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Research Article

Student Records Management System SRMS using IoT

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Abstract:

The Student Records Management System (SRMS) is a modern digital platform based on IoT (Internet of Things), designed to streamline the process of managing student attendance during lectures and practical sessions at Kadri Zeka Public University in the Republic of Kosovo. This digital system enables professors to generate and store real-time attendance records for students participating in lectures and exercises. The RFID (Radio-Frequency Identification)-based Student Records Management System is developed using PHP (Hypertext Preprocessor), HTML (Hypertext Markup Language), CSS (Cascading Style Sheets), MySQL (My Structured Query Language), and JavaScript. When a student scans their personal RFID card, the system logs their arrival time along with personal details. Additionally, when the same student scans their card again before leaving, the system records their departure time. This approach aligns with the Bologna System criteria, ensuring a fair and accurate assessment of student participation throughout the semester. This will also increase the transparency for students and professors in keeping all the records for each student and let to generate different reports by the end of semester. Beyond universities, this system can be implemented in primary and secondary schools, industrial and commercial companies for employee attendance tracking, hospitals, manufacturing firms, state institutions at local and central levels, and any other setting where participant registration and monitoring are needed, all while leveraging IoT technology.

1. Introduction

The Student Records Management System (SRMS) is designed to enable professors and assistants to generate and store attendance data for students during lectures and practical sessions. This digital system consists of three main components: hardware, software, and a web application, which utilizes IoT (Internet of Things) [1]. A digital RFID (Radio-Frequency Identification) device is installed at the entrance of each classroom within the university. When a student presents their personal RFID card near the reader, their attendance data is transmitted via Wi-Fi to the system’s database, recording the date and time of entry into the lecture or practical session [2]. If the same student scans their card again within the same date and classroom, the system, leveraging IoT, registers this as their exit time [3]. If the student scans their card for a third time, either at the same RFID device or another RFID device in a different classroom (within the same system), it is recorded as the start of another lecture or session. This process continues throughout the day from 7:00 AM to 8:00 PM.

The RFID system ensures that the number of scans per student per day is always even, meaning the student has attended a specific number of lectures or sessions on that academic date [4]. If a student's card is scanned n times, the number of attended lectures or sessions for that day is jet $\frac{n}{2}$, always resulting in a whole number. The web application, developed using PHP, HTML, CSS, and JavaScript, plays a critical role in the system’s functionality and is closely integrated with the digital hardware components. When a student’s RFID card is scanned, the application receives the data and archives it in a MySQL database.

The application, utilizing IoT, consists of two main modules:
Administrator Module – Managed by administrator or authorized personnel, this module allows the configuration of digital devices within the system and the management of professor and student data [5].
Professor Module – Enables registered professors to log into the system using their personal accounts. Professors can manage student attendance records in real-time and at any point during the academic year. They can also generate student attendance reports based on parameters such as date, time of entry and exit, faculty, and classroom.

A conceptual model of the SRMS system and its Wi-Fi-based communication between digital devices, IoT components, and the web application is illustrated in Figure 1 [6].

Figure 1. *Conceptual model of the SRMS system using IoT*

2. Material and Methods

The digital devices are the core components of the Student Records Management System (SRMS). The device structure includes the following components: ESP8266 NodeMCU module, RFID reader, LCD (Liquid Crystal Display) screen, LED (Light-Emitting Diode), buzzer, and connecting wires for electronic components.The NodeMCU board, in conjunction with the RFID reader, captures the chip ID from the student's card and transmits it via Wi-Fi router to the web application, where the ID is verified and recorded along with the student's details. The hardware connection structure of the digital devices is illustrated in Figure 2 [7].

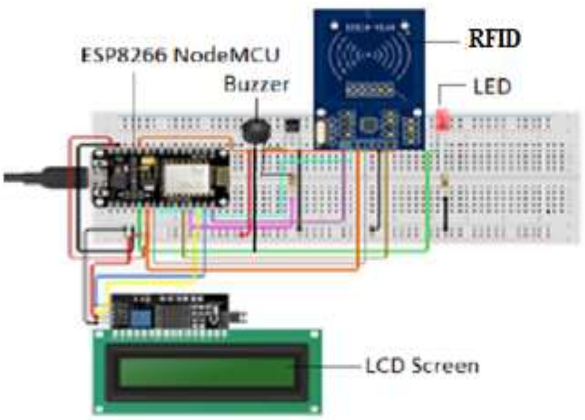

Figure 1. *Physical connection diagram of digital devices*

The ESP8266 NodeMCU is an open-source microcontroller module, compatible with the Arduino UNO, and Wi-Fi-enabled, serving as a bridge between digital devices and the web application [8], [18-21]. The ESP8266 NodeMCU is powered by a 32-bit processor, making it an excellent choice for IoT and automation projects in various residential and workplace environments, specifically in university spaces for this use case.
This microcontroller can function either as a standalone device or as a UART (Universal Asynchronous Receiver/Transmitter) to Wi-Fi adapter, allowing other microcontrollers, such as the Arduino UNO, to connect to a Wi-Fi network.
The ESP8266 NodeMCU can operate in two modes: Access Point (AP Mode) – Generates its own Wi-Fi network. Station Mode (STA Mode) – Connects to existing Wi-Fi networks for internet access [9–11]. This capability enables the ESP8266 to access online services for HTTP (Hypertext Transfer Protocol) requests, store data in the cloud, and allow users to remotely monitor and control systems via IoT technology [12].
RFID – (Radio-Frequency Identification) consists of two main components: RFID cards and an RFID reader. The RFID reader includes a radio frequency module and an antenna that generates a high-frequency electromagnetic field. The RFID card is a passive device (it does not contain a battery or external power supply) and consists of a microchip that stores information and an antenna for receiving and transmitting signals. For the implementation of this system, the RC522 RFID module has been used. The table 1 presents the connection between the ESP8266 NodeMCU and the RC522 module [12]–[18], [23].

Table 1. *Connection Between ESP8266 NodeMCU and RC522 RFID Module*

NodeMcu	RFID-RC522
D4	SDA/SS
D5	SCK
D7	MOSI
D6	MISO
GND	GND
D3	RST
3V	3.3V

LCD Screen – I2C LCD 16x2

The I2C LCD 16x2 display consists of 16 characters per row and 2 rows in total. Its purpose is to visually display data that is executed within the system. The LCD is connected to the ESP8266 NodeMCU, which sends the commands for displaying information. The table 2 shows the connection between the ESP8266 NodeMCU and the I2C LCD module [13–16].

Table 2*. Connection between ESP8266 and RC522*

NodeMcu-ESP8266 Pin	I2C LCD Pin
GND	GND
VIN	VCC
D2	SDA
D1	SCL

LED and BUZZER– The LED (Light-Emitting Diode) is a semiconductor diode that emits light when a voltage is applied. In this case, a red LED is used. The Buzzer is a small speaker that produces sound when an allowable voltage is applied.

The purpose of using these two components is to provide both a visual and an audible signal when an RFID card is scanned using the RC522 module. The LED and Buzzer are connected to the ESP8266 NodeMCU via the D0 port.

Current Limitation and Component Protection

It is crucial to protect the ports of electronic devices, including the LED [25-27]. Excessive current can damage both the LED and the microcontroller pins. To limit the current, a resistor is placed in series with the LED.

According to LED manufacturer specifications, the recommended voltage for a red LED is 2V DC, and the maximum continuous current should not exceed 20mA [28-30].

To ensure the protection of ESP8266 pins, the required resistor value must be calculated and connected in series with the LED.

The circuit diagram for the LED connection is illustrated in Figure 3, based on the schematic shown in Figure 2.

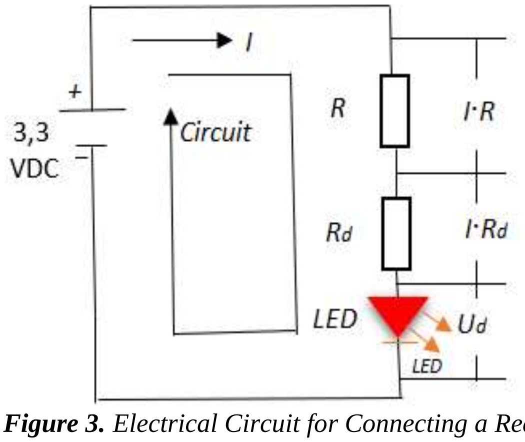

Figure 3. *Electrical Circuit for Connecting a Red LED to ESP8266 NodeMCU*

The allowed voltage for the red LED is 2 [VDC], and a sufficient current is 12 [mA], rather than the maximum 20 [mA], since the ESP8266 NodeMCU can supply this current from its pins. On the other hand, the minimum output voltage from the ESP8266 GPIO pin is 3.3 [VDC]. To ensure proper current limitation, we need to determine the resistor value R that will protect both the LED and the ESP8266. By applying Kirchhoff's Voltage Law (KVL) to the electronic circuit (as shown in Figure 3), we can calculate the required resistor value in Ohms $[\Omega]$.

$$3{,}3\ [VDC] - R \cdot I - R_d \cdot I - U_d = 0 \quad (1)$$

R_d – The internal resistance of the diode is very small and is usually negligible in practical calculations ($R_d \ll$). Therefore, the following equation is obtained:

$$3{,}3\ [VDC] - R \cdot I - U_d = 0 \quad (2)$$

Therefore:

$$R \cdot I = 3{,}3\ [VDC] - U_d \quad (3)$$

$$R \cdot 12\ [mA] = 3{,}3\ [VDC] - 2[VDC] \quad (4)$$

$$R = \frac{1{,}3\ [VDC]}{12\ [mA]} = \frac{1{,}3\ [VDC]}{12 \cdot 10^{-3} [A]} = \frac{1{,}3 \cdot 10^3}{12} [\Omega] = \frac{1300}{12} [\Omega] \quad (5)$$

$$R = 108{,}33\ [\Omega] \approx 100\ [\Omega] \quad (6)$$

Practically, a 100 [Ω] resistor is used because it is the closest standard value available in industrial resistor manufacturing. On the other hand, the buzzer used for sound production has technical characteristics very similar to the LED, both in terms of supply voltage and the permissible current intensity. Therefore, the LED and buzzer are connected in separate electrical circuits, with the buzzer also being protected by the same 100 [Ω] resistor. The calculation for the buzzer is entirely identical to that of the LED.

If the 100 [Ω] resistor is not used in the electrical circuit, as shown in Figure 3, then Equation (1) would be defined as follows:

$$3{,}3\ [VDC] - R_d \cdot I - U_d = 0 \quad (7)$$

From this, it follows that the voltage across the LED, given that $R_d \ll$ would be:

$$U_d = 3{,}3\ [VDC] \quad (8)$$

This voltage is 1.65 times higher than the allowed voltage for the red LED, where the maximum permissible voltage is 2 [VDC]. Therefore, such an excessive voltage would damage the LED.

On the other hand, if we calculate the electric current intensity using Equation (7) for a supply voltage of 3.3 [VDC] from the ESP8266 NodeMCU microcontroller and the allowed voltage U_d of 2 [VDC] for the LED, we obtain the following equation:

$$I = \frac{3{,}3\ [VDC] - 2\ [VDC]}{R_d\ [\Omega]} = \frac{1{,}3\ [VDC]}{R_d\ [\Omega]} \quad (9)$$

The internal resistance of the diode is very low, especially when it is forward biased ($R_d \ll$). As a result, the electric current intensity in the circuit where the LED is connected would be several times higher than the allowed current for the LED. This excessive current would not only damage the LED but also burn out the output pins of the ESP8266 NodeMCU microcontroller, or even the Arduino Uno if it were used in the system. The same issue would occur with the Buzzer, as it has similar electrical characteristics!

2.1 Conceptual model of the Web Application

In Figure 4 below, the conceptual model of the Web Application is presented. The model consists of two main modules: Administrator Module and Professor Module.

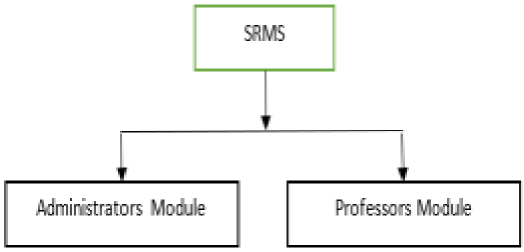

Figure 4. *Conceptual model of the Web Application*

2.2 Administrator module

The Administrator Module includes the following menus: Home, Manage Students, Students, Professors, Faculties, Devices, Profile, and Log Out. With this module, all data related to students, professors, faculties, and devices can be modified, changed, or deleted. The module also allows the modification of administrator accounts, but the data cannot be changed without entering the correct password associated with the respective administrator's account. In Figure 5, the login form for the Student Records Management System (SMES) is shown.

Figure 5. *Login form for Administrator module*

Access is granted as an administrator only through email and password, ensuring that unauthorized logins are prevented from accessing the system [19-22].

The Students Menu contains a form that displays all the students registered in the SMES. Through this form, the administrator can search for student data based on the student's name, student ID, and faculty.

The Manage Students Menu enables the management of registered student data and displays their information in a shared table. This page includes forms for adding new students, modifying the data of existing students, as well as deleting students from the system.

The Professors Menu allows the management of registered professors' data and displays their information in a shared table. This page includes forms for adding new professors, modifying the data of existing professors, as well as deleting them from the system.

The Faculties Menu enables the management of faculty data and displays it in a shared table. It also allows for the addition of new faculties within the university, modification of existing faculty data, and deletion of faculties.

The Devices Menu allows for the management and configuration of devices. It also enables the addition of new devices, modification of the characteristics of existing devices, and deletion of devices.

The Profile Menu allows for the modification or updating of the profile data of the administrator currently logged into their account.

The Logout Menu allows the user to log out from the application and return to the login page.

2.3 Professors module

Professors module contains: Homepage, Profile and logout as shown in the Figure 6.

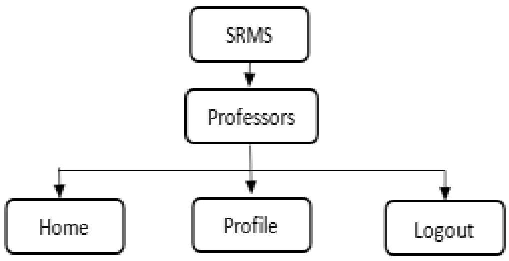

Figure 6. *Professors module menus*

The Home Menu contains a table displaying the attendance data of students present during lectures and exercises throughout the day at the faculty. Additionally, it includes a "Filter/Export to Excel" button, which allows the generation of student data

based on several parameters such as: date, entry and exit time, faculty, and room.
The Profile Menu allows for the modification or updating of the logged-in professor's information within the application.
The **Logout Menu** enables users to log out of the application and return to the login page.
Initially, upon launching the SMES application, as shown in Figure 7, users are presented with the option to select their role before logging in, either as an administrator or as a professor.

Figure 7. *Homepage of SRMS system*

Configurations:
To fully operationalize the SRMS system several configurations must be made in Arduino IDE [20]:

1. Open IDE
2. Go to File > Preferences (or press CTRL Key + comma)
3. Copy: http://arduino.esp8266.com/satble/package_esp8266com_index.json in Additional Boards Manager URLs.
4. Go to Tools > Boards Manager and install esp8266.
5. Go to Tools > Port and select the port on which is connected esp8622.

In the following section of the program code, the SendCardID method is created initially with the RFID card ID as a parameter [18-19]. Then, we declare an object of the HTTPClient class to send requests and receive responses. We also declare the getData variable, which is used to obtain the ID value. Once the request is initialized, it sends the ID and receives a response, which is displayed on the LCD screen.

```
void SendCardID(String Card_uid){
If(WiFi.isConnected( ){
HTTPClient http;
getData = "?card_uid=" + String(Card_uid) +
"&device_token=" + String(device_token);
http.begin(Link); // start HTTP request
int httpCode = http.GET( ); // send request
String payload =- http.getString(); // get response
Serial.println(httpCode); // print HTTP returned
code
Seria.println(Card_uid); // print ID card
Serial.println(payload); // print request – response
payload. Printing request in LCD screen
lcd.clear( ); // clear screen
lcd.setCursor(0, 0); // put cursor in the screen with
coordinates  (0, 0)
lcd.print(payload) // print payload value
delay(2000); // wait 2 seconds repeating the infinite
cycle of the program code
lcd.clear( ); // clear the screen
```

3. Results and Discussions

The Student Records Management System (SRMS) using IoT provides an excellent solution for digitalization, transparency, and accuracy in generating student attendance lists for lectures and exercises. Initially implemented at the Faculty of Computer Sciences, it has since been extended to other faculties at the "Kadri Zeka" Public University in Gjilan, in the world's newest state, the Republic of Kosovo. Naturally, this same digital system, which utilizes IoT, can be applied to universities and colleges across the entire territory of the Republic of Kosovo and potentially beyond. Until now, professors and assistants have manually recorded student attendance with printed lists, where students wrote down their data at the beginning of the class. This method of keeping records consumed valuable teaching time for professors and especially the students' learning time, particularly when the number of students present was in the tens, and sometimes even hundreds or more.
To make optimal use of lecture and exercise time, it was a request from students, professors, assistants, and university management to find an innovative way to record student attendance during classes. Therefore, by leveraging information technology, smart devices like microcontrollers, IoT, and programming languages, this classic problem has been transformed into an excellent digital innovative solution that resulted in an artificial intelligence-powered system. All of this meets a condition of the Bologna system, which has been in place in the Republic of Kosovo for around twenty years. According to the Bologna system, the student's attendance in lectures and exercises is considered when evaluating the final grade at the end of the semester. The method of determining the professor’s decision regarding the final grade for a passed exam, expressed as a percentage based on the student's academic activity, is shown in Table 3. In cases where a student has not been regular in attending lectures and exercises, they automatically lose 10% of their grade, which corresponds to 10 points out of the total 100 points available.

Table 3. *The grading criteria for students according to the Bologna university system*

Academic activity	Percentage %	Points
Colloquium-First test	10%	10
Colloquium-Second test	10%	10
Homework	10%	10
Regular attendance, lectures and exercises	**10%**	**10**
Seminar paper	10%	10
Final exam	50%	50
Total:	100%	100

Table 4. *Grades of students based on the points accumulated during the course activities*

Points	**Grade (number)**	**Grade (Letter)**
91 – 100	10	A
81 – 90	**9**	B
71 – 80	8	C
61 – 70	7	D
51 – 60	6	E
1 – 50	5	FX

Therefore, the maximum grade they can achieve is no higher than nine, since passing grades according to the Bologna system range from six to ten, as shown in Table 4.

The manual system of record-keeping was not only a laborious task but also frustrating for professors and assistants to compile attendance records for each student, especially when the number of students per professor or assistant exceeded hundreds. Determining the percentage of students present in lectures and exercises was particularly difficult. With the introduction of SMES, this problem has been completely eliminated. The digital platform allows generating student lists in Excel spreadsheet format for each class session throughout the semester. Additionally, with minimal effort, data in Excel tables can be filtered, sorted, or separated based on dates, days, months, or six-month periods, providing the necessary information for professors.

Another positive effect of this digital system is the increased attendance rate of students in lectures and exercises. By using IoT, specifically Wi-Fi in this digital system, multiple connections and distances, which may reach tens of meters for the hardware components, especially the RFID components, are avoided. These components are placed at the entrances of each lecture hall distributed across the university's facilities [24]. In fact, SMES can be expanded, enhanced, or edited to achieve better performance and effects that have not been utilized until now. Therefore, a scientific paper like this will help future researchers develop even more advanced intelligent systems.

4. Conclusions

This innovative and scientific work, based on hardware and software utilizing IoT, in fact represents an Artificial Intelligence system for managing student attendance in the educational process at "Kadri Zeka" University in Gjilan, Republic of Kosovo. SMES enables the following:

1. Reducing the time spent recording student attendance in lectures or exercises according to the courses in the university's faculties.
2. Increasing the valuable time of lecturers during teaching hours in university courses.
3. Simplifying attendance tracking by excluding the traditional method of handwritten notes on paper.
4. Generating reports for professors and assistants regarding the teaching hours and student attendance.
5. For each lecture during the respective semester, generating student attendance in the form of electronic sheets in Microsoft Excel and creating easy options for printing and further processing.
6. Adding RFID devices to the system for new classrooms and simultaneously adding students, professors, and assistants whenever the need arises.
7. Modifying or even removing students, professors, and assistants whenever necessary.
8. Ultimately, digitizing the tracking of student attendance in lectures and exercises.
9. Electronic confirmation of the lecturers' and assistants' teaching hours for the needs of university management, especially for the finance department.
10. Creating an intelligent system that embodies Artificial Intelligence.

Author Statements:

- **Ethical approval:** The conducted research is not related to either human or animal use.
- **Conflict of interest:** The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper

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- **Data availability statement:** The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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