BANKNOTES RECONITION SYSTEM

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Graphic User Interface

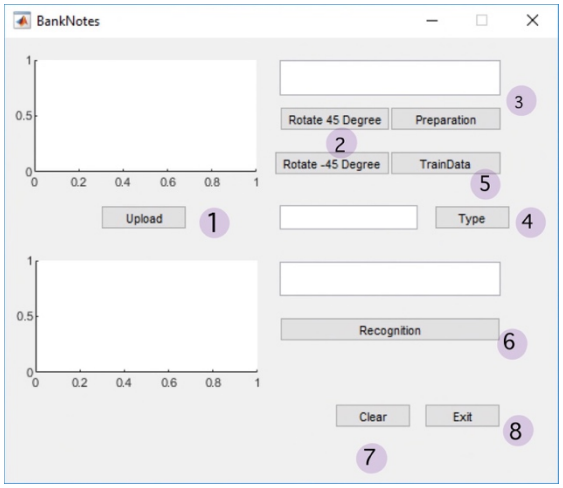

Figure 1: User Interface

Implementation

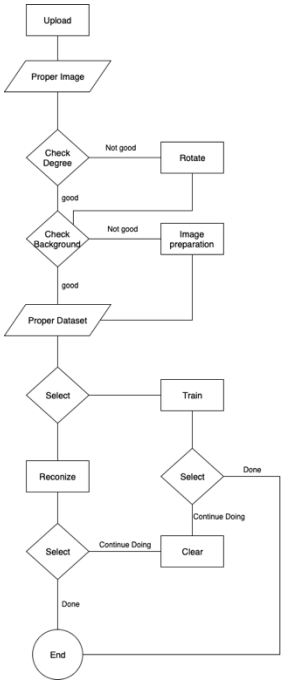

Figure 2: Flow chart of Implementation Process

1. Upload

```
global image;
global pic;
global filename;

image = strcat(pathname,filename);
pic = imread(image);

axes(handles.axes1); imshow(pic);
axes(handles.axes2); cla;

set(handles.edit1,'string',filename);
```

2. Rorate 45 or -45 degree

```
global pic

pic = imrotate(pic,45);

% imrotate(pic,-45)%
axes(handles.axes1); imshow(pic);
```

3. Preparation [Crop an object]

```
global pic;

hsvImage = rgb2hsv(pic);
sImage = hsvImage(:, :, 2);

mask = sImage > 0.1;
mask = bwareafilt(mask,1);
mask = imfill(mask, 'holes');

props = regionprops(logical(mask),
'BoundingBox');
croppedImage = imcrop(pic,
props.BoundingBox);

axes(handles.axes1);

imshow(croppedImage);
```

4. Color Recognition

```
global pic;

 r=mean(mean(pic(:,:,1)));
 g=mean(mean(pic(:,:,2)));
 b=mean(mean(pic(:,:,3)));
 Thou = abs(r-b);
```

```
%Thou > 3 is not 1000%
onethou = false;
if Thou <=3
   onethou = true;
end

if (r > g) && (r > b)  && (onethou ==
false)
   set(handles.edit3,'string','100');
      elseif (b>r) && (b>g)&& (onethou
== false)
   set(handles.edit3,'string','50');
elseif (g>b) && (g>r)  && (onethou ==
false)
    set(handles.edit3,'string','20');
      else
   set(handles.edit3,'string','1000 or 500');
end
```

5. Preparing data for Euclidean distance Recognition [Train]

```
global pic;
global filename;
global excel;
excel =
'E:\MATLAB\R2018\bin\Project\DB_Trai
n.xlsx';

tab=xlsread(excel);
[rr,cc]=size(tab);
% ..... Calculate Features
mred=mean(mean(pic(:,:,1)));
mgreen=mean(mean(pic(:,:,2)));
mblue=mean(mean(pic(:,:,3)));
gray=rgb2gray(pic);
mgray=mean(mean(gray));
%energy
gray=rgb2gray(pic);
glcm = graycomatrix(gray, 'o', [0,1]);
S = graycoprops(glcm);
energy = S.Energy*100;

%entropy
rngfil = rangefilt(pic);
entro = entropy(rngfil)*100;

%homo
Homo = S.Homogeneity*100;

%contrast
Contrast = S.Contrast*100;

%Correlation
correlation=S.Correlation*100;

% ..... calculate Excel Cell
cell1=cat(2,'A',num2str(rr+2));
cell2=cat(2,'B',num2str(rr+2));
cell3=cat(2,'C',num2str(rr+2));
cell4=cat(2,'D',num2str(rr+2));
cell5=cat(2,'E',num2str(rr+2));
cell6=cat(2,'F',num2str(rr+2));
cell7=cat(2,'G',num2str(rr+2));
cell8=cat(2,'H',num2str(rr+2));
cell9=cat(2,'I',num2str(rr+2));
cell10=cat(2,'J',num2str(rr+2));

% ..... Write Excel Data
xlswrite(excel,[{filename}],1,cell1);
xlswrite(excel,[mred],1,cell2);
xlswrite(excel,[mgreen],1,cell3);
xlswrite(excel,[mblue],1,cell4);
xlswrite(excel,[mgray],1,cell5);
xlswrite(excel,[entro],1,cell6);
xlswrite(excel,[energy],1,cell7);
xlswrite(excel,[Homo],1,cell8);
xlswrite(excel,[Contrast],1,cell9);
xlswrite(excel,[correlation],1,cell10);

system('taskkill /F /IM EXCEL.EXE');
```

6. Euclidean distance Recognition

```
global pic;
global excel;

excel =
'E:\MATLAB\R2018\bin\Project\DB_Trai
n.xlsx';
datasetpath
='E:\MATLAB\R2018\bin\Project\Dataset\
';

tab=xlsread(excel);
[rr,cc]=size(tab);

% ..... Calculate Features
data(1)=mean(mean(pic(:,:,1)));
data(2)=mean(mean(pic(:,:,2)));
data(3)=mean(mean(pic(:,:,3)));
gray=rgb2gray(pic);
```

```
 data(4)=mean(mean(gray));
 gray=rgb2gray(pic);
 glcm = graycomatrix(gray, 'o', [0,1]);
 S = graycoprops(glcm);
 rngfil = rangefilt(pic);
 data(5) = entropy(rngfil)*100;
 data(6) = S.Energy*100;
 data(7) = S.Homogeneity*100;
 data(8) = S.Contrast*100;
 data(9) =S.Correlation*100;

% ..... Matching
min=999;
rec=0;

for i=1 : rr
diff=0;
    for j=1 : cc
        diff=diff+sqrt(power(tab(i,j)-
data(j),2));
    end
if (diff <=100)
    min=diff;
    rec=i;
end
end

if (rec ~= 0)
    %found
   cellx=cat(2,'A',num2str(rec+1));
    %cellx = A3
   [~,ff]=xlsread(excel,1,cellx);
   file=ff{1};
   imgfile = strcat(datasetpath,file);
   result=imread(imgfile);
   axes(handles.axes2); imshow(result);
file= strcat('Found : ',file);
   set (handles.edit2, 'string',file);
else
    % not found
   fig=zeros(250,300);
   axes(handles.axes2); imshow(fig);
   set (handles.edit2, 'string','NOT
FOUND');
end
```

A	B	C	D	E	F	G	H	I	J
Filename	Red	Green	Blue	Gray	Entropy	Energy	Homogeneity	Contrast	Correlation
20-1.jpg	170.43579	171.34534	173.72782	171.33276	406.834	21.540698	94.437518	13.284939	94.75482
20-2.jpg	161.91586	164.08868	167.9865	163.8631	388.82578	23.041594	96.318451	8.4412394	96.018055
20-3.jpg	78.924137	79.843387	81.408513	79.73824	277.47092	31.587265	98.152747	5.5747542	99.519193
20-4.jpg	82.522364	83.364826	84.931448	83.273812	289.12584	31.104932	97.313681	8.2845608	99.35825
20-5.jpg	41.481576	41.724247	42.375568	41.725923	173.95517	58.238367	98.54271	4.6543623	99.499121
20-6.jpg	39.71663	40.171529	40.870544	40.114239	171.14495	58.342643	98.906235	3.4070944	99.596997
20-7.jpg	19.765121	20.050421	20.421973	20.005966	97.388676	77.338461	99.511025	1.5472084	99.68077
20-8.jpg	83.300565	83.218723	84.432449	83.382477	284.07619	31.225098	97.352569	8.2174736	99.36141
20-9.jpg	20.908214	21.005943	21.384715	21.018698	98.510912	77.32756	99.371671	2.1035932	99.612504
20-10.jpg	20.111366	20.175505	20.533888	20.193806	96.204648	77.344161	99.521857	1.5586992	99.683541
20-11.jpg	172.57138	171.71687	178.86304	172.79221	330.6906	24.654549	96.528839	8.1241527	96.514715
20-12.jpg	21.119833	20.907939	21.704103	21.057531	86.991085	77.369389	99.574139	1.4825671	99.724722
20-13.jpg	41.691304	41.557674	43.37087	41.796955	150.96564	58.399039	99.041126	3.2129533	99.652758
20-14.jpg	20.835251	20.734607	21.617026	20.862342	87.096149	77.352092	99.558771	1.4922498	99.719117
20-15.jpg	10.463915	10.436765	10.88871	10.495185	49.964124	88.212088	99.752851	0.8233139	99.712503
20-16.jpg	166.68339	163.96535	171.08512	165.56484	322.48987	23.375112	96.491555	8.4102519	96.148617
20-17.jpg	80.2326	79.36551	83.136724	80.047008	239.75675	31.533206	98.261747	5.5652429	99.531048
20-18.jpg	40.674506	39.977467	41.785125	40.38576	147.54537	58.354316	99.045947	3.3073333	99.618033
20-19.jpg	20.330123	20.011281	20.859965	20.202919	84.826887	77.347741	99.604457	1.4087959	99.717741
20-20.jpg	170.89602	169.66648	172.93162	170.37688	394.29463	20.874262	95.106632	11.347948	95.816672
20-21.jpg	165.01226	164.07982	168.12004	164.79596	377.81559	23.309298	96.746765	7.1141573	96.751745
20-22.jpg	80.878811	80.108206	81.842385	80.524653	272.38339	31.511179	98.26938	5.4115676	99.545088
20-23.jpg	40.541211	40.143573	41.069398	40.366192	161.9468	58.332463	99.112784	2.8252094	99.672515
20-24.jpg	10.031401	9.9819992	10.232941	10.024751	52.30556	88.207852	99.757865	0.7698993	99.704878
20-25.jpg	20.129961	19.996398	20.439969	20.08378	93.514673	77.334934	99.562382	1.4545648	99.703357
20-26.jpg	20.892301	20.696334	21.191676	20.810814	94.922548	77.330883	99.455288	1.7982577	99.658535
20-27.jpg	41.562864	41.393804	42.311625	41.541627	169.12806	58.208449	98.674284	4.1911324	99.543511
20-28.jpg	83.689042	83.225511	85.219254	83.57932	275.39864	31.149707	97.693183	7.1689938	99.447216
20-29.jpg	171.68503	169.78401	173.36982	170.75569	386.35283	19.915001	95.418191	10.582858	96.394821
20-30.jpg	165.52284	164.31901	170.18055	165.34648	384.78737	22.033849	95.276628	10.869935	95.164423
100-1.jpg	172.17725	160.27999	167.92779	164.68315	376.70378	23.913586	96.093739	8.9751159	95.625566

Figure 3: Data table from excel file

7. Clear a Data

```
axes(handles.axes1); cla;
axes(handles.axes2); cla;

set (handles.edit1,
'string','                ');
set (handles.edit2,
'string','                ');
```

8. Exit the System

```
close
```

Experiment Result

Thai Banknote Recognition System can recognize banknotes by 2 techniques which are Color Recognition and Euclidean distance Recognition. The experiment uses 12 pictures for each type of bank from the internet. For color recognition technique, it can recognize all pictures including both match and not match. Another technique which is Euclidean distance recognition can find only 1 match from all 60 banknotes.

Type	Color Recognition			Euclidean distance Recognition		
Result	Match	Not Match	Not Found	Match	Not Match	Not Found
20 Baht	6	6	-	-	-	12
50 Baht	7	4	-	-	-	12
100 Baht	12	-	-	-	-	12
500 Baht	1	11	-	1	-	11
1,000 Baht	1	11	-	-	-	12

Figure 4: Result table from the experiment

References

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[2] Rubeena Mirza and Vinti Nanda, “Paper Currency Verification System Based on Characteristic Extraction Using Image Processing (2012)”, URL: https://www.semanticscholar.org/paper/Currency-Verification-System-Based-on-Extraction-Mirza-Nanda/0e8f89e2dae48ed45a6ba07b5b9523bebd64c015

[3] Vedasamhitha Abburu, Saumya Gupta, S. R. Rimitha, Manjunath Mulimani, and Shashidhar G. Koolagudi, “Currency recognition system using image processing (2017)”, URL: https://www.researchgate.net/publication/323056402_Currency_recognition_system_using_image_processing

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[8] Malladi Tejasvi, A.Nayeemulla Khan, A.Shahina, “Perfecting Counterfeit Banknote Detection - A Classification Strategy”, URL: https://www.ijitee.org/wp-content/uploads/papers/v8i6/F3597048619.pdf

[9] M.A. Zamalloa Jaraa, C. Luízar Obregónb, C. Araujo Del Castilloa, “Exploratory analysis for the identification of false banknotes using portable X-ray Fluorescence spectrometer”, URL: https://www.sciencedirect.com/science/article/pii/S0969804317300167

[10] Sumeet Shahani, Aysha Jagiasi, Priya R. L., “Analysis of Banknote Authentication System using Machine Learning Techniques”, URL: https://www.ijcaonline.org/archives/volume179/number20/shahani-2018-ijca-916343.pdf

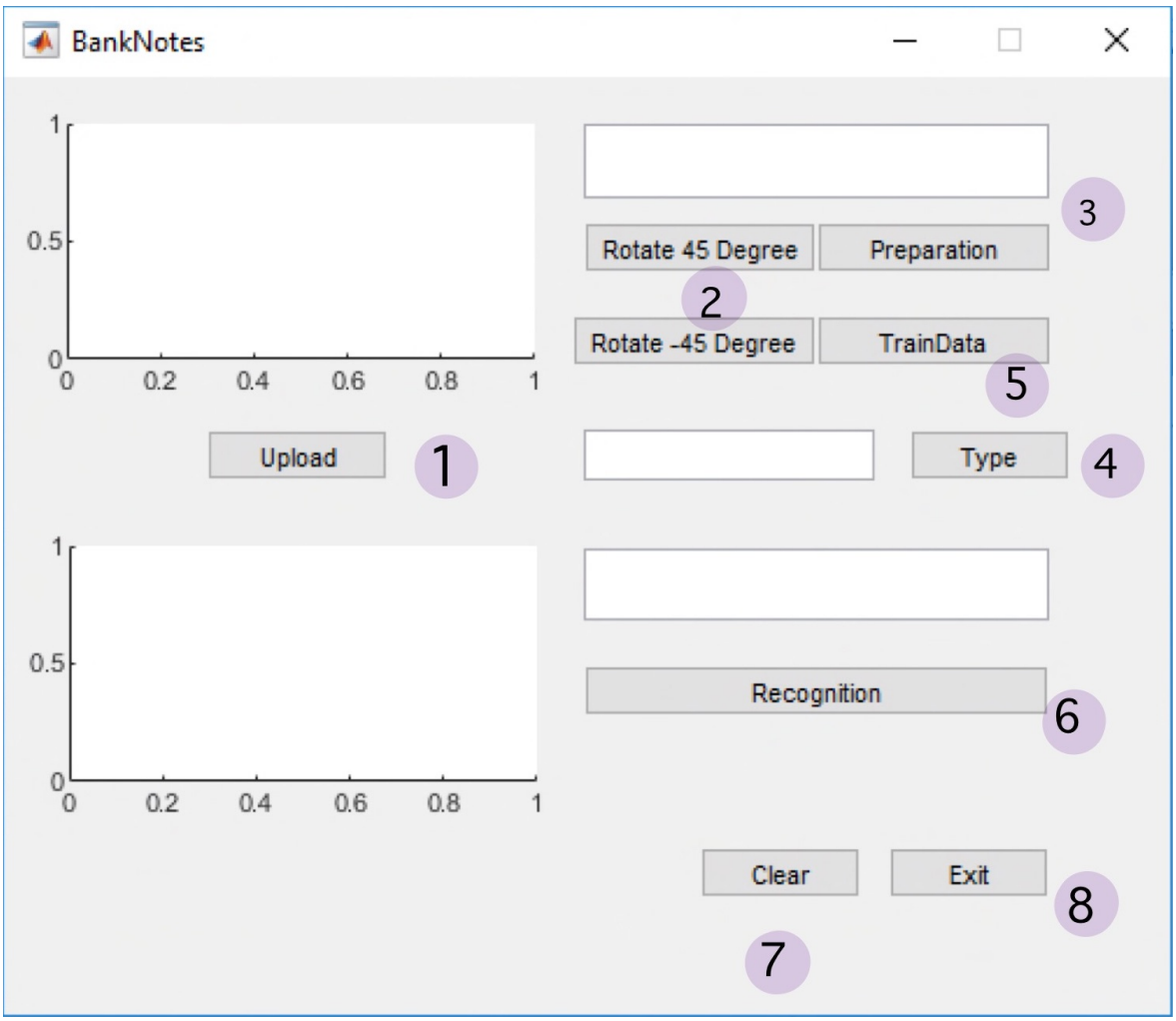

Figure 1: User Interface

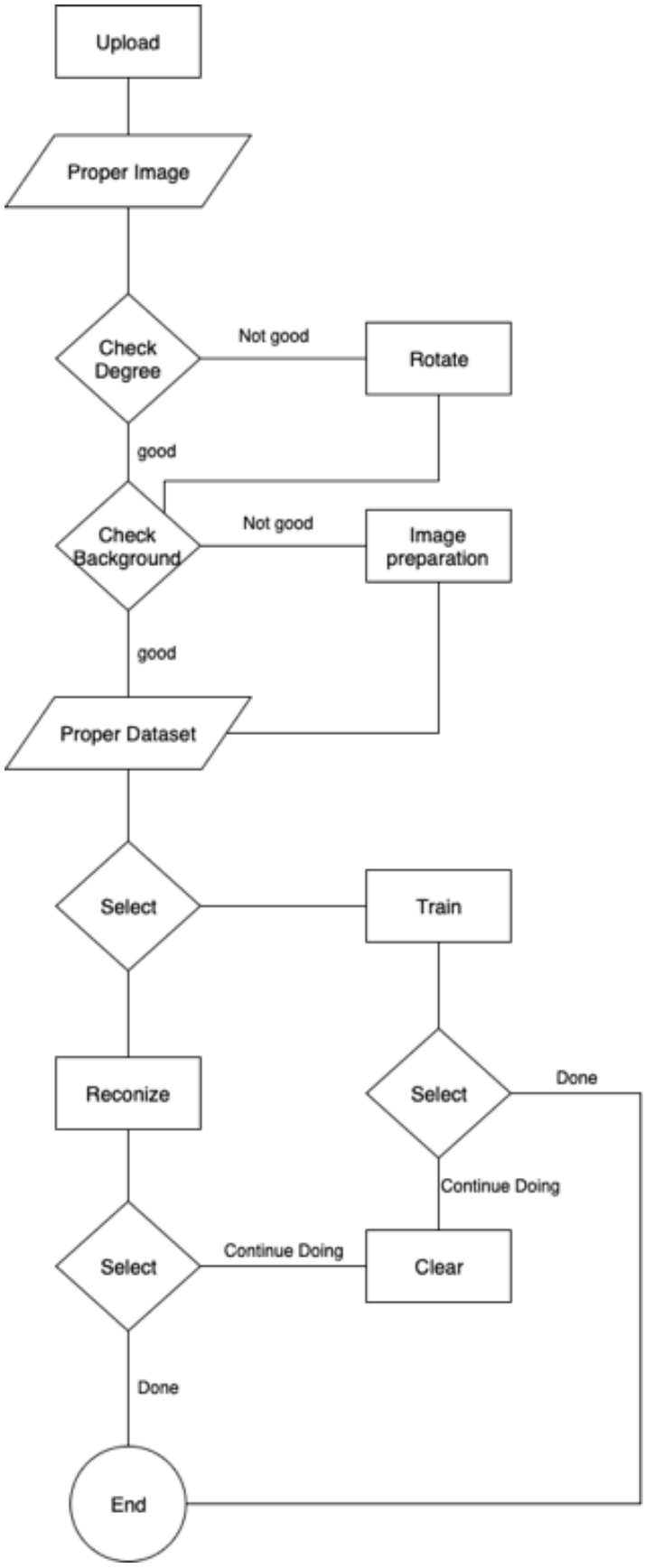

Figure 2: Flow chart of Implementation Process

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500 Baht	1	11	-	1	-	11
1,000 Baht	1	11	-	-	-	12

Figure 4: Result table from the experiment