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.

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
```

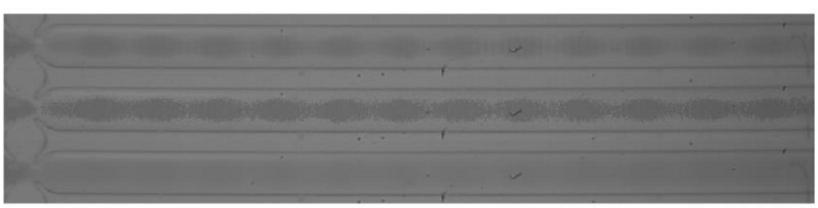
```
totframes = 5741
```

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);
```

```
Processed video: DYE003_52%Gl_W_0.003_Ink_SO_SPAN80_0.003_2kfps_.avi
Median; Elapsed time = 4.91
Mode; Elapsed time = 5.48
Mean; Elapsed time = 6.29
```



2b) Background generation - 'Complex' Statistical Approach

(Adapted from ADM method)

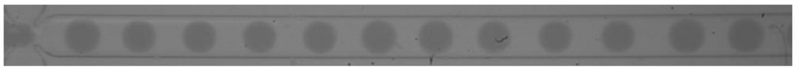
```
n = 40;     % number of frames to use for background generation <--------- user-defined input!!

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

```
Processed video: DYE003_52%Gl_W_0.003_Ink_SO_SPAN80_0.003_2kfps_.avi
Using standard algorithm...
Elapsed time is 10.126524 seconds.
```

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

figure; imshow(bg);
```

3) Load test image

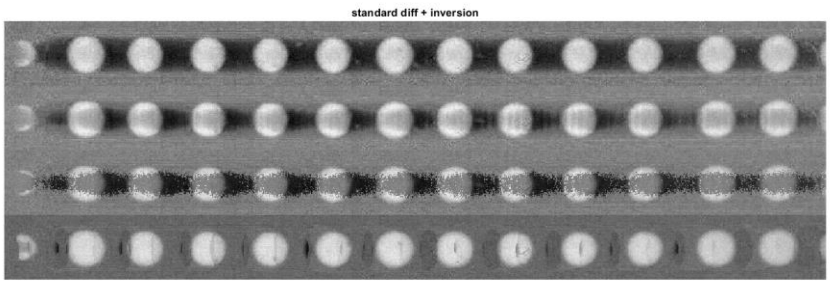
```
% Load images
I = imread('DYE003_19.jpg');   %<--------- user-defined input!!

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



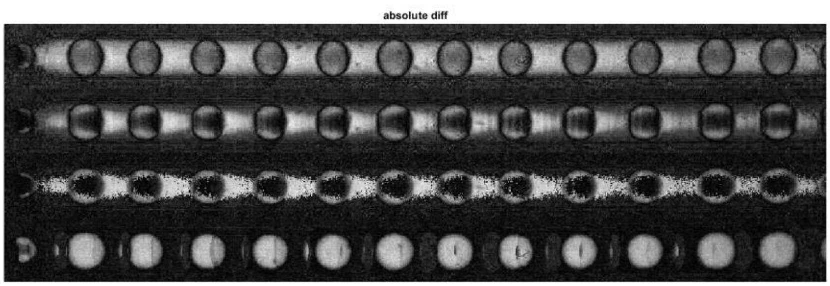
4) Background Subtraction

```
%% 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');
```



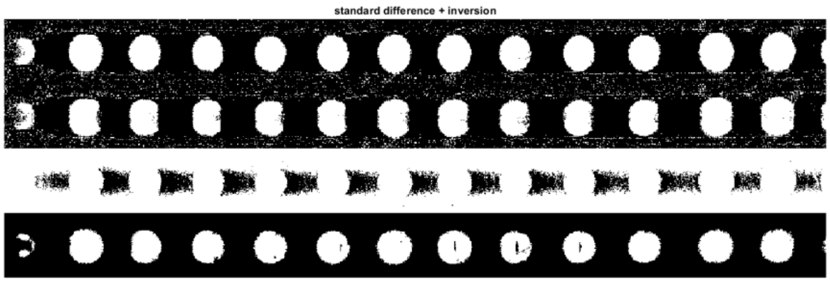

```
figure; montage({subMean2 subMed2 subMax2 subCom2}, 'Size', [4 1]);
title('absolute diff');
```



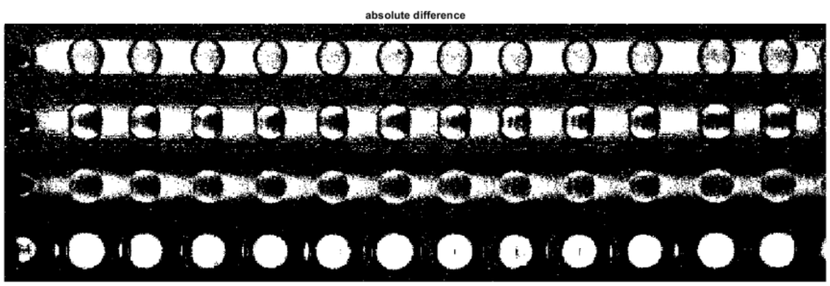

```
% figure; imshow(subMean); title('mean')
% figure; imshow(subMed); title('median')
% figure; imshow(subMax); title('mode')
% figure; imshow(subCom); title('complex')
```

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 = 14×1 table

	Area
1	91
2	89
3	1434
4	1241
5	1249
6	1272
7	1293
8	1445
9	1406
10	1216
11	1254
12	1247
13	1397
14	1350

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

minA = 578

```
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
% 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	164	25.5793	40.1829	
2	1064	102.5714	41.6353	
3	889	176.5872	42.1507	
4	874	253.4073	42.1304	
5	909	331.3256	43.1738	
6	942	409.1645	43.1656	
7	1073	485.9049	42.8546	
8	1041	559.5255	42.8770	
9	886	635.2494	42.6862	

	Area	Centroid	
10	917	714.3097	42.6412
11	904	795.4093	42.3053
12	1017	884.3402	41.7168
13	979	960.8274	41.1879

```
% 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 = 32.5793
```

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

ROI = 12×3 table

	Area	Centroid	
1	1064	102.5714	41.6353
2	889	176.5872	42.1507
3	874	253.4073	42.1304
4	909	331.3256	43.1738
5	942	409.1645	43.1656
6	1073	485.9049	42.8546
7	1041	559.5255	42.8770
8	886	635.2494	42.6862
9	917	714.3097	42.6412
10	904	795.4093	42.3053
11	1017	884.3402	41.7168
12	979	960.8274	41.1879

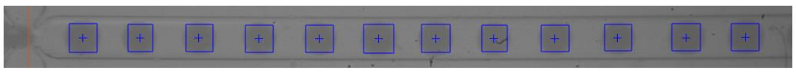
Assumptions:

- 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
```