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# Design and implementation of a system for student evaluation and attendance in labs using Arduino Nano

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**ABSTRACT**

The process of evaluating and recording student attendance in the classroom is the basis for giving the final evaluation of the student. Paper methods of recording student attendance and evaluating their performance suffer from problems such as inaccuracy, wasting time, and difficulty in obtaining reports when needed. The research provides a solution to the problems of these systems using Arduino Nano to build a system for evaluating and recording student attendance, where the laboratory teacher gives each student a grade for each project from 1, 2 .. 10, and these grades are stored in a text file that is accessed via Excel, and the time and date of the evaluation are saved, and the student is given (0) if he did not attend the laboratory. The system reduces the time of recording student grades and attendance manually, complies with academic accreditation requirements, provides access to real-time information, reduces administrative burden, facilitates obtaining final evaluation reports for students, facilitates obtaining student attendance statistics, accuracy of entered data, and reduces human errors. The research aims to eliminate paper systems in student assessment and attendance recording and move to electronic systems. The limitations of the system lie in the cost if the system is adopted on a wider scale in educational institutions, the insufficiency of the Arduino Nano memory if it is used to assess all students at all levels, as the Arduino Nano memory is not enough for the programming code, and the large number of student names.

## 1. Introduction

Technological developments and the information revolution have pushed most sectors to integrate into this digital transformation, and universities were not far from it. This transformation has allowed universities to implement smart and flexible digital strategies to enhance the quality of educational services and improve academic results to meet contemporary technological challenges and the requirements of sustainable development [1][2][3].

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The electronic student evaluation system is a new student evaluation system that has been developed in many educational institutions. This system was developed to reduce the problems that prevailed in the traditional evaluation method, which required a lot of effort and time, as well as being prone to human errors, which led to inaccurate results. The data or information is stored in a specific database where analytical reports are issued for the operations carried out on that data. Thus, this reduces errors as the evaluation is done automatically without manual work, which enhances efficiency by reducing the time lecturers spend evaluating student performance. The system includes an analytical tool for grades and student performance in relation to academic years, and is therefore best suited for making better academic decisions. Another advantage of the electronic system is related to academic accreditation; as the system meets the standards required by academic accreditation bodies. The system also ensures easy access to information and facilitates updating it in order to prepare accurate reports and improve the decision-making process to improve the educational reality [4].

Attendance plays an important role in universities and educational institutions in general. According to the traditional method, the lecturers keep a paper copy of the attendance lists and records the attendance on this paper, then another employee enters the data into the electronic system, calculates the percentages, and prepares reports based on it. The main disadvantage of this method is the great effort required to enter attendance, calculate the percentages, and generate reports, in addition to the possibility of errors. Developing a student attendance system based on information technology and software solves these problems as it saves time and effort in addition to the high accuracy of the results [5].

## 2. Literature Review

Various electronic systems have been proposed for student assessment and attendance systems. The following are the most cited works and studies on the subject of the study. An automated attendance and performance assessment system for students, designed by Nidhi Malhotra (2018) is based on RFID technology with wireless connectivity using Wi-Fi and GSM networks to help in recording student attendance as compared to tedious and time-consuming manual methods. The system suffers from problems related to high hardware maintenance costs and the system may also fail if it cannot provide constant internet connectivity [6]. Muhammad Asaf Uddowla Golap et al. (2019) proposed a comprehensive system based on integrated fuzzy logic for student performance assessment. In this system, student performance assessment is recorded by identifying attendance, hours spent in class, in-class test marks and final exam grades. The drawbacks of the system are that the assessment process is complex and requires computational resources. This hinders the widespread adoption of the system across many educational institutions [7].

An automated student attendance monitoring system was developed by Prashanth Addagatla (2019) using RFID technology connected to GSM network and sending messages to parents about the students' attendance. The RFID reader will read the tag and pass it to Arduino which compares it with the database and then displays the student's attendance status on LCD screen. The system then sends a message to the parents of the students. The system has proven to be efficient and easy to use but it has some limitations like cost of sending messages and also short detection distance of less than 5 cm where the student has to move the tag very slowly in front of the reader to confirm his/her attendance and any other student can check the attendance of another student by just holding that student's tag[8]. An intelligent system for managing and recording student attendance in boarding schools was developed by Matthew Koh Kah Wen et al. (2020) using RFID technology with an Arduino Mega 2560 and an LCD screen. The data is then stored in XAMPP database. Signal interference may occur when multiple RFID cards are read simultaneously when using the system, which is a potential problem because the system will lose data. This problem can be solved by using anti-collision algorithms [9]. Nesma Abd el-Mawla et al. (2022) developed a smart attendance system using facial recognition, fingerprint and QR code technology, which provides a safe and effective way to record attendance and absence in educational institutions as well as in companies during the COVID-19 situation. An Android application was used along with a database. The system is programmed using Java language in addition to using Internet of Things (IoT) technology with GPS (Global Positioning System) location. Student attendance is determined via mobile phone. The

system has proven its speed and accuracy when compared to the traditional method. The limitations faced by the system are provision of smart devices in addition to the possibility of access to the Internet connection permanently [10]. The web-based performance evaluation system, designed by Gauri Prakash Jadhav et al. (2022) . HTML, CSS, JavaScript, PHP, and MySQL were used in the implementation of the system. The system provided ideal results with minimal error and more accuracy; however, the problem with the system is that the system must be always connected to the Internet [11]. Nuha Al-Ruwais et al. (2023) The researchers developed a model to classify students based on their level of knowledge and identify potential factors that may affect their performance and the model was based on machine learning. Finally, the researchers selected seven classification algorithms, namely support vector machines (SVM), logistic regression (LR), random forest (RF), decision tree (DT), gradient boosting machine (GBM), Gaussian naive Bayes algorithm (GNB), and multilayer perceptron (MLP). The researchers reported that in this study, the GBM algorithm showed the highest accuracy [12]. Ameera Sheikh et al. (2023)improved the old student assessment process at LR Tiwari College of Engineering which relied on manual data entry and Excel spreadsheets through a web application using MySQL and PHP database. However, the system faced problems with large files, which could cause delays in the system, and accuracy would require regular data updates; hence, it was not ideal [4].

## 3. Proposed Methodology

The basic requirements for designing and implementing the proposed system can be divided into two main sections:

### 3.1. Hardware

#### 3.1.1. Arduino Nano

Arduino Nano is an integrated development board with an ATmega328 processor and a clock frequency of 20 MHz, and is ideal for embedded projects. Its compact design, low cost, low power consumption, and ease of programming make it suitable for small projects, so it is a suitable platform for complex educational and embedded systems. [13].

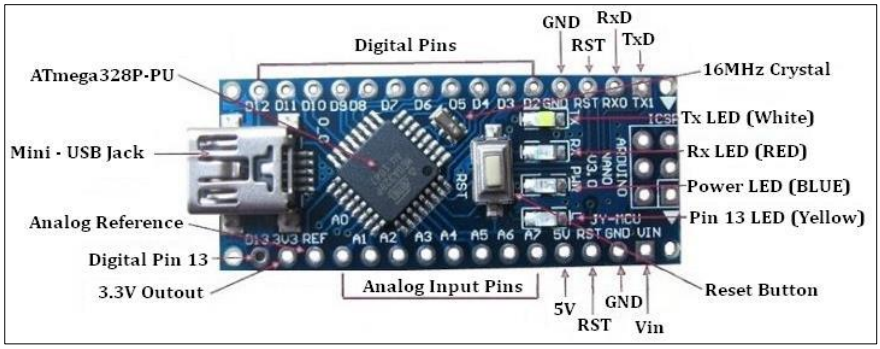



**Fig.1.** Arduino Nano [13]

#### 3.1.2. Liquid Crystal Display (LCD)

Liquid Crystal Display (LCD) is an essential component in electronic projects, allowing users to display data clearly. Arduino connects to LCD through a bidirectional link, enhancing user and system interaction the programming was done with the library LiquidCrystal_I2C, and a screen of size 16x2 was used [13][14].

**Fig.2.** LCD Display [13]

### 3.1.3. The Real-Time Clock (RTC)

A real time clock (RTC) is a device that specifies time and date in any electronic system or microcontroller such as Arduino. It can specify time and date in seconds, minutes, hours, days of the week, days of the week, as well as in month and year format. It also has the ability to specify leap year. It is most widely used in time-based data logging systems and industrial automation applications worldwide [15][16].

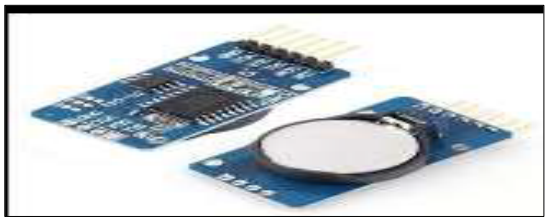


**Fig.3.** RTC [15]

### 3.1.4. Micro SD Card Adapter

It is a simple device that reads small memory cards like micro SD (Secure Digital) and micro SDHC (Secure Digital High Capacity) using the SPI (Serial Peripheral Interface). It uses basic pins like (chip select), SCK (Serial Clock), MOSI (Master Out Slave In), MISO (Master in Slave Out), VCC (Voltage at the Common Collector) and GND (Ground) for power pins. This fast data transfer device is ideal for reliable and portable storage applications due to its small size [17][18].

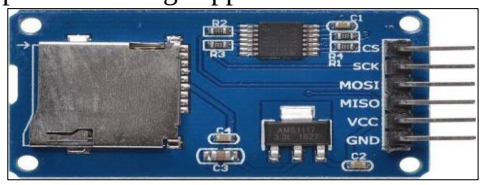



**Fig.4.** Micro SD Card Adapter [17]

### 3.1.5. Buttons

The system uses buttons to select the group to be evaluated, select students, and enter evaluation grades These buttons facilitate interaction between the user and the system in a more easy, flexible, and fast way, allowing for easy selection of the group, name, and entry of grades.

## 3.2. Software

The Arduino Nano board is programmed using the Arduino IDE in C/C++, and the data stored in a text file is exported to Excel for efficient data management to generate attendance reports for students by day and month, as well as final reports of students' final grades at the end of the semester. The SD card stores the data, and libraries dedicated to programming Arduino and other devices make programming easier and more efficient. Several libraries have been used in the system, including the

SPI.h library, SD.h library, EEPROM.h library, Wire.h library, DS3231.h library, and LCD I2C library, which reduces programming errors and saves time and effort in programming the system.

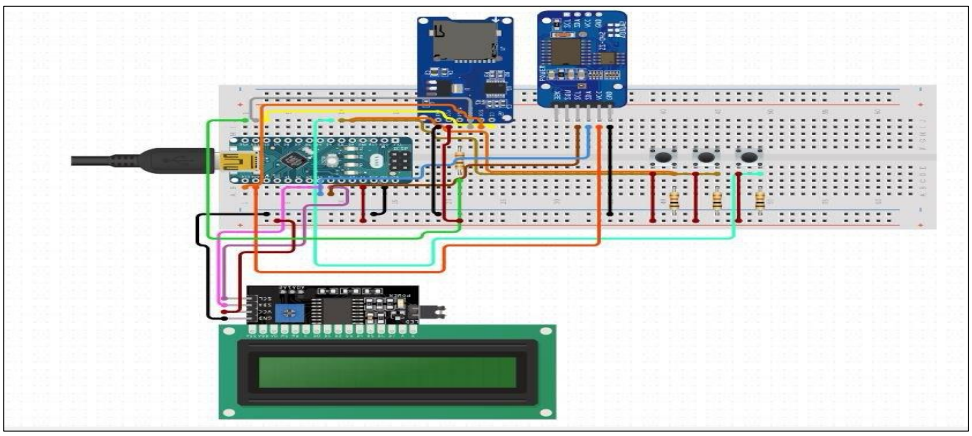
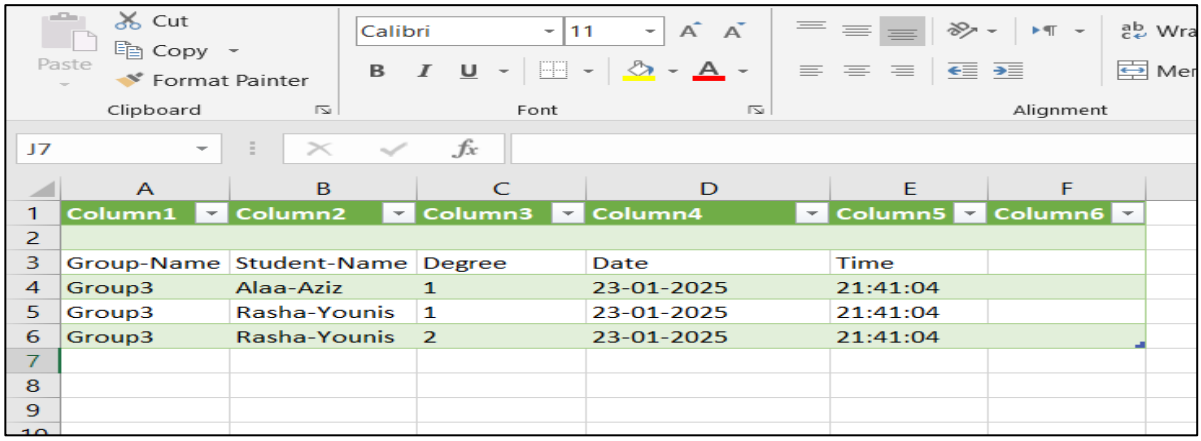


**Fig. 5.** Breadboard Circuit Design of The Proposed System

### 3.3. Implementation of the proposed system

When implementing the proposed system, the fourth morning stage was chosen in the College of Computer Science and Mathematics / Department of Computer Science at the University of Mosul for the purpose of applying the system to it. The fourth stage was divided into four groups and the total number of students in this stage was (67 students).



| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | Column1 | Column2 | Column3 | Column4 | Column5 | Column6 |
| 2 | | | | | | |
| 3 | Group-Name | Student-Name | Degree | Date | Time | |
| 4 | Group3 | Alaa-Aziz | 1 | 23-01-2025 | 21:41:04 | |
| 5 | Group3 | Rasha-Younis | 1 | 23-01-2025 | 21:41:04 | |
| 6 | Group3 | Rasha-Younis | 2 | 23-01-2025 | 21:41:04 | |
| 7 | | | | | | |
| 8 | | | | | | |
| 9 | | | | | | |

**Fig.6.** Output of the proposed system implementation

## 4. Mechanism of operation of the proposed system

When the system is running, a message will appear on the screen that the micro SD card is ready. The lecturer will enter his code to start the evaluation process for his students. Then he will choose the academic stage and the section that he is evaluating, he will choose the student to be evaluated. Then he will assign the student's grade from 1 to 10. The student will be recorded as present. If he gives him zero, the student will be recorded as absent. If the lecturer does not complete the evaluation process for all students, the system will revert to selecting the student. If the lecturer completes the evaluation process, the student's data will be stored on the SD card in a text file that can be exported later to the Excel program, through which reports on student attendance can be issued in addition to calculating the student's final grade at the end of the semester. Then this data is stored on the computer. figure (6) explain how proposed system work

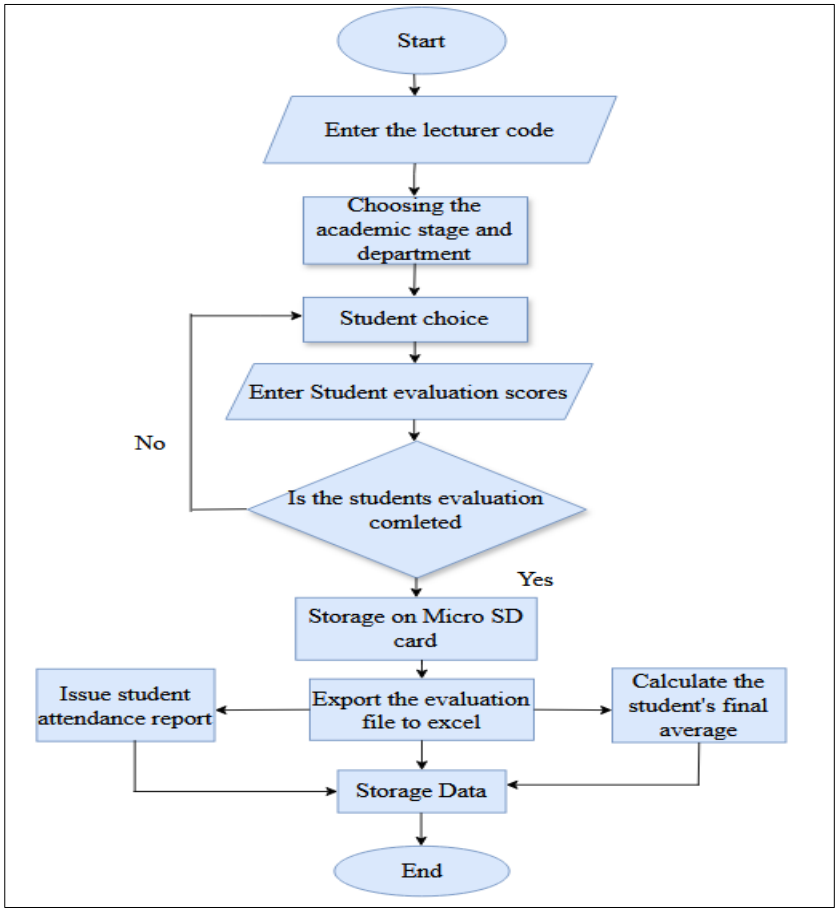



**Fig.7.** The Proposed System

## 5. Proposed system contribution

Through this prototype of the electronic student assessment and attendance system, and the application of modern technology frameworks such as Arduino with innovative ideas, the system has shown improvements in operational efficiency, accuracy and data management. The design integrates the student performance assessment and attendance tracking systems. There are several advantages that make this system better than the existing traditional manual methods. The following are the main points that present the results of the proposed system:

1. Improved operational efficiency in terms of documenting assessment and attendance: The proposed system reduced the time required to enter and record students' grades and attendance compared to using paper methods and manual calculations in traditional methods of entering, assigning, storing and updating grades in real time. This makes the assessment process fast and efficient.

2. Accuracy of data entered without human errors: There are many traditional techniques by which assessments and attendance records are recorded that may allow errors to occur through human interaction with the system. The proposed system overcomes this shortcoming by fully automating the data entry process so that a high level of accuracy is ensured in maintaining students' grades and attendance. This provides strong support to students who participated in the laboratory lecturer and gives zero marks to those who were absent. In addition, the assessment date is entered with the exact time each assessment was conducted. This reduces additional errors that may be related to how data is entered manually.

3. Access to information at any time: The main advantage of the proposed system is access to information at any time we need to access it. The system keeps records of grades and attendance in a text file format stored on the SD card that can be easily imported into Excel spreadsheets, making it easy for lecturers or even administrators to access the data at any time.

4. Reduce administrative burden: The automation involved in assessment and attendance tracking processes greatly reduces the administrative burden that usually falls on lecture and other university administrators. Lecturer do not need to manually record each student's attendance or calculate individual grades, which is time-consuming in teaching activities and providing constructive feedback to students.

5. Compliance with accreditation requirements: The system is supposed to comply with all requirements set by accreditation bodies to provide accurate and rigorous information on student performance and attendance. This information can be applied to meet quality standards, prepare reports for accreditation, provide verification of the institution's performance, and ensure that this information is easily updated and accessible, ensuring that the educational institution complies with accreditation standards and enhances its educational practices.

6. Ease of preparing reports: Calculating the final grade with less effort and more accuracy, which is calculated by adding several different values that may include laboratory implementation grades, daily exam grades, semester exam grades, laboratory attendance rate... where the student's final result can be calculated easily and more accurately, in addition to the ease and speed of obtaining statistical reports on student attendance in the laboratory using Excel tables on the values that were recorded in the system. This information will at least help lecturers and administrators in colleges to monitor performance indicators and develop strategies aimed at improving educational outcomes.

7. Limitations of the proposed system: The limits of the proposed system lie in the cost of the devices used in the event that the system is adopted more widely in educational institutions, as each lecturers is required to obtain his own device, which may constitute a financial burden in addition to the maintenance cost in the event that one of these devices breaks down, in addition to the insufficient memory size of the Arduino Nano in the event that it is used to evaluate all students at all levels, as the Arduino Nano memory is not sufficient for the programming code in addition to the relatively large number of student names.

## 6. Conclusion

The proposed system in this paper is to develop an automation system for evaluating students' performance and attendance, which will help in digitizing Iraqi universities by integrating hardware and software applications (Arduino) for automation in evaluation and attendance. The system addresses the basic problems of manual systems, whether related to wasting time, high levels of errors, or inefficiency. By automating the process of recording evaluations and attendance, the time of lecturers and administrators will be saved, and information related to students will be very accurate. The proposed system provides an effective strategy towards achieving automation in student evaluation and attendance management with the aim of transforming Iraqi universities to adopt electronic systems in addition to improving the quality of academic services in general. These technological developments will contribute to enhancing the position of universities in facing the challenges of digital development, as well as achieving sustainability goals, achieving academic excellence, and enhancing the institutional identity of universities.

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# تصميم وتنفيذ نظام لتقييم الطلبة وحضورهم في المختبرات باستخدام اردوينو نانو

**سرى حسن فالح ، ياسين حكمت اسماعيل***

جامعة الموصل, كلية علوم الحاسوب و الرياضيات, قسم علوم الحاسوب.

**معلومات البحث**

الاستلام 8 كانون الثاني 2025
المراجعة 12 شباط 2025
القبول 12 شباط 2025
النشر 31 حزيران 2025

**الكلمات المفتاحية**

نظام تقييم الطلاب، نظام حضور الطلاب، أردوينو نانو

**الملخص**

تعتبر عملية تقييم وتسجيل حضور الطلبة في الفصول الدراسية هي الأساس لإعطاء التقييم النهائي للطالب، وتعاني الطرق الورقية لتسجيل حضور الطلبة وتقييم أدائهم من مشاكل مثل عدم الدقة وإضاعة الوقت وصعوبة الحصول على التقارير عند الحاجة إليها، ويقدم البحث حلاً لمشاكل هذه الأنظمة باستخدام أردوينو نانو لبناء نظام لتقييم وتسجيل حضور الطلبة، حيث يعطي مدرس المختبر لكل طالب درجة لكل مشروع من 1، 2 .. 10، ويتم تخزين هذه الدرجات في ملف نصي يتم الوصول إليه عبر برنامج إكسل، ويتم حفظ وقت وتاريخ التقييم، ويعطى الطالب (0) إذا لم يحضر إلى المختبر، ويقلل النظام من وقت تسجيل درجات الطلبة وحضورهم يدويًا، ويتوافق مع متطلبات الاعتماد الأكاديمي، ويوفر إمكانية الوصول إلى المعلومات في الوقت الفعلي، ويقلل العبء الإداري، ويسهل الحصول على تقارير التقييم النهائية للطلبة، ويسهل الحصول على إحصائيات حضور الطلاب، ودقة البيانات المدخلة، ويقلل من الأخطاء البشرية، ويهدف البحث إلى التخلص من الأنظمة الورقية في تقييم الطلاب وتسجيل الحضور والانتقال إلى الأنظمة الإلكترونية .وتكمن حدود النظام في التكلفة إذا تم اعتماد النظام على نطاق أوسع في المؤسسات التعليمية، وعدم كفاية ذاكرة Arduino Nano إذا تم استخدامه لتقييم جميع الطلبة على جميع المستويات، حيث أن ذاكرة Arduino Nano لا تكفي لكود البرمجة، والعدد الكبير من أسماء الطلبة.

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