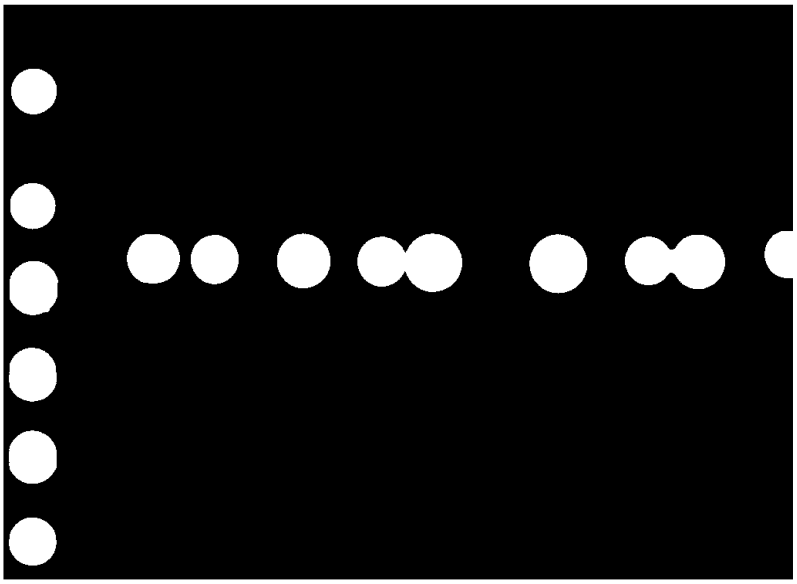
	Area
1	3501
2	3493
3	3036
4	3592
5	2762
6	1122
7	3529
8	3111
9	3863
10	7663
11	4490
12	6925
13	414

```
[bwl n] = bwlabel(cfill1,8); %assign label to each detected ROI
minA = 0.4*max(rg.Area)
```

```
minA = 3.0652e+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',20)); %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);
```

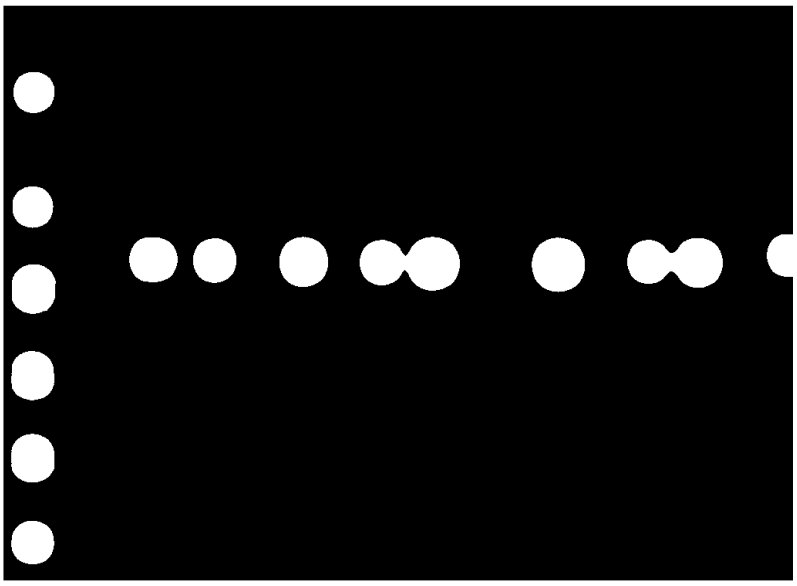


7) Drop Segmentation

- 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	3173	38.2909	479.6004
2	3178	38.3940	586.4443
3	2726	38.4314	695.6031
4	3199	39.2001	367.6561
5	2464	38.3636	261.0515
6	2493	39.8817	112.6992
7	3208	194.7684	329.3148
8	2814	274.5192	330.3927
9	3545	389.8674	332.2688
10	7051	530.1533	333.9592
11	4148	720.3717	335.9549
12	6396	873.5300	332.7958
13	1700	1.0091e+03	323.6724

```
% 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 = 78.8909
```

```
% remove any drops outside of main flow channel
ROI(ROI.Centroid(:,1) < leadEdge, :) = []
```

ROI = 7×3 table

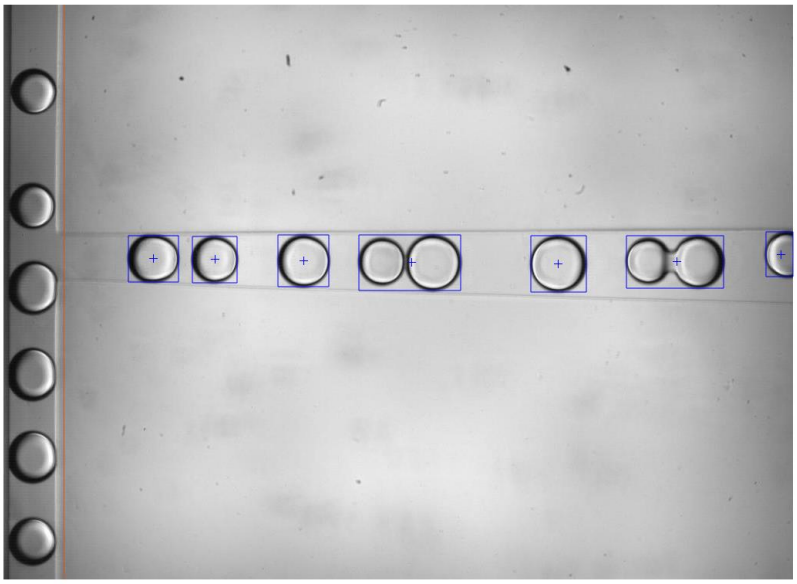
	Area	Centroid	...
1	3208	194.7684	329.3148
2	2814	274.5192	330.3927
3	3545	389.8674	332.2688
4	7051	530.1533	333.9592
5	4148	720.3717	335.9549
6	6396	873.5300	332.7958
7	1700	1.0091e+03	323.6724

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 = 1.5*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
```