Design and Implementation of an RFID Monitoring and Biometric based Attendance Management System.

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Abstract

In order to ensure that students at Edo State Polytechnic, Usen, are promptly identified and located during class and exam periods, this research focuses on the necessity of a more reliable system for tracking student attendance and identification on campus. By utilising fingerprint and radio frequency identification (RFID) technology to track and identify registered students, the system aims to reduce and eliminate the undetected persistent impersonation and frequent student absences from class. This system utilises radio frequency identification tags and readers equipped with signal antennas to keep tabs on students' whereabouts; it also makes use of biometrics technology, specifically a fingerprint reader, to record students' attendance. By utilising RFID and fingerprint devices, this system electronically records attendance in real-time, which is then stored in a database. The system was built using the Visual Studio IDE's Window Forms application, and it uses fingerprint scanners and RFID devices to implement the system's Graphical User Interface (GUI) (IDE). C# and the Structure Query Language (SQL) server are used to create the back-end design.

Introduction

Traditional methods of taking attendance in schools, such as having students write their names or sign a sheet of paper, have several security flaws that allow students to easily impersonate others, sign on as someone else, or engage in other illicit activities undetected. An entirely new paradigm for automating data collection, transfer, transmission, and storage has emerged with the rise of cutting-edge technological tools that capture data, code it, and store it in databases.

The use of intelligent applications and devices to meet the demands of contemporary education is one area where ICT is seeing new trends. Wasted time, impersonation, missing student attendance records, and inaccessible location data on demand are just a few of the issues that have arisen as a result of the current manual attendance and monitoring system at EDO STATE POLYTHECHNIC, USEN.

Efficient, safe, and fully automated attendance tracking with real-time report generation, data storage, and transmission is what you can expect from the proposed RFID monitoring and biometric based attendance management system. It's built with cutting-edge processes, applications, and devices. The proposed system will bolster the

institution with cutting-edge tech. Several additional advantages, such as web-based and mobile interfaces, an automatic SMS alert, a daily absence report, and so on, are associated with RFID-based systems.

LITERATURE REVIEW

The conventional method of taking attendance is still in use by the vast majority of institutions worldwide. Teachers are taking attendance by calling out each student's name and crossing them off the list. A number of issues, including inefficiency, inaccurate marking, time wastage, and proxy attendance, are linked to this method of taking attendance. As a result, the time has come to replace the inefficient and cumbersome manual attendance management system with one that makes use of modern technologies like biometrics and radio frequency identification.

An important part of evaluating students is keeping track of their attendance. Class attendance is highly valued by educational institutions; in fact, some school exams require students to meet a certain attendance threshold before they can take them. Additionally, students are not permitted to participate in the exams if their class attendance falls below the required minimum. Conventional methods of taking attendance in class are labor-intensive and open to mistakes made by teachers and students alike.

The creation of an RFID-based student attendance system is detailed in a 2012 publication by Kassim et al. Students still need to physically sign the attendance sheet each time they show up to class under the current traditional system. A system for managing attendance has been developed using radio frequency identification technology (Shukla et. al., 2013). Displaying live ID tag transactions, registering and deleting IDs, recording attendance, and other minor functions are all provided by the Attendance Management System. Research into smart classroom attendance tracking systems using RFID and GSM technology was conducted by Chen in 2014. We present an intelligent system for checking attendance in the classroom. This system can intelligently complete the examination of students' attendance, which is an important component of the campus management system. The current standard procedure for taking attendance calls for each student to sign the attendance sheet by hand. As a solution to the problems with the current attendance system, we will create an RFID-enabled smart attendance management system (RFID-SAMS) (Zhi et. al., 2015). In order to streamline classroom management, attendance tracking, and student-teacher interaction, (Atabekov, 2016) suggests a comprehensive system with ten smart chairs that utilise the Internet of Things paradigm. Radio frequency identification (RFID) sensors can automatically read the RFID tags on student ID cards, allowing for efficient student identification. Faculty members in higher education face a significant challenge when trying to manage student attendance effectively; this task requires quick and precise solutions. In a recent study, Mohammed et al. (2018) found an efficient way to handle student attendance in big lecture halls in real time. By replacing a number of tedious manual procedures, an

automated attendance management system can simplify the process of keeping track of employees' whereabouts and how many hours they've worked. (Akter et. al., 2018) offer a straightforward method of student attendance tracking through an IoT-based system that securely stores fingerprint-based attendance records in a database. A smart attendance management system that uses radio frequency identification is studied by Meghana et. al. (2020). Using RFID technology that is directly linked to an Excel spreadsheet, the suggested method can be applied to the creation of attendance simulations in any industry. Using the suggested method, which is widespread across all industries, the smart attendance management system performed satisfactorily. An organization's or company's staff can benefit from an attendance management system that uses radio-frequency identification (RFID) technology (Mukherjee, 2021). Creating an organised system to computerise each employee's attendance is the primary goal of developing an RFID-based attendance management system. A system for tracking attendance that uses face recognition and Radio Frequency Identification Devices (RFID) is designed and developed by Chen et al. (2021). The accuracy of attendance certification and the reliability of attendance management are both improved by using a composite authentication method with high recognition (Chen et. al., 2021).

Radio-Frequency Identification (RFID)

Radio-frequency identification (RFID) is a system that allows objects to be identified and tracked by transferring data from an electronic tag (also called a label) to a reader. A reader can read the RFID tags embedded in the student ID cards. A computer connects this RFID system to a database.

RFID Mode of Operation

A RFID system is composed mainly of three main elements they are:

i. A scanning antenna
ii. Transceiver
iii. Transponder

The radio frequency identification reader consists of a transceiver and a scanning antenna. A network-connected, portable or permanently attached device is the main component of an RFID reader. Radio frequency waves are used to activate the tag and transmit signals. Initiated by returning waves to the antenna for translation into data, the tag is a wireless sensor (raw fact). The RFID tag also contains the transponder, which is an essential part of the RFID system. Factors such as RFID frequency, tag type, reader type, and environmental interference affect the record range of RFID tags. A schematic of an RFID tag and reader is shown in Figure 1..

Fig. 1: RFID Reader and Passive Tag

Fingerprint Reader

A computer stores the fingerprint in a database, runs a comparison algorithm, and mimics the application's function; all while the fingerprint reader takes the picture. Through its USB port, the fingerprint scanner is linked to the computer. The creation of hardware is not fundamental to this task. If you own a ZK4500 fingerprint reader, you can connect it to your attendance tracking software using the ZKFingerprint Software Development Kit (SDK) toolbox, which is available in the ZKFinger SDK development Guide.

Fig. 4: *ZK4500 Fingerprint Reader*

METHODOLOGY

Research for this project primarily relies on student and instructor interviews and observation. From what I could tell about the current setup, it was simple to derive conclusions. With the integration of fingerprint authentication and RFID technology, this proposed system brings a new automatic attendance management system to the student attendance management process. Enrollment and authentication are its two main components. During the enrollment process, the user's biometric data is collected and

saved in a database along with their ID. This data serves as a template for the subject. The enrollment module's goal, following feature extraction, is to allow users admission into a database by means of their ID and fingerprints. The authentication process is based on these characteristics, which serve as a template for determining the user's identity. The administrator of the attendance management system is responsible for the enrollment process. Authentication involves recapturing the user's biometrics and comparing the extracted features to those already in the database in order to establish a match. The user's ID that was used to match the templates is recorded when attendance is marked after a successful match.

The program's fingerprint recognition and identification system and database to store user information were built using a fingerprint reader as input to acquire images. Users' attendance records, bio-data (such as fingerprint templates), and other personal information are all part of the database.

The student's identity is stored on an RFID (radio frequency identification) tag (ID-Name, Matriculation Number). The RFID reader verifies the student's identity. In this device-based system, students are required to wear RFID cards that contain microchips, and readers and detectors are to be placed within specific frequency ranges in order to collect real-time data and send timely information about the subject's location and identification.

SYSTEM DESIGN

The design of the RFID and fingerprint-based attendance management system is made up of the following:

i. Enrolment module
ii. Authentication Module
iii. System database.

Enrolment Module

Adding users and their fingerprints to the system database is the responsibility of the enrollment module. Upon enrollment, the user's bio-data, including fingerprints, is collected. The specific characteristics of the fingerprint are then extracted from the image and saved in a database alongside the user's ID to serve as a template for the subject. Matrix number, last name, other names, sex, department, level, studentship, phone number, and passport photo are all pieces of student bio data that need to be collected. For a more precise picture, two image samples are taken for each fingerprint that is used during enrollment or registration.

Authentication Module

The authentication module's job is to check the user's credentials before granting them access to the system. A user can verify their identity by placing their finger on a fingerprint scanner and then indicating their identity. The biometric template is extracted

during the feature extraction stage after the acquired fingerprint images have been enhanced and thinned in the image processing stage. The information is subsequently input into a matching algorithm, which compares it to the individual's biometric template that is kept in the system database. This process confirms their identity.

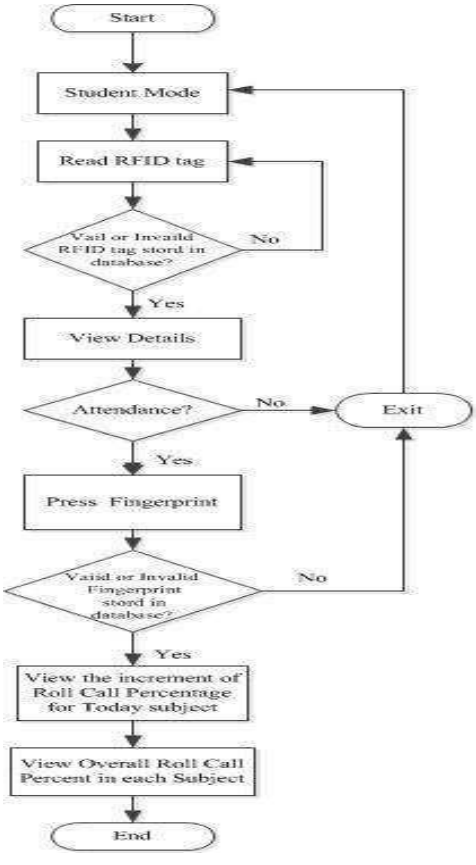

Fig. 2: *Flowchart for the Student Attendance System*

The Database

Records pertaining to authorised users are stored in the database tables that make up the attendance management system. A user's username and fingerprint templates, among other pieces of information, are stored in each record. The system's database is structured according to the relational data model, which stores information in a set of tables. The database that was used was Microsoft SQL Server.

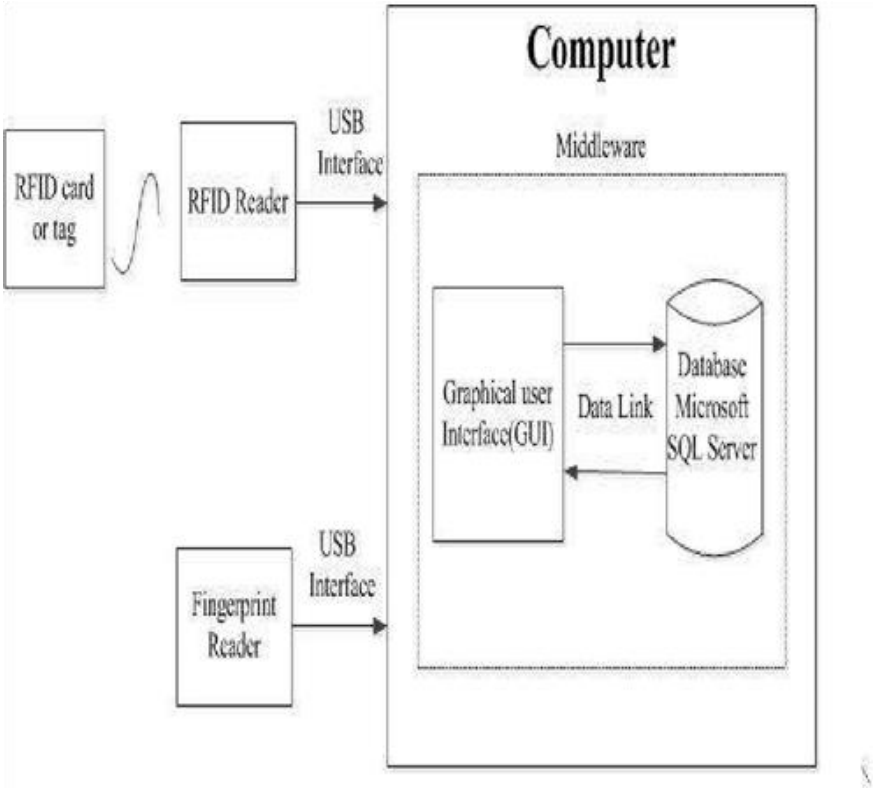

Fig. 1: Block Diagram of the RFID and biometric Attendance Management System

EXPERIMENTAL RESULTS

Ten students from the computer science department at Edo State Polytechnic in Nigeria were bio-scanned and fingerprinted for the proposed system. Each person in the group will have their fingerprints taken from one of their ten fingers; to verify their identity, they must recall which finger was used. If a finger doesn't enrol because its ridge structure isn't good, you can use an alternate finger instead.

Through the use of RFID-installed devices, the proposed system will be able to track students' attendance at the polytechnic and provide reports promptly upon request. In addition to saving time for both students and teachers, the system can conveniently record students' clock in and clock out times using their fingerprints, which helps to prevent impersonation and lowers the level of absence. Also, it's easier to keep track of attendance, lessens the likelihood of proxy attendance, and decreases the likelihood of human error.

Through its development, expertise in RFID and fingerprint reader systems, database architecture, and C# user interface design were brought to fruition. This system has offered a more practical way of taking attendance than the old-fashioned way, both in terms of efficiency and performance. Data is better organised when stored in databases.

So, it can be used in both academic institutions and businesses. Due to environmental considerations regarding radio signals, low power consumption, and low cost, passive tags are preferable to active tags for this system. It is reasonable to assume that the product is an extremely efficient GUI based component after carefully examining the component's benefits and limitations. All user requirements are being satisfied by this application, and it is functioning correctly.

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