Research Article

Intelligent Digital Learning Services Laboratory in Smart Classroom Environment

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Abstract: The application of the concept of the Internet of Things in a laboratory environment will improve the quality of learning processes in the classroom because several activities are represented by technology so that lecturers and students will organize their assignments more efficiently and effectively. This paper is designed to describe the concept of models, symbols, technology, and the Internet of Thing's challenges for a better life. The Internet of Things' role illustrates the broader concept of Smart Classroom by offering the integration of multiple ThingSpeak sensors, microcontrollers, actuators, and equipment as the Internet of Things applications and APIs in authenticating experienced and prepared smart laboratory models. The smart laboratory system modeling results based on the Internet of Things are expected to support digital learning services, automatic data processing, and collect statistics on students' whereabouts in each practicum course.

Keywords: Smart Laboratory, Digital Learning, Smart Classroom, Internet of Things, Thingspeak.

1. Introduction

Educational institution's role in disseminating knowledge is becoming increasingly urgent because of the continuous expansion of knowledge. Meanwhile, the education process service model is undergoing a conversion where students' learning needs to be completed in various ways. Therefore, a smart educational environment is encouraged through the incorporation of different information and communication technologies to activate the learning process and adapt to the diverse needs of students [1][2][3][15][16][17] [18] [19][20][21].

The quality of a student's learning process can be improved through continuous monitoring and analysis of different student conditions and activities through information sensing devices and information processing platforms to offer feedback on other student learning processes. The Internet of Things promises to achieve great variety in life, the good of individual lives, and organization's productivity. [4][5].

Through a widespread local smart network of smart objects, IoT can enable expansion and enhancement of essential utilities in various fields while introducing a new ecosystem for developing applications [6][7]. Internet of Things (IoT) is a system that makes it possible to increase comfort in the teaching and learning process [8] [9], both in theoretical class environments and in laboratory environments. The application of IoT technology in digital learning services in the Smart Classroom environment, which is being developed, enables a broader integration [10]. The concept of Smart Classroom in a laboratory environment in this paper offers the integration of several sensor equipments, microcontrollers, actuators that may be integrated with the Learning Management System (LMS) portal, in this case, LMS the Padang State of University (UNP), to create a smart laboratory model.

Currently, UNP already has online attendance in each department, but the attendance is only for educators and education personnel. Student attendance is available at https://portal.unp.ac.id/pertemuan/list_kelas/ for each course, but it is still manually inputted by the lecturer who teaches the course during lectures takes time. IoT is also often identified with RFID as a method of communication. Even so, IoT can also include other sensor technologies, such as wireless technology or QR codes that we often find around us, where these sensors can be used as an alternative to authenticating student attendance.

A smart Classroom environment where the entire room is controlled using technology that runs automatically [6], [7], [8], [12]. Examples of settings commonly used in Smart Classroom are setting the study room temperature, attendance systems, recording cameras that move according to the active audience, audio equipment that is active when an audio amplifier is needed, and other activities in the class.

This study's general objective is to design a smart laboratory into a digital learning service in a smart classroom environment through current technology support, supporting the design of a wider Smart Classroom infrastructure environment with several sensor equipment as needed. Implement sensors (RFID or Fingerprint) as an attendance input tool (access authentication) in every classroom, especially in laboratories, so that the attendance of lecturers and students is recorded and visible with the LMS database, student attendance portals, and or student attendance in e-learning as proof of existence Student participation in lecture sessions. Authentication Access to this classroom via a fingerprint sensor and multiple sensors that measure other conditions integrated into the security system, smart laboratory verification.

2. Methods

The need for designing a smart laboratory system is met through two interconnected devices, namely hardware, and software.

2.1. Research Material

The material in this research applies smart laboratories to digital learning services in smart classroom environments through the Internet of Things and Fingerprint (IoT) support. To create digital learning services' efficiency in authenticating access to laboratories and controlling several conditions, it becomes a smart learning environment in smart classrooms.

2.2. Research Equipment

Modeling on this smart laboratory system requires some hardware and software. Hardware is available in registration rooms, some laboratory rooms, and server rooms. The primary devices/components used to develop the system include Hardware: Arduino UNO ATMega328 Microcontroller Processor, Raspberry Pi 3B +. Sensor Devices: RFID Reader, Fingerprint Sensor (optional retina sensing), MLX90614 Infra-Red Contactless Temperature Sensor, Vibration Sensor, PIR Sensor. Drive: Relay Module, Solenoid Door Lock. Display Device: TFT LCD (Liquid Crystal Display) Module, Loudspeaker.

While the software is the Arduino IDE, Writing C / C ++ language programs are done using the Arduino IDE application, where the program listings that have been typed will be saved in * .ino format. Cloud Thingspeak; Thing Speak functions as integrated data communication with Arduino Uno and Raspberry Pi 3 B +. Thing Speak is an open-source Internet of Things (IoT) application and API for retrieving, storing (Cloud), analyzing, visualizing, and actualizing data from sensor or actuator readings in internet-based cloud applications or via Local Area Networks using the HTTP protocol.

3. Design and Analysis

3.1. Analysis of System Problems and Needs

Attendance is a form of professionalism for each actor in the learning environment. Currently, UNP already has online attendance in each department, but attendance is only for educators and education staff. Student attendance is available at https://portal.unp.ac.id/pertemuan/list_kelas/ for each course, but the manual is still filled in by the lecturer who teaches the course during lectures course takes time and is not efficient.

IoT is also often identified with RFID as a method of communication. Efforts to solve this problem by developing a new presence model using the Internet of Things and Fingerprint Modeling. The model work system starts when the laboratory user performs a fingerprint through the Fingerprint module. The personal data will appear on the Node Register, and then the recorded data will be sent to the server. During lecture attendance, the Fingerprint module connected to the Class Node will send student attendance data to the server (https://portal.unp.ac.id/pertidang/list_kelas/) via Raspberry Pi 3B + Communication using an internet connection. Laboratory user attendance data can be read in a smart application via the ThingSpeak cloud on the browser server.

3.2. Design of System

The model design in the design of this smart laboratory system uses the following equipment: Arduino Uno to automatically control the device, Raspberry Pi 3 B as a storage medium (local server) and data selectors, Fingerprint sensor, and RFID sensor to lock the entrance (authentication), a touch sensor as a door lock from inside the laboratory, a PIR sensor to detect the presence of people in the laboratory when an earthquake occurs, a Solenoid Door Lock as an automatic door lock, a loudspeaker as a warning indicator when an earthquake occurs and when an attempt is made to break a door, and a monitor output TFT LCD so that data can be viewed. These tools are interrelated with each other's services to produce the right work automation system in creating efficiency and time effectiveness in learning.

The system model design is developed to monitor the overall laboratory activity through several sensors; restricted access to users with an interest in the RFID sensor as well as a security system, the Attendance System for Lecturers, Students and Employees with a Fingerprint sensor, non-contact human temperature measurement through the MLX90614 Contactless Temperature Sensor, detecting the existence of people in the laboratory through the PIR sensor and detecting earthquakes through Vibration sensor.

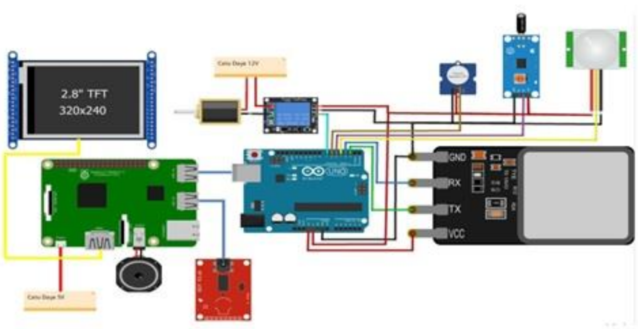

Figure 1. Smart Laboratory System Design

The data from the five inputs will be selected by the Raspberry Pi 3 B+ and Arduino Uno. The selection results will then be displayed on the TFT LCD and activate the Relay to move the Solenoid Door Lock to unlock the door. While the software in the form of Arduino IDE, Cloud Thingspeak is useful as a data source connected to the laboratory user's presence at www.portal.unp.ac.id according to the code section for student courses. The existing system modeling results are expected to support a smart environment (Smart Learning Environment) for safe and comfortable Smart Laboratory support. The system design is shown in Figure 1.

3.3. Flowchart System

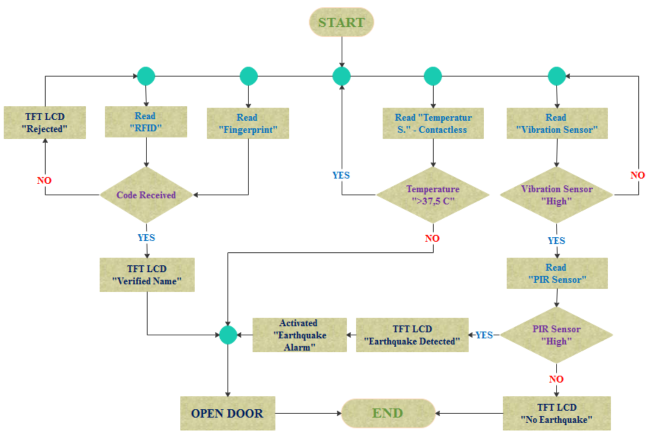

Figure 2. Smart laboratory flowcharts as digital learning services in smart classroom environments

The flowchart of a smart laboratory as a digital learning service in a smart classroom environment is shown in Figure 2. The program flowchart is a chart that describes in detail the steps of the program process. The program flowchart is created from the derivation of the system flowchart. A program logic flowchart is used to describe each step in a computer program logically.

4. Conclusion

Results Smart laboratory system modeling can be applied to support smart learning services automatically in laboratories and the classroom by considering the level of security and comfort of users during the Covid-19 pandemic. It can also be a solution to separate student attendance into one eLearning system and produce statistical data based on student attendance (users) in each theoretical and practicum course.

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