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Smart kindergarten classroom with the help of IoT

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ABSTRACT

With the introduction of the smartphone, life has become more convenient, leading to the emergence of a new research topic called the Internet of Things. Due to the advancement of technology, it is now common to remotely connect with your everyday interactive device using a portable device such as a Smartphone with internet access, leading to billions of devices currently benefiting from this capability. This paper describes the implementation of a system that simplifies communication within kindergarten classrooms by using automation and security measures with the assistance of the Internet of Things. The system allows individuals to remotely monitor and control certain areas of a classroom from any location. There are different methods for automating your classroom, including automatic lighting and fans, smart projectors, smart water purifiers, and more. Savings of just a few minutes each day lead to a rapid return on investment in terms of both real costs and better student results. Thanks to advanced automation and wireless technology, all the devices in the classroom can now be connected to the internet. This enhances the energy support skill, indoor safety, and cost savings for the classroom. The presence of a person in the classroom can be detected by using an IR Sensor. The sensor emits a signal and detects the signal as it bounces back from the person. The duration of the emission and reception assists the IR sensor in determining the distance between individuals.

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Introduction

This introduction establishes the basis for a project aimed at redefining how technology is utilized in preschools to create an effective and innovative learning environment. The project aims to develop a smart classroom automation system using a web server and Wi-Fi technology. The device can be turned on or off, and the sensors can be monitored using a controller via Wi-Fi technology. The term 'automation' is widely used in this platform. Using the capabilities of the Internet of Things (IoT), this project seeks to develop a smart and effective classroom system. The project includes elements like regulating the temperature, detecting presence, and automatically controlling the lighting, all working together to improve the overall teaching and learning environment. The goal of the Smart Classroom is to create a supportive, secure, and energy-efficient environment for both teachers and young learners in a preschool setting by effectively incorporating technology. This allows for an engaging and adaptable atmosphere. The goal is to target the concept of frequency division multiplexing technology. The range of Wi-Fi technology is 40-300 feet. NodeMCU, an affordable open source IoT platform, serves as the controlling tool for project automation. The Wi-Fi module connected to Node Mcu will receive the statement sent from the PC over Wi-Fi. The Node Mcu is able to interpret the statement and select the option to activate the electrical devices connected to it using Relays.

If classroom automation come to our thought, most of them may imagine about living in a smart classroom. Examples are one remote for every household device, cooking the rice automatically, starting AC automatically, heating water in geyser automatically. we can say that classroom automation is equal to smart classroom. They both bring out smart living condition and make our life more convenient, comfortable, compatible and provides security. This paper designs which entitle the end user to use the process variables on the distributed control system, remotely. In the year 2006, S. M. Anamul Haque, S. M. Kamruzzaman and Md. Ashraful Islam introduced a system entitled "A System for Smart-classroom Control of Appliances found on Time and Speech Interaction" that automates the classroom devices by using the personal computer. This system is developed by using the as programming language and Microsoft voice engine tools for speech recognition purpose. A device can be either controlled by timer or by voice command. Stanescu Ciubotaru-Petrescu, Cioarga, and Chiciudean shares a design and implementation of SMS involved control for examining the devices. Wi-Fi based home automation system Home automation systems using smartphone, NodeMCU board and Wi-Fi technology are secured and low cost. The Wi-Fi arrangement uses a PC or smart phone as receiver device. It has a high communication rate, great security and low cost, so it can be executed as a real time system. Wi-Fi network has no range limitation for smartphone, then it will be up-to command the home appliances, this is one of the major advantages of Wi-Fi based home automation system.

Method

The devices are used to automate the classes through mobile phones or personal computer. Using the internet connectivity these systems in the classes are managed with the help of IoT. Android Apps with user interface manage the devices. The project are centred around creating a smart and responsive classroom environment. First, the project aims to detect and monitor the classroom temperature effectively using the Temperature Sensor Module. This feature ensures a comfortable learning atmosphere for both teachers and students, allowing for proactive adjustments as needed. Second, the project incorporates the MQ2 Smoke LPG CO Sensor Module to detect the presence of gas or smoke within the classroom. In the event of such detection, the system is designed to send timely notifications through the Blynk application, providing a safety measure that enhances the well-being of everyone in the classroom. Another crucial goal involves the remote control of lighting within the classroom through the Blynk application. This allows teachers the convenience of managing the lighting conditions without manual intervention, contributing to energy efficiency and creating a more adaptable learning environment. Furthermore, the project strives for automation by initiating all the sensors when detecting the presence of students in the classroom using an Infrared (IR) sensor. This intelligent feature not only streamlines the operation of the sensors but also ensures that the system is activated when needed, optimizing energy usage and responsiveness based on the occupancy of the classroom.

Table 1 < Features in developing a Smart Classroom System>

Title	Service Implemented	Outcomes
Arduino with Internet of Thing (IoT)	Classroom Automation	create innovative and interactive solutions that enhance the learning experience, automate tasks, and optimize resource management.
IR Based Sensor	Temperature Sensor Module.	Ensures a comfortable learning atmosphere for both teachers and students, allowing for proactive adjustments as needed.
	MQ2 Smoke LPG CO Sensor Module	Detect the presence of gas or smoke within the classroom
Blynk application	Environmental Monitoring	A user can quickly create a dashboard to control their lights, temperature, and other devices without extensive coding experience, using drag-and-drop widgets and pre-built libraries for common sensors and actuators.

System Requirement

A comprehensive smart classroom system requires careful consideration of various technical and logistical aspects. Here's a breakdown of the system requirements, divided into functional and nonfunctional requirement including hardware, software, and infrastructure. First functional requirements for the Smart Classroom System outline the specific capabilities and features the system must possess to meet its objectives effectively. Here are key functional requirements: (1) Temperature Control. The system should be able to monitor and regulate the temperature within the classroom based on predefined settings. Users, particularly teachers, should have the capability to adjust temperature settings manually; (2) Presence Detection. Utilize sensors, such as IR sensors, to detect the presence of students in the classroom. Trigger automated actions, such as turning on lights and adjusting environmental conditions, based on the detected presence; (3) Gas/Smoke

Detection. Integrate sensors, like the MQ2 Smoke LPG CO Sensor Module, to detect the presence of gas or smoke within the classroom. Implement real-time notifications through platforms like Blynk to alert users in case of gas/smoke detection; (4) Mobile Application Integration. Develop a mobile application, possibly using Blynk, for remote monitoring and control of the smart classroom system. Ensure seamless communication between the mobile app and the central system for real-time updates and user commands; (5) Security Measures. Implement security measures, such as encryption and user authentication, to protect data and system access. Include intrusion detection and incident response mechanisms to address potential security threats.

Second nonfunctional requirements for the smart classroom pro max project focus on aspects other than specific functionalities. These requirements address qualities such as performance, reliability, and usability: (1) Performance. Response Time: The system should exhibit low latency, with a rapid response to user inputs and sensor readings; (2) Throughput: Ensure the system can handle a significant number of simultaneous users and sensor data inputs without degradation in performance; (3) Reliability. Availability: The smart classroom system should aim for high availability, minimizing downtime for critical functionalities. Fault Tolerance: Implement mechanisms to recover gracefully from faults or failures to maintain continuous operation; (4) Compatibility. Ensure compatibility with a variety of IoT devices, sensors, and communication protocols to enhance interoperability. Support compatibility with different operating systems for the mobile application, catering to both Android and iOS platforms; (5) Data Privacy. Adhere to data protection regulations and standards to ensure the privacy of user information collected by the system. Implement anonymization techniques wherever applicable to protect user identities; (6) Environmental Considerations. Design the system with energy efficiency in mind to minimize power consumption. Ensure that materials used in the hardware components are environmentally friendly and comply with relevant regulations.

Hardware and Software Requirement

Table 2 <Hardware Requirement>

Item	Picture	Description
Node MCU ESP8266		The Node MCU ESP8266 is an extensively employed development board in IoT applications, providing a versatile and cost-effective approach to connect devices to the internet. It features Wi-Fi and programming capabilities, facilitating speedy prototyping and deployment of IoT solutions.
USB Micro B		The Micro B type connector holds 5 pins to support USB OTG, which permits smartphones and other similar mobile devices to read external drives, digital cameras, or other peripherals as a computer might.
IR Sensor		An infrared sensor (IR sensor) is a radiation-sensitive optoelectronic component. IR sensors are now widely used in motion detectors, which are used in building services to switch on lamps or in alarm systems to detect strangers.
Temperature Sensor Module		NTC Thermistor temperature sensor module is low cost, small size module. It is very sensitive to ambient temperature. It is generally used to detect the temperature of the surrounding environment.
MQ2 Smoke LPG CO Sensor Module		The MQ2 Gas Sensor module detects gas leakage in home and industry. The MQ series of gas sensors use a small heater inside with an electrochemical sensor.

Item	Picture	Description
Relay module		The 2 Channels Relay Module is a convenient board which can be used to control high voltage, high current load such as motor, solenoid valves, lamps and AC load. It is designed to interface with microcontroller such as Arduino, PIC and etc.
LED strips		An LED strip light is a flexible circuit board that is populated with LEDs that you can stick almost anywhere you want to add powerful lighting in a variety of colours and brightnesses.
Arduino UNO		Arduino Uno is a microcontroller board based on the ATmega328P (datasheet). Arduino is an open hardware development board that can be used by tinkerers, hobbyists, and makers to design and build devices that interact with the real world.
Male to Female Jumper Wire		Male to female jumper wire is used for easy and convenient interconnection between components in electronic prototyping and testing projects, without the need for soldering.
Power Supply 12V		A 12VDC power supply is a device that supplies electrical energy to a load. In other words, a power supply's primary purpose is converting electric current from the source into the required voltage, frequency, and current, which powers the load.
Mini DC Motor		Small DC motors are compact electro-mechanical devices that transform direct current (DC) electrical energy into mechanical motion. They operate on the fundamental principle of electromagnetic interaction, where the interaction between magnetic fields and current-carrying conductors generates rotational motion.

Table 3 <Software Requirement>

Item	Picture	Description
Arduino IDE		Arduino Integrated Development Environment (IDE) is an opensource IDE that allows users to write code and upload it to any Arduino board. Arduino IDE is written in Java and is compatible with Windows, macOS and Linux operating systems.
Blynk IoT		Blynk is an IoT platform for iOS or Android smartphones that is used to control Arduino, Raspberry Pi and Node MCU via the Internet. This application is used to create a graphical interface or human machine interface (HMI) by compiling and providing the appropriate address on the available widgets.

Development

Building a successful smart classroom system requires a systematic and well-defined development process. This process can be broken down into several key stages:

Figure 1 <Coding>

Results and Discussion

The Smart Classroom System offers a multitude of advantages that significantly enhance the educational landscape. One of the primary benefits lies in its cost efficiency, marked by a reduction in energy consumption through features such as automated lighting and temperature control, translating to substantial cost savings for educational institutions. Furthermore, the project contributes to an enriched learning environment, fostering student focus and engagement through the automation of classroom conditions.

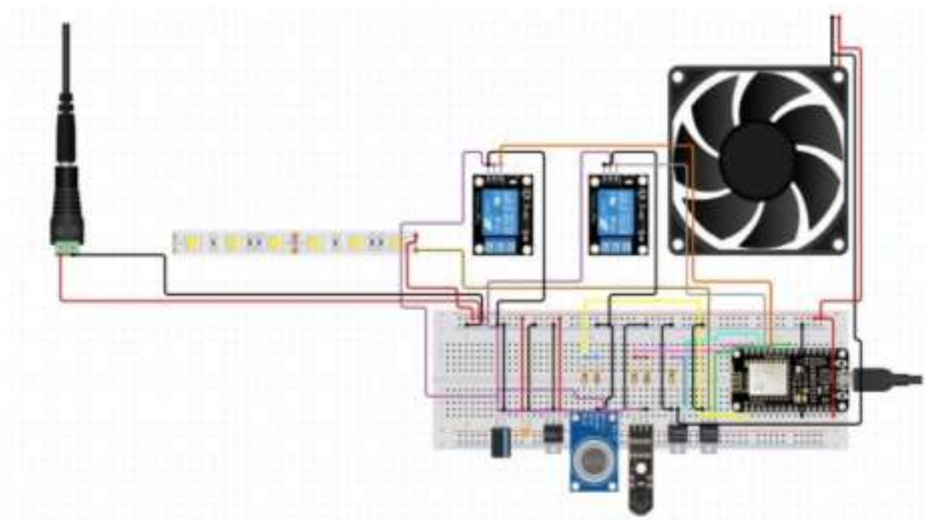

Figure 2 <Schematic Diagram>

The user-friendly interface of the Blynk application empowers teachers and staff to effortlessly monitor and control classroom settings remotely, promoting convenience and efficiency. Safety features, including sensors like the MQ2 Smoke LPG CO Sensor, enhance the overall security of the environment by promptly detecting potential hazards and triggering timely notifications. Notably, the project is tailored to meet the specific needs of preschool settings, ensuring non-disruptive operation during classroom activities and accommodating the unique schedules and routines of educational institutions. With capabilities for remote control, efficient sensor activation, and customizable automation, the Smart Classroom System stands as an innovative solution that positively impacts both the learning experience and the overall sustainability of educational spaces.

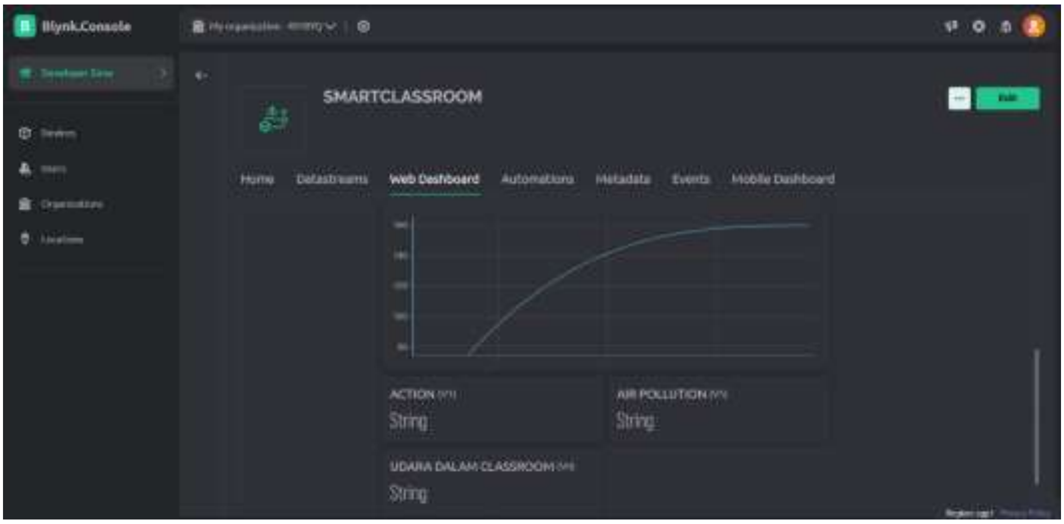

Figure 3 <Interface Blynk on Website>

Figure 4 <Interface Blynk on Phone>

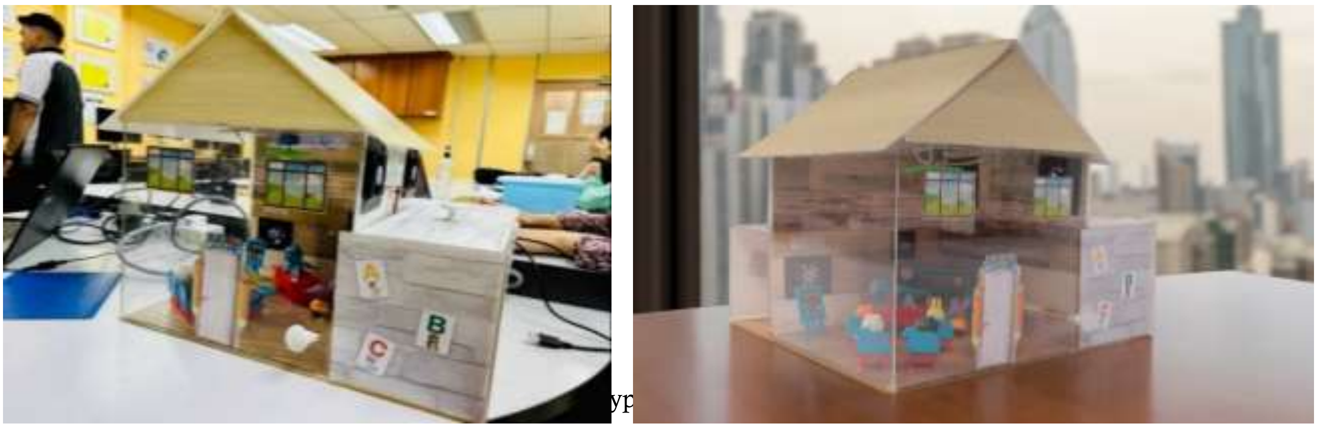

Figure 5 <Prototype>

User Testing and Feedback

The User Acceptance Test for the Smart Classroom System involves validating that the system meets the requirements and expectations of end-users, particularly teachers and administrators in a Tabika Kemas (Preschool) setting. They focus on assessing the system's usability, functionality, and overall performance in the intended environment.

Conclusion

Therefore, this project demonstrates that a smart classroom system can be developed at a very low cost using readily available components. This system can effectively control various home appliances, including security lamps, televisions, washing machines, air conditioners, and even the entire house lighting system. However, the components needed are minimal, and some devices can even fit in the palm of our hand, making them easily packable and portable. The smart classroom design underwent multiple rounds of testing and research to ensure it could effectively control a variety of home and classroom appliances, including those used for lighting, air conditioning, and home entertainment. After these tests, it was certified for this purpose. Therefore, this system can be expanded and easily moved to different locations.

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