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DESIGN AND IMPLEMENTATION OF A SMART STAFF ATTENDANCE SYSTEM USING QR CODE TECHNOLOGY

Okon Emmanuel Tamuno

Computer Science Department, Rivers State University, Port Harcourt.

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Abstract: Attendance impersonation, poor performance, abstinence from work, lack of effective productivity are some the challenges being experienced in organizations. Some organizations have adopted the use of attendance management system to address these challenges. This research work is aimed at developing staff attendance management system using Quick Response (QR) code, which would solve the problems of attendance being faced in organizations. Attendance data are gathered by the system, the data is processed into relevant and meaningful information that helps stakeholders to make decisions for the improvements of staff participation and their productivity. The system acts as a motivational tool and staff attendance enforcement to improve staff performance. To develop the system, the qualitative research methodology was used, enabling opinions and views from users/stakeholders through focus group interviews. Heuristic evaluation of the system done, shows 72% conformity index, which means that the system conforms in all part evaluated.

Keywords: QR Code, Attendance Management System and Qualitative Methodology

Introduction

Attendance management is the act of managing attendance or presence in a work setting to minimize loss due to employee downtime. Attendance control has traditionally been approached using time clocks and timesheets, but attendance management goes beyond this to provide a working environment that maximizes and motivates employee attendance (Shakil and Nandi, 2013). Sometimes staff calls in sick or come in late. Attendance management is a way you keep track of staff hours at work, whether or not a staff came to work. It is a system that is use to track staff attendance to take note of staff efficiency and dedication to work. It can also help the employer to calculate the hours accurately that a staff has worked either daily, monthly or annually. Attendance management can be done by recording employee hours on paper, using online time and attendance software for your business (Riley, 2017). A system to manage the attendance is surely a necessary strategy put in place by some organizations and firms, which manage the staff attendance and participation to work. A high productivity/performance of an industry/organization could be greatly affected by staff's attendance (Rodgers,

Original Article

2015). Base on cost and other special consideration some organization continues to implement the manual attendance of signing attendance sheet every day as they come to work and even signing for persons not present. As simple as this method appears it lacks automation and a number of problems may arise, such problems may include misplacements of sheets used, duplication of names on a particular sheet and the inability to handle large number of attendees and events over large networks (Root, 2018). There are many attendance management systems that have been implemented to handle the attendance issues in organization, some of it includes: fingerprint, iris scanner and Radio frequency identification (RFID) etc. However, this research suggests the adoption of the latest technology of Quick Response (QR) code in attendance management system. The proposed system would serve as both an enforcing tool as well as a motivational tool to manage staff participation and attendance to work.

Review of Related Work

Various related research work that has been done in the area of attendance management system. There are many attendance management systems that have been implemented to handle the attendance issues in organization, some of it includes: fingerprint, iris scanner and Radio frequency identification (RFID) etc. The work by Arulogun et al. (2015), Radio frequency identification (RFID) approach was proposed for solving staff attendance challenge using RFID cards being read by RFID scanners and data sent to the controlling system, the drawback of this system is that RFID tag read rates tremendously degrades as it comes in close proximity to electronic devices. Using special camera technology Shehu and Dika, (2010) proposed a real time computer vision algorithms attendance Management system, which needs special cameras to be installed. One challenge of this system is the cost of installation of these systems in all the venues. Similarly, in wireless iris technology, Kadry and Mohamad (2010) proposed a wireless iris recognition attendance management system is designed and implemented using Daugmans' algorithm. This system uses iris recognition technique and wireless technique, this system appears to be very expensive to acquire and maintain for universities with low budget and poor power infrastructure as common in developing countries. Baban, (2014) using QR code technology, proposed a system to record and view attendance information using a QR code scanned by smart phones to help students avoid penalties that may result from poor attendance. In proposed system, students can easily view their attendance records for each course. Each week, teachers place a QR code image on their doors that students can scan using a smart phone. This QR code contains a URL that links to a web page that displays the student's absentee rate, the problem affiliated to this system is the fact that implementing it in an undeveloped country where there is poor power supply, and charging of phones could be a serious issue and affording a smart phone too. The proposition of this research is to develop a minimal viable product, a solution with the minimum number of features to be accepted or marketable towards development of an attendance management system using QR code to solve the challenges of managing attendance and encouraging staff performance in the targeted institution.

Methodology

The purpose of this work, is to develop an attendance management system using QR code, where the staff clocks on arrival daily, it is presumed that the best approach to be able to develop a sustainable system is getting users opinion through interview or by question and answers etc. qualitative research method has been chosen as the research methodology for this research work to gain an understanding of underlying reasons, opinions, and

Original Article

motivations, providing insights into the problem. Also for the software methodology, agile software methodology was used since it promotes development iterations (oniru aman, 2013) . Each stage would be developed, implemented and tested to meet user requirements in the development phase, this will minimize the risk of software failure by aiding iterative development and aiding continuous testing and debugging of errors after each iteration. The requirement was collected through reviewing literature and participant focus group interview from the proposed users. Furthermore, system requirement for the attendance management is gathered based on the challenges of the related works reviewed earlier in chapter 2 of this research work. The system proposed to manage staff attendance in this research work follows the architectural and software design pattern as shown below

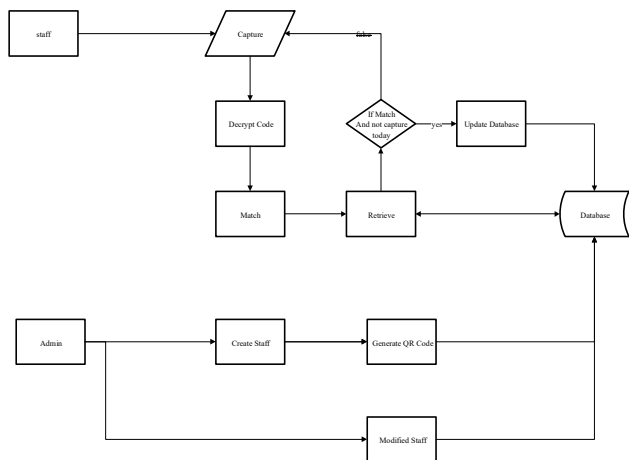


Fig. 1: Architectural design of the proposed system

The architectural design of the proposed system in fig. 1 denotes that the staff role is to clock in and for capturing to take place, the QR code needs to be decrypted by the system and then matched in the database, the system then checks if the record is found in the database, If the record is found in the database, the system checks if the staff has already been captured for that day, the system returns the result, if no, the system updates, capturing the details saving the time and date. On the other hand, an admin can create new staff, edit staff records, encryption and decryption is done by the system to avoid mistakes and data tampering. The application was designed using bootstrap, which consist of (html, Css and JavaScript), and php/MySQL.

QR Code

Quick Response code (QR code) which was developed by denso co-operation in 1994 is a typical matrix two-dimensional barcode, (Chen, 2014) that code database on the position of black spots within a matrix, where each black element is the same dimension and it is the position of the elements that codes the data. It has 40 versions and four (4) level of error correction. The maximum symbol size (the highest version encodes 7089 numeric data and 4296 alphanumeric data. The highest level, which is the fourth level, error correction in the QR code, allows 30% recovery of the symbol code words.

QR code can hide large amount of data, numeric and alphanumeric. Thus, they have become popular all over the world. Moreover, contain software that can read QR-code images (Chang, 2014). A QR-code image comprises a

Original Article

functional pattern and an encoding region as can be seen in fig. 1. The patterns included in a QR-code image are finder, alignment, timing, and Encoded data. Each of these patterns has its own functionality.

- **Finder pattern:** This pattern can be found at the edges of a QR code image. The finder pattern is a square block that contains a black square. There are three finder patterns on every QR code image; at the top left, top right, and bottom left. There is no finder pattern at the bottom right. The primary functionality of the finder pattern is to tell a scanner or decoder that the image that has been encoded is a QR-code image. No data is stored in the finder pattern.
- **Alignment pattern:** Similar to the finder, there is no data stored in the alignment pattern; however, it provides information scanner devices to correctly position the data stored in the encoded data region. The alignment pattern is positioned between encoded data and is usually in the center of the image. The structure of this pattern consists of a small square with a tiny dot inside. In addition, the number of alignment patterns can differ for different QR codes.
- **Timing pattern:** This pattern lies between two finder patterns. Timing patterns are arranged both vertically and horizontally. There is a black dot inside each timing pattern. The main purpose of the timing pattern is to correct the central coordinate for each data cell when any distortion occurs during decoding of symbols or when an error is found in any cell pitch in the QR code. No data is stored in the timing pattern.
- **Encoded data:** This pattern is located at the center of the image. Data is stored within this pattern. In addition, when data is inserted, it is converted to binary data. This binary data is converted back to the normal text when a scanner decodes the image.

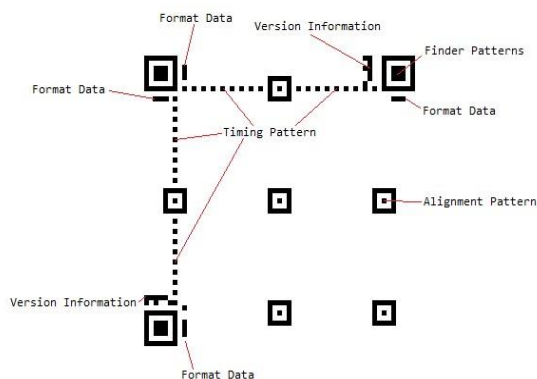


Fig. 2: Structure of a Quick Response Code (QR Code)
QR Code in Analytic Staff Attendance Management System

In the proposed method, the QR code is used instead of manual login. The QR code is a two dimensional code which has black Square arranged on a white background which efficiently stores data (Kumar, 2017) This means that pieces of information are encoded horizontally and vertically instead of being only horizontally encoded like a standard bar code. A QR code can be embedded anywhere, here it is embedded on a card. The QR code is scanned using a web cam. QR codes are unique so it differs from one employee to another. The QR code is processed using Reed–Solomon, error correction until the image can be appropriately interpreted the highest recovery percent of 30 was chosen and the version used was a level 3 which is (33 rows by 33 columns). The

Original Article

required data which contains the staff name and id number which is unique for all staff, is then extracted from patterns that are present in both horizontal and vertical components of the image (Pal, 2017) Once scanned the id is directly logged-in. The requirement was collected through reviewing literature and participant observation/focus group interview from the proposed user that was held with group of staff and admin. Furthermore, system requirement for the attendance management is gathered based on the challenges of the related works reviewed. A diagram to identify who uses the system is shown below.

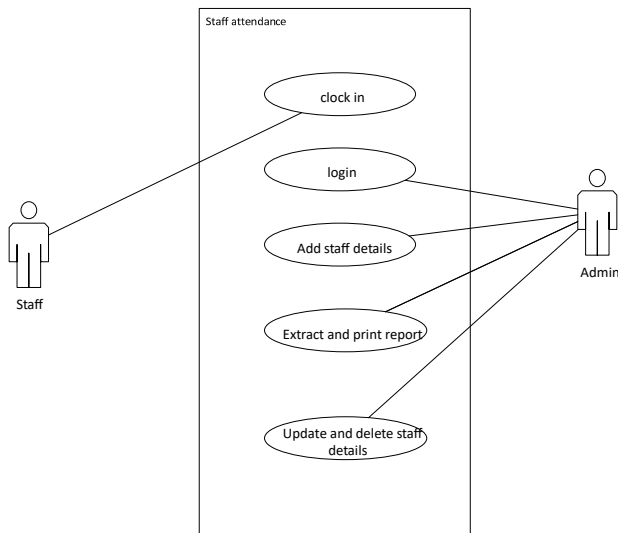


Fig. 3: Use case diagram

The admin has a full privilege to add, edit, update, delete user and extract/print report, while the user only has just a privilege, which is to clock in using the QR code generated. The class diagram in fig.4 describes the structure of the system by showing the system's classes, their attributes, operations (or methods), and the relationships among objects, there are four classes in this research work, the staff class, the admin class, the QR code class and the clock in class.

Original Article

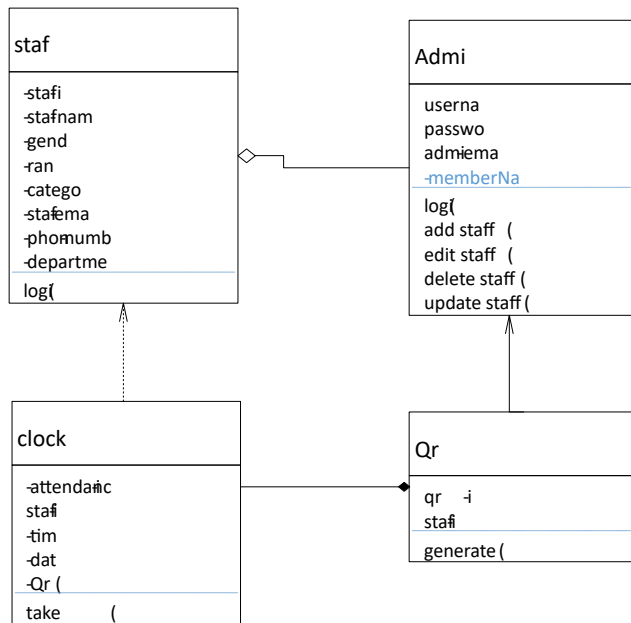


Fig.4: Class Diagram of the Proposed System

Result/ Discussion

Individual programs such as the code and the interface are run and tested for syntax and logical errors, after this has been successfully carried out; the entire system is tested as a whole, for this research work, heuristic evaluation was done to check for conformity, the black box testing to test for functionality while the white box test was carried out to check for usability of the codes.

Table 1: Black box/Functional Testing

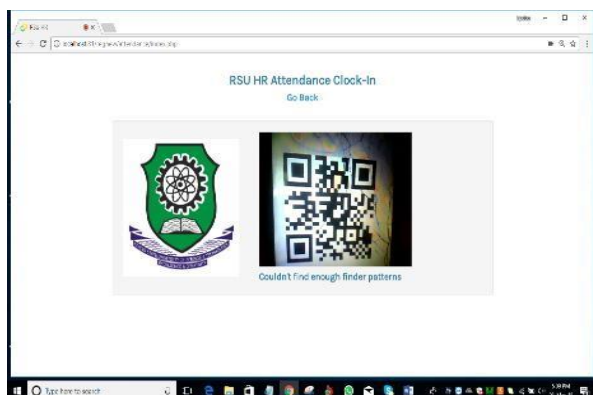
s/no	Test case	Expected outcome	Actual result
1.	Enter invalid login details	Error message should be displayed informing the admin that the login details are not correct.	System performs as expected
2.	Enter correct login details	Successful login message should be displayed to the user and the expected page is loaded	System performs as expected
3.	staff attempts to take attendance when record not in database	Display an error message, staff record not found	System performs as expected
4.	Staff succes	The system should display a message of the time, date staff name	System performs as expected

Original Article

	sfully attendance	takes		
5.	Using the find dialogue box admin types in staff details not in the database	The system should display an error message record not found	System performs as expected	
6.	Staff positions QR code id horizontally or vertically while taking attendance	The system should read code successfully	System performs as expected	



Fig.5: showing the QR code deliberately stained The QR code is scanned placing the card directly in front of the web cam as follows



Original Article

Fig.6: showing when the QR code is placed in front of the web cam

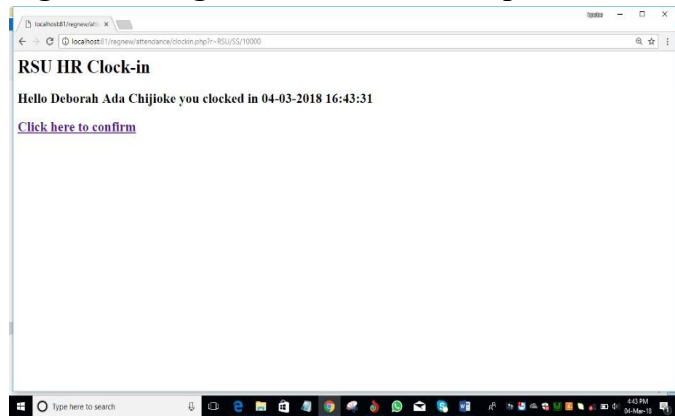


Fig.7: Shows the report when a staff clocks in

When the QR code staff id is placed in front of the web cam, as seen above, a report comes up, the PHP application compares the scanned QR code if the staff id contained in it is a valid one associated with a staff record in the database, if there is a match the PHP application sends a request to mysql and the staff is clocked in.

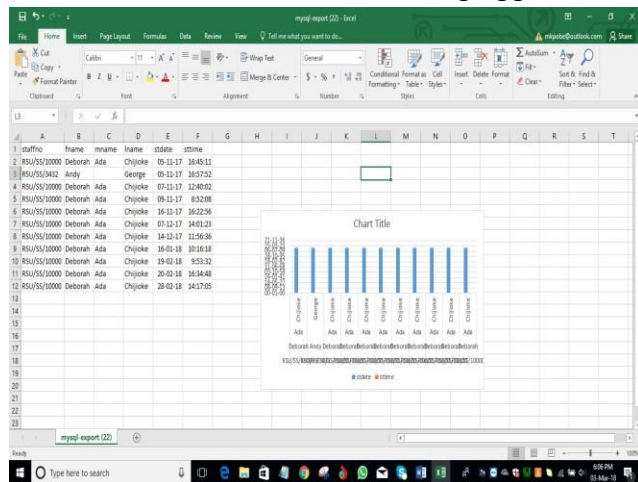


Fig.8: shows the attendance report on Excel sheet

Only the admin is privileged to extract the report using the link, a graph could be plotted as seen above for proper reporting, and presentation after successful design, implementation and testing of the system it is very necessary to perform evaluation of the system. The purpose of the evaluation is to measure the level of functionality of the system against system requirements.

The system is evaluated based on the following:

Heuristic evaluation

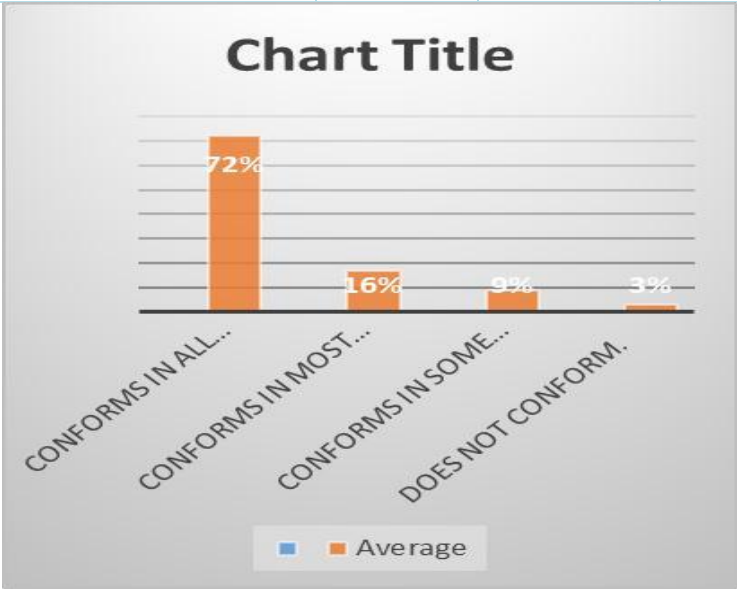
Conformity Indices

- (a) 1 = Conforms in all parts.
- (b) 2 = Conforms in most parts.
- (c) 3 = Conforms in some parts.
- (d) 4 = Does not conform.

Original Article

Table 2: Heuristic Evaluation

Usability Criteria (Heuristics) Suitable Use	1	2	3	4
Consistency	15	2	2	1
User Focused Control	13	5	1	1
Color scheme and Interface Text	15	4	1	0
Dialogue and Feedback	15	3	1	1
Buttons	12	5	3	0
links	16	2	2	0
Dashboard	15	2	2	1
Average	72%	16%	9%	3%



Original Article

Table.3: Heuristic evaluation findings charts representation

The heuristic evaluation of twenty (20) users gives a 72% of conformity index which mean that the system conforms in all part evaluated. The white box test shows that all the internal design structure is functional.

Conclusion

As Quick response code, QR code becomes very popular and reliable in storing and in easy scanning of data. In this research work, it was used in developing a staff attendance management system to encourage staff performance, with its ability of correcting error using the reed Solomon error correction. A QR code generated for a staff was deliberately damaged and stained for testing, yet it was successfully read by the system. On the entire test carried out, the system performed as expected, the results from the system evaluation shows that the implemented system meets the system requirements.

The system with little modification can be used to address attendance issues in different use cases and scenarios such as examinations, secondary education and various small and medium scale businesses etc., which require attendance information for decision-making. In addition, this system has the potential to help get meaningful data about staff approach to work which can help academic institution gain data to be used in improving performance. This is the start of a big and unique work in the area of enhancing staff performance and productivity, but the focus of this particular research had been on staff attendance management but just for clocking in. Nevertheless, an improvement could be made to accommodate many business rules such that it becomes possible to have flexible configurations for early, late and absent conditions and other use cases

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Original Article

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Original Article

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