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A Comprehensive Synopsis of Scanning Technology with its Application in Framing of an IoT-Based,Autonomous Data Handling System

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Abstract:

A Wireless Sensor Networks (WSN's) technology is one of the most emerging technologies in recent years. This paper aims to build a WSN-based, Autonomous Data Collection and Management System using Fingerprint Recognition Technology. The work contains an overview of different proposed methods in the last decade in fingerprint technology to perform data management tasks. Based on the past work performed, we concluded various pros and cons of deploying technologies, which are summarized in the paper. The study extends further to the various types of scanners that have evolved over time as a result of advancements in fabrication industries. The study proposes a useful system that is the outcome of a trade-off between cost-effectiveness, feasibility, and accuracy parameters. Biometrics is one of the unique characteristics held by any individual. It varies person-to-person and that is the reason, they are widely used in areas of Forensic Science, Law Enforcement. In Mobile security features in Organizations, etc. Biometric parameters include face Recognition, voice, and fingerprint patterns, which are highly advanced, efficient and secured features for a person's identification. The work also visualizes a comparison between different biometric traits and then a comparative analysis is portrayed for Touchless and Touch-based fingerprint scanners.

Keywords ***—Big data, biometric traits, Comparison, Cloud, fingerprint sensor module, Touchless scanners, Touch-based scanners, Wireless sensor network***

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I. INTRODUCTION

Data Collection and Management is a very important task in business areas and organizations where real-time data is the primary requirement. Now to collect this real-time data is not a very simple task, it requires continuous monitoring and processing of data for further storage purposes. Manually doing this job is a cumbersome process and that is the reason why Big Data Handling is one of the most favorite fields for researchers to work on.

In this paper, a wireless approach for collecting and storing the data is performed using domain technologies as WSN's and IoT. This paper includes the detailed methodology proposed to build the system, description of components, interfacing and assembling part with the programming code uploaded in the processing unit of the system, i.e. Arduino Uno Board. An

overview on related research works in this area completes our work. Furthermore, shortcomings in available resources motivated us to suggest this system. This paper aims to propose an effective solution, which collects data and then stores it in a remote cloud. The data can be easily retrieved whenever required for further processing. Hence, more secure way than the traditional methods employed to record data (i.e.by security guards and peons in law firms, organizations, companies, etc.) in registers for keeping the attendance of employees. Furthermore, the same practice is performed while taking attendances in educational institutions. The following are the disadvantages of manually collected data:

- It increases the chances of more proxy attendances.
- It is a very cumbersome process.
- It causes the manipulation of false data.
- Less secure.
- Takes more time.

In addition, some prominent institutions use RFID (Radio Frequency Identification) systems to record the data of their workforce. This technology works on Electromagnetic waves, which is a wireless mode of communication. The data is shared between the RFID reader and RFID tagger. The user has to swipe his/her identity card on the hanging RFID machines on the wall. However, this technology has some disadvantages too.

- Costly to implement
- Complexity issues
- Possibility of gathering false data (As the card of any person can be swiped by some anonymous personalities or by other personnel).

TABLE I CHALLENGES STATED BY VARIOUS BIOMETRIC TRAITS[1]

Face[2] Recognition	***Speech Recognition***	***Signature Recognition***	***Iris[3] Recognition***
1. 2D recognition is highly affected by illumination and obstructed faces covered by scarfs. 2. Requires Camera equipment for identification purpose and is not readily available as of now as a standard equipment 3. Costly	1. Person's voice can be recorded easily and can be used for unauthorized use. 2. Low Accuracy 3. Sensitive to user's illness in cough and cold cases.	1.Consistency issues. 2. Security issues.	1. Expensive 2. Large size of Memory 3. Used only for highly secured applications. 4. Loss of pixels while image restoration.

This paper uses RTC module, Arduino Board, Fingerprint Scanner to build a cost-effective yet accurate system with the use of WSN and IoT. However, a system can also be built without the involvement of IoT[4], which can be used in applications like in Voting machines where only person's biometrics is required. The other biometric[5] techniques include retinal and iris patterns recognition, face recognition, voice (audio) identification, hand-veins identification, and signature. However, the most highly reliable and efficient technique is fingerprint technology. The challenges stated by various recognition technologies are specified in Table 1.

The Fingerprint recognition[6-8] is highly efficient, cost-effective and robust for identification purposes with outlined following features:

- Easy to use
- Highly accurate
- Small storage space required
- Easy to deploy

- Offline Mapping of database provides user-friendly environment

II. LITERATURE REVIEW

TABLE 2
LIMITATIONS PROPOSED IN PAST CONTRIBUTIONS (2013-2021)

Year	Features	*Limitations proposed*
2022	Proposed Work • Cost-Effective (As Arduino Board is used instead of Raspberry Pi) • Offline Mapping of Scanner by testing under larger dataset • Easy to deploy • Power Backup is provided in system	
2021[9]	Scanner Type: Touchless 2D • Fast Capturing Process • High Rate of usability • Less Restriction on orientation of finger • Due to hygienic constraints, touchless has high user acceptability and deployment rate.	• Inferior recognition accuracy rate of 2D touchless scanners than touch-based. • More processing power is required.
2019 [10]	Scanner Type: Touchless (Smartphone) • Monogenic wavelet based algorithm for touchless identification • Uses smartphone to capture the pattern and works on to improve the matching accuracy.	• System lacks in Quality Assessment of touchless scanner • Further improvement is required in area of Template Security.
2018 [11]	Scanner Type: Touchless*(Industrial Camera) • Multi-Purpose System used for Border security application. • Uses TFT Touch Screen Display	• Costly
2018 [12]	Scanner Type: Touch-Based Optical Sensor • The paper finds a new approach in updating data in Microsoft Excel Sheet by directly interlinking local PC to Arduino Board using PLX-DAQ Toolbox.	• Not Flexible: very hard to carry PC anywhere with a USB Cable • Not effective for remote areas as the range is less
2017 [13]	Scanner Type: Touchless (Smartphone) • Multi-Finger identification System • Easily Deployable • Fast capturing time	• Extensive Pre-processing is required.
2016 [14]	Scanner Type: Touchless(Digital Camera) • A very first prototype worked with sweat pores. • Resolution is high	• Constraints on Finger orientation
2015 [15]	Scanner Type: Touch-Based ZFM20 scanner • Portable System: As uses security mechanism (encryption) technique to prevent alteration of stored data. • For Encryption: Cryptographic	Highly sensitive to: • Finger Orientation • Dirt on finger • Wet finger In addition, power backup is required.

	• Technique • For Decryption: Bloodshed Dev C++ software.	
2014 [16]	Scanner Type: Touchless* (Low Cost Equipment) • Used box like setup with LEDs to achieve high performance rates. • Improved results as homogeneous illumination on finger via LEDs	• Work should be done in Biometric security area i.e. Presentation Attack Detection(PAD) [17]
2013 [18]	Scanner Type: Touch-Based • The system is deployed using Wi-Fi Shield, GSM Shield, LCD Display, Fingerprint Sensor, Raspberry Pi[19] and Keyboard	• System is costly as GSM Shield and Raspberry module is used.

***Prototype based setup:** designed setup based on the recent developments to increase the efficiency and effectiveness of overall system. It is specifically designed to work on the proposed challenges in the specified area and hence produces results that are more accurate.

Over the last decade, survey analysis in this field has grown tremendously. Many authors have focused their effort on these specialized identifying technology problems. The contributions[10,13,14] has expanded their work in touchless fingerprint scanning technology to include the usage of commercially accessible general-purpose devices. Though they linked the system with box configurations with LEDs to enhance the finger's lighting range, the exposure of the finger in front of the gadget increased, which promoted improved outcomes. Many authors[20] used wireless technologies such as ZigBee[21] to extend the range of system.

The authors[11,16] employed a prototype model that was created by examining the most recent ongoing studies in order to solve the shortcomings of existing systems. Touchless scanners have received a lot of attention because of their high acceptability and user-friendly applications. Touchless sensors have conceptual advantages such as a less restricted acquisition method and no deformation concerns, in addition to the fast capturing time. However, due to some of the disadvantages of touchless scanner technology, the authors[18,22] stuck to the core touch-based technology.

TABLE 3
ADVANTAGES OF TOUCH-BASED SCANNERS OVER TOUCHLESS

	Touch-Based Fingerprint Technology	***Touchless Fingerprint Technology***
Computational Cost	Cost-Effective	Costly
Presentation Attack Detection (PAD)	Secure (As PAD modules are integrated in systems)	Security issues
Recognition Accuracy	High	Low(due to illumination and orientation issues)
Preprocessing time	Less(As impression obtained is in grayscale image and can be directly used in Feature Extraction phase)	More(As impression is colour image and requires further pre-processing)
Complexity	Simple	Complex
Environmental Influences	No Environment influence as finger is pressed all over the sensor area.	Unconstrained environment interferences and needs modules in system for background clearance

Table 3 shows the advantages of touch-based fingerprint technology over touchless technology. The paper[9] highlights the most recent breakthroughs in touchless technology, as well as concerns and challenges in the field of touchless 2D fingerprint scanner technology.

The fundamental problem with touchless 2D technology is its accuracy in recognizing pattern.Though 3D touchless scanners produce excellent results, they are expensive to deploy and demand a lot of computer power. The researcher opted Touchless technology because of biometric template concerns, although the recognition

performance is seen to be better in touch-based than touchless, which was due to varied illumination settings and pore reflection.

III. PROPOSED SYSTEM

The proposed work solves the described problems in Table 2. Our project uses basic components and is highly reliable with the
following features:

- ✓ Effective cost as uses ESP8266 Module instead of GSM shield
- ✓ Less Sensitive as uses highly advanced Optical Fingerprint Sensor
- ✓ Portable
- ✓ Secure as data is stored in remote cloud
- ✓ Data can be accessed from anywhere in the world.

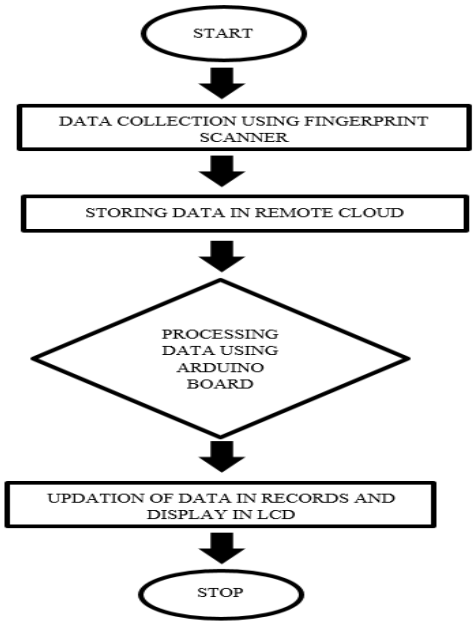

Fig.1 Flow-Chart of proposed system

IV. RESEARCH METHODOLOGY

The steps included in this project are described below:

Data Collection and Processing

Components used for the purpose include the Fingerprint Scanner Module and Arduino Uno Board[22] which are used to take the data and keep the record of the data. Fingerprint Scanner module takes the data from the user and stores it. Whenever the fingerprint is placed on the screen of the scanner, the fingerprint pattern is compared with the previously stored pattern, if it will be matched, Arduino Board will print the user data/identity stored in its sketch into an LCD Display.

Data Storage

Components used for the specified purpose include a Wi-Fi Module and access to any cloud platform. A Wi-Fi module is used to upload the required data into the remote cloud. Systems that involve collecting, storing, visualizing, and providing access to retrieve the user's data via remote Cloud access are highly secure, flexible, and scalable. The user can visualize the data stored in its local PC via dashboards or in Google spreadsheets. The used Wi-Fi Module is ESP8266 with Things Board as a cloud platform. ThingsBoard is a highly advanced, high fault-tolerance, IoT-based cloud platform.

Block Diagram

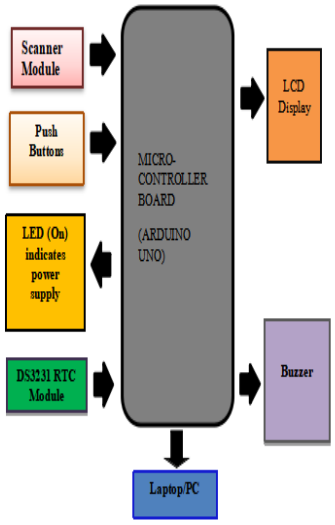

Fig. 2 Block Diagram of System

V. CIRCUIT LAYOUT

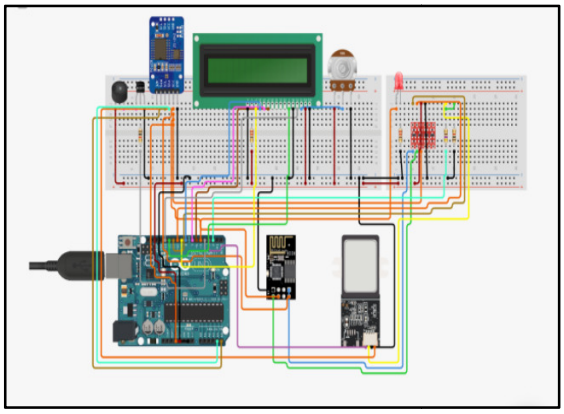

Fig. 3 Circuit Layout for project

VI. ASSEMBLING AND INTERFACING OF COMPONENTS

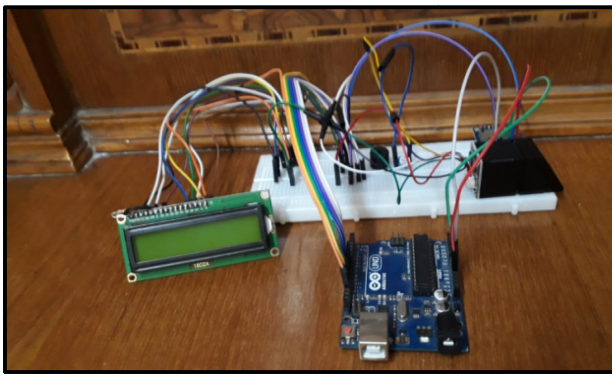

Fig. 4 Project setup

VII. HARDWARE AND COST ANALYSIS

TABLE 4
LIST OF COMPONENTS

S.No.	*Component*	*Specifications*	*Qty.*	*Cost (Approx.)*
1	Fingerprint Scanner	Finger Print Sensor (R307)	1	795/-
2	RTC Module	ROBU-DS3231 Real-Time Clock module	1	200/-
3.	LED	ELECTRONICS PICES: Red Colour	1	99/-
4.	Arduino	APTECH DEALS	1	500/-
5.	Jumper Wires		20	219/-
6.	Battery(4V)	**ELECTRONICS: 4 Volt, Battery Rated Capacity: 4V, 0.5AH**	2	200/-
7.	LCD Display	ROBOELEMENTS : (16*2) LCD Display Module	1	119/-
8.	Buzzer	ROBU : 5V Passive Buzzer	1	69/-
9.	Battery(5V)	5V, 1000 mAh	1	700/-
10.	ESP8266 Wi-Fi Module	ROBU ESP8266, Wi-Fi module	1	149/-
11.	Resistor	2.7and 1kohm	1	119/-
12.	SPST Switch	SPST 2 Pin Switch	1	10/-
13.	Push Buttons	ERH India: on/off Switch	5	10/-
				3189/-

VIII. CALCULATIONS

Sample: For the strength of 70 students in Class

A. ***Manual Work***

The average time required for attendance includes:

- Time required by the teacher to open the present register (t_p)
- Time duration when teacher announcing the name of the student (t_n)
- Student response time(t_r)
- Teacher marking/writing time(t_w)

Total manual time (t_m) = (tp + tn+ tr + tw)*70 **(1)**

B. ***Smart Fingerprint Scanner work***The average time required to perform all tasks including:

- taking attendance, storing and updating sheet(t_f)

Total time by system (t_a) = (t_f)*70 **(2)**

Hence, using Equation (1) and Equation (2):

$$\textbf{Efficiency of System} = \left[\frac{(tm)-(ta)}{tm}\right] * 100 \qquad (3)$$

IX. CONCLUSIONS

The system works very efficiently. Firstly, it takes input from the user via Enroll key. LCD will ask to enter the user ID. After pressing enroll key, the user has to select the memory location via Up/Down keys where the user will be labeled by that ID name. Now, LCD asks the user to place his/her finger on the scanner module. The scanner takes pattern images. Now LCD asks the user to remove the finger and place it again. This time module converts digital image patterns to templates. Now, user is successfully registered into the module by the respective user ID. Similarly, 70 students (sample size) are registered into the module by the same procedure. Whenever the user places his/her finger, the module matches it with stored data patterns in its EEPROM. If the user's pattern matches, attendance is marked otherwise LCD Display asks the user to again place the finger on the module. The values of t_p ,t_n, t_r ,t_w are 9 sec, 4sec,1sec,1sec respectively. Thus, leading to t_m= 1050sec (17.5 min). Whereas,t_f is calculated as 3 sec on an approx. Therefore, t_a=210 sec(3.5 min). Therefore, by using Equation (3), we get efficiency of system calculated as 80%.

X. FUTURE WORK

The proposed system can be extended further to make highly advanced and secure systems. The project can be collaborated with Face recognition technology to provide a more secure system. This will include multiple domains like Computer Vision; Image processing, Coding, WSN'S and IoT to work together. Therefore, contributing immensely to human civilization through advancement in technology. Also, many old face techniques can be fused with new ones to make hybrid[22] systems.

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