# **EmpAMPS: A Secure Biometrics Framework for Mitigating the Menace of Ghost Workers in Developing Economies**

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**Abstract.** Strong inclinations towards controlling and monitoring employees are becoming a more prevalent feature of working life. The success of any organization is directly proportional to the contributions of the workers either from executive level or operational level. The objective of managing workers attendance in working place is to improve profits and to minimize costs. Biometric authentication is an exciting technical improvement in recent times over other methods of human. A secure Employees' Attendance Management framework (EmpAMS) with remote monitoring that curtails the influx of ghost workers in public civil service integrated with a web-based, real-time monitoring tool that allows people in management positions to see when their employees check in and out, for informed decision-making during performance appraisal that avoids buddy-punching is presented. One major strength of the proposed system is that it provides a data security structure for ensuring the security of biometric templates (the finger-prints acquired from workers during the enrolment phase.

Keywords: Data Security, fraud, biometrics, employee monitoring, human resource management.

#### 1. Introduction

Managing employees' attendance during the working hours to ensure that remunerations only go out to the legal employees of the organization has become a difficult task in most public sectors in developing societies. Therefore, a biometric (fingerprint)-based attendance monitoring system would offer a remedy to the detrimental consequences of ghost workers in the public service sectors.

An individual who has been falsely registered in a payroll and still does not work for a company or the government is referred to as a "ghost worker" or "ghost employee." The "ghost" is actually a depiction of a person who has been added to a payroll using a fake profile with the goal of tricking a company or government into paying wages and sometimes, pension or retirement benefits to a nonexistent individual. The "ghost employee" scam is only successful if the perpetrator has un-monitored access to the government systems. Ghost employees on pension schemes or in payroll systems have been a significant source of fraud and revenue losses for privately-owned or government-owned organizations all over the globe. The fraud is perpetuated through the creation of the ghost, making fictitious time sheets, as well as obtaining and even cashing time payments. Any organization that is on the path of success must maintain a comprehensive attendance system of the employees for accurate processing of payrolls [1].

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Numerous governments annually distribute significant quantities of money in the form of salary and pension payments to ghost workers, or nonexistent individuals who have been registered inadvertently or through payroll fraud. The issue of ghost workers on public payrolls is a long standing and escalating problem. Ghost profiles are sometimes created on the official payrolls in developing nations due to poor record management in the public sector. Poor human information systems make it difficult for most nations, especially the least developed ones, to accurately track and keep payroll records up to date. Weak personnel databases make it difficult for designated authorities to efficiently monitor employees' activities, which leads to a lack of control over staff.





Employees of public service sectors are characterized with a lot of unwholesome activities at the detriment of their employers. Fingerprint biometrics may be the best method for preventing ghost worker fraud, establishing employee accountability, and creating a robust audit trail.

# 2. Related Works

The following studies that relate to approaches for curbing frauds, as well as the adoption of biometrics in various spheres of life were reviewed so as to develop an effective and efficient framework for ameliorating or eliminating some of the challenging problems of existing techniques;

Employee management is crucial in any firm, and is a key factor in determining the set objectives of the organization. The study in [2] carried out a study on how biometric technologies can be applied for attendance management. The study noted that fraudulent cases of attendance register can be solved using a biometric based attendance management system giving consideration to subjective and objective external environment. For staff and students at colleges and universities, the study in [3] recommended an integrative fingerprint-based attendance tracking system with remote monitoring. However, the system lacks portability with hand held devices and modular fingerprint.

Employee Identification and personal verification technologies must be given utmost consideration if the prevailing cases of Ghost workers would become a thing of the past. Moreover, these two are necessary ingredients for the actualization of organizational objectives. Similarly, the study in [4] proposed a biometric based employee attendance management system. The work lacks any framework for the acquisition and accurate processing of the biometric traits. Oloyode et al. in [5] noted that the productivity of employees at work place can be improved using fingerprint attendance system, and concluded that fingerprint is a suitable biometric trait for employees' attendance management system.

Ikuomola in [6] developed a practical fingerprint-based time and attendance management system for students during class hours. The formulated model was not extended to handle employees in working places. The study in [7] presented an attendance management system for factory workers. However, the paper did not make use of any image processing technique for image pre-processing and enrolment in the database. To avoid stressful and time-consuming attendance taking in institutions of higher learning, Adetiba et al. developed a web-based biometric attendance system in [8]. The system was proven to be

reliable but it lacks computational intelligence. Biometric identification systems are cost effective and reliable means of human identification in any society. There are many biometric traits that can be used for human identification such as face, gait, iris, fingerprint, palm print, and voice. Acquiring fingerprint templates and samples for registration of users and subsequent verification is the cheapest, simplest, and reliable option among others.

The study in [9] designed a fingerprint attendance tracking system which sends SMS notification to the parents of the wards, informing them of their presence or absence in class attendance. However, the system was not adopted for full-scale deployment majorly as a consequence of its time of execution. Akinduyite in [10] presented a fingerprint attendance management system for students of higher institutions to curb the high rate of impersonation during students' class attendance. In the work, the unique features of the biometric images are taken using the Crossing Number (CN) method. Gabriel and Egwuche in [11] presented a model for the management of personnel on duty post. The design could generate the clock in and clock out records of the target workers but no biometric features of the workers was considered as part of the authentication procedures for a more secured system against impersonation.

Some of the difficulties and opportunities of deploying an automated employee performance management system were addressed by Egwuche et al. in [12]. Some of these challenges highlighted in the paper include weak government structure to embrace new technologies that enhance productivity, insecurity of physical infrastructure, and poor services offered by telecommunication industries in developing countries because of a number of factors. The paper highlighted some of the benefits of shifting to electronic human resource management to include strategic human resource planning, reduction of cost and effects in records keeping and good communications among others.

The study in [13] opined that those cases of document forgeries and impersonation of personal identity can be can be reduced by the use of biometric system. Additionally, for a cost-effective and dependable attendance management system, Sarker et al. in [14] incorporated RFID, fingerprint-based biometrics, as well as password-based technologies. The proposed system cannot run on mobile devices because it is not IoT compliant. The study in [15] did present a portable attendance management system that is integrated with a learning management system. As a movable device, the designed system requires being circulated from one student to the other in the class.

Because no two persons will ever have same fingerprint pattern, fingerprints can be regarded as the most trustworthy human feature that is frequently utilized for person identity verification in the domain of biometric systems.

In view of the benefits and contribution of biometrics to research in data security and human personnel management, this work studies fingerprint-based biometrics and how they can be used for improving economies of nations especially by ensuring high-level productivity of employees and or working personnel. Adopting biometrics-based techniques could go a long way in mitigating the many negative consequences of the fraud called "ghost workers", ultimately preventing unscrupulous elements from sabotaging the efforts of governments.

# 3. The Proposed EmpAMP Framework

Ghost workers in developing countries are a common government level fraud that drains the economy of the society which often goes unnoticed to the common citizens. The exaggerated pay to ghost workers in governments and organizations affects the gross performance of such organization. Even though individual retirement benefits payments may seem little at first, they can build up to a sizeable sum over time, especially if enough of these "ghosts" are added and eventually retire. Most of the developing societies that are affected by the ghost workers' fraud eventually end up paying the staff/employee wages late. This then creates a justification for further fraud as a justification for survival.

The Fingerprint authentication offers many advantages over all other biometric traits. It has a higher accuracy of human recognition, it is safer and easier to enrol, it utilises smaller memory space, and decreasing the amount of memory needed for the database as a result, which ultimately improves computational efficiencies.



**Figure 2.** The Proposed Architecture of Employees Attendance Management System. There are various stages in the architecture as shown in figure 2. These stages are further highlighted as follows;

# 3.1. Fingerprint Acquisition

In this module, fingerprint modalities are acquired from the workers for enrolment and subsequent authentication through the use of a scanner. The scanner takes the image of the finger and determines the unique characteristics of the fingerprint image. The enrolment is done once for each person.

# 3.2. Fingerprint Pre-processing

At this stage, the system performs a pre-processing technique, so as to acquire the unique features of the fingerprint taken by the sensor which will serve as the templates (encrypted series of numbers) in the database for subsequent comparison with the life image.

# 3.3. . Binarization and Thinning

Binarization is the process of converting a grayscale image into a binary one. This facilitates the mining of minutiae by increasing the contrast between most of the ridges and valleys present in a fingerprint image

Utilizing an adaptive thresholding, binarization is applied. Bearing in mind the intensity mean calculated as in equation 1, every pixel of the fingerprint is given a new value (1 or 0).

$$I_{new}(n_1, n_2) = \begin{cases} 1 \text{ if } I_{old}(n_2, n_2) \ge Local Mean\\ 0 \text{ otherwise} \end{cases}$$
(1)

The binary images are subjected to a morphological procedure known as "thinning", to eliminate particular foreground pixels. Morphological thinning operations are used to obtain the thinned ridgelines. Thinning is used prior to the minutiae extraction stage. It is essential to grasp basic definitions in order to properly comprehend the algorithm. When all four of a pixel's neighbours—(x+1, y), (x-1,y), (x,y+1), and (x,y-1)—are zero, the pixel is said to be internal (black pixel). Its eight connections are used to determine the limit. If a pixel is not internal but only one of the eight neighbours is equal to 1, then that pixel is a limit pixel. A particular pixel is a connector pixel if, in some kind of a 3 x 3 matrix, its neighbours are unconnected when it is removed. The approach basically entails locating the inner pixels in the image and then removing the pixel limit. This procedure is continued until no more internal pixels can be found.

#### 3.4. Minutiae Detection

The image is ready following the thinning procedure, thus the algorithm for minutiae detection is used. The crossing quantity of pixels approach is used to extract the finer points, such as ridge ends and bifurcations.

Equation 2 is used to determine the quantity of pixels that overlaps a center pixel (Cp) in the algorithm.

$$Cp = \sum_{i=1}^{8} p(i) \tag{2}$$

where P1 to P8 represent the block of 8 pixels that surround the center pixel in an ordered succession. The Discrete Wavelet Transform (DWT) is applied on minutiae feature matrix to obtain the DWT sub bands. The Mean, Standard Deviation (SD) and Variance of sub bands are measured using equations (3), (4), (5) respectively. The log transformation is applied on each value of Mean, SD and Variance in order to obtain final DWT features set.

$$\dot{\mathbf{X}} = \frac{1}{N} \sum_{i=1}^{N} X_i \tag{3}$$

$$SD = \sqrt{\frac{1}{N} \sum_{i=1}^{N} X_i - \dot{X}^2}$$
 (4)

$$Variance = \frac{\sum X - \dot{X}^2}{N}$$
(5)

where:

N stands for the quantity of elements the column vector contains; while  $X_i$  is the coefficient values in the column vector.

#### 3.5. Fingerprint Matching

This interface is used to compare the features of the processed fingerprint templates already enrolled in the database with the life fingerprint image acquired from the sensor.

The Euclidean Distance (ED) is used for the comparison between features vector of database images with features vector set of test images using Equation 6, given for the authentication of employees' identity. The ED values are compared with prefixed threshold values to identify a person. The employee is granted access and attendance record updated or denied based on the pre-defined algorithm for denial and acceptance.

$$ED = \sqrt{\sum_{i=1}^{N} q_i - p_i^2}$$
(6)

where:

 $p_i$  represents the features of the database; and

 $q_i$  represents the features of the test images

All fingerprints acquired from workers/employees during the enrollment phase are processed and stored in the database daily attendance of employees at working place.

In this study, we applied Wiener Filtering to lower noise and spatial histogram equalization to contrast enhancement. Morphological filtering is used to fill in some gaps in legitimate ridgelines and to remove artifacts in areas where noise is present.

To achieve a consistent distribution of gray levels q, histogram equalization specifies a mapping of gray levels p onto gray levels q. The transformation facilitates the identification of several picture features. A pixel's intensity level's probability density function.

#### 3.6. Architecture of the Proposed EmpAMS

The Employees' Attendance Monitoring or tracking System (EmpAMS) is a fingerprint-integrated attendance tracking system for employees of public and private sectors in developing economies. It offers efficient, safe and automated attendance recordkeeping function that enables employers keep tab on their employees in any organization. The system makes use of an e-fingerprint scanning device connected to a PC for the verification of each employee.



Figure 3. The Integrated view of the Proposed EmpAMS.

3.7. The Algorithm for the Proposed EmpAMS

Input: Database Fingerprint and Test Fingerprint image

Output: Verified Fingerprint image

Step 1: Read finger image from database

Step 2: Binarize and crop the finger image in preprocessing

Step 3: Convert the cropped binarized image to one pixel width, or thin the image.

Step 4: Generate minutiae points.

Step 5: DWT is applied to obtain final features set.

Step 6: Using ED, the characteristics of the test and database fingerprints are compared.

Step 7: If the test image's ED value is less than a predetermined threshold value, it is deemed to be matched; otherwise, it is said to be unmatched.

### 4. System Implementation and Evaluation

The proposed system will be implemented to assist employers of labour in the management or monitoring of their workforce or human resource. Indeed, fingerprint identification mainly used in the proposed system, is the procedure for recognizing a query fingerprint from a pool of enrolled or registered fingerprints. The time of response to the query is dependent on the size of the database.

True accept and false reject are terms used when a fingerprint matches the fingerprint template of the person in the database but does not match. We refer to it as a fake accept if the fingerprints of several employees match or a genuine reject if it rejects them.

The error rates that are utilized to describe matching trustworthiness in the system are false acceptance rate (FAR) and false rejection rate (FRR).

Equation 7 is used for computing FAR A formula is used to determine FAR :

$$FAR = \frac{FA}{N} * 100 \tag{7}$$

where; FA stands for Number of False Accepts, while N denotes the Total number of verified employees.

FRR on the other hand is defined by Equation 8;

$$FRR = \frac{FR}{N} * 100 \tag{8}$$

where FR represents the number of False Rejects.

The monthly attendance percent of employees can be computed using Equation 9:

$$Attendance = \frac{NumberOfDaysPresent}{TotalNumberOfDaysInaMonth} * 100$$
(9)

These highlighted standard metrics would aid the proper evaluation of the proposed system and ultimately improve the productivity of workers in both private and government owned businesses or organizations.

#### 5. Conclusion

The contributions of adequate attendance management to the overall success of any organization cannot be over emphasized. The implementation of the system will ensure that the salaries and wages paid to employees are justified and it will provide a good ground for appraisals of workers. Fingerprint biometric trait was chosen because of its suitability for identity verification. In this work, a fingerprintbased attendance management framework that curbs the ugly trend of ghost workers in developing economies. The records captured from the system can be used for promotional appraisal and processing of payroll. The technique can work for the attendance management of any organizations. The proposed framework will enable/encourage proactive employee monitoring/management and ultimately improve efficiency and productivity. The proposed framework's implementation and subsequent system evaluation will be investigated further.

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