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Facial Recognition System Using Local Binary Pattern (LBP) Algorithm as a Tool in Curbing Agricultural Loan

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ABSTRACT

Face recognition (FR) technology can be used in wide range of applications such as identity authentication, access control, and surveillance. Interests and research activities in face recognition have increased significantly over the past twenty years, in this research, local binary pattern was be used to design a system that will store all the faces of the Central Bank of Nigeria (CBN) anchor borrowers' loan beneficiaries, the system will use farmers faces binary information and inject the binary information into the recovery farmers database so that no multiple loan will be given to any defaulter and their facial identity will be revealed. The final output of the anchor borrower programme(ABP) is to create economic linkage between smallholder farmers and reputable large-scale processors with a view to increasing agricultural output and significantly improving capacity utilization of processors.

Keywords: LBP, CBN, Agriculture, Loan, Facial Recognition.

1.0 INTRODUCTION

1.1 Background of the study

The ABP scheme was introduced by President Buhari in 2015 in furtherance of the Agricultural Transformation Agenda (ATA) of the Goodluck Jonathan administration. Inaugurating the scheme in 2015 during the dry season farming in Birnin-Kebbi, Kebbi State, Buhari frowned on importation of foods that the country could produce, stressing that Nigeria's N1 trillion food importation bill at the time was not sustainable, and tenable. Before the scheme commenced, forex to importation of rice, wheat, milk, tomato, fish, cotton and fertilizer, among others, depleted the country's forex reserves, put pressure on the exchange rate and caused galloping inflation amid the 2016-2017 economic recession.

Facial recognition is a way of identifying or confirming an individual's identity using their face. Facial recognition systems can be used to identify people in photos, videos, or in real-time (Bouguila and Khochtali, 2020). One of the algorithm used in facial recognition is local binary pattern (LBP), is a nonparametric descriptor, which efficiently summarizes the local structures of images (Huang *et al.*, 2011). The Central Bank of Nigeria (CBN) in line with its developmental function established the

Anchor Borrowers' Programme (ABP). The Programme which was launched by President Muhammadu Buhari (GCFR) on November 17, 2015 is intended to create a linkage between anchor companies involved in the processing and small holder farmers (SHFs) of the required key agricultural commodities. The programme thrust of the ABP is provision of farm inputs in kind and cash (for farm labour) to small holder farmers to boost production of these commodities, stabilize inputs supply to agro processors and address the country's negative balance of payments on food. At harvest, the SHF supplies his/her produce to the Agro-processor (Anchor) who pays the cash equivalent to the farmer's account. The Programme evolved from the consultations with stakeholders comprising Federal Ministry of Agriculture & Rural Development, State Governors, Millers of agricultural produce, and smallholder farmers to boost agricultural production and non-oil exports in the face of unpredictable crude oil prices and its resultant effect on the revenue profile of Nigeria.

The broad objective of the ABP is to create economic linkage between smallholder farmers and reputable large-scale processors with a view to increasing agricultural output and significantly

improving capacity utilization of processors. Other objectives of ABP include to :

- i. increase banks' financing to the agricultural sector
- ii. reduce agricultural commodity importation and conserve external reserves
- iii. increase capacity utilization of agricultural firms
- iv. create new generation of farmers/entrepreneurs and employment
- v. depend the cashless policy and financial inclusion
- vi. reduce the level of poverty among smallholder farmers
- vii. assist rural smallholder farmers to grow from subsistence to commercial production levels.

About Five Billion and Four Hundred Million Naira (N5.4 billion) was advanced to the farmers under Maize Association of Nigeria (MAAN) but no repayment had been concluded when the disruption came around February/March, 2020, RIFAN got over One Hundred and Ninety Billion Naira (N190 billion) which was disbursed to about 1.1 million farmers holding fewer than five (5) hectares each. But less than 20% of the recovery was made.

ABP loan targeted at smallholder farmers engaged in the production of identified commodities across the country, the Farmers should be in groups/cooperative(s) of between 5 and 20 for ease of administration (CBN 2020). Statistics has shown that most beneficiaries will collect the loan and evade from repaying the loan back, Central Bank of Nigeria rely in using only Bank Verification Number (BVN) as a means of tracking the farmers that collect loan but today most of the beneficiaries hide their actual BVN and generate information from local people and pay them a token amount, the fake information is given to banks and collect loan on their behalf.

CBN has series of complaints of very poor loan repayments and the farmers on the other hand have expressed displeasure with the timely disbursement of the integral components of the programme, we still feel the intervention is helpful. With modification, the ABP will make more impact going forward (Femi, 2020). If people will collect loan and fail to repay the loan back it will reach to a point where the program may likely fail as a result of poor recovery system. This is a serious challenge and a problem

that need a technological approach that will save the country

The objectives of this research are to:

- i. analyze the process of existing loan recovery.
- ii. design an algorithm to track defaulting farmers.
- iii. identify farmers from their digital images.
- iv. implement the tracking system

1.2 Related Works

The human face plays an important role in our social interaction, conveying people's identity. Using the human face as a key to security, biometric passwords technology has received significant attention in the past several years due to its potential for a wide variety of applications. There are a lot of research work on using the local binary pattern (LBP) algorithm (Abbasi and Tajeripour, 2017; Wibowo et al., 2019; Mishra, 2020; Toffa and Mignotte, 2020). Abbasi, and Tajeripour, (2017) proposed an automatic method for brain tumor detection in 3D images. In the first step, the bias field correction and histogram matching are used for preprocessing of the images. In the next step, the region of interest is identified and separated from the background of the Flair image. Local binary pattern in three orthogonal planes (LBP-TOP) and histogram of orientation gradients (HOG-TOP) are used as the learning features. Since 3D images are used in this research, the idea of in local binary pattern in three orthogonal planes was used in order to extend histogram orientation gradients for 3D images. The random forest is then used to segment tumorous regions. The performance of the algorithm was evaluated on glioma images from BRATS 2013. The experimental results and analyses indicate that the proposed framework is superior in detecting brain tumors in comparison with other techniques.

Wibowo et al., (2019) proposed a technique that addressed the problem of the accuracy of the thresholding technique frequently decreasing due to the changing of lighting conditions by applying a Local Binary Pattern (LBP) based ball detection system. The results show that the performance of the system has percentages of success of 96.97% in bright lighting conditions, 80.69% insufficient lighting conditions, and 98.74% in dimmed lighting conditions when the ball moves slowly. Whereas, the percentage of successful detection

becomes 70.74% during bright lighting conditions, 60.42% for sufficient lighting conditions, and 83.79% for minimum lighting conditions when the ball moves quickly.

Mishra (2020) present a work where a texture based analytic machine learning algorithm known as Local Binary Pattern (LBP) as shown

in Figure 1 is used for the extraction of texture features of the Friction Stir Welded joints which are welded at a different rotational speed. It was observed that LBP algorithm can accurately detect any irregularities present on the surface of Friction Stir Welded joint.

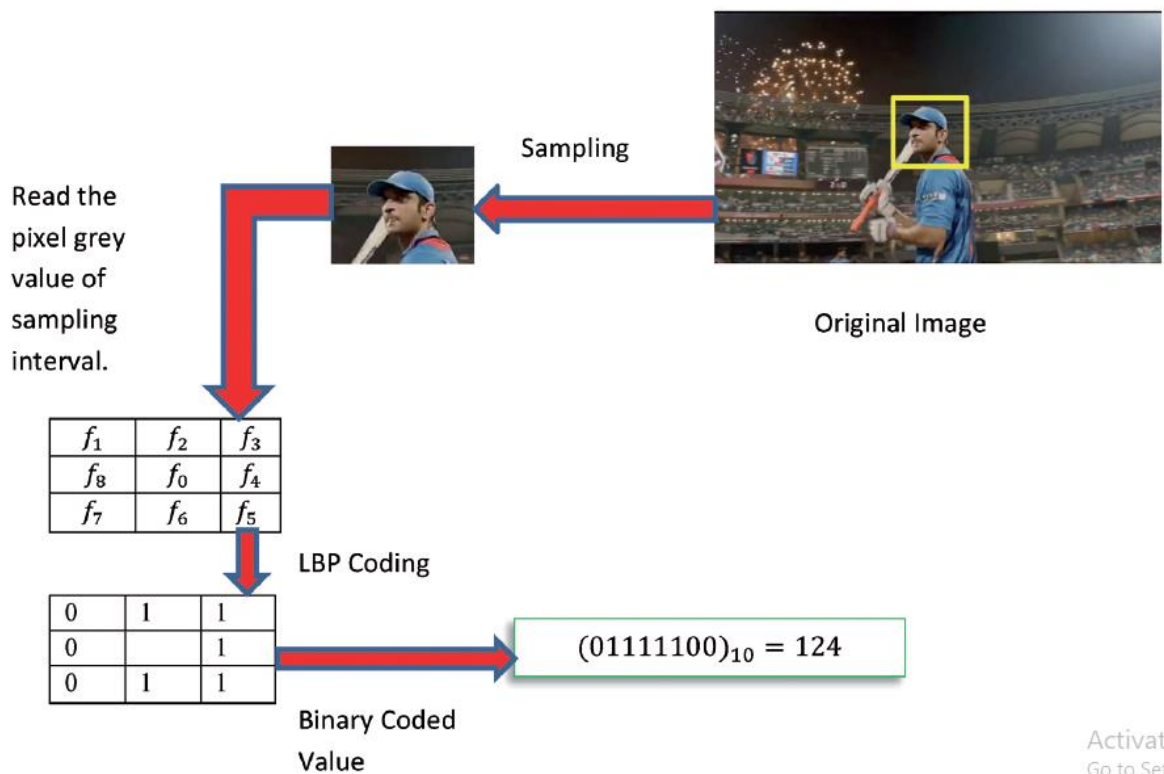


Figure 1: Schematic Diagram representing the working of Local Binary Operator
Source: Mishra, (2020)

Toffa, and Mignotte (2020) presented a new approach to classify environmental sounds using a texture feature local binary pattern (LBP) and audio features collaboration. They generalized and defined LBP-1D and local phase quantization (LPQ)-1D on the 1-dimensional (1D) audio signal and have applied the original LBP, the variance LBP (VARLBP) and the extended LBP (ELBP) thus generated to the spectrogram of the audio signal in order to model the sound texture. The results showed that the LBP features outperform the classical audio features. It was found that the method is not the cutting edge of the state-of-the-art methods, but it is faster than any convolutional neural network methods and represents a better choice when there is data scarcity or minimal computing power

There are several biometrics available like: finger print, iris identification etc. But Facial recognition or detection (Coşkun et al., (2017; Kambi Beli, and Guo, 2017; Nguyen et al., 2017; Wang et al., 2018; Priya, 2018; Korshunov, and Marcel, 2018) is one of the biometric software applications that can identify a particular individual in a digital image. Coşkun et al., (2017) proposed a modified Convolutional Neural Network (CNN) architecture by adding two normalization operations to two of the layers. The normalization operation which is batch normalization provided accelerating the network. It shows that the proposed approach has improved the face recognition performance with better recognition results.

Hossain and Muhammad (2017) proposed an emotion recognition with high performance for mobile applications as depicted in Figure 2. Some representative frames are extracted from the

video, and a face detection module is applied to extract the face regions in the frames. The results reveal that the proposed system achieves high recognition accuracy in a reasonable time.

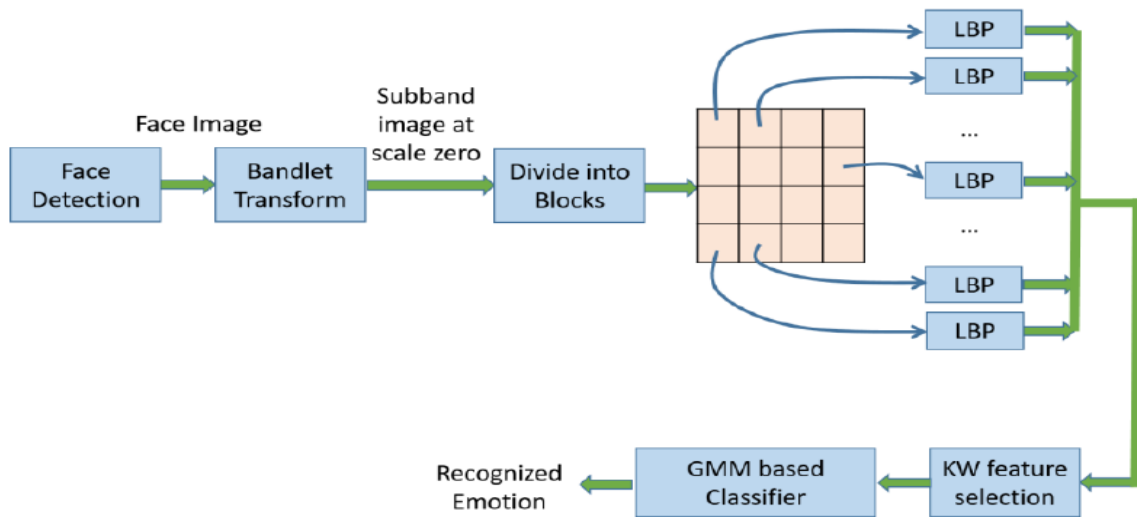


Figure 2: Block Diagram of the Proposed Emotion Recognition System.
Source: Hossain, and Muhammad (2017)

In their proposed system, facial video is captured by an embedded camera of a smart phone as illustrated in Figure 3. Kambi Beli, and Guo, (2017) proposed a work that provides an

approach that contributes to resolve face identification issues with large variations of parameters such as pose, illumination, and expression as shown in Figure 4.

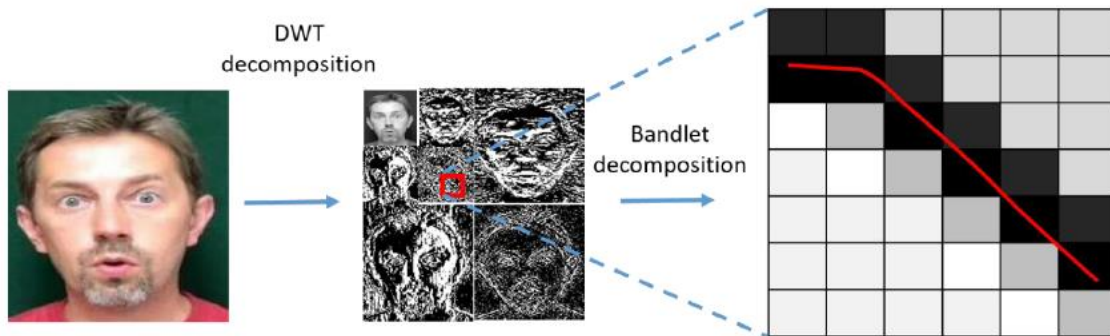


Figure 3: Illustration of the Bandlet decomposition.
Source: Hossain, and Muhammad (2017)

The results identification system show higher performance, and also provides successful face similarity measures focus on feature extractions. Face recognitions were used in many applications in the field of banking, passport office etc. But the problem in the face recognition is it cannot identify the person in the case of identical twins. So, the algorithm called local binary patters were

used to identify the face in the case of identical twins because the LBP can describe well about the micro patterns present in the face (Priya, 2018). Korshunov and Marcel (2018) presented the first publicly available set of Deepfake videos generated from videos of VidTIMIT database. They used open source software based on GANs to create the Deepfakes, and emphasize that

training and blending parameters can significantly impact the quality of the resulted videos. In order to prove this impact, they generated videos with low and high visual quality (320 videos each) using differently tuned parameter sets. It showed that the state of the art

face recognition systems based on VGG and Facenet neural networks are vulnerable to Deepfake videos, with 85.62% and 95.00% false acceptance rates (on high quality versions) respectively, which means methods for detecting Deepfake videos are necessary.

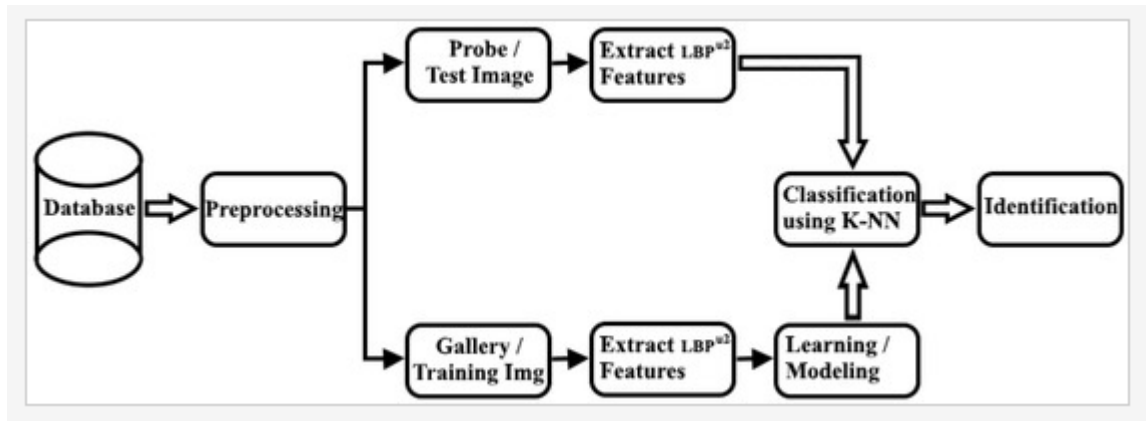


Figure 4: Face Identification System.

Source: Kambi Beli, and Guo, (2017)

By considering several baseline approaches, it was found that audio-visual approach based on lipsync inconsistency detection was not able to distinguish Deepfake videos.

Wang et al., (2018) used stationary wavelet entropy to extract features, and employed a single hidden layer feedforward neural network as the classifier. To prevent the training of the classifier fall into local optimum points, we introduced the Jaya algorithm. (Results) The simulation results over a 20-subject 700-image dataset showed that the algorithm reached an overall accuracy of $96.80 \pm 0.14\%$. Nguyen et al., (2017) use the images of human body for recognizing individuals. To overcome the limitations of previous studies on body-based person recognition that use only visible light images for recognition, they use human body images captured by two different kinds of camera, including a visible light camera and a thermal camera. The experimental results show that the method is efficient for enhancing recognition accuracy compared to systems that use only visible light or thermal images of the human body.

Faces can have many variations in appearance (aging, facial expression, illumination, inaccurate alignment and pose) which continue to cause poor ability to recognize identity. We intend to combine the idea of face recognition and Local Binary Pattern (LBP) to design an algorithm that

will help to curbing agricultural loan for central bank of Nigeria anchor borrowers' programme.

Anchor Borrowers Programme (ABP) in the Northwest is threatened by the failure of farmers to repay loans. ABP, an agricultural loan scheme launched in 2015 by the Federal overnment, through the Central Bank of Nigeria (CBN) was designed to boost agricultural yields, halt large volumes of food importation and address negative trade balance. Guidelines for the programme stipulate that upon harvest, benefiting farmers are to repay their loans with produce (which must cover the loan principal and interest) to an anchor, who pays the cash equivalent to the farmer's account. Anchor could be either a private large-scale integrated processor or a state government (Murtala *et al.* 2021). The Governor of the CBN, disclosed that 3,107,890 farmers had been empowered under the scheme to cultivate 3,801,397 hectares of land and produce 21 commodities, leveraging the services of 23 financial institutions acting as direct links to farmers. Most farmers in Northwest states have, however, not been able to settle their loans from the CBN, largely because of the activities of bandits and insurgents (Murtala *et al.* 2021).

2.0 RESEARCH METHODOLOGY

The algorithms work with two data set, loan beneficiaries and loan request from CBN. The pictures are converted to grayscale pictures for processing the training. The pixel in the center is compared to its neighbors. Each neighbor which

is smaller than the pixel in the middle, the value 0 is added to the thresholded square which is in charge to store the results, otherwise, a 1 will be added. The thresholded square and weights square are not present in the picture, they are only

a representation to understand the process. When all the comparisons have been completed, each result will be multiplied by a weight. Each pixel has a weight to the power of two from $2x$ to $2y$.

Algorithm I

```

Function all_images;
Begin
  clear all
  % To clear all variables from the current workspace
  clc
  % clc clears all the text from the Command Window, resulting in a clear screen.
  cd 'C:\IBR_RESEARCH\FR_2022\Anchor_FaceDataSet'
  all_Images ← zeros(10304,10);
  % zeros returns an array of zeros where size vector is defined by variable.
  for i←1:40
    cd(strcat('s',num2str(i)));
    for j←1:10
      grayImage1 ← imread(strcat(num2str(j),'.pgm'));
      [rows, columns, numberOfColorBands] ← size(grayImage1);
      localBinaryPatternImage1 ← zeros(size(grayImage1), 'uint8');
      image_Container2 ← imread(strcat(num2str(j),'.pgm'));
      all_Images2(:,(i1)*10+j) ← reshape(image_Container2,size(image_Container2,1)
      *size(image_Container2,2),1);
      tic; % tic works with the toc function to measure elapsed time.
      for row = 2 : rows - 1
        for col = 2 : columns - 1
          centerPixel = grayImage1(row, col);
          pixel7←grayImage1(row-1, col-1) > centerPixel;
          pixel6←grayImage1(row-1, col) > centerPixel;
          pixel5←grayImage1(row-1, col+1) > centerPixel;
          pixel4←grayImage1(row, col+1) > centerPixel;
          pixel3←grayImage1(row+1, col+1) > centerPixel;
          pixel2←grayImage1(row+1, col) > centerPixel;
          pixel1←grayImage1(row+1, col-1) > centerPixel;
          pixel0←grayImage1(row, col-1) > centerPixel;
          eightBitNumber ←uint8(pixel7 * 2 ↑ 7 + pixel6 * 2 ↑ 6 + pixel5 * 2 ↑ 5 +
          pixel4 * 2 ↑ 4 + pixel3 * 2 ↑ 3 + pixel2 * 2 ↑ 2 + pixel1 * 2 + pixel0);
          localBinaryPatternImage1(row, col) ← eightBitNumber ;
        end
      end
      image_Container ← localBinaryPatternImage1;
      all_Images(:,(i1)*10+j) ←reshape(image_Container,size(image_Container,1) *
      size(image_Container,2),1);
    end
  end
  display('Loading Database');
  cd ..
end
End

```

Each pixel in the center of a 3x3 square has 8 neighbors. These eight pixels represent one byte which explains the reason of using these weights. The weights are affected in a circular order. It does not matter which weight is affected to which

pixel, however, the weight of a pixel does not change. For example, if the pixel top left has a weight of 128, it will keep this weight for all the comparisons in the picture. Then, the sum of the weights is calculated and becomes the value of

the pixel in the middle of the square. When this process has been completed for each part of the picture, the picture is divided into a certain number of regions. Then, a histogram is extracted from each region and all the histograms are concatenated. For recognizing a face, exactly the same process is performed, and the final histogram is compared to each final histogram in the training data. Comparison and matching is done between those that fail to repay the loan and the new beneficiaries, if there is a match the picture information is stored.

This algorithm extract all the images in the given directory create an array of zeros for the vector

Algorithm II

image where each image has 10 different samples as sub directory the images are stored in pgm format, the images will then be converted in to binary images using LBP function, however the binary images will then be passed to the next algorithm for processing. Algorithm II calls the function all_images in Algorithm I, decompose and reduce the dimensionality of the binary image it employs the use of principal component analysis PCA that can be used I the next algorithm for histogram equalization of the images

Begin

```

numeric_Image ← uint8(all_Images);
numeric_Image2 ← uint8(all_Images2);
random_Index ← round(400*rand(1));
random_Image ← output_value(:,random_Index);
random_Image2 ← output_value2(:,random_Index);
rest_of_the_images ← output_value(:,[1:random_Index-1 random_Index+1:end]);
rest_of_the_images2 ← output_value2(:,[1:random_Index-1 random_Index+1:end]);
L ← single(mean_Removed)*single(mean_Removed);
[V,D] ← eig(L);
% returns diagonal matrix D of eigenvalues and matrix V whose columns are the corresponding right
eigenvectors,
V ← single(mean_Removed)*V;
for i ← 1:size(rest_of_the_images,2);
    all_image_Signature(i,:) ← single(mean_Removed(:,i))*V;
end
subplot(221);
imshow(reshape(random_Image2,112,92));
title('Looking for this image', 'FontWeight','bold','FontSize',14,'color','red');
subplot(222);
p ← random_Image-mean_value;
S ← single(p)*V;
z ← [];
for i ← 1:size(rest_of_the_images,2)
    subplot(222);
    z ← [z,norm(all_image_Signature(i,:)- S,2)];
    if (rem(i,10)=0),imshow(reshape(rest_of_the_images(:,i),112,92)),
end;
E1 ← imhist(random_Image );
E2 ← mhist(rest_of_the_images(:,i));
E_distance ← sqrt(sum((E1-E2).^2));
subplot(223);
imshow(reshape(rest_of_the_images2(:,i),112,92));
E1 = imhist(random_Image );
E2 = imhist(rest_of_the_images(:,i));
E_distance = sqrt(sum((E1-E2). ↑2));
title(sprintf('Recognition Percentage = %0.2f,100-E_distance/20), FontWeight','bold','FontSize',
14,'color','blue');
subplot(223);
title(sprintf('Recognition Percentage = %0.2f,100-E_distance/20), 'FontWeight','bold','FontSize',
14,'color','blue');

```

End

The system requested for two image databases, where each image will pass through the LBP operator and the result will be compared and check for matching analysis and the result is passed into the result database for further analysis. The system was designed from the derivation of the LBP shown in Algorithms I and II. Let us define texture T as the joint distribution of the gray levels of $P + 1$ ($P > 0$) image pixels:

$T = t(g_c, g_0, \dots, g_{p-1})$ Equation 1
 where g_c corresponds to the gray value of the center pixel of a local neighborhood. g_p ($p = 0, \dots, P - 1$) correspond to the gray values of P equally spaced pixels on a circle of radius R ($R > 0$) that form a circularly symmetric set of neighbors. Figure 5 illustrates three circularly symmetric neighbor sets for different values of P and R .

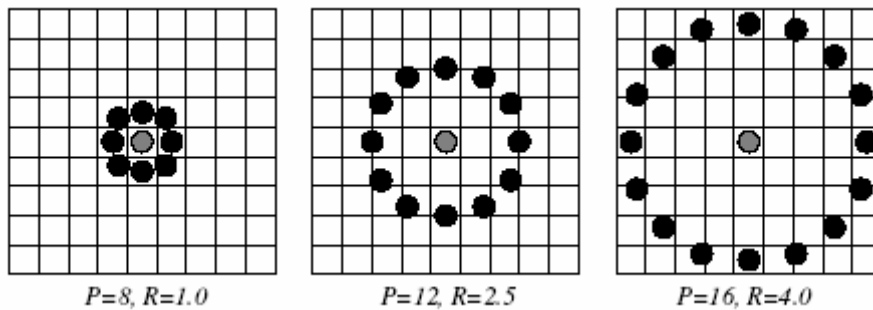


Figure 5: Circularly symmetric neighbor sets.

Without losing information, g_c can be subtracted from g_p :

$T = t(g_c, g_0 - g_c, \dots, g_{p-1} - g_c)$Equation 2

Assuming that the differences are independent of g_c , the distribution can be factorized:

$T = t(g_c)t(g_0 - g_c, \dots, g_{p-1} - g_c)$Equation 3

Since $t(g_c)$ describes the overall luminance of an image, which is unrelated to local image texture, it can be ignored:

$T = t(g_0 - g_c, \dots, g_{p-1} - g_c)$Equation 4

Although invariant against gray scale shifts, the differences are affected by scaling. To achieve invariance with respect to any monotonic transformation of the gray scale, only the signs of the differences are considered:

$T = t(s(g_0 - g_c), \dots, s(g_{p-1} - g_c))$Equation 5

where as $s(x) = \begin{cases} 1, & x \geq 0 \\ 0, & x < 0 \end{cases}$

$LBP(p_c, q_c) = \sum_{n=0}^7 (r(t_n - t_c))2^n$ Equation 6

When the pictures are pass through Equation 6, the pictures will change as shown in Figure 6.



Figure 6: Image Sample before and after LBP.

4.0 CONCLUSION

In this paper, we reviewed related works on image recognition with the aim of identified their areas of applications and limitations. Algorithms of LBP were presented that were used for facial recognition of farmers to recover loan. The final output of the anchor borrower programme(ABP) is to create economic linkage between smallholder farmers and reputable large-scale processors with a view to increasing agricultural output and significantly improving capacity utilization of processors. The proposed algorithm will implemented in our future work to indicate its workability with the full dataset.

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