Nile Journal of Communication &Computer Science

Volume 2, Number 1, February 2022

Journal Webpage: https://njccs.journals.ekb.eg

Print ISSN: 2805-2366
Online ISSN: 2805-2374

Smart Attendance System Using QR-Code, Finger Print and Face Recognition

Nesma Abd El-Mawla[1], Mohamed Ismaiel[2], ASQR Team[3]

[1,3]Communications and Electronics Department, Nile Higher Institute for Engineering and Technology, Mansoura, Egypt,

[2]Communications and Electronics Department, Delta Higher Institute for Engineering and Technology, Mansoura, Egypt,

Abstract

Smartphones now play an important role in our daily lives. It has made life simpler and easier for everyone with various social, commercial, problem-solving, educational, and marketing apps... etc., and in light of the need for social distancing following Covid-19, we have designed a system that addresses the problem of student and employee attendance in various institutions. They were utilizing a paper-based approach to keep track of their attendance. The suggested system is an Internet of Things (IoT)-based attendance system that makes use of the IEEE 2413 Standard for an Architectural Framework for the Internet of Things (IoT) (Face recognition - Fingerprint - QR code). Our system may be used in two sorts of organizations: the first is for businesses, where attendance is recorded using one of two characteristics (Face recognition or fingerprint), and the system is also designed to manage employee working hours. The second system is for educational institutions, and it is responsible for managing and analyzing all students' attendance. For pupils to take attendance, a (Face recognition& QR code) will be provided. The professor is in charge of determining whether or not all of the pupils in the group or class are present. To authenticate their attendance and exit, users will only need their smartphones.

Keywords: *QR, System, Attendance, Technology, Face Recognition.*

1. Introduction

Regular attendance in all organizations, whether educational or at the corporate level, is necessary to improve the efficiency of the organization, and in light of the conditions that the world is suffering from due to Covid-19, in addition to the traditional means used by institutions at present, such as fingerprint devices and paper, which were causing congestion when completing attendance processes [1-3]. This process takes a long time, especially when the numbers are large, and in light of the current circumstances and with the spread of Covid-19and the need to achieve social distancing, it was necessary to have an easy solution that ensures the

accuracy and speed of the processes of attendance and departure of employees while maintaining their safety and saving time and effort to complete this process [4-6]. That is why we thought of developing an easy-to-use application to record attendance and leave processes for all students and employees.

This paper proposed Attendance management system is an easy-to-use smart system based on (Face recognition- Fingerprint - QR code) to record the attendance and departure of all students and employees, in addition to integrating an Android device with databases to store attendance results, moreover, analyzing attendance on a weekly and monthly basis and the main objective of the automated attendance system It is calculating the traditional method for recording attendance and providing an efficient and secure method for tracking attendance in organizations. Both the employee and the student will get a free mobile application that they use to take attendance and leave. The main objective of the Automated Attendance System is to computerize the traditional way of recording attendance and provide an efficient and automated way to track attendance in organizations.

1.1. Problem statement

There is a strong need to develop an intelligent attendance system. The proposed system is easy to use and smart based on (Face recognition - Fingerprint - QR code) to record attendance and leave processes for all students and employees, in addition to integrating an Android device with databases to store attendance results, moreover, analyzing attendance on a weekly and monthly basis and the main objective of the system Automated attendance is computing the traditional way of recording attendance and providing an effective and secure way to track attendance in organizations.

1.2. Amis of Work

The project rises to avoid the role of paperwork permanently and to automate all procedures equally in all organizations, whether educational or at the corporate level, and thus: (i) Saving time and effort spent in attendance and departure processes in the country. (ii) Achieving social distancing and privacy for people working under the current global conditions and Covid-19. (iii) The professor can very easily monitor and follow the absence, and it is more secure so that no student can be able to register his colleagues and allows the student to follow his absence at any time and easily and know the number of lectures that have been attended. Thus, providing the paper on which the absence was written, and most importantly, preventing hands touching between students to protect against Covid-19.

1.3. Motivation

In most institutions, there is a major problem with: Real-time access to attendance data; Proof of identity and location; frequent changes in working hours; Hardware and maintenance; Attendance and departure reports, and Department of sections and branches. Therefore, an urgent need emerged for: (i) developing an intelligent attendance system that relies on speed and accuracy to save time and effort and achieve social distancing. (ii) Integrate mobile phones with QR codes and databases to store attendance and display results for you to reduce friction and

keep workers safe. (iii) Analysis of attendance on a weekly and monthly basis to achieve fairness and transparency in institutions.

1.4. Work Organization

The paper is organized as follows: Section 2 presents a literature survey while section 3 introduces a work overview. In section 4 we introduce the application's workflow and application scenario. Section 5 discusses how the application has been implemented and gets the results. Finally, the paper is concluded and gives a summary of the future work in section 6.

2. Literature Survey

Social media plays a very important role in the lives of users [7], and with the development of technologies for smart and sophisticated devices that are used daily, such as smartphones [8-9], which secure the Internet, the user has become open all the time on the Internet. For this, we find that the rapid response code technology is one of those technologies that allow the user to quickly access For its services, which require very little storage memory on smartphones, this is why it has become more popular with various companies, and examples of quick response codes are: QR Code is an abbreviation of the English word Quick Response code, which means a quick response code, it is a two-dimensional code designed first by Denso [10-11], a subsidiary of Toyota, to facilitate tracking cars during the manufacturing cycle, then spreading in all areas due to the advantages it provides and the volume of data that it can be stored [12-13]. The QR code consists of black units arranged in a specific shape on a white square background, scanning them reveals the data that they symbolize.

As previously mentioned, the QR code can be employed in almost all fields [14], and thus we find it present in the automotive industry, commercial tracking of goods, transportation tickets, and product price definition, and it is also used extensively by companies as a practical and fast way to access their websites, Through the mobile tag feature, it suffices to indicate that the month of June 2011 witnessed the use of 14 million rapid response codes in the United States of America alone [15], so that we realize the importance of this new technology and the extent of its penetration in our daily life.

Version 40 of the QR code can store 7089 numbers or 4296 between numbers and letters [16], which in practice means the ability to contain relatively large data in a small area of no more than a few square centimeters, and it is the feature that enables saving in paper and ink, which makes QR technology Code is environmentally friendly. On the other hand, QR code technology provides instant access to links, without having to rewrite them on the mobile browser [17-20]. This promising technology can also be used in encrypting personal information, and converting it into codes on cards that can be read using a mobile phone camera, in addition to this, the QR code is characterized by the ability to be read using a mobile phone that contains a camera and an application that allows reading this type of code, They are widespread tools in our time, which promises a prosperous future for this technology.

There are many creative ideas in which QR Code can be employed as in 2017: A group of

students using QR Code technology improves office services (field study at the Faculty of Science and Technology Library at Mohammed Khudair. Biskra) was aimed at facilitating access to the content of the sources with the possibility of loading the summary or bibliographic data for each container at the Faculty of Science and Technology Library [15].

If we shed light on the economic, social, or educational (academic) field in general, we will realize the extent of its need to introduce modern technology in the conduct of services [21-22]. And we will find that in light of the conditions that the world suffers from due to Covid-19, we urgently need to apply this technology in companies and educational institutions to achieve divergence. Social and privacy of working people and preventing contact between students, so we worked to design a system that deals with the problem of attendance registration and departure for students and employees in different institutions through their smartphones. Thus, we will work to achieve leadership in the field of institutional technological development in Egypt and the Middle East.

3. Work Overview

It is a system designed to control the employees' working hours using the Internet of Things (IoT) technology based on Standard for an Architectural Framework for the Internet of Things (IoT) IEEE 2413 [23], through the use of (Face ID or Fingerprint), and the system deals with managing and evaluating the attendance of all students by providing the student with a QR code for the professor to take their attendance, both the employee and the student will get A free mobile application that uses it to take attendance and leave and the employee finishes their leave on time.

3.1. Application in Companies

The employee is the first time he makes a login, so the application asks him to imagine five images, the five images he takes pictures of and sends them to be registered in the database so that we refer with the five images that we know we work based on the face recognition. This is how Login is for the first time. When the login is done, every time he checks the name and password of the employee is correct, he will set it up; an error will ask him to enter them again. Each account with a name and password will be from one device only. The application takes the id from his mobile phone (in reality, you are known by the human fingerprint) and each Android mobile has the ID that distinguishes it from any other mobile.

When the employee enters his account from his mobile for the first time, his account is registered on it, and he is not allowed to register from the mobile of any other employee. And there are two ways to attend. He does face recognition, so he takes a picture of himself and sends it to the server, and the server makes sure he and he doesn't, or by the way of the fingerprint that he works check-in or checks out, provided that the employee is inside the workplace because the step is done. After all, in GPS he determines the location of the work and his location must be In the workplace to know the attendance record. Concerning the sheets, each employee has the right to know his Sheet to know the number of times he attends in the month, and the sheet system provides him with knowing how to check in his nation or check out his nation and the number of hours between them, and he has a wage, whether

throughout the month or day. And the manager has the right to see the staff's sheets.

3.2. Application System in Educational Organizations

The student makes a login for the first time, the application asks him to imagine five images, the five images are photographed and sent and they are registered in the database, so that we refer with the five images that we know we work based on face recognition. This is a login for the first time, when the login is made every time it checks the name and password. With the right student, he will pass him, wrong; he will ask him to enter them again. Each account with a name and password will be from one device only. The application takes the id of its mobile phone (in reality you know the human fingerprint) and each mobile has the Android ID that distinguishes it from any other mobile. When the student enters his account from his mobile for the first time, his account is registered on it, and he is not allowed to register from the mobile of any other student.

The process is how: The professor login into the application, the application checks whether the professor is the professor or not, and then the professor enters his lecture data and sends the request to the server. The server will make a QR code with the information that the professor gave him. For example, the professor chooses a lecture of such and such material and sends the data to the server, and accordingly, the server will make a QR Code with the data and send it, so the professor has a QR Code for the lecture, for example, who will explain it now, and present it to the students, for example, on the PowerPoint or whomever the student is when he comes to press the buttons to enter the QR Code will ask him the first Face recognition for the first to confirm that the student owns the count. If the Face recognition is correct, the student will be infected and the student will scan the QR Code.

An error will be recorded, the absence will be recorded, and the process will be concluded. The time available for the student to scan the QR code is ten minutes. For sheets, each student has his sheet, through which he knows the number of lectures that have been attended over the course of the term and the number of times he has been absent easily. The professor has the right to simply look at the students' sheets.

3.3. Application Characteristics

The application has many characteristics that could be listed as follows:

(i) A variety of identification methods: The application offers various methods of proving employee and student attendance. Where the employee has two ways to register his presence: (i) Face recognition and (ii) Fingerprint. This allows him to have multiple options that suit his needs. The student has one method, which is the *QR Code*.
(ii) Just need a smartphone to do the job: Without installation and problems with technical and electrical connections and maintenance, you only need to phone the person (employee or student) through which he can attend through the application.

(iii) Easy login and data validation: You can add employees, access their information, or distribute them according to the responsible departments, in addition to the ability to amend, delete, or transfer the information of each employee between departments. As the professor facilitates access to the information of each student and makes it easier for each student to know the number of lectures he attended during the semester.

(iv) Determine the worksite and verify the accuracy of the data: Our app makes sure that an employee is present at the workplace during attendance processes through several technologies such as the Internet of Things (IoT) and GPS.

(v) Instant access to attendance data: The application provides you with the maximum speed in providing attendance and departure data for employees and students, only once your employee or student attends you will receive all data and attendance details.

(vi) Supporting thousands of employees: The app saves your employees' time, so there is no need for long waiting lists that count within working time. Employees can attend via the mobile app, regardless of the large number of employees attending the company at the same time.

(vii) Record the attendance of the employee or student: Our application displays the employee or student's attendance record through the mobile application, which enables the employee to view his attendance and vacations and the student to follow his absence and know the number of lectures attended during the semester.

(viii) Reports and printing: Our application displays the employee's attendance record and also provides many detailed reports that show the employee's attendance, absence, overtime accounts, and late hours. You can get them daily, weekly, monthly, term-based, export, or print. The same applies to the student in knowing his absence and his subjects during the semester.

3.4. Application Design Diagrams

In the proposed model, (Face ID - Fingerprint - QR code) technology will be used simply to facilitate the attendance and departure process for employees and the follow-up process for managers, as well as for students when taking the absence process to find out who attended the lecture/lab / educational program by a system without the need for any external devices. Figures1 and 2 show the component diagram of the presented system.

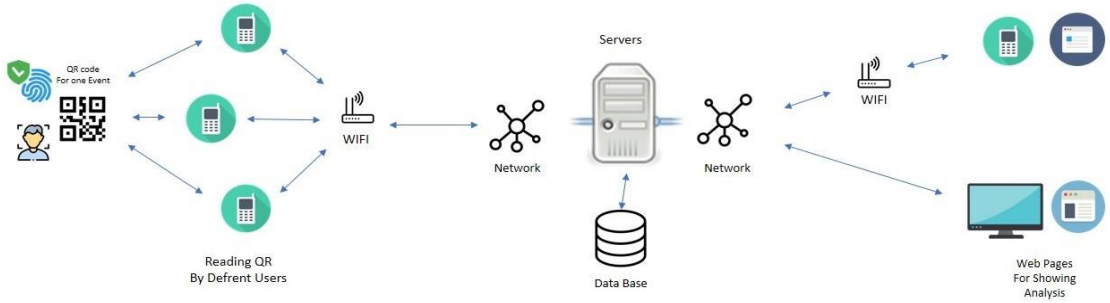

Fig.1. System Architecture **[15].**

Fig.2. System Internal Structure [15].

However, Flowcharts are graphic representations of the steps. It originated from computer science as a tool for representing algorithms and programming logic [24-25], but it has expanded to be used in all kinds of other operations. Nowadays, flowcharts play a very important role in presenting information and aiding in thinking. They help us visualize complex processes, or clarify the structure of problems and tasks. A flow chart can also be used to define a process or project to be implemented. Figures 3 and 4 show system flowcharts.

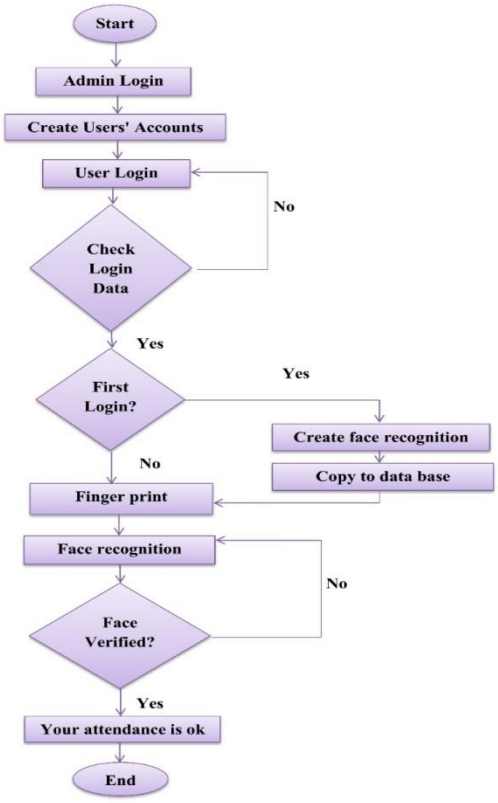

Fig.3. Application Flowchart for Enterprise Use [15].

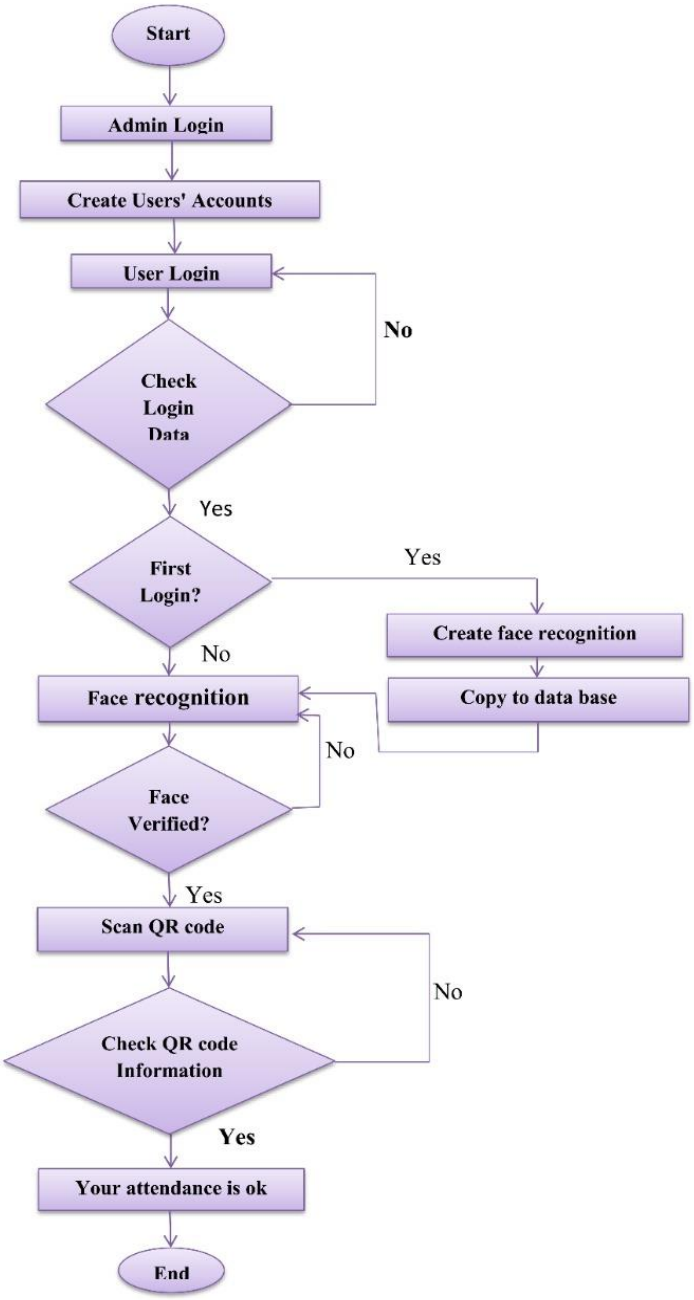

Fig.4. Application Flowchart for Educational Organizations Use [15].

4. Work Scenario

The Scenario clarifies all the steps from installing the app until the users attend him on the system. After installing the app, our user will face an activity only the first time he uses the app which will ask him which organization he targets, and according to his selection, we select to him the track that he will follow inside the app.

If the user press on the company selection button, the app enters him to login activity and ask him again if he is an employee or a manager, and based on that we will define the power of each of them, And before the user begins to prepare himself on the system, the application will ask permission to verify his location whether he is inside the company or not.

After verifying the location and the result is correct, the application will allow him to register his attendance on the system using any of the features available in the application such as fingerprint or facial recognition. And if the result of the location verification is wrong, the application will not allow him to register his attendance on the system.

At the end of the day, he can look at his worksheet to follow up on his attendance. *Note: The application does not allow the user to register his attendance twice a day, and this is one of the strengths of the system.

If he presses the university selection button, the user will enter the login activity and be asked whether he is a professor or a student. And also the application will show the specific permissions for each of them. The professor generates the QR Code and has the right to see the attendance sheet of his students. As for the student, he scans the QR Code that was generated by the professor and prepares himself on the system. And both the professor and the student have the right to see the sheet of their attendance. Also, before the professor or the student uses the application, they must check their location to allow them to use the application. Figure 5 summarizes the workflow between application layouts while Fig. 6 shows the application database.

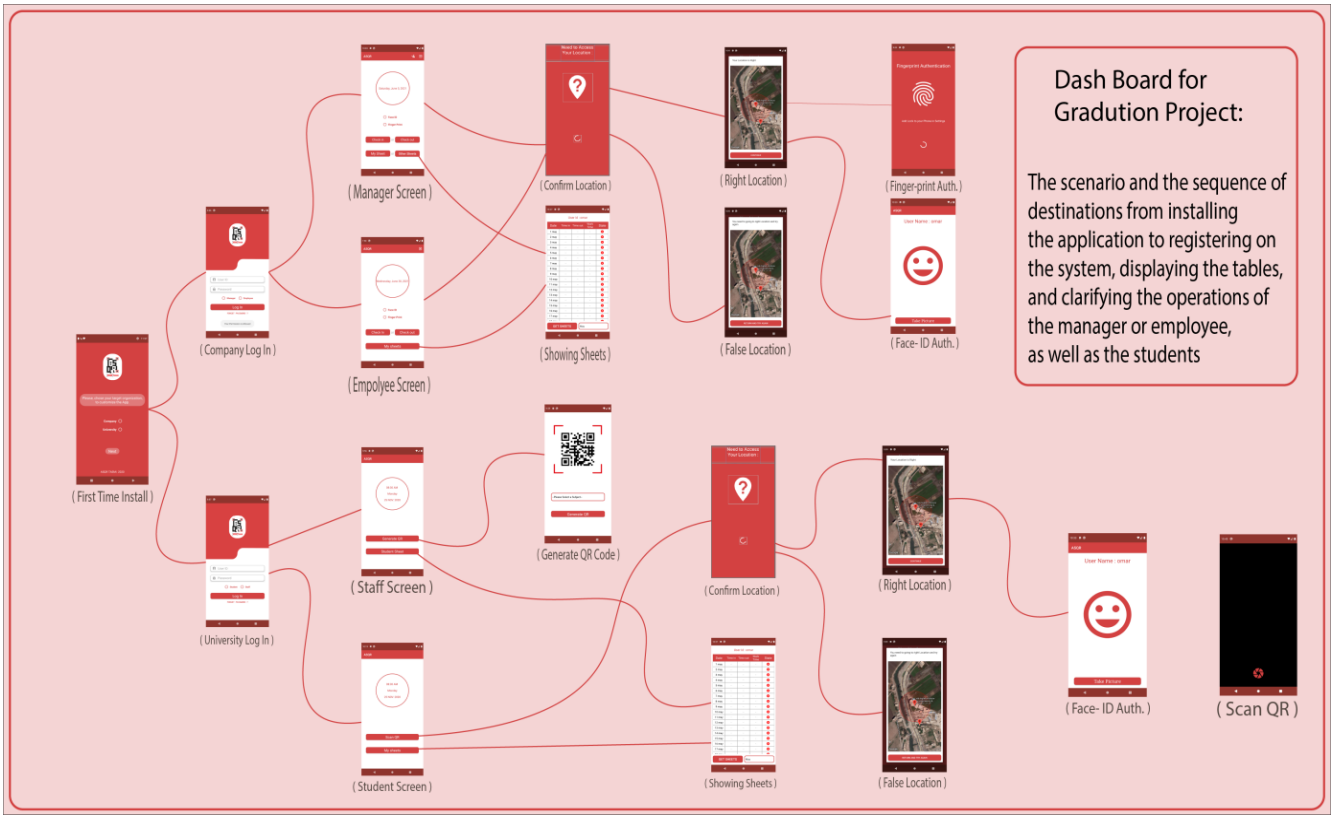

Fig.5. Application's Work Flow [15].

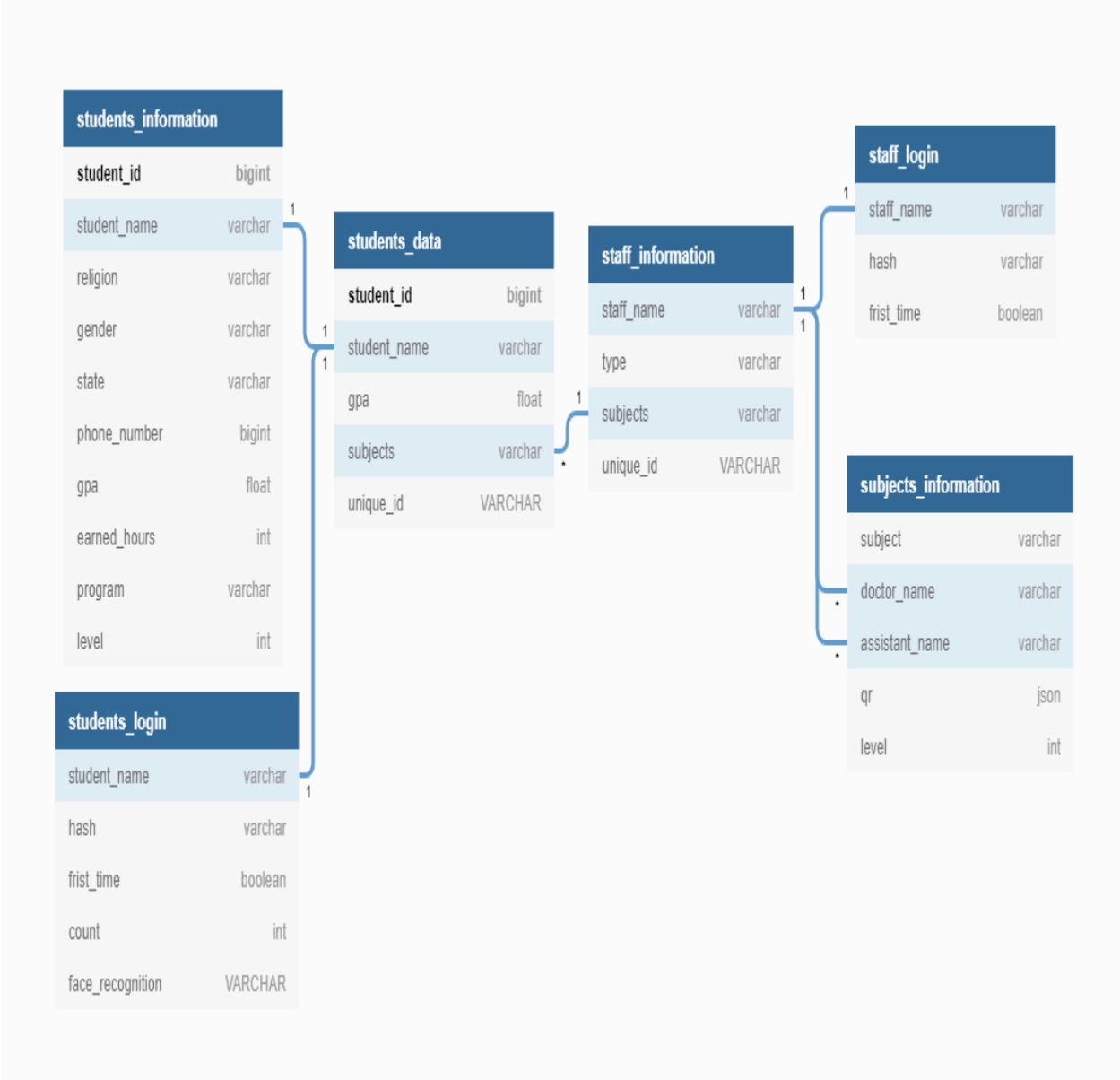

Fig.6. Application Database.

5. Implementation Techniques

A machine language consists of very simple instructions that can be executed directly by the CPU of a computer. Almost all programs, though, are written in high-level programming languages such as Java, Python, or C++. A program written in a high-level language cannot be run directly on any computer [26-30].

First, it has to be translated into machine language. This translation can be done by a program called a compiler. A compiler takes a high-level language program and translates it into an executable machine-language program. Once the translation is done, the machine-language

program can be run any number of times, but of course, it can only be run on one type of computer (since each type of computer has its machine language). If the program is to run on another type of computer it has to be re-translated, using a different compiler, into the appropriate machine language.

There is an alternative to compiling a high-level language program. Instead of using a compiler, which translates the program all at once, you can use an interpreter, which translates it instruction-by-instruction, as necessary. An interpreter is a program that acts much like a CPU, with a kind of fetch-and-execute cycle. To execute a program, the interpreter runs in a loop in which it repeatedly reads one instruction from the program, decides what is necessary to carry out that instruction, and then performs the appropriate machine-language commands to do so. (A compiler is like a human translator who translates an entire book from one language to another, producing a new book in the second language. An interpreter is more like a human interpreter who translates a speech at the United Nations from one language to another at the same time that the speech is being given) [31-32].

The programming language used in this project is Java. Java is a high-level object-oriented programming language [This means that the focus is on objects (who) as well as procedures (what). Objects are persons, places, or things that do the action in a situation or are acted upon] that runs on most computers and many small electronic devices. It is widely used in industry and universities.

5.1. Fingerprint Handling

The analysis of fingerprints involves the matching of patterns which includes the several features of ridges and the minutiae [33]. The fingerprint is made of ridges and valleys, the ridges are represented by the dark areas and the valleys are represented by light areas. The basic patterns of fingerprints are classified as arch, loop, and whorl. The classifications that arise in the ridges are crossover, core, bifurcation, pore, delta, ridge endings, and island. In recent days, the most commonly used minutiae points are the bifurcations and the ridge endings, because these points can be detected by looking at the points surrounding them.

The processing has three primary functions: enrollment, searching, and verification. The enrollment function captures the fingerprint image from the sensor, which is called a live image. Regarding the verification function, there are several techniques to match the fingerprints such as correlation-based matching, minutiae-based matching, ridge feature-based matching, and minutiae-based algorithm. Matching algorithms are used to compare the fingerprint templates against the candidate fingerprints for authentication purposes. The two basic algorithms are Pre-processing and Pattern-based matching algorithms. The pre-processing algorithms help in enhancing the image by filtering and removing the unnecessary noises from the image. The pattern-based matching algorithms compare the basic patterns (arch, loop, and whorl) of the fingerprint.

5.2. Compare User Location with Target Location

Here we use the command Compared (), public means that the method is visible and can be called from other objects of other types. Other alternatives are private, protected, package and package-private. Void means that the method has no return value. Here the longitude and latitude of the current location are compared to the target location where the user is supposed to be and then Map Dialog will appear telling the user if his site is correct or wrong for the target site.

5.3. Map-Dialog (True-False)

Class map-dialog displays the result of checking the target site, and a dialog box appears telling the user if his site is correct or wrong for the target site and display details of the place (a business or other point of interest) at that location. In this code, the application takes information about the user's location and thus can know if it is in the right place or not.

5.4. Get QR

Quick Response (QR) Code for information dissemination which can be decoded using smartphones, digital tablets, and other electronic devices [34-35]. Quick Response Code (QR) is a 2-Dimensional matrix type barcode used to store data. It is more popular because of its storage capacity and fast readability. The popularity of QR codes grows rapidly with the growth of smartphone users and thus the QR code is rapidly arriving at high levels of acceptance worldwide. In this step, we generated the QR code to be used in the attendance register. Mobile application connects with the server database to get a response.

Traditionally, companies used large-scale databases as central data warehouses for their entire company. This changed as more companies embraced mobile applications and other remote computing devices. Over time, distributed database applications became the norm which required robust and powerful networks as well as a strong central database. However, this paradigm developed further into the mobile database systems we use today.

Mobile apps use databases because wireless and mobile computer technology let people use resources anywhere in the world [36]. There is no fixed location or device type. Any device with a network connection can connect to your network at any time from anywhere. Mobile databases allow you to deploy database-powered applications on mobile devices. This allows mobile employees to log into their corporate networks, download data, work offline, and then connect to the network again to synchronize the data with their main corporate database with program size and memory as the only constraints. Mobile apps use databases for much the same reasons desktop and web applications do. Databases allow you to store data in a secure place so you can access it later. However, apps cannot directly use external databases to store this data.

After we showed you some pictures of the codes that we used, we tell you the importance of the Android Studio program that we used in programming the application. Android Studio is Android's official IDE. It is purpose-built for Android to accelerate your development and help you build the highest-quality apps for every Android device [37-39]. Android Studio uses its knowledge of object-oriented programming to generate extremely relevant and well-formed code. Features of it include overriding methods, surrounding statements with Java blocks, using templates to insert code, using auto-completion, commenting code, and moving code. Now we show you the importance of the Java language that we used in application programming, Java is one of the most popular programming languages used to create Web applications and platforms [40].

It was designed for flexibility, allowing developers to write code that would run on any machine, regardless of architecture or platform. According to the Java home page, more than 1 billion computers and 3 billion mobile phones worldwide run Java. Based on a C and C++-based syntax, Java is object-oriented and class-based. Developers adopt and use Java because code can be run securely on nearly any other platform, regardless of the operating system or architecture of the device, as long as the device has a Java Runtime Environment (JRE) installed. The JRE varies depending on the specific type of device, but essentially it runs a "virtual" machine, or environment, that translates the code into an application or program.

Now we show you the importance of a database in our application. The database is an important part of software and management solutions, helping store, organize and manage data scientifically and systematically. The database is the collection of information that is organized in a certain structure, so that it can be easily read, edited, added, or deleted data. For example, the customer list of a company includes at least name, phone number fields, which is considered data. Using this database system will overcome the disadvantages of separated file data storage:

- Reduce replicated information, assure data consistency and integrity.
- Allow retrieving in several different ways, users and applications.
- Increase the ability to share information.

Finally, we have improved the GUI of our application to be friendlier than the first release in our first version mentioned in [15], Fig. 7 presents a real updated layout of the application.

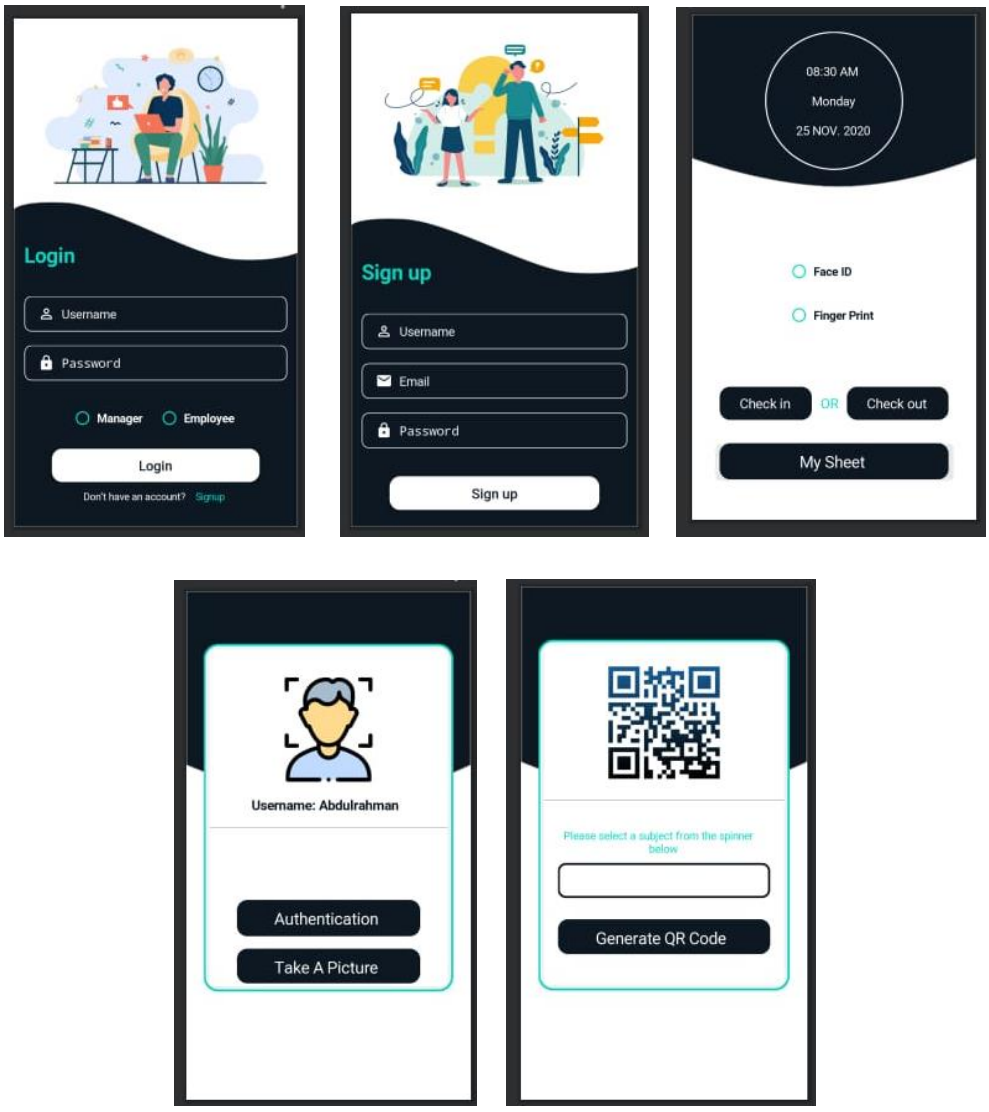

Fig.7. Real Updated Layouts of the Application.

6. Conclusions and Future Work

Given current global conditions and COVID-19, introducing a new system to reduce time and effort in attendance and leave operations in the country, as well as to achieve social distancing and privacy for working people. Furthermore, in our daily lives, the attendance and monitoring system is critical. An easy-to-use and smart system based on (Face recognition - Fingerprint - QR code) has been developed to track leave attendance processes for all students and employees, as well as integrating an Android device with databases to store attendance results, as well as attendance analysis on a weekly and monthly basis. The main goal of the Automated Attendance System is to computerize the traditional way of recording attendance and provide an efficient and secure way of recording attendance. Among other scan code technologies, the QR code-based smart attendance system is the most accurate. Our future work will focus on expanding the

system to support factories and companies with large numbers of workers who need attendance monitoring. We will also provide safer and improved options. Finally, we conclude, if we combine this attendance monitoring system with the financial system tool of any company, hotel, or resort, the system will solve the problem of global attendance in real-time as it will reduce the time and effort required for the check-in / check-out process.

References

[1] Huang, M. C., Chen, I. P., Huang, H. L., Sung, S. F., & Wang, A. G. (2021). Project Design and Implementation of Face Recognition, Fever Detection, and Attendance Record Based on Sensing Technology. Sensors and Materials, 33(6), 1787-1797.

[2] Reddy, K. P., Latha, R. C., Lohitha, M., Sonia, R., & Usha, A. B. (2021). Smart Attendance Management System Using Face Recognition.

[3] Rajamanogaran, M., Subha, S., Priya, S. B., & Sivasamy, J. (2021). Contactless Attendance Management System using Artificial Intelligence. In Journal of Physics: Conference Series (Vol. 1714, No. 1, p. 012006). IOP Publishing.

[4] Preethi, K., & Vodithala, S. (2021, May). Automated Smart Attendance System Using Face Recognition. In 2021 5th International Conference on Intelligent Computing and Control Systems (ICICCS) (pp. 1552-1555). IEEE.

[5] Strueva, A. Y., & Ivanova, E. V. (2021, September). Student Attendance Control System with Face Recognition Based on Neural Network. In 2021 International Russian Automation Conference (RusAutoCon) (pp. 929-933). IEEE.

[6] Sambath, M., Kumar, P. N., Kartheek, U., Sumana, G. S., Joseph, L., & Padmaveni, K. (2021). Smart Attendance Using Face Recognition. Annals of the Romanian Society for Cell Biology, 1913-1917.

[7] Ryu, E. A., & Han, E. (2021). Social Media Influencer's Reputation: Developing and Validating a Multidimensional Scale. Sustainability, 13(2), 631.

[8] Kolluru, D. S., & Reddy, P. B. (2021, December). Review on communication technologies in telecommunications from conventional telephones to smart phones. In AIP Conference Proceedings (Vol. 2407, No. 1, p. 020003). AIP Publishing LLC.

[9] Ferrari, A., Micucci, D., Mobilio, M., & Napoletano, P. (2021). Trends in human activity recognition using smartphones. Journal of Reliable Intelligent Environments, 7(3), 189-213.

[10] Lee, E., & Jang, J. (2021). Research Trend Analysis for Sustainable QR code use-Focus on Big Data Analysis. KSII Transactions on Internet and Information Systems (TIIS), 15(9), 3221-3242.

[11] Shirley, D. R. A., Amruthavarshni, R. B., Durainathan, A., & Karthika, M. P. (2021, May). QR-BASED INVENTORY MANAGEMENT SYSTEM (QR-IMS) OF PASSENGER LUGGAGE USING WEBSITE. In 2021 5th International Conference on Intelligent Computing and Control Systems (ICICCS) (pp. 1180-1185). IEEE.

[12] Moro, A., & Virgillito, M. E. (2021). Towards the factory 4.0? Convergence and divergence of lean models in Italian automotive plants (No. 2021/38). LEM Working Paper Series.

[13] Bhattacheryay, S. (2021). Multinational working capital management a study on Toyota Motor Corporation. International Journal of Finance & Economics.

[14] Reddy, K. R. K., Gunasekaran, A., Kalpana, P., Sreedharan, V. R., & Kumar, S. A. (2021). Developing a blockchain framework for the automotive supply chain: A systematic review. Computers & Industrial Engineering, 157, 107334.

[15] Team, A. S. Q. R., Abd El-Mawla, N., & Ismaiel, M. Smart Attendance Control System Using GPS & QR-Code.

[16] Kim, H., Choi, Y., Lee, A. C., Bae, J., Yoon, J., Kim, K., ... & Park, W. Ampoule-Like Microvolume Containers with Transparent Code for Easy-to-Use and Space-Saving Storage of Small-Volume Biospecimens. Advanced Materials Technologies, 2101266.

[17] Stockwell, G. (2022). Mobile assisted language learning: Concepts, contexts and challenges. Cambridge University Press.

[18] Yan, L. Y., Tan, G. W. H., Loh, X. M., Hew, J. J., & Ooi, K. B. (2021). QR code and mobile payment: The disruptive forces in retail. Journal of Retailing and Consumer Services, 58, 102300.

[19] Raijada, D., Wac, K., Greisen, E., Rantanen, J., & Genina, N. (2021). Integration of personalized drug delivery systems into digital health. Advanced Drug Delivery Reviews, 176, 113857.

[20] Vakaliuk, T. A., & Pochtoviuk, S. I. (2021, July). Analysis of tools for the development of augmented reality technologies. CEUR Workshop Proceedings.

[21] Zhang, H., & Zhu, Q. (2021). Instructor perceptions of engineering ethics education at Chinese engineering universities: A cross-cultural approach. Technology in Society, 65, 101585.

[22] Jayabalan, J., Dorasamy, M., & Raman, M. (2021). Reshaping Higher Educational Institutions through Frugal Open Innovation. Journal of Open Innovation: Technology, Market, and Complexity, 7(2), 145.

[23] Logvinov, O., Kraemer, B., Adams, C., Heiles, J., Stuebing, G., Nielsen, M., & Mancuso, B. (2016). Standard for an architectural framework for the internet of things (iot) ieee p2413. IEEE-P2413 Working Group. Technical Report.

[24] Raiyn, J. (2016). The Role of Visual Learning in Improving Students' High-Order Thinking Skills. Journal of Education and Practice, 7(24), 115-121.

[25] Ensmenger, N. (2016). The multiple meanings of a flowchart. Information & Culture, 51(3), 321-351.
[26] Dmitrii, R. (2020). The C++ programming language in cheminformatics and computational chemistry. Journal of Cheminformatics, 12(1).
[27] Wilson, L. B., & Clark, R. G. (2001). Comparative programming languages. Pearson Education.
[28] Psarras, C., Barthels, H., & Bientinesi, P. (2019). The linear algebra mapping problem. arXiv preprint arXiv:1911.09421.
[29] Deitel, P. J., Deitel, H. M., & Deitel, A. (2013). Android for Programmers: An App-Driven Approach (Vol. 1). Pearson Education.
[30] Deitel, P. J. (2002). Java how to program. Pearson Education India.
[31] Muhammad, A. A., Mahmoud, A. T., Elkalyouby, S. S., Hamza, R. B., & Yousef, A. H. (2020, October). Trans-Compiler based Mobile Applications code converter: swift to java. In 2020 2nd Novel Intelligent and Leading Emerging Sciences Conference (NILES) (pp. 247-252). IEEE.
[32] Hutchins, J. (2005). Current commercial machine translation systems and computer-based translation tools: system types and their uses. International journal of translation, 17(1-2), 5-38.
[33] Ross, A., Jain, A., & Reisman, J. (2003). A hybrid fingerprint matcher. Pattern Recognition, 36(7), 1661-1673.
[34] Din, Marina Md, and Ahmad Fazal Fazla. "Integration of Web-Based and Mobile Application with QR Code implementation for the library management system." Journal of Physics: Conference Series. Vol. 1860. No. 1. IOP Publishing, 2021.
[35] Ozkaya, E., Ozkaya, H. E., Roxas, J., Bryant, F., & Whitson, D. (2015). Factors affecting consumer usage of QR codes. Journal of Direct, Data and Digital Marketing Practice, 16(3), 209-224.
[36] Dresselhaus, A., & Shrode, F. (2012). Mobile technologies & academics: do students use mobile technologies in their academic lives and are librarians ready to meet this challenge?. Information Technology and Libraries, 31(2), 82-101.
[37] Pise, S., Moundekar, R., Meshram, R., Mohadikar, S., Durugwar, R., & Banabakode, D. (2019). Implementation of Handling Android Application using SMS (Short Message Service).
[38] Bagaitkar, K., Lande, K., Welekar, A., Yadav, A., Tambe, A., & Chopade, A. (2019). Tractor Hiring application for Farmers. International Research Journal of Engineering and Technology, 6(3), 2401-2409.
[39] Wong, J. W. (2020). Ecommerce shipping solution for mobile platform (Doctoral dissertation, UTAR).
[40] Fourment, M., & Gillings, M. R. (2008). A comparison of common programming languages used in bioinformatics. BMC bioinformatics, 9(1), 1-9.