A Framework for Verification in Contactless Secure Physical Access Control and Authentication Systems

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Abstract— **Biometrics is one of the very popular techniques in user identification for accessing institutions and logging into attendance systems. Currently, some of the existing biometric techniques such as the use of fingerprints are unpopular due to COVID-19 challenges. This paper identifies the components of a framework for secure contactless access authentication. The researcher selected 50 journals from Google scholar which were used to analyze the various components used in a secure contactless access authentication framework. The methodology used for research was based on the scientific approach of research methodology that mainly includes data collection from the 50 selected journals, analysis of the data and assessment of results. The following components were identified: database, sensor camera, feature extraction methods, matching and decision algorithm. Out of the considered journals the most used is CASIA database at 40%, CCD Sensor camera with 56%, Gabor feature extraction method at 44%, Hamming distance for matching at 100% and PCA at 100% was used for decision making. These findings will assist the researcher in providing a guide on the best suitable components. Various researchers have proposed an improvement in the current security systems due to integrity and security problems.**

Keywords-- Security, Integrity, Contactless, Biometrics, Authentication

I. INTRODUCTION

The aim of this paper is to identify the components of existing systems that are used in Higher Education Institutions. Biometric authentication is a technique of using the distinctive features of an individual's biological features for authentication and security purposes. This paper aims to make an economical and contactless system using biometrics, for this, we use the unique pattern of veins present in our palms. A vein pattern is a group of blood vessels beneath an individual's skin. They are unique to each person and are difficult to forge as compared to other traditional biometrics. They also have a property to absorb infrared light owing to the hemoglobin present in our blood. Using this property, we create a system to perform image processing on these patterns and use it for authentication purposes. The findings will be used to allow the researcher to develop a security framework for higher Educational Institutions through the use of contactless biometric technology.

A. Problem Statement

Identity theft and the trustworthiness of authentication tools in higher education institutions are issues that jeopardize system integrity and impede excellent service delivery. The students and employees of the institution who utilize the biometric system to clock in are the target population. When affected employees try to clock in, the system is unable to authenticate their information. The fingerprint biometric technology also has a high False Rejection Rate. Such problems demonstrate the biometric system's inefficiency and ineffectiveness, which puts the system's integrity at risk. The success or failure of a biometrics system is determined by a variety of factors and application areas. Palm vein technology is one of the ways that can be used to address the concerns that have been discovered. Due to virus transmission via surfaces, the present biometric system has been underutilized since the advent of the covid-19 pandemic. There have been instances where users, particularly

those in charge of systems, databases, and servers, have been drugged and their fingerprints captured by unauthorized individuals who then produce artificial fingerprints that can be used to log on to the systems later. This can compromise the information's integrity and secrecy because it can be altered, resulting in inconsistencies and data loss. This depicts the operation's system inefficiency.

B. Research Objective

To investigate the existing security systems in higher education institutions?

C. Research Question

Many countries in the world still are without sufficient regulation and/or enforcement to protect user's data and privacy [22], the author analyzed the existing security systems in Ugandan Universities. According to [10],[21],) Information security works under the principles of confidentiality, integrity and availability. Effectiveness in security policy performance is very crucial and it should serve for the benefits of the organizations and the government as well. According to [20], the number of threats and design flaws increases in a system due to the advancement in technology and sophistication in technology. This possess a great challenges for any business due to the advancement in technology thus jeopardizing the security of any information system. Information security is defined as a set of strategies for managing the processes, tools and policies necessary to prevent, detect, document and counter threats to digital and non-digital information [23], The research question was guided by the above narrative on how the current existing security systems are working towards ensuring there is efficiency, integrity and privacy of the information.

i. What are the components of the contactless security systems in Higher Education Institutions?
ii. How are the existing security systems in higher learning institutions?
iii. How do you design a contactless security framework for HEI's?

II. LITERATURE REVIEW

A significant number of authors have conducted research on how the current security systems are working.

Data security keeps on receiving developing consideration with different researchers and experts offering center to the subject [1] [2].his is to a great extent ascribed to the way that security is a basic component when creating and implementing out IT infrastructure inside organizations. Various studies have underscored on the significance of eliminating shortcomings in a data security chain. Such shortcomings frequently would introduce itself when individuals unwittingly or intentionally meddle the current frameworks.

With the increase in internet by the end of 2011, many teachers in universities of Uganda increased the utilization of internet which now calls for security concerns to maintain the technology introduced [7],. This has encouraged the rise of activities related to evaluation, assessment and analysis of information systems security usage and corresponding performance outcomes in higher learning institutions to ensure quality sustainability of their performance. The government of Uganda has tried its best to introduce a number of ICT institutional reforms to stabilize and rehabilitate the information cyber security in many sensitive departments of higher learning institutions so as to curb the recurring issues of information mismanagement. The Uganda Internet Governance Forum report (2012), also confirmed it that Uganda made some progress in implementing some key Internet Governance issues related to affordability and access to cyber security management and critical Internet resources.

According to [3], any verification innovation is unusable if its users don't utilize it.This happens even with the most efficient security systems thus it's critical to consider the agreeableness of e-verification innovation along these lines. Adequacy is a positive mental portrayal that a client has prior to utilizing a specific device or system [5],Studying the selected learners perspectives gives significant data to the two fashioners of e-confirmation tools and Higher education institutions utilizing or intending to utilize them. A student probably won't acknowledge an e-verification framework that isn't successful, having significant high risks or proficient, or is generally not acceptable to utilize. New European enactment (legislation) underlines the way that Digital learning environments ought to have compelling and solid security components to ensure their reliability [3],[4].Trust is a central precondition for the accomplishment of any innovation that is considered to be new, particularly in schooling, and trust in e-authentication gives off an impression of being unpredictable. [6]

For instance, biometric verification may give improved client experience by decreasing the need to make and remember passwords; yet, then again, it adds to various types of difficulties, for example, security concerns [4]. [17], further recommend that there are various layers of trust identified with the establishment, e-verification tools, instruments deployment, utilization of the gathered information, and the results of the cycle. Besides, [8], express that worthiness is a significant issue inside biometric frameworks and it shows the degree to which individuals will accommodate the utilization of biometric identifiers in their regular day to day lives.

As per [9],e-authentication is a novel technique as of now. There is a moderately little studies that relates to the impact of e-validation frameworks across particular end clients. [9],contemplated perspectives and encounters of 328 advanced education understudies of Open University (UK) who utilized an e-verification framework created in the Trust-based authentication and authorship e-assessment analysis project. They contend that distance training learners had extensively certain perspectives on e-validation innovations. There were additionally basic reactions, in any case. Reactions demonstrated, for example, that learners with handicaps were bound to dismiss e-authentication because of worries about

their exceptional instructive requirements. Many young learners were likewise less able to utilize e-confirmation because of concerns encompassing information protection and security, and ladies were less able to give individual information than men. The requirements of learners ought to be considered inside the setting of e-validation [9],In this manner, it is imperative to realize how diverse learners respond to electronic verification. For example, scientists are far from completely understanding Special educational needs and disabilities (SEND) learners' perspectives on the utilization of e-authentication.

Many educational institutions have made computer skills a requirement of overall instruction; however, data security training is never a requirement. When looking at the educational strategies for various programs given by Kenyan universities, data security education is mostly provided to students enrolled in IT-related degree programs [10] Attributable to the inescapable of cybercriminal activities, students, regardless of their career direction need to have a decent comprehension of data security issues to safeguard themselves and the establishment against potential dangers and adventures. While the facts demonstrate that colleges have IT divisions and may offer certain actions as foundation administration to ensure IT asset clients, there are scenarios when choices made by line clients like learners have security hazard suggestion [18];[24]; [1]. Similarly, such dangers would be serious since they would likewise have negative repercussions in the academic arena.

Inside Higher Education Institutions, security breaches may cause loss of information, time, and negative reputation to both the organization and the learner. It is thusly basic that learners who are one of the key line users of innovation assets inside colleges, have a decent information on potential dangers they are exposing themselves and to the institution at large. It's essential to be aware that there has been a consistent ascent in security penetrations and misuses both regionally and all around the world in all areas of the economy [1]; [25].

A survey on human palm vein identification was done based on Laplacian Filter. During the survey the feature extraction was done using Laplacian filter on convolved images while vein attributes were enhanced using histogram equalization. The research revealed that it can also be implemented in multimodal veins not only the unimodal onces.The research also proved that the technology can of great benefit in online security systems associated with biometrics. [26].

The identification of humans using palm vein pictures was the subject of a study. The edges and curves of the image were retrieved, and the attributes of vein images from the palms were extracted using the canny edge detection approach. This approach is connected with low computing complexity and low cost. Following the study, it was discovered that the recognition time was only 0.5 seconds.[45].

S. Bharathi, Valentina E. Balas, and R. Sudhakar submitted a paper in Acta poltechnica hungarica in 2015 about a hand vein based multimodal biometric system. The retrieved features are in the form of coefficients and are based on the Shearlet transform and scale invariant feature transform. The fusion of finger hand and palm vein coefficients are then put in the database. With FAR and FRR, this fusion technique was able to achieve the greatest accuracy of 94 percent.

According to a research by[27],he proofed that the Palm vein recognition was able to outweigh all the biometric systems. With this technology there is high level of recognition accuracy. Many studies have tried to propose many approaches on how the palm vein can enhance the security of information systems [32]. Geometry-based approaches use spatial methods like the Gabor filter and vector grams of maximum intra-neighbor difference to extract characteristics from segmented blood vessels. As a rule, its exhibition is influenced in light of the fact that the pixel-to-pixel handling is incredibly touchy to distortions. Subspace-put together techniques are received with respect to AI to decrease or work on the information structure by displaying the palm vein picture into subspace. The principle contributions of the research identified with the subject are centered on phases of feature extraction and acknowledgment on the grounds that these are definitive segments in the precision of the outcomes. [27].

As revealed by [27], the majority of the exploration works are centered on contactless palm vein acknowledgment framework. A palm vein contactless framework is more reasonable for genuine situation. In any case, a contactless plan framework produces issues, for example, non-uniform enlightenment and relative change which isn't appropriate for certain strategies. Other than that, palm vein pictures, just as finger pictures, are seriously influenced by distortions, which happen because of scale change and furthermore influence the precision of the framework. The picture quality is generally addressed utilizing visual improvement methods like histogram leveling [49]. As to vein picture misshapenness, crafted by [50] to be featured, which acquaints another viewpoint that can assist to manage the issue of distortions for finger-vein biometric system. Their commitment is unique in relation to different works that attempt to lessen the impact of misshapenness by executing a more exact division of Return on investment (ROI), or utilizing a more powerful component extraction among others [28].The highlights got at the pixel level depend on the perception that the removal of pixels produced in the coordinating with measure, because of the misshapenness of vein pictures, are helpful as biased data.

III. METHODOLOGY

The researcher collected the data from selected 50 journals obtained from the Google scholar. The methodology used for research was based on the scientific approach of research methodology that mainly includes –data collection from the selected 50 journals, analysis, and assessment of results and later designing the contactless security framework. Following are techniques used to form an identification model for recognition of the subject based on uniqueness and

distinctness in palm vein pattern of an individual. From the 50 journal papers.20 of them were used to identify the components of the proposed contactless security framework. The methodology was suitable since the researcher analyzed the selected journals in order to determine the components required and existing literature about contactless biometric security systems.

A. Inclusion and Exclusion Criteria

Inclusion Criteria-The research included all the studies about biometric security systems and information security. All studies from 2011 will be included in the research with at least 50% of the studies will be from the last five years.

Exclusion criteria-The research excluded all security systems that are not related to biometric technologies. All studies below 2011 will not be included in the research apart from those that will be classical.

1) 3.2 Study Populations

The researcher had a population of 50 journals which were related in the area of study.

IV DISCUSSIONS

As revealed by [27], the majority of the exploration works are centered on contactless palm vein authentication framework. A palm vein contactless framework is more reasonable for genuine situation. In any case, a contactless plan framework produces issues, for example, non-uniform enlightenment and relative change which isn't appropriate for certain strategies. Other than that, palm vein pictures, just as finger pictures, are seriously influenced by distortions, which happen because of scale change and furthermore influence the precision of the framework. The picture quality is generally addressed utilizing visual improvement methods like histogram leveling [29].As to vein picture misshapenness, crafted by[50] ought to be featured, which acquaints another viewpoint that can assist to manage the issue of distortions for finger-vein biometric system. Their technology is unique in relation to different works that attempt to lessen the impact of misshapenness by executing a more exact division of ROI or utilizing a more powerful component extraction among others. [28].The highlights got at the pixel level depend on the perception that the removal of pixels produced in the coordinating with measure, because of the misshapenness of vein pictures, are helpful as biased data. Edges and valleys with a high degree of distinctiveness are used in palm vein technology. Flexion wrinkles, auxiliary wrinkles, and ridges make up the palm[16]. There are several important qualities in a palm print, including the palm math, rule lines (life, heart, and head), wrinkles, subtleties, and the delta point [12]. They contain information necessary for accurate, unmistakable identification of an individual [30], and because they hold unusual information [15], Fig. 2 depicts the highlights in a palm print.

Fig 1: Features on a fingerprint (Ali and Gaikwad, 2016)

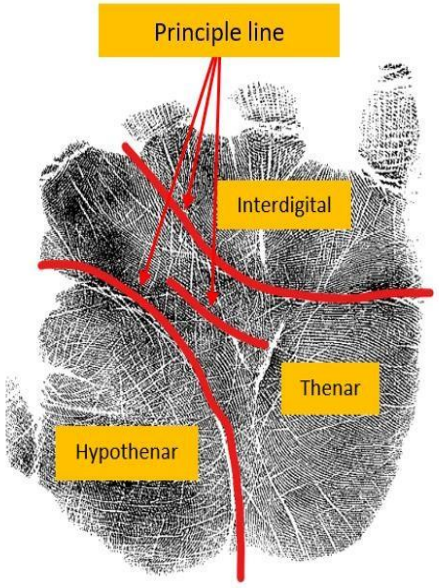

Fig 2 Features of a palmprint (Ali and Gaikwad, 2016)

The vascular patterns of people's palms are used as recognized proof or identification sources. As shown in Fig. 4, the palm vein architecture is used to authenticate users [13]. Several investigations based on the palm vein structure have been done in the last decade [14]. An individual's vein pattern is established in utero, and no two people have identical palm vein patterns [13]. Inside the vein vessels, there is deoxidized hemoglobin that retains light with a frequency of typically (7.6*10.4mm) in the near infrared area [19]. We can see some dull vein design lines that include deoxidized hemoglobin particles along these lines. The palm vein design is deciphered by the vein verification device as dark lines of infrared beam or ray picture. [13]

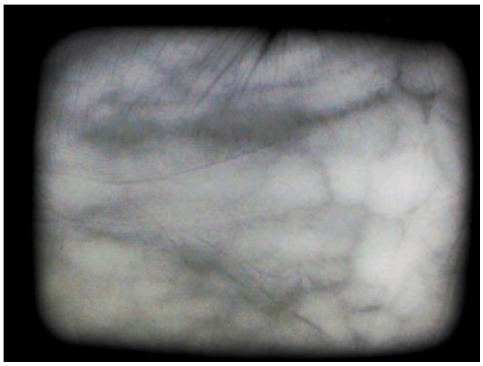

Fig. 3**:** Palm vein image (Mahto and Yadav, 2013)

When the palm print is recorded, it appears as a smattering of dull lines. With a low shallow segment friction ridge skin (Fig. 5) [16], it addresses a high cresting bit of the grinding edge skin, though the valleys that occur between the edges are displayed as void.

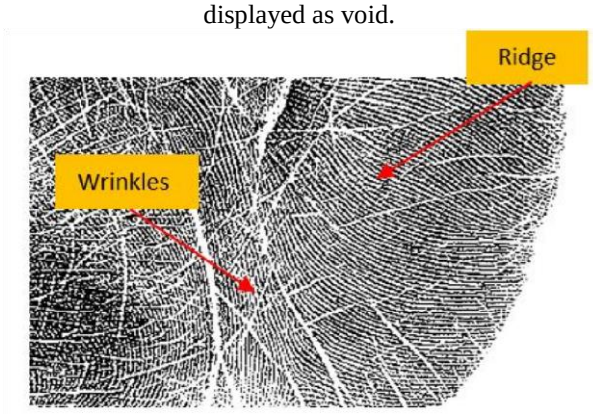

Fig. 4: Ridges in palm print (George et al., 2014)

Components of palm vein

a) Database

PolyU Image Database

The Hong Kong Polytechnic University has developed a multispectral palm print image database [46]. The database includes an image captured under red, green, and blue and near infrared light illumination source as shown in Fig. 2. The device has configured with image capturing algorithm that could result region of interest image. The light spectrum range to capture image beyond visible spectrum is 700 to 1000 nm.

CASIA-MS-PalmprintV1 Database

According to [48]. All palm pictures are 8 cycle dark level JPEG documents. For each hand, we catch two sessions of palm pictures. The time span between the two sessions is over one month. In every session, there are three examples. Each example contains six palm pictures which are caught simultaneously with six distinctive electromagnetic ranges. Frequencies of the illuminator comparing to the six range are 460nm, 630nm, 700nm, 850nm,940nm and white light separately. Between two examples, we permit a specific level of varieties of hand stances. Through that, we expect to expand variety of intra-class tests and reenact useful use.

In our gadget, the subjects are needed to place their palm into the gadget and lay it above a sensor. The gadget supplies a uniformly dispersed brightening that captures palm pictures utilizing a CCD camera fixed on the lower part of the gadget.

b) Sensor

CCD camera

The CCD camera is situated at the lower part of the gadget and the LEDs in various frequency spectra are situated around the camera. (Sierro et al, 2015) likewise proposed two contactless palm vein capturing gadget models. Both are utilizing the mirrored or reflected light set-up and are furnished with ultrasonic sensors to quantify the distance between the camera and the hand. The principal model uses 20,940 nm LEDs (TSAL6400) as a light source and a Sony ICX618 CCD camera in blend with a 920 nm long-pass channel. The subsequent model can catch multi-unearthly pictures and uses an extra PTFE (Teflon) sheet to accomplish a more uniform brightening.

c) Feature Extraction & Transformation

To extract features various techniques are used like Gabor Filters, Geometric based approaches, LDP, PCA, SIFT and random transform. It works by binarizing the image first, then skeletonizing it, and finally generating line segments.

The image quality increases after preprocessing, but the vein pattern is still surrounded by many weak white patches. Separating the vein pattern from the background of the image is required to create a better vein pattern. Separation of the vein pattern from the background of the image is required to create a better vein pattern.

d) Matching

The degree of matching between two vein patterns is calculated at this stage. The vein patterns recovered from the input image can be compared directly to the saved templates. To determine the degree of similarity between a template and an input pattern, a similarity measure should be utilized. The matching algorithms consists of Euclidean Distance Measure, Hamming distance, Line/Curve Matching, Cross Correlation Algorithm, Parallel Matching process and Sparse matching multi-core algorithm.

e) Preprocessing- A grayscale image is created from the captured image. This is crucial since grayscale photos can be easily modified later on. In order to boost the image's contrast, histogram equalization is also applied. This makes it easier to get the details right and more clearly. The images captured by the NIR camera may or may not have zero noise**.** Noise removal is essential in order to extract a clear vein pattern. This is accomplished through the use of a median filter. Then, to achieve a clear perspective of the background and foreground, thresholding is applied. The Otsu technique is used to do this. It's a global thresholding method for converting a grey

image to a binary image by computing a threshold value.

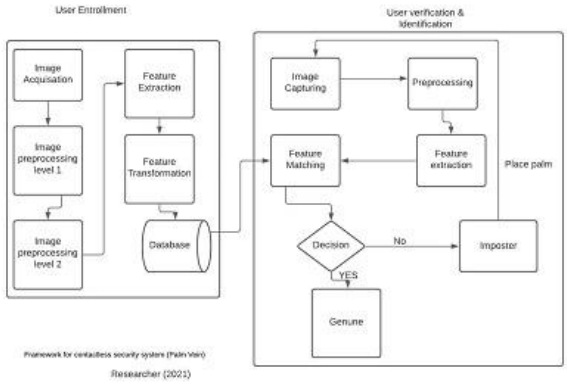

Fig. 5: Contactless Security Framework (Researcher 2021)

The palm vein procedure involves the following stages.

a) **Image Acquisition**- The image acquisition consists of a NOIR camera module connected to a Raspberry pi, along with infrared LEDs for illumination. The wavelength is between 760 to 110 nm. The resolution of camera used is 5MP. The image is saved on an SD card on the Raspberry Pi. [47]. In the literature, a number of low-cost vein acquisition techniques have been proposed to capture the image needed for the operations indicated above [11]. Because the amount of hemoglobin in an individual's blood impacts light penetration, the visibility of different veins in infrared light varies.

b) **Image Processing**- Image processing applies certain algorithms to the image to get desired output. The image is first converted to grayscale to make the processing faster as extra color channels are not needed. Its histogram is then equalized, which essentially means that very dark and very light areas are brought to a middle ground. Finally, Gaussian blur is added to remove noise and image artifacts for smooth final image.

c) **Template matching**- Template matching is the process of matching a base image to another image. The image is iterated over numpy arrays and ratio of similarity is given. TM_CCOEFF_NORMED template matching is used in this system for matching source and destination images. [46].

TABLE 1: RESEARCH ARTICLES ANALYZED

ID	APPLICATION AREA	NO OF ARTICLES	REFERENCES ANALYZED
1	Biometric Authentication & Recognition	16	[3],[4], [5], [6], [8], [9], [12], [14], [16], [17], [1], [2], [7], [18],[27, [45]
2	Information Security	12	[1], [2], [7], [10],[18], [21], [20], [22], [23], [24], [25],[28]
3	Feature extraction methods, Palm vein components & Image processing	22	[15], [19], [29],[31], [32], [33], [34], [35], [36], [37], [38], [39], [40], [41], [42], [43], [44], [46], [47], [48], [49], [50]

IV. RESULTS

TABLE 2: COMPONENTS

	DATABASE				**FEATURE EXTRACTS**		
	CASIA	PUT	Poly U multi-spectral palm print		Gabor Filter	LBP Local binary pattern	Geometric Approaches
No of Papers	8	3	4		7	5	4
	MATCHING		**DECISION**		**SENSOR**		
	HAMMING DISTANCE		PCA		CCD Camera	NIR	
No of Papers	4		5		10	8	

From the results, the most popular database is CASIA (Chinese Academy of Science Institute of Automation) in security systems is CASIA.Out of 20 journal publications considered 53% use CASIA, 20% use PUT,27% use Poly u Multispectral Palm print database. For feature extraction 44% use Gabor Filter, 31% LBP, 25% use Geometric approaches. For the sensor, the most common camera is CCD Camera with 56%, NIR Camera with 44%.Hamming distance was used to match the templates while for decision making that helps in verifying and authenticating the user, Principle component Analysis (PCA) was used.

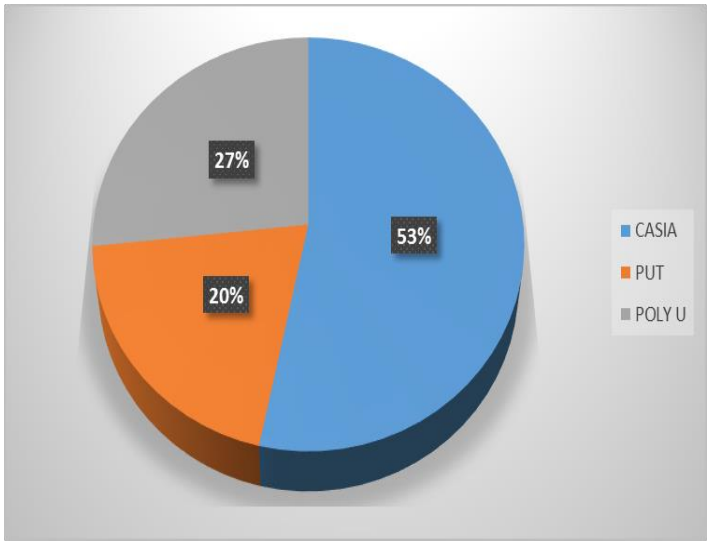

Fig. 6: DATABASES

Fig. 6 above shows a representation of popular databases with CASIA having a lead with 53%,PUT database with 27% while Poly U database with 20%.From the above analysis we can conclude that the CASIA database is the widely used in the pam vein device.

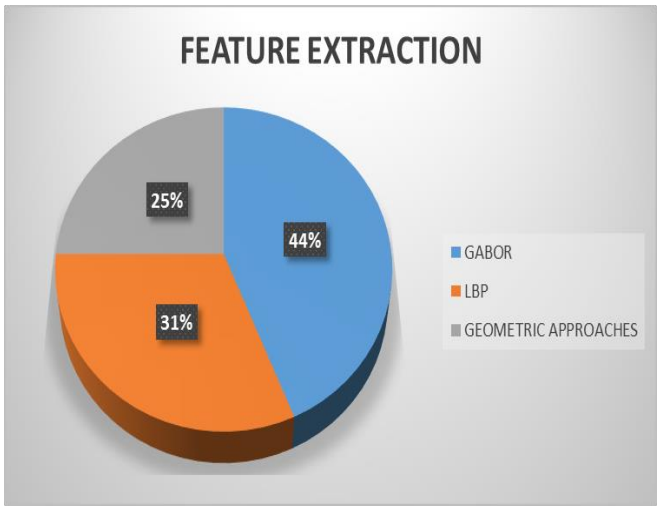

Fig. 7: FEATURE EXTRACTION METHODS

Fig. 7 above shows the various feature extraction methods. Gabor filter methods is widely used with 44%, LBP (Local binary Pattern) with 31% while Geometric approaches have 25%.

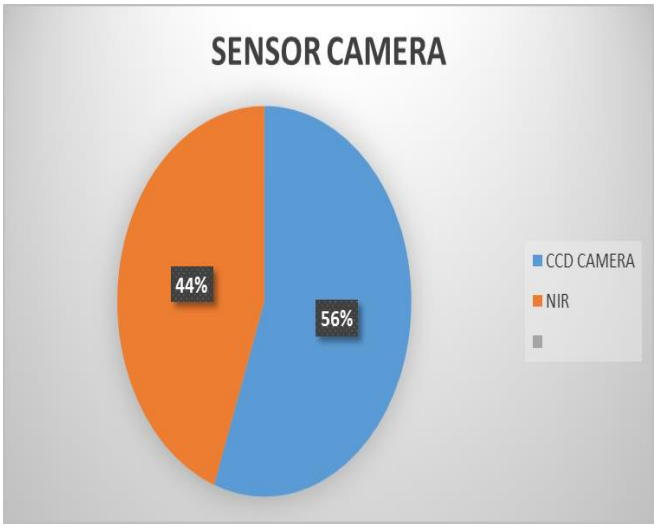

Fig..8: SENSORS

Fig. 8 above shows the various sensor used. CCD Camera is widely used with 56%, while NIR Camera at 44%.

V. CONCLUSION AND FUTURE WORK

This paper introduces the various components such as the most suitable palm vein database to store palm veins using a contactless sensor to capture palm veins, as well as an open source experimental framework that may be used to conduct repeatable research. It was evident that the current fingerprint system was no longer usable after COVID-19 outbreak due to the physical contact with the device. Due to the scarcity of databases and the ambiguous procedures provided thus far in the literature, the database, sensors and feature extraction methods will be valuable resource for improving palm vein recognition algorithms. From the analysis the most common database is CASIA which had 53% .CCD Sensor camera with 56% and Gabor feature extraction method with 44% and PCA was used for decision making. These findings will assist the researcher in providing a guide on the best suitable components required for the contactless security framework. The results acquired thus far indicate the database's utility and provide a chance to investigate new ways in the field of palm vein pattern detection. As a result, the components will be beneficial to the research community as a reference point that provides replicable and transparent analysis methodologies as well as a free experimental framework for learning institutions before they implement a security systems. There are still gaps for future researchers where they need to focus on the various decision algorithms that are best efficient in verify users before they are authenticated in the system.

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