Journal of Advanced Research in Embedded System
Volume 11, Print Issue 2 - 2024, Pg. No. 22-27
Peer Reviewed Journal

Review Article

RFID Based Attendance Management System

Kevin A Anand Raj[1], Naresh Kannan V[2], Prithive S[3], Sriram R[4]

[1,2,3,4]UG Student, Department of EEE, Karpagam College of Engineering, Myleripalayam, Coimbatore,Tamilnadu.

I N F O

Corresponding Author:
Kevin A Anand Raj, Department of EEE, Karpagam College of Engineering, Myleripalayam, Coimbatore,Tamilnadu.
E-mail Id:
kevinanand2004@gmail.com
Orcid Id:
http://orcid.org/0009-0002-5273-5220
How to cite this article:
Raj K A A, K V Naresh, Prithive S, Sriram R. RFID Based Attendance Management System. *J Adv Res Embed Sys* 2024; 11(2): 22-27.

Date of Submission: 2024-09-01
Date of Acceptance: 2024-10-13

A B S T R A C T

This article presents the design and implementation of an RFID-based Attendance Management System utilizing the ESP8266 Wi-Fi module. Unlike traditional attendance methods, this system automates the process of recording and managing attendance in educational institutions or workplaces, enhancing accuracy, efficiency, and reliability. Each user is issued a unique RFID card that, upon scanning, communicates the card information to the ESP8266 microcontroller. The ESP8266, with its integrated Wi-Fi capabilities, processes the data and sends it in real-time to a centralized server. This server, managed by a web application, logs the attendance details and maintains a comprehensive database accessible through a user-friendly interface. The system offers a scalable, secure, and cost-effective solution, leveraging the ESP8266's connectivity and processing power for seamless integration with existing IT infrastructure. It provides a robust platform for future enhancements, such as integration with biometric systems or mobile applications. Demonstrating the potential of IoT applications, this project streamlines administrative tasks, reduces manual effort, and minimizes errors in attendance tracking, underscoring the viability of RFID and Wi-Fi technologies in creating smart, connected solutions for modern institutions.

Keywords: RFID, Attendance Management, ESP8266, Wi-Fi, IoT, Automation, Educational Institutions, Workplace Efficiency

Introduction

In contemporary educational and professional environments, efficient and accurate attendance management is crucial for operational success and accountability. Traditional methods, such as manual roll calls or sign-in sheets, are not only time-consuming but also prone to errors and manipulation. To address these challenges, technological advancements offer innovative solutions, among which Radio Frequency Identification (RFID) stands out as a promising approach. This report introduces an RFID-based Attendance Management System developed using the ESP8266 Wi-Fi module, with data collection and management facilitated through the Thing Speak platform. The system aims to streamline the process of recording and managing attendance by automating data capture and transmission, thus reducing manual intervention and the potential for inaccuracies. RFID technology employs electromagnetic fields to automatically identify and track tags attached to objects.[1]

In the context of attendance management, each individual is provided with an RFID card containing a unique identifier. When the card is scanned by an RFID reader, the information is transmitted to the ESP8266 microcontroller. The ESP8266, renowned for its low cost and robust Wi-Fi capabilities, processes the scanned data and communicates with ThingSpeak to log attendance records in real-time. Thing Speak is an IoT analytics platform that enables the collection, visualization, and analysis of live data streams in the cloud. The integration of Thing Speak with the ESP8266 enhances the system's connec-

tivity, allowing for real-time data synchronization and remote monitoring. This connectivity is pivotal in creating a seamless and efficient attendance management system that can be accessed and managed from anywhere with an internet connection.

Proposed System

The power supply is the initial component in the system, providing the necessary electrical power to the entire setup. It ensures that the ESP8266 microcontroller and all connected devices receive a stable and adequate voltage for their operation. A reliable power supply is crucial for the consistent and uninterrupted functioning of the system.

The RFID module, connected to the ESP8266, serves as the reader for RFID tags or cards. Each tag or card contains a unique identifier (UID) that corresponds to an individual, such as a student or an employee. When an RFID tag is brought near the RFID reader, it reads the UID and transmits this information to the ESP8266 microcontroller. This process is fundamental to the attendance tracking mechanism, as it allows for the identification of individuals entering or leaving a designated area.

An LCD display is connected to the ESP8266, providing a visual interface for users. When an RFID tag is scanned, the corresponding information, such as the individual's name or ID number, is displayed on the LCD. This immediate feedback is useful for confirming successful scans and for monitoring purposes.

The system includes an IoT module that enables connectivity to the internet, allowing data to be sent to a cloud-based platform such as ThingSpeak. This connection is crucial for real-time data logging and remote monitoring. When the ESP8266 processes an RFID scan, it can send the attendance data to ThingSpeak, an IoT analytics platform. This platform stores the data and can generate reports, visualizations, and alerts based on the attendance records, providing valuable insights and easy access to attendance data from anywhere with an internet connection.

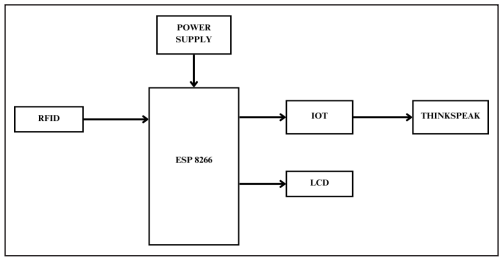

Figure 1.Block Diagram

Components NodeMCU ESP8266

The NodeMCU ESP8266 integrates various

functionalities, including GPIO, PWM, I2C, 1-Wire, and ADC, into a single board. The NodeMCU features firmware that runs on the ESP8266 Wi-Fi SoC from Espressif Systems, and its hardware is based on the ESP-12 module. Key features of the NodeMCU ESP8266 include 802.11 b/g/n Wi-Fi connectivity, multiple GPIO pins for interfacing with sensors and peripherals, PWM for controlling devices like LEDs and motors, and an ADC for reading analog sensors. It supports communication protocols such as I2C, SPI, and UART.

RFID Reader Module

The RFID reader module is a crucial component for identifying and tracking tags attached to objects, operating typically at frequencies of 125 kHz or 13.56 MHz. It features a read range from a few centimeters to several meters and supports communication protocols like UART, SPI, and I2C for interfacing with microcontrollers such as the NodeMCU ESP8266. The module's ability to wirelessly read data from RFID tags makes it indispensable in security, inventory management, and various automated systems.

RFID Card

An RFID (Radio Frequency Identification) card is a contactless smart card that contains an embedded RFID chip and antenna, designed to wirelessly transmit data to an RFID reader. Operating typically at frequencies such as 125 kHz or 13.56 MHz. When an RFID card is brought near an RFID reader, the reader's electromagnetic field activates the card, allowing it to transmit its stored data.

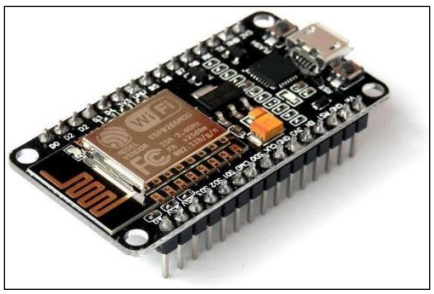

Figure 2.NodeMCU ESP8266

Figure 3.RFID Reader Module

16x2 LCD

An electronic display module named LCD screen uses liquid crystal to produce the dot and further that turns into an image. The 16*2 LCD is a very basic module commonly

used in DIYs and circuits. The 16*2 translates the display of 16 characters per line in 2 such lines. There is a 5*7-pixel matrix in each character of the LCD. There are two registers in a 16*2 LCD, namely, command and data. To switch from one register to another register, select is used. Command register RS = 0, whereas data register RS = 1.

PCF8574

The PCF8574 is a popular integrated circuit commonly used as an I/O expander for microcontroller-based systems. Manufactured by Texas Instruments, this IC allows users to expand the number of digital input/output pins available to a microcontroller via the I2C serial communication protocol. With 8-bit parallel input/output ports, the PCF8574 simplifies interfacing between microcontrollers and peripheral devices such as sensors, switches, and LEDs, enabling more efficient and flexible circuit designs. Its simplicity, low cost, and ease of use make it a versatile choice for various embedded systems applications, from robotics to home automation.

L7805

The L7805 is a widely used linear voltage regulator integrated circuit produced by various manufacturers, including STMicroelectronics. Operating as a fixed 3-terminal device, the L7805 is designed to provide a stable, regulated output voltage of 5 volts from an unregulated input voltage source. With a maximum input voltage of typically around 35 volts, the L7805 is capable of supplying up to 1 ampere of current, making it suitable for a variety of low- to medium-power applications.

Figure 4. RFID Card

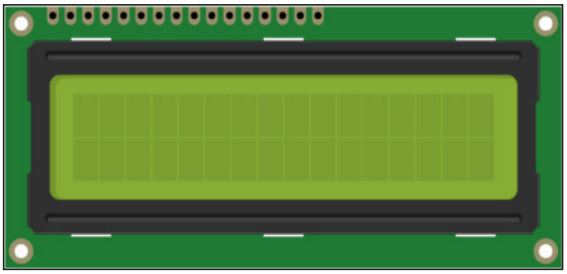

Figure 5. 16x2 LCD

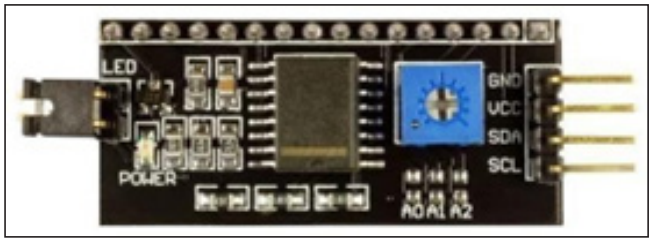

Figure 6. PCF8574

Figure 7. L7805

Design and Implementation

This circuit diagram illustrates an RFID-based attendance management system featuring a NodeMCU (ESP8266), a PCF8574 I/O expander, and an LCD display. The NodeMCU acts as the central controller, interfacing with the PCF8574, which expands its I/O capabilities. The LCD display is connected to the PCF8574, allowing for data to be displayed without using too many GPIO pins on the NodeMCU.

The connections are as follows: the SDA and SCL pins of the PCF8574 (pins 15 and 14, respectively) are connected to the corresponding SDA and SCL pins on the NodeMCU to facilitate I2C communication. Multiple resistors (10k) are used for pull-up purposes on these I2C lines. The PCF8574's various P0-P7 pins are connected to the data pins (D4-D7) and control pins (RS, RW, EN) of the LCD to control the display. A 330-ohm resistor is connected in series with the backlight of the LCD to limit current.

Additionally, the RFID reader is connected to the NodeMCU, though specific connections are not shown in this portion of the diagram. The LCD is powered by the NodeMCU, with the VDD pin of the LCD connected to a 5V supply and the VSS pin connected to ground. The VEE pin of the LCD, which controls the contrast, is connected to a 10k potentiometer to allow for adjustable contrast. This setup enables the system to read RFID tags and display the corresponding information on the LCD, which is managed and processed by the NodeMCU through the I/O expander.

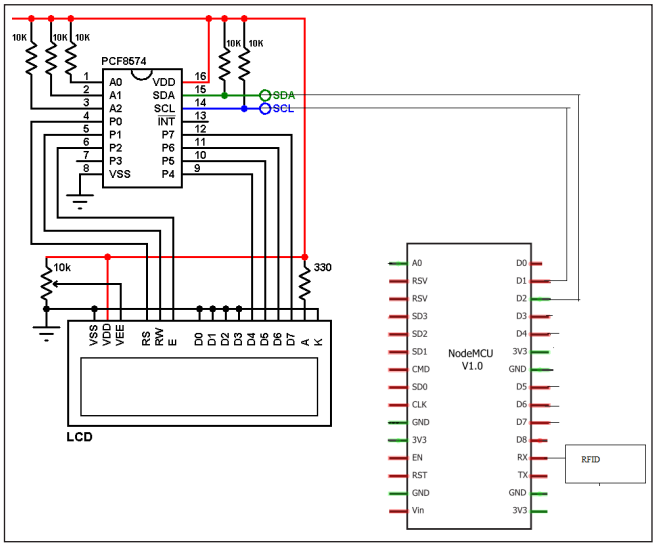

Figure 8. Circuit Diagram

Simulation

The NodeMCU, serving as the central processing unit, processes the received RFID data. The NodeMCU is connected to a PCF8574 I/O expander via the I2C communication protocol. This expander effectively increases the number of GPIO pins available for controlling additional components, such as the LCD display.

The LCD display is used to show information such as the RFID tag ID, the status of the read operation (e.g., "Tag Read Successfully"), and possibly the user's name if the tag ID is matched with a pre-stored list in the system. The data pins (D4-D7) and control pins (RS, RW, EN) of the LCD are connected to the corresponding pins on the PCF8574, allowing the NodeMCU to manage the display output efficiently. A 330-ohm resistor is placed in series with the backlight of the LCD to limit the current and protect the backlight.

A 10k potentiometer is used to adjust the contrast of the LCD, ensuring that the display is readable under various lighting conditions. When the RFID tag is read, the NodeMCU processes the information and sends the appropriate commands to the PCF8574, which then drives the LCD to display the relevant data.

The result of this system is a user-friendly interface for tracking attendance. When a valid RFID tag is detected, the LCD displays a message confirming the successful read and any associated user information. This setup is particularly useful in environments like schools, offices, or events where monitoring attendance is crucial. The NodeMCU can also be programmed to log the attendance data to a remote server or database, allowing for real-time attendance tracking and management.

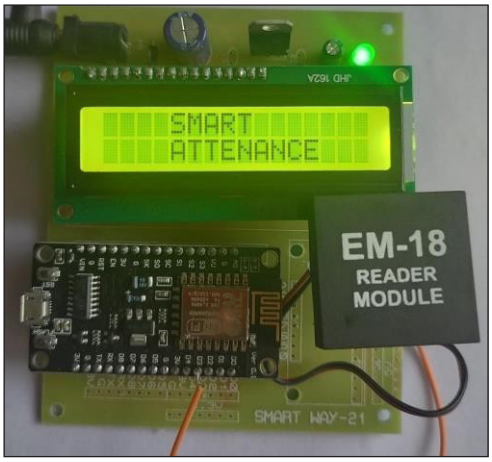

Figure 9. Working Image

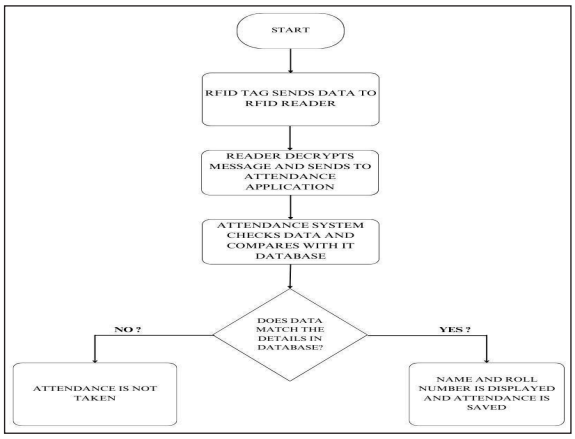

Figure 10. Working Flow

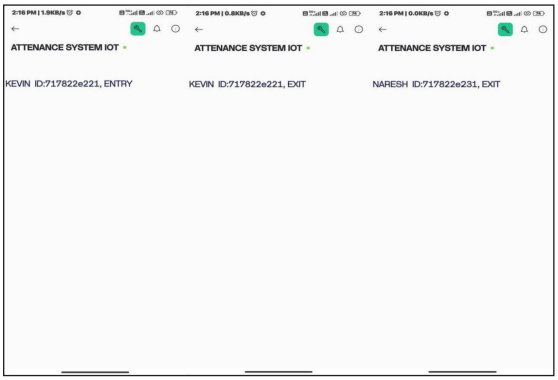

Figure 11. Blynk App Dashboard

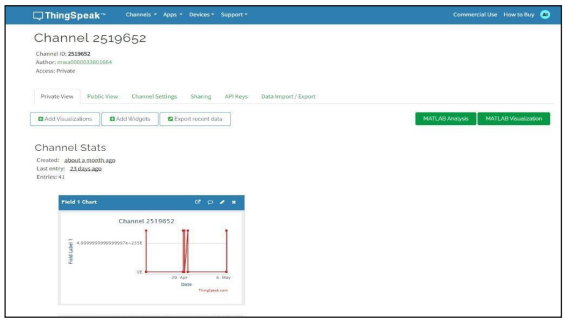

Figure 12. Thing Speak Dashboard

	A	B	C
1	created_at	entry_id	field1
2	2024-04-23 11:25:27 UTC	1	717822e221 - Kevin Anand Raj-ENTRY
3	2024-04-23 11:25:43 UTC	2	717822e231 - Naresh Kannan-ENTRY
4	2024-04-23 11:26:00 UTC	3	717822e236 - Prithive-EXIT
5	2024-04-23 11:26:59 UTC	4	717822e221 - Kevin Anand Raj-ENTRY
6	2024-04-23 11:27:21 UTC	5	717822e221 - Kevin Anand Raj-EXIT
7	2024-04-23 11:27:49 UTC	6	717822e248Â -Â Sriram-EXIT
8	2024-04-23 11:28:09 UTC	7	717822e236 - Prithive-ENTRY
9	2024-04-23 11:28:29 UTC	8	717822e236 - Prithive-EXIT
10	2024-04-23 11:28:48 UTC	9	717822e231 - Naresh Kannan-ENTRY
11	2024-04-23 11:47:07 UTC	10	717822e236 - Prithive-ENTRY
12	2024-04-29 09:22:58 UTC	11	717822e231 - Naresh Kannan-ENTRY
13	2024-04-29 09:23:20 UTC	12	717822e248Â -Â Sriram-ENTRY
14	2024-04-29 09:24:06 UTC	13	717822e221 - Kevin Anand Raj-EXIT
15	2024-04-29 09:31:20 UTC	14	717822e231 - Naresh Kannan-ENTRY
16	2024-04-29 09:31:38 UTC	15	717822e221 - Kevin Anand Raj-EXIT
17	2024-04-29 09:39:39 UTC	16	717822e231 - Naresh Kannan-ENTRY
18	2024-04-29 09:40:03 UTC	17	717822e248Â -Â Sriram-ENTRY

Figure 13. Recorded Data

Future Scope

The RFID-based Attendance Management flexibility and ease of access. Features of the mobile app could include:

- Real-time attendance monitoring and notifications.
- Remote check-in and check-out capabilities for off-site
- Access to attendance reports and analytics on the

System utilizing the ESP8266 and ThingSpeak platform demonstrates a robust and efficient solution for managing attendance. However, there are several avenues for enhancement and expansion to further improve its capabilities and applications. The following outlines potential future developments:

Integration with Biometric Systems

Combining RFID with biometric verification (such as fingerprint or facial recognition) can significantly enhance security and ensure that the individual scanning the RFID card is the authorized user. This dual-factor authentication can prevent proxy attendance and improve overall system integrity.

Mobile Application Development

Developing a mobile application can provide users and administrators with greater notifications.

- Remote check-in and check-out capabilities for off-site locations.
- Access to attendance reports and analytics on the go.

Enhanced Data Analytics

Incorporating advanced data analytics and machine learning algorithms can offer deeper insights into attendance patterns and trends. Predictive analytics could help identify potential attendance issues before they become problematic, and anomaly detection algorithms could flag irregularities for further investigation.

Expanded Notification Systems

Integrating the system with various messaging platforms (such as SMS, email, or push notifications) can broaden the scope of real- time alerts and notifications. This ensures that administrators and users are promptly informed of important events, such as unauthorized access attempts or unusual attendance patterns.

Geofencing Capabilities

Implementing geofencing technology can restrict attendance logging to specific geographic locations. This feature can be particularly useful in large campuses or workplaces with multiple buildings, ensuring that attendance is only recorded when individuals are within designated areas.

Cloud Platform Interoperability

Expanding the system's compatibility with other cloud platforms beyond ThingSpeak (such as AWS IoT, Azure IoT Hub, or Google Cloud IoT) can provide additional features, better scalability, and integration with other enterprise systems.

Battery-Powered Portable RFID Readers

Developing portable, battery-powered RFID readers can enhance the system's flexibility, allowing it to be used in outdoor events, field trips, or locations without stable power supplies. These portable units can sync data with the central server when reconnected to the internet.

Customization and Scalability

Providing customization options for different organizational needs (e.g., educational institutions, corporate offices, healthcare facilities) can make the system more adaptable. Additionally, improving the system's scalability to handle a larger number of users and RFID readers without performance degradation is essential for broader adoption.

Integration with Other Administrative Systems

Integrating the attendance system with other administrative and human resource systems can streamline operations. For instance, syncing attendance data with payroll systems can automate salary calculations based on attendance records, thereby reducing administrative workload.

Energy-Efficient Hardware Improvements

Optimizing the power consumption of the ESP8266 and other components can enhance the system's efficiency, especially for battery- operated or solar-powered deployments. This can be particularly beneficial in remote or resource-constrained environments.

The future scope of the RFID-based Attendance Management System is vast, with numerous opportunities for technological enhancements and expanded functionalities. These developments can make the system more versatile, secure, and user-friendly, ultimately contributing to more efficient and effective attendance management across various sectors.

Algorithm

Initialize libraries and define constants/variables

Function setup:

Begin serial communication at 9600 baud Initialize LCD and turn on backlight Initialize timer with 1-second period Display "SMART ATTENDANCE" on LCD Connect to Blynk with auth token, WiFi SSID, and password Initialize ThingSpeak client Clear LCD after 3 seconds

Function loop:
Call rfidread()

Delay for Staybility:
Run Blynk tasks

Function Action:
Increment sec counter

Function rfidread:

If RFID data available:

Read data into input array Print input for debugging

If input matches reader1 and id1state is 0: Write entry data to ThingSpeak

Display "KEVIN ENTRY" on LCD Update Blynk with entry status Clear LCD after 3 seconds Set id1state to 1

If input matches reader1 and id1state is 1: Write exit data to ThingSpeak

Display "KEVIN EXIT" on LCD Update Blynk with exit status Clear LCD after 3 seconds Set id1state to 0

Repeat above steps for reader2, reader3, reader4 with corresponding states and messages.

Conclusion

The development and implementation of the RFID-based Attendance Management System using the ESP8266 and ThingSpeak platform represent a significant advancement in attendance tracking technology. This project successfully demonstrates the potential of leveraging RFID technology and IoT capabilities to create a reliable, efficient, and scalable attendance management solution.

This project addresses the key challenges associated with traditional attendance methods, such as manual data entry errors, time consumption, and the potential for manipulation. By automating the attendance recording process, the proposed system ensures real-time data capture and provides instant synchronization with a cloud-based platform for seamless data management and analysis. The result is a robust alternative that reduces the need for manual intervention and enhances overall efficiency.

The system effectively captures and logs attendance data using RFID tags and an RFID reader, significantly reducing the manual workload. Additionally, the ESP8266 microcontroller enables real-time data transmission to the ThingSpeak platform, ensuring that attendance records are updated instantly and can be accessed and monitored in real- time.

In conclusion, the RFID-based Attendance Management System offers a modern solution to traditional attendance challenges, providing significant improvements in accuracy, efficiency, and reliability. By embracing IoT technology and cloud-based data management, this system paves the way for more intelligent and automated administrative processes. Ultimately, it contributes to better organizational management and productivity, demonstrating the transformative potential of integrating advanced technologies into everyday operations

References

1. Bharathwaj VA, Krishnan GN, Sundaram S, Harish PS, Prashanth MV, Gayathri S, Rajthilak S, Ganesh CS. RFID-Based Intelligent Security System for School Children. International Journal of Engineering and Management Research (IJEMR). 2017;7(4):337-9.
2. Vanitha V, Ganesh CS. Microcontroller Based Night Detecting and Automatic Light System. Advances in Multidisciplinary Research and Development. 2023:11.
3. Yamalov I, Faizova R, Obudenov M. Combustion engine intelligent control system based on fuzzy logic. In2020 International Conference on Electrotechnical Complexes and Systems (ICOECS) 2020 Oct 27 (pp. 1-4). IEEE.
4. Borchardt N, Hinzelmann R, Pucula DS, Heinemann W, Kasper R. Winding machine for automated production of an innovative air-gap winding for lightweight electric machines. IEEE/ASME Transactions on Mechatronics. 2016 Feb 25;21(3):1509-17.
5. Olanipekun AA, Boyinbode OK. A RFID based automatic attendance system in educational institutions of Nigeria. International Journal of Smart Home. 2015 Dec;9(12):65-74.
6. Yuvashree S, Sumathi S, Ganesh CS. Automation of hand-powered loom and fault detection using Raspberry Pi and monitoring using IOT. Journal of advanced research in embedded system. 2018;5(4):1-7.
7. Rathod H, Ware Y, Sane S, Raulo S, Pakhare V, Rizvi IA. Automated attendance system using machine learning approach. In2017 International Conference on Nascent Technologies in Engineering (ICNTE) 2017 Jan 27 (pp. 1-5). IEEE.