Can Implementing Smart City Technologies Save the African Cities? – Part I

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INTRODUCTION

Over the past year, I have taken interest and have attended one Smart Cities Innovation Summit in Austin, Texas, USA. This was also a combined a Global City Team Challenge (GCTC) and the US Ignite Application Summit. I will explain each shortly. As you will come to see, this was an opportunity of a life time for me when such convergence of innovation and community development came together. At the same Summit, there was a symposium, speaker after speaker emphasized the advantages and benefits of smart city technologies to the citizens of the community, if such technologies are implemented with care. According to Wikipedia [WIKIPEDIA], a *smart city* is an urban development vision to integrate multiple information and communication technology (ICT) and *Internet of Things (IoT)* (network of physical devices, vehicles, buildings and other items—embedded with electronics, software, sensors, actuators, and network connectivity that enable these objects to collect and exchange data), solutions in a secure fashion to manage a city's assets – the city's assets include, but are not limited to, local departments' information systems, schools, libraries, transportation systems, hospitals, power plants, water supply networks, waste management, law enforcement, and other community services. Why big and small cities would across the global would like their cities to be classified as smart cities, you would ask? There are lots and lots of benefits, the most outstanding are building a community where there is improved quality of life for all residents through use of urban informatics and technology to improve the efficiency of services and meet residents' needs. ICT allows city officials to interact directly with the community and the city infrastructure

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and to monitor what is happening in the city, how the city is evolving, and how to enable a better quality of life [WIKIPEDIA]. Of course, the kind of technologies used in cities vary from city to city and country to country depending on the level of development. The technology you expect to find in Amsterdam, the Netherlands is not the same technology you would expect to find in Abuja, Nigeria or Nairobi, Kenya. The goal here is to be able to use the technology that is available to the city and improve the quality of life of the residents of the city.

One thing is clear, though, because of the sprawling growth of ICT and corresponding growth of smart and mobile technologies, every city now across the globe has some rudimentary but basic technologies to qualify as a smart city, depending on how that technology is used. It would be good to have advanced sensor technology, but not essential for development.

WHY DO AFRICAN CITY PLANNERS NEED TO CONSIDER SMART CITY TECHNOLOGIES

Before we talk about what is required for an African city to become a smart city, let take a look at the current characteristic of an African city.

CHARACTERISTIC OF AFRICA CITIES

To understand the characteristics of an African city, one has to understand the history of the growth of African cities. Most African cities were started by colonial powers and since then, African cities, mostly their former colonial power. In addition to that, the different political and cultural upheavals and experiences these countries have gone through post-independence, has forced the rapid growth of cities, minus planning. This explains why, the rate of growth of African cities is amongst the most rapid in the world. The concentration of African populations in cities is as much as 60% of the total population in many countries [ENDA]. In their article, "Africa's Urbanization: Challenges and Opportunities" Maria E. Freire, Somik Lall, and Danny Leipziger observe that Africa is urbanizing fast. Its rate of urbanization soared from 15 percent in 1960 to 40 percent in 2010, and is projected to reach 60 percent in 2050. They went on to say that African urban populations in Africa are expected to triple in the next 50 years, changing the profile of the region, and challenging policy makers to harness urbanization for sustainable and inclusive growth. With such expected growth most of it composed of youth with limited resources and poorly to no education, the challenge for African city planners are huge.

NEEDED TECHNOLOGIES

In their article, "From Intelligent to Smart Cities", Deakin and Al Wear have articulated factors that must be followed to turn a city into a smart city whatever the technology at hand:

- The application of a wide range of electronic and digital technologies to communities and cities
- The use of ICT to transform life and working environments within the region
- The embedding of such ICTs in government systems
- The territorialisation of practices that brings ICTs and people together to enhance the innovation and knowledge that they offer.

These are things that city planners in most major African cities can do with the technology their have at hand. These are workable and indeed some African cities like Abuja in Nigeria are doing this with the limited technologies they have and it is bearing good results.

In Part II of this article, I go into details of applying available technologies to turn your city anto a smart city and improve the quality of lives of your citizens.

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An Improved Palm Vein Based Recognition System

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Abstract

Though biometrics techniques has been recording high level of security when compared with other forms of authentication, it still come with challenges of speed and accuracy of the technique been used. In this paper an improved palm vein based recognition system was developed and implemented. The development procedure was divided into four stages which are Image enhancement, Image segmentation, Image thinning and Pattern Matching. The Image was enhanced using Histogram Equalization, after which it was passed for Segmentation by K-Means algorithm. The binarized image from K-Means was then thinned using the Zhang Suen's algorithm. The Pattern Matching section of the project was done using the Euclidean Distance. Inter-distances of the intersections from the thinned image were stored in a database for subsequent matching. Results from the various test carried out showed that the system has high speed and accuracy.

Keywords: Palm vein verification, enhancement, segmentation, thinning, pattern matching

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1. Introduction

According to Chowdary, Verma and Monga (2014), authentication in use today comes in three forms: something you know, something you have and something you are. Where the first refers to authentication that utilizes tools such as passwords, and PIN (Personal Identification Number), it has been in the world scene for decades. The second refers to smart cards or tokens, these items have to be carried along. While the third type of authentication is biometrics. Biometrics has a higher level of security when compared the other forms of authentication as it cannot be lost, borrowed, stolen or forgotten.

Chowdary, Verma and Monga (2014), defined Biometric technology as a pattern recognition system which depends on physical or behavioral features for the person identification. Biometrics systems have been researched and tested for a few decades, but have only recently entered into the public consciousness because of high profile application, usage in entertainment media and increased usage by the public in day-to-day activities. Many companies are also implementing biometric technologies to secure areas, maintain time records, and enhance user convenience. Before now commonly implemented biometric modalities include fingerprint, face, iris, voice, signature, and hand geometry.

As technology advances, humans try to use these technological tools to achieve things that seemed impossible at a given time. Previously used biometric systems were based on outward physical or behavioral characteristics of an individual, but this has led to issues of porous security in terms of increased high impersonation rate as regards these technologies.

Recently, many personal authentication methods have proposed the vein patterns such as palm veins and finger veins have been used in security applications. In palm vein recognition, vital information is extracted from the internal part of an individual body- the vein, this information is thus used for authentication purposes. Palm vein authentication has high level of authentication accuracy due to the singularity and intricacy of vein patterns of the palm (Aj-juboori, Bu, Wu, and Zhao, 2014). Unlike other biometric approaches, the palm vein patterns are difficult methods to forge because it is internal in the body.

This paper work proposes a technique for palm vein biometric verification enhancement and accuracy using statistical and data mining tools.

2. System Overview

Although, there are numerous methods already in existence for addressing the issues of palm vein recognition, the following algorithms are used are used for the system development.

- Histogram Equalization
- K-means
- Zhang Suen
- Euclidean distance

In handling image enhancement, Histogram Equalization is used while for image segmentation, K-means algorithm. Zhang Suen's algorithm is employed for thinning while Euclidean distance is used for inter-distance calculation of intersections hence handling the pattern matching aspect of the system. Microsoft C# programming language and SQL server is also used at the front and back end respectively for the implementation.

3. Related Works

In (Ahmed, Ebied, El-Horbaty, Salem, 2014), authors focused on the utilization of Homomorphic filtering for the preprocessing step which is a generalized technique for image enhancement and/or correction. The pattern matching was done using the canny edge detection filter images was gotten from CASIA Multi-Spectral Palmprint Image

In the reported work by (Kumar and Gayathri, 2014) for feature extraction and classification, the subspace learning approach using kernel principal component analysis (KPCA) was used to extracts the vessel structures by analyzing the eigenvalues of the normalized palm-vein images and also the Local mean based k-nearest centroid neighbor (LMKNCN) approach achieves the palm-vein authentication.

Aj-juboori, et.al, 2014 reported on Gabor filter for the extraction and feature reduction dimensional and matching for Palm Vein Verification.

Manocha and Kaur, 2013 discussed on using neural network palm vein recognition. The back propagation algorithm was used for the neural network implementation. The project simultaneously utilized the palm surface and palm subsurface features for identification.

In the work by Saravanan and Prabhu, 2013. The authors presented the juncture point approach and hand geometry for recognition. The junction point approach extracts palm-vein features by analyzing the junction point of the palm image.

Deepamalar and Madheswaran, 2010 used Multi-level Fusion of Multimodal Features and Adaptive Resonance Theory. Multiple Feature extraction technique was used to extracts hand shape features, Adaptive sequential floating forward search (ASFFS) was then applied for feature optimization after which pattern matching which was carried out using k-Nearest Neighbor classifier.

4. Methodology

Different algorithms have been implemented over the years for palm vein pattern recognition which have been successful. The developed system improves on the efficiency of existing system by using a simple and more efficient algorithm, paying attention to time taken for the algorithm completion and also accuracy in matching patterns.

Essential components for the system development are listed below:

a) Image Acquisition
b) Image Enhancement
c) Image Segmentation
d) Image Thinning
e) Inter-Distance Computation

4.1 Image Acquisition

Dataset used for the development and implementation were collected from the CASIA Multi-Spectral Palmprint Image Database V1.0 (CASIA database).

The Near Infrared Imaging is more tolerant to changes in environment and body condition and hence is employed in the data acquisition of palm dataset by CASIA database which is utilized in this project.

4.2 Image Enhancement

A region of Interest (ROI) of 100 * 100 is extracted from the collected dataset. The palm images collected are often blur. The image firstly has to be enhanced to increase its contrast, and make the patterns more visible. Histogram equalization is used for Image enhancement.

In histogram equalization, the input pixel intensity, x is transformed to new intensity value, x^t by T. The transform function, T is the product of a cumulative histogram and a scale factor.

$$x^t = T(x) = \sum_{i=0}^{x} n_i \frac{max\ intensity}{N} \qquad 4.1$$

where n_i *is the number of pixels at intensity i*

N is the total number of pixels in the image

4.3 Image Segmentation

The K-means algorithm is used for the segmentation stage after successful image enhancement with the histogram equalization.

The algorithm is composed of the following steps:

Let X = $\{x_1, x_2, x_3, \ldots\ldots, x_n\}$ be the set of data points and

V = $\{v_1, v_2, \ldots\ldots, v_c\}$ be the set of centers.

a) Select *'c'* cluster points randomly.
b) Compute the distance between each data point and cluster centers.
c) Assign the data point to the cluster center whose distance from the cluster centre is minimum of all the cluster centers.
d) Re-compute the new cluster center using:

$$J = \sum_{j=1}^{k} \sum_{i=1}^{x} \left|\left| x_i^{(j)} - c_j \right|\right|^2 \qquad 4.2$$

where, 'c_i' represents the number of data points in i^{th} cluster.

e) Re compute the distance between each data point and new obtained cluster centers.
f) Stop if no data point was reassigned, else repeat from step c.

4.4 Image Thinning

After segmentation is completed, the binary images obtained are now thinned to single pixel width vein patterns. This is done by using the Zhang Suen algorithm.

The algorithm operates on all black pixels P1 that can have eight neighbors. The neighbors are, in order, arranged as:

P9	P2	P3
P8	P1	P4
P7	P6	P5

Define A (P1) = the number of transitions from white to black, in the sequence P2,P3,P4,P5,P6,P7,P8,P9,P2. (Note the extra P2 at the end- it is circular)

Define B (P1) = the number of black pixel neighbors of P1. (= sum (P2…P9))

The algorithm based on [25] is given below

i) Step 1

All pixels are tested and pixels satisfying all the following conditions are just noted at this stage

- the pixel is black and has eight neighbors
- (1) 2 <= B(P1) < = 6
- (2) A(P1) = 1
- At least one of P2 and P4 and P6 is white
- At least one of P4 and P6 and P8 is white

After iterating over the image and collecting all the pixels satisfying all step 1 conditions, all these condition satisfying pixels are set to white.

ii) Step 2

All pixels are again tested and pixels satisfying all the following conditions are just noted at this stage

- the pixel is black and has eight neighbors
- (1) 2 <= B(P1) < = 6
- (2) A(P1) = 1
- At least one of P2 and P4 and P8 is white
- At least one of P2 and P6 and P8 is white

After iterating over the image and collecting all the pixels satisfying all step 2 conditions, all these condition satisfying pixels are again set to white.

iii) Iteration

If any pixel were set in this round of either step 1 or step 2 then all steps are repeated until no image pixels are so changed.

4.5 Inter-Distance Computation

Euclidean distance is employed for inter-distance computation of cross through intersections. Cross through intersection were used to reduce time taken for inter distance computation. The intersections are gotten by the following method:

1	0	1
0	1	0
1	0	1

0	1	0
1	1	1
0	1	0

For any nine pixels arranged in any of the two forms above, the coordinate of the central pixel is taken as the intersection points. The intersections are used in the computation of the inter-distance using the Euclidean distance formula.

$$D = \sqrt{(x_1 - x_0)^2 + (y_1 - y_0)^2} \qquad 4.3$$

where x_0, y_0 *are coordinates of the first intersection*

x_1, y_1 *are coordinates of the second intersection*

The computed inter-distances are stored in the created database.

When a test sample is brought to the system, all the previously analyzed process performed for the training set is as well performed on the test image, after which the stored inter-distances is matched with the trained one retrieved from the database to verify if it is the same palm sample.

4.6 Threshold Estimation

A threshold value of 0.7 is chosen for the matching process. This value is computed based on the pseudo code below:

```
START Process
    GET the length of the array holding the data to match with and place in A.
    GET the length of the array holding the data to verify and place in B
    COMPARE both arrays for identical elements.
    GET the number of the identical elements and place in x.
DIVIDE x by A and B
    IF the result of any division is greater than 0.7 THEN
    Return it is a Match
    ELSE
    Return it is not a match
END Process
```

A threshold value of 0.7 was choosing due to the inconsistencies present in the extraction of the Region of Interest (ROI).

5. Result and Discussion

After the training and testing images were acquired, the ROI was firstly extracted. A region of 100 * 100 was used in the development and a K-value of 5. The essence of the ROI is to separate the part that possess more feature from the image, which is then forwarded as the actual input to the system. The irregularities present in the extraction of the ROI did not affect the result since inter-distances of 2 point are the same even when read from different locations (i.e. different coordinates).

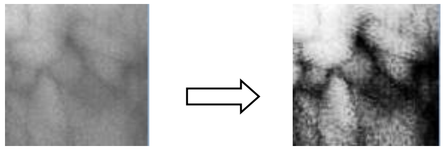

Figure 1: The image enhancement stage

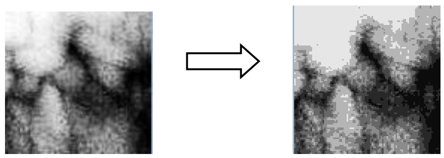

Figure 2: The segmentation stage successfully separated the image from the background.

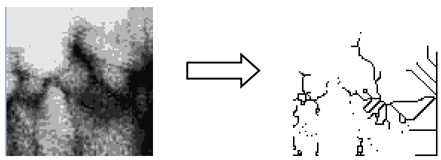

Figure 3: The binarized image which was also successfully thinned

5.1 Feature Extraction

Features of the palm vein patterns were extracted and the distance values between cross through intersection. As shown in figure

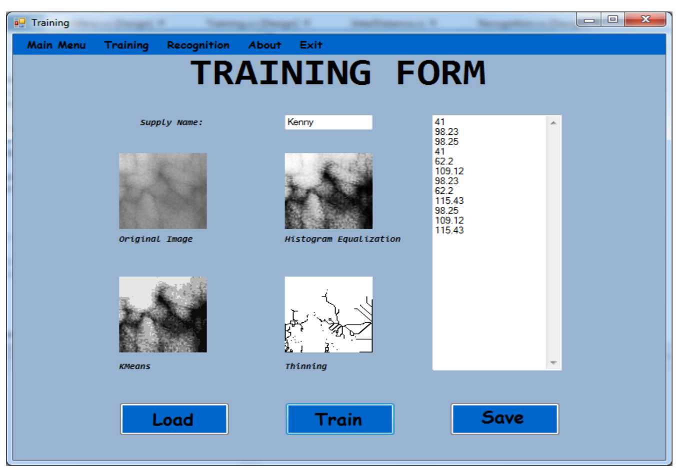

Figure 4: Interface for the Training Form

For verification, a threshold value of 0.7 is set for match due to inconsistencies in extraction of the ROI. If value is 0.7 and above a match is registered, else a mismatch.

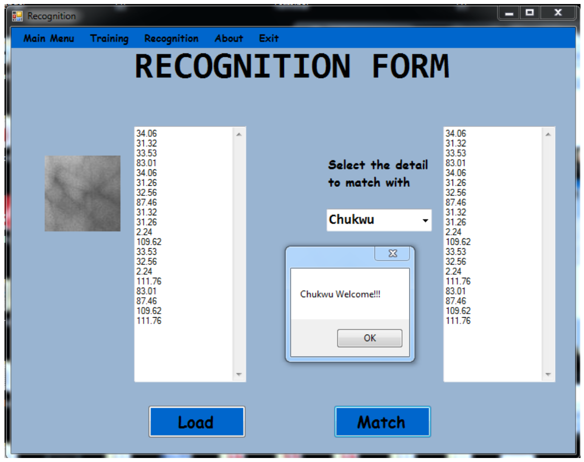

Figure 5 (a): Interface for Recognition match

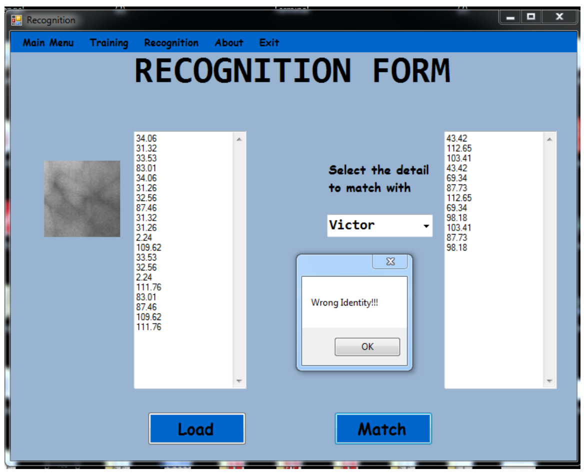

Figure 5 (b): Interface for Recognition mismatch

6. Conclusion

Biometrics system is now becoming a normal norm for enhanced security measures due to the fact that it is part of us hence cannot be forgotten or stolen. Despite its high security among other approaches, there is still a need to enhance its speed and accuracy.

The developed application was successfully tested using the CASIA database and has shown high accuracy and speed in recognition. The system has a very low dependency rate with the ROI size extracted. The system was tested with an ROI of 100 * 100 but has shown to have an increased accuracy when the region is between 150 and 220.

The work brings to light a faster system with high efficiency for good experience when addressing security.

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