An Efficient Framework for Intelligent Learning Based on Artificial Intelligence and IoT

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Abstract—Learning based applications have become smarter with the emergence of Internet of Things (IoT), and the devices which were connected with it give rise to their exploitation in all facets of a modern education. As the volume of data increases, IoT-based techniques are applied to further enhancing an application's knowledge and capabilities. Many researchers have been drawn to the area of smart learning using both the Internet of Things (IoT) and Agent based system. The main aim of the learning management is to make the students and its teachers to develop skills, use and implement the technologies in a scenario that produces advanced outcomes in learning process. There are many technologies which help the exposure of smart education. In this paper, a systematic review is carried out on the applications of Artificial Intelligence (AI) in the learning management. Various AI systems used in the field of application in learning management were analyzed. A novel framework based on a proposed architecture and its implementation requirements of the AI and IoT based Learning management system is also discussed.

Keywords—artificial intelligence, Internet of Things, e-learning, smart learning, artificial neural networks

1 Introduction

The classroom is an instructional space. Typically, a generic classroom has a blackboard, a lectern, desks, and seats. Over the last few years, educational institutions have steadily installed digital equipment, such as microphones, screens, recording devices and computers, in classrooms to render the activities more effective. Their ability to improve education system [22, 45-47] and also to facilitate the growth of student-centered, interactive learning [30] and to promote a broad approach to learning [12] are among the most significant explanations outlined for the huge investment in internet technologies. As a position to react to the current variety of defined requirements, the concept of E-Learning was introduced. E-Learning is defined as the technology management of education that reconstructs the features of software for computer-based interaction and online delivery methods of curriculum materials [1,7]. IT-based e-learning is becoming the required platform for a teacher to manage learn-

ing so that the instructor is one who can improve the learners by developing the ability to search for information and then applying them to their everyday activities.

Smart learning is a modern form in which smartphones, computers, and digital tablets are embraced by the learning system as aid for the method of teaching but not as a replacement for it. Smart learning is related to a modern type of education which relies on the application of technology, in virtual classes which can be participated from anywhere in the globe, and provides the material of the course with versatility and productivity at all times, because it is a constant, refreshed learning methodology that is accessible to the digital world. While we advance with in field of AI, modern technologies are being framed for enhancing the efficacy of machine learning and make AI based applications such as deep learning and Artificial Neural Networks (ANN) [43, 42] far-reaching and practical. To establish and sustain its view of the world, AI tries to minimize the human mind. It also includes algorithms that similar amount of user data-based results, allowing a computer to show behavior patterns learned from perceptions instead of social behavior. It allows mechanization to gain knowledge from information utilizing methodologies and draw inferences and forecasts. Each new knowledge which is received by the AI-based system makes it much more convenient.

2 IoT based smart campus

The smart institution focuses heavily on the use of IoT in higher education. This is done to represent a new level of involvement between students and professors in order to create a smart-based educational environment. It presented a design for combining IoT and smart learning that primarily addresses all of the obstacles and issues raised in the preceding sections. Compatibility, maximal reusability, and flexibility are all features of this architecture. The design must be flexible in nature so that it may be quickly adjusted and integrated in order to adapt to future needs. The schematic illustration of a smart university for evidence points learning is shown in Figure 1. The ideas of providing a proper education are highlighted in learning design. This study focused mostly on the need for smart classrooms as a paradigm for surroundings that emphasize smart learning. This also preserves the educational goals of producing intelligent learners.

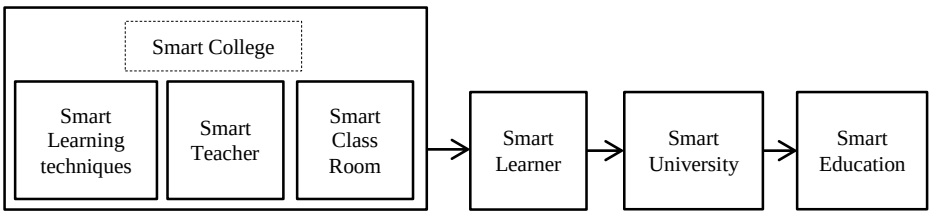

Fig. 1. Schematic representation of an IoT based smart campus

2.1 Smart classroom

The smart classroom is a type of innovative learning will help educators to integrate Information Technology (IT) into their classrooms. A smart classroom is a transformative area where the traditional ways of working can be converted to a digitalized way of working [2, 39-42]. The learner's actions should be linked to both the user's material and real-world applications. The smart campus should also be defined as a space that combines multiple IoT-based technologies and services to enable blended learning, learner-centered instruction, and more customized creative and dynamic learning methodologies. The smart classroom technique for E-Learning is made up of interdependent and interconnected components. Smart classrooms encourage students to use digitalized materials and can interact with educational environments from any place and at any time. It should also provide proactive and essential peer review, instruments for aiding learning, or recommendations for gaining knowledge in the correct shape, at the correct time, and in the right location.

2.2 Core elements of a smart classroom

- A personal computer for general purposes with common installed operating system and software applications and Web connectivity.
- At least two screens are linked to the computer. One is a large screen for all the audience and the other one is for managing the computer.
- A multi touch function should be available so that the teachers can mark the grades with fingers on the display itself during the lecture.
- A microphone at the time of lecturing.
- An electronic speaker that takes the voice and input of the device as a source of audio input.
- Devices like a laptop computer or DVD player, video/audio switches.

2.3 Smart teaching

Smart teaching entails the possible engagement of educational institutions in the use of development tools for classroom instruction [21]. It is, in general, the process of enhancing the effectiveness of the teaching experiences. Smart teaching uses next-generation classes and resources that are centered on the teacher. It also allows students to take benefit of the internet's benefits in the teaching and learning process. It includes a number of various teaching styles as well as instructions on how to use smart devices in the classroom [3].

2.4 Smart learning

S-learning is a challenging and complex task education. It establishes a new framework for teaching that allows students to learn in a healthier atmosphere [4, 29, 41]. It also customizes technical place to learn using computer-based solutions.

Figure 2 depicts the overall framework of a smart student learning.

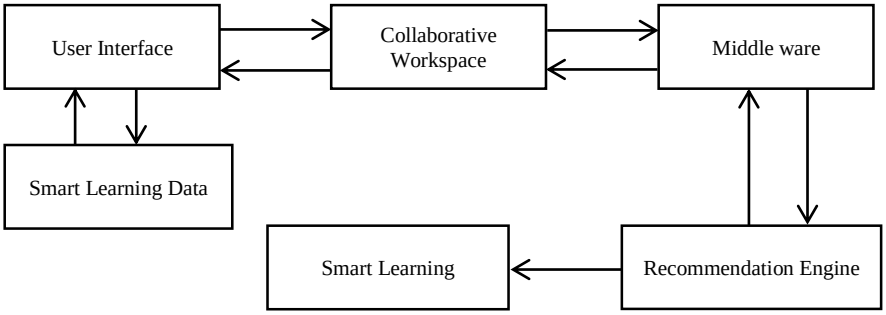

Fig. 2. The overall structure of smart learning environment

The participants will benefit from the following aspects of smart education.

1. It is built on sophisticated software techniques and concentrates on instructor material.
2. It is a smart, efficient, and personalized learning technique built on modern IT architecture.

3 AI based smart learning and smart classrooms

User viewpoint, confirmation, interface design, spoken system apps and identification, regulating participation using an enrollment software, hand motion instructions, and so on are all part of AI-based Smart Teaching and Smart Lecture halls. Through the portal, interaction in a teaching method, among various gadgets, and with the consumers is handled by AI-based methods. The placement of an access point between the equipment indicates that the AI-based smart campuses model is built on IP networks, implying that each lecture must have its own unique IP network for managing the equipment. Numerous investigations in the subject of education based on ANN have been achieved by variety experts. In [31], the authors developed an unique multi-agent E-Learning framework based on a hybrid of Item Response Theory (IRT) and Artificial Neural Networks (ANN). Their technology displayed adaptive exams and personalized advice. These professionals assist to the supportive learning environment with adaptability and intelligence, and they act as a human educator, guiding students through a well-designed and individualized learning environment. The authors of [5] proposed an ANN strategy for determining understudy' learning styles [40]. Authors in [8] implemented the Updated DA model used to measure the output of student grades to acquire scoring from old datasets to determine new features using a NN.

Authors in [6] proposed a framework using the ANN, Multi-Layer Perceptron (MLP) and Radial Basis Function (RBF), by predicting the students attending an e-learning program with a success predictor. In their methodology, the students were tested online with a structured interview of 25 queries, administered with a query complexity as per the teaching principles. Each assessment was registered at the end in a unique database. Their method provides statistical information for each student

during the online course duration relating to the evaluation operation. Operations of various devices which are used in the AI based smart classrooms model is as follows:

3.1 Voice command and recognition

Speech recognition is a computer or system's ability to learn and interpret commands or to comprehend and execute voiced instructions. Speech recognition process allows users to simply connect with devices by speaking to it, allowing for hands-free queries, notifications and other basic tasks. Software or hardware is used to record the students and the faculties voice commands so that it can be converted to respective commands.

3.2 Face recognition application

Face recognition is a biometric technology that traces the facial characteristics of individuals numerically and stores the information as a face print. In order to verify the identity of a person, the program uses deep learning algorithms to match live captures images with the already stored face print. The facial recognition system used in the AI based classrooms enable to record the students and the faculties face print and facial gestures so that it can be converted to respective commands.

3.3 Gesture triggered commands

Any motion in the body, smaller or larger which can be detected by a motion detector is known as a gesture. Identification of gestures is a form of user interface for perceptual computing that enables computers to recognize and convert the human gestures as instructions. A computer's ability to recognize movements and to perform actions based on those gestures is the basic principle of gesture recognition. The gesture recognition system used in the AI based classrooms enable to record the gestures of students and the faculties so that it can be converted to respective commands.

3.4 Attendance application

The attendance application allows the faculties to automate the attendance by tracking the presence of students. This application enables the intelligent learning process to be initiated by decreasing the paper works and removing the participation records as manual process. This attendance-based application is connected with the face Recognition application so that commends from it can be changed to attendances. Table 1 highlights the current applications based on deep learning, technological advantages and drawbacks of each model in E-Learning.

Table 1. Summary of artificial intelligence models in smart learning

No	AI Model	Main Area	Applications in Smart Learning
1	Convolution Neural Networks	Face Recognition, provides model-based learning	Expect the dependent variable of the tools for learning. [36] [36] Usage of face expression to identify the thoughts of learners [37]
2	Recurrent Neural Networks	Speech recognition, Prediction of feedbacks	Obtain the sequential events and interactions in the design Deliver a strong precision in recognition of speech & character and NLP based assignments [20]
3	Deep Learning based Neural Networks	Online presentations,	Supports the virtual presentations more precisely.
4	Item response theory and ANN	Personalization of E-learning system	A customized e-learning system focused on multiple agents that provides the predictive tests and customized e-learning system [28, 31]
5	Deep belief network	Natural language processing [33], speech recognition [32, 38]	This model Provide good accuracy in understanding the natural language and the speech recognition.
6	Artificial Neural Networks, K-Nearest Neighbor	Performance prediction of students	This model predicts the performance of students based on their scores in the e-learning management system [10, 11].
7	Self-Organizing Map and Back Propagation Neural Networks	Recognize the connection between both the content of learning and the learner's necessity for learning.	A combination of personalized AI based system which is used to select the learning objects for each student [9]

3.5 Smart pedagogies

Smart pedagogies are described as those practices and teaching methodologies that promote intelligent learning and allow it [27]. Smart pedagogies comprise of different methodologies and methods for learning, such as density based generative learning, entity based personalized learning, collective group-based learning, and segregated class-based teaching.

3.6 Mass based generative learning

The basic idea of generative learning requires the development and refining of individual mental frameworks about the environment [13]. In [14], the authors suggested a theoretical structure for generative learning which incorporates interpretation of content and context. The aim is to enable learners to prepare the material transmitted and to shape the meanings of training and transition to establish inter-contextuality. They are able to relate new knowledge with the old in order to gain significant information and use their abilities while students are studying online. Such activities will motivate the students to actively engage in the creation of appropriate information. Online learning makes the learners to overcome space and time constraints [15]. It is highly interactive, collaborative and real. In order to establish inter-contextuality, these characteristics may help to frame the time and involvement. Then the skills for

learners especially communication and coordination must be promoted in the learning process.

3.7 Personalized learning based on individuals

Personalized learning is characterized as adapting speed, adapting approach and relating to the desires and perceptions of learners [16] in order to meet the needs of students and to provide resources for each student to promote the ability of learning. Students accomplish objectives in the customized learning process or pursue interests based on their inspiration. However, the secret to personalization is that content is customizable in order to accommodate the needs of individual students. When students engage with private learning environments, their knowledge of IT will be strengthened. They will participate in active learning and their imagination can be stimulated by the teaching practice. There are four main issues to facilitating individualized instruction by means of IT such as making students' educated learning choices, developing and diversifying various knowledge and skills, building different teaching and learning environments, and focusing on student assessment and feedback [17].

3.8 Collaborative learning based on community

Collaborative learning is a method in which multiple individuals learn or try to learn together. In order to create a meaningful learning opportunity and encourage the ability of students by solving the real-world problem, the teachers design the interactive learning process. Computer aided Collaborative Learning (CACL) has emerged with the growth of technology to enhance the learning by using computers and IT [18]. By developing applications to encourage decision making, focus on the methods of problem solving of students, and encourage the inter-subjective logical reasoning. When students study in organized teams, CSCL will include students in collaborative problem solving [18].

3.9 Proposed model based on the AI and IoT based smart learning

User education data from multiple gadgets, AI and agent-based systems, and smart learning-based technologies are all part of the suggested approach. The overall design of the proposed system is shown in Figure 3.

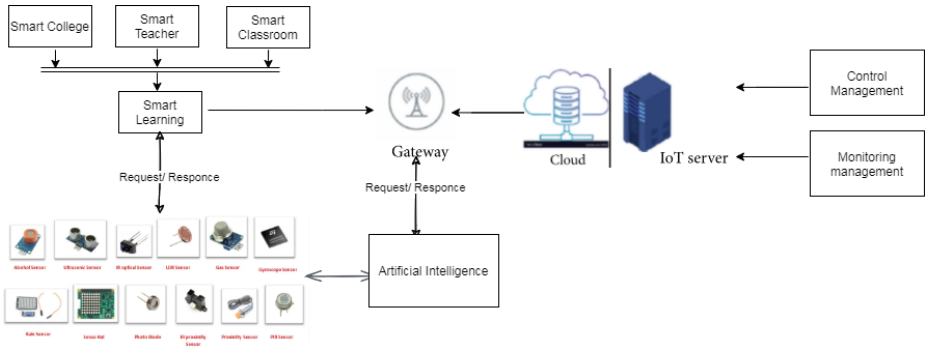

Fig. 3. Architecture of the proposed AI and IoT based smart learning system

The entire framework for evaluating various types of data obtained from different learning systems. This data is processed by combining AI and agent-based technologies. The data management component and the content management tool were two aspects of the AI-based technology. The suggested system's main goal is to use AI-based systems to automate the user's contributions. It also serves as a platform for data gathering, report administration, and input strategic planning. By identifying user input using the free text technique, the AI-based process ability component receives, analyzes, performs, and triggers the action. All of the studied materials have been saved and changed in the training dataset. This component has a number of features, including learning-based storage of information and a computational tool. The AI-based information processing tool accepts input data, transforms it into statistics, and delivers it to the reporting management software. The smart teaching method receives input on all of the requests and streams that were processed. Since AI and education approaches were merged, this model enhances the general efficiency of learning algorithms.

3.10 Implementation of the AI based smart classrooms

The smart classroom is primarily used for the training of university courses in the classroom. The intelligent classroom will be a place for learners to learn theoretical information and movements. Smart classroom design is split into two parts such as the spatial design and technological design. The room is accurately planned and the teaching facilities are fairly distributed and the features of complex combinations are realized to the greatest extent possible, in order to have an evolving learning atmosphere for the learners. The technological architecture focuses on smart management and centralized control, and the different units and devices are interconnected to achieve a high degree of wireless based network functionality.

The smart classroom's fundamental devices are the monitor, smart chalkboard, floor, etc. Features such as presentation of content, management of environment, sharing of resources, and circumstance acquisition will be realized through the introduction of the smart classroom to the instruction of the University course. The Hard-

ware requirements and software requirements for AI based Smart Learning environment is shown in Table 2.

Table 2. Hardware and software requirements for an AI and IoT based smart learning environment

Hardware/ Software	Name	Description
Voice Recognition System	Sensor	3
Face Recognition system	High Resolution Camera	3
Development Language	Python	3.0
Database Core Server	MySQL	5.5
Database Management Tool	MySQL Tool Kit	5.1
Server	Apache Tomcat	6.0
Operating System	Windows 10	Ultimate
NAT Gateway	Private Network	External IP

4 Conclusion

E-Learning can be described as an integrated learning-based software system that synthesizes computer-mediated interaction of software functions and methods of providing teaching materials. Similarly, the application of AI in learning is considered as one of important achievement for the intelligent based education system. In order to improve existing learning methodologies, application of AI and IoT based learning environments can be used provide personal services improve the skill of the learner and faculty by interacting with the learning system. In this paper, a detailed review of various applications of artificial intelligence in the smart learning is done. In particular, all the benefits of specific technical areas and components of earning methods such as smart classroom, smart teaching and smart learning are described in detail. Several research such as customized learning models and self-learning were investigated for the use of AI in tutoring and learning techniques are done. The role of different AI based methods within the current model of learning management is also highlighted.

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