



Catalyzing Future Education: Dynamic Learning and Remote Experiments through IoT-Integrated Learning Management Systems and Virtual Reality

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Abstract

As tools for developing, distributing, tracking, and managing a variety of training and educational materials online, Learning Management Systems (LMS) have become increasingly popular as tools for developing, distributing, tracking, and managing a variety of types of training and educational materials online. The evolution of Learning Management Systems (LMSs) has been dramatic since they were introduced in the 1990s. They have emerged as powerful applications for managing curricula, providing rich content courseware, assessing and evaluating student performance, and facilitating dynamic collaboration between educators and students. We can expect many changes in the structure, the functionalities, and the implementation of the learning management system in the near future as a result of a number of research fields exploring various technologies related to the learning management system. Our daily lives will be impacted by a wide variety of aspects as a result of the Internet of Things (IoT), as we move forward. There are several components to a learning management system that can be enhanced with the use of IoT capabilities that are discussed throughout this paper. In addition to its impact on many aspects of the learning management system, the Internet of Things will also bring to the learning management system a number of enhancements and changes that are expected to enhance the functionality of the system. An IoT-enhanced learning management system is one of the outcomes of a three-year research project that Arts, Science, and Technology University (AUL) is conducting as part of its Distance Learning program. It is intended to provide a brief overview of the project and the implementation plan for each component along with a description of the anticipated effects and the benefits that are anticipated to be derived from it. Locating objects in images and videos is one of the most fundamental and challenging tasks. Object classification, counting of objects, and object monitoring have received much attention in recent years. An in-depth literature review focusing on object detection is presented here.

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1. Introduction:

In today's technological age, learning management systems (LMS) are becoming increasingly important as tools that facilitate the creation, delivery, management, tracking, reporting, and assessment of online learning materials as they are increasingly used as tools that facilitate the delivery, assessment, and management of learning materials. By leveraging the latest technological advancements in the virtual learning environment, it utilizes the most up-to-date pedagogical research and offers a wide range of pedagogical features. By using personal devices such as mobile phones and tablet computers, learners are able to use resources, upload assignments, take tests, and share information with their peers and instructors using this system. Learning management software plays a significant role in

automating the learning process by enabling users to register for courses, track their progress, capture their data, and create reports.

A common component of an LMS is the server component, which is responsible for executing all of the core functions of the system (creating, managing, and delivering courses, authenticating users, distributing data and generating notifications). The user interface, on the other hand, is accessed by administrators, instructors, and students through their browsers via the web service (such as Gmail or Facebook) as a web service. There are significant benefits to be gained by universities by implementing and utilizing a learning management system (LMS) as a part of their education programs. This is a fact that should not be overlooked. There are a number of benefits associated with centralized learning such as time reductions, cost reductions, as well as the ability to track and report.

There has been a considerable amount of evolution in the concept of a Learning Management System (LMS) over the past few years. It was once a simple online application allowing teachers and students to share lectures online, but it has now evolved into a dynamic learning environment that can be customized to accommodate modern learning methods like collaboration, personalization, and flexibility. With the increasing use of current learning management systems (LMS), SCORM (SCORM, 2015) has been proven to be a very effective way of encapsulating online courses and assessments in the use of current learning management systems (LMS). It is through the advent of social media and collaborative tools that learners have been able to share their learning experiences across geographical boundaries across the globe, and also have been able to collaborate with one another to enhance their learning experience. With the help of the assessment tools included in the software, it is possible to create online tests and quizzes as well as administer them to students. Administrators and academic leaders are increasingly using LMS real-time data to facilitate emerging educational models, student success initiatives, and institutional objectives (Lang & Pirani, 2014). Over the next few years, new features are expected to be integrated into the LMS's functionalities.

The server is one of the most crucial components of a learning management system (LMS), since it performs all its core functions (creation, management, and delivery of courses, authentication of users, distribution of data, and notification of course progress). There is, however, an interface that is available for administrators, instructors, and students through their browsers via a web-based service (such as Gmail or Facebook) rather than through a dedicated application. As part of an education program [1] [2], an institutional learning management system (LMS) can provide a university with significant benefits in terms of the effectiveness and efficiency of the program. There is no way we can ignore this fact. Several benefits have been demonstrated to result from centralizing learning, including time and cost savings as well as the ability to track and report on activities and the ability to reduce the number of errors caused by different methods.

There has been a considerable evolution in the concept of a Learning Management System (LMS) in recent years. At its earliest stage, it was an application that students and teachers could use to share lectures online; however, it has evolved into a dynamic learning environment that can be customized to accommodate modern learning methods [3][4], such as collaboration, personalization, and flexibility, that are now becoming increasingly popular. SCORM (SCORM, 2015) is a standard that is used to encapsulate online courses and assessments in learning management systems (LMSs). The advent and use of social media and collaborative tools has allowed learners across geographic boundaries to be able to share ideas, learn more easily, and collaborate more easily than ever before. It is possible to give online tests and quizzes to students using the software's assessment tools. Lang and Pirani (2014) provide an overview of the growth of applications and functions that use LMS real-time data in order to facilitate the development of new instructional models, enhance student success initiatives, and assist with achieving institutional objectives. It is expected that at least a few new features will be added to the LMS in the next few years as a result of which it will be more functional. Moodle News (2017) reported that Moodle could be used to implement several of these features, according to their report.

Internet use has been deeply integrated into the education system over the past decade, but new technologies such as the Internet of Things (IoT) will make even greater changes to the system in the coming years. The use of IoT devices in education can be seen in the use of interactive boards and digital highlighters. With digital scanners, students have the opportunity to transfer texts digitally to their smartphones, improving their learning experience. A powerful feature of this system is that it enables students to communicate with teachers, experts, and peers around the world

(Ralhan, 2017). The Internet of Things has been proposed as a vehicle for the creation of smart learning environments on university campuses in a number of research studies. IoT facilitates a collaborative and self-directed education in a "Smart University" by facilitating collaboration and self-direction.

The purpose of this paper is to discuss how the Internet of Things can be integrated with learning management systems. A future learning management system is proposed using IoT facilities. By combining existing learning management systems with IoT services and connecting them with IoT modules, we describe several services currently provided by existing learning management systems. Several new services will also be developed as a result of the integration of IoT into the LMS. Each proposed LMS service is described as to how it will be integrated within the LMS, how it will be integrated with other LMS services, and how it will enhance teaching and learning on campus. Next, we summarize the state of the art of research on the future "Smart University" in Section 2 and detail our proposed framework and discuss its operation in Section 3.

2. IoT in Education: A Literature Review

An IoT device is a device that connects to the Internet but is not a standard computer or smartphone. With IoT advancements, the world will be transformed in such a way that people can better manage their energy, health, transportation, and life resources. IoT has already made a significant impact in areas such as healthcare and customer service. Education is also likely to be affected by the increased use of connected devices in schools and universities. Education textbooks now include Quick Response (QR) codes. With the help of QR codes, students can access feedback, assignments, and additional knowledge resources on the go. In addition, radio-frequency identification (RFID) chips are being used by students to research physical objects by tagging and tracking them. Aside from tracking equipment, taking attendance automatically, and monitoring lighting and security, universities use IoT devices to manage their operations.

IoT-based digital campus structure and design

The authors of (Veeramanickam & Mohanapriya, 2016) propose using e-Learning techniques on campus through the implementation of the so-called "Smart I-Campus" model. This model provides various smart services such as "Smart Classroom" and "Smart Lab" with features accessible from handheld devices and integrated within the e-Learning system or LMS. Smart Classrooms will collect and upload real-time data for future use. Another feature called "Smart Notes Sharing" allows a smart board equipped with IoT devices to transfer real-time data to the e-Learning application in an automated way thus enabling any person connected to the campus network to share classroom notes. Another important feature of the "Smart I-Campus" is the *augmented reality and 3D virtual objects* within the "Smart Classroom", which will enable students to discover important and real-time information when they come near to learning objects that will be connected to sensor devices.

The Internet of Everything and Cisco

Cisco envisions the Internet of Everything (or IoE) as a networked connection that brings together people, data, processes, and things in a more valuable way, transforming the information they gather into actions with richer customer experiences. It is important to recognize that IoE does not solely focus on IoT, which is the connectivity of physical objects, but it includes capabilities such as context awareness and increased processing power for billions of connected devices. Education can be summarized as four pillars of the internet of things (IoE):

- As a result of the Internet of Everything, people become nodes in a network, which connects them both to experts and to peers with similar passions and interests.
- Additionally, things can also be physical objects that are embedded with sensors and are able to collect and upload data in addition to being embedded with sensors.
- Educators and learners often have access to high-level information provided by connected "things" due to the availability of data.
- An important component of delivering the right information at the right time is the process. *IoT devices are utilized in 2.3*

A model for smart universities is proposed in (Cata, 2015), in which five different types of sensors are utilized to detect noise, temperature, and lightning. These sensors are classified into the following five main categories: (1) Environmental sensors that detect noise, temperature, and lightning; (2) Security sensors for motion detection, opening and closing of doors and windows, and fingerprint recognition; (3) Sensors that detect fire, smoke, and water; (3) Sensors that detect electrical voltage and NFC tags; and (5) Readers which detect RFID codes, QR codes, and barcodes. According to (Cata, 2015), IoT services will be beneficial to many smart university applications, including: (1) A smart parking system allows you to monitor vacant parking spaces to avoid accidents and jams; (2) In smart lighting, light is reduced automatically depending on the amount of natural light outside gathered from sensors, thereby reducing electricity consumption; (3) RFID-based Smart Tracking is used to track university equipment and goods to identify emergency cases using QR tags; (4) By reading QR tags with a barcode reader, Smart Inventory identifies any equipment associated with a barcode.

2.4 IoT Intelligent Agents

Throughout the history of computing, agent-based architectures have been introduced as methods of representing knowledge in a collaborative environment. It can be said that an agent is a type of computer program that is specialized to perform certain tasks, however it differs from a computer program in the sense that it is autonomous and can function independently without being directed. These problem-solving entities are able to work continuously while they perceive and adapt to the changes in their environment, allowing them to solve problems as they perceive and adapt to the changes. The most effective way to keep track and maintain control over one's internal state and actions is to refine one's goals, take proactive initiatives to achieve them, and have proactive approaches to achieve them. The use of intelligent agents embedded in IoT devices can be incorporated into the development of a Multi-Agent System (MAS) that is capable of supporting students' learning activities adaptively, allowing learners and teachers to collaborate in real-time and allowing tutors to adjust the learning path of a student in real-time (Moubaidin et al., 2013).

I am convinced that Internet of Things will play a very important role in the future of education[5]. But despite the fact that all of us agree that IoT will play a significant role in improving learning management systems, very little is being done to take advantage of IoT to improve these systems. There is a whole new world of possibilities that have been opened up by learning management systems (LMS) in both the education and training sectors over the past decade as they have shifted toward offering more personalized learning experiences to learners, making it more convenient for them to collaborate and discover new learning methods as a result. There will be a number of LMS future trends that will emerge as IoT and VR concepts become more and more popular over the next few years, and as IoT and VR concepts become more pervasive, there will be many LMS future trends that will emerge. In the following section, we present our vision of a future LMS based on a framework for leveraging IoT capabilities to transform the existing features of the LMS into enhanced services that will provide students with new learning opportunities and instructors with new teaching and management tools. We have proposed the general design for each new and enhanced feature in this IoT-enhanced Learning Management System as part of an ongoing research project, illustrated its expected benefits, and described how it will be implemented within this IoT-enhanced Learning Management System [8].

3. IoT-enhanced Learning Management System

Today, our world is characterized by a constant engagement with learning, which is seamlessly woven into most of our daily activities. Learning is one of the most important aspects of our lives. With the advancement of technology, the classroom is becoming more and more mobile. Through the use of software such as Learning Management Systems, which is constantly being developed in order to offer a continuous flow of information, the classroom is getting carried around in our pockets. As shown in the following section, it is expected, however, that 'smart' IoT devices will be the primary technology for enhancing and expanding educational opportunities in the future, as illustrated in this section.[7]

If IoT is paired with the Learning Management System in a university, it is possible to broaden the scope of the educational process since it allows data to be exchanged between sensor modules installed in classrooms, laboratories, libraries, and other campus locations as well as between students, instructors, and other university personnel. The purpose of this section is to present a diagram illustrating the various components that make up an IoT-enhanced Learning Management System. Our team has begun working on this project since the beginning of the summer of 2017, and we are aiming to have an initial prototype containing all of the features described in this section by the end of 2019. Throughout the development of our IoT-enhanced Learning Management System, we intend to work in accordance with the Moodle platform, which was chosen for several reasons, including its open-source nature, a global development community, the ability to modify open-source plugins, and the ease with which PHP development can be carried out. The rest of this section will provide a more detailed description of each of the features that will be enhanced as a result of the integration of IoT tools and services into the Learning Management System. Our plan for this section is to provide details regarding the implementation of each feature as well as what changes it will bring to the use of the LMS and what benefits it will bring to the educational system as a whole.

3.1 Experimentation

Students will be able to collect real-life data by using the IoT-enhanced LMS for their experiments and projects. It is possible for students to search online for the data that they need in order to conduct a lab experiment or a project, download it, and enter it into their project by searching online for data they need to acquire. A lot of the time, students need a specific characteristic of the data that is not readily available on the internet. The student should obtain the data from the original source if that source possesses all the necessary characteristics, such as a natural habitat, a laboratory in a hospital, or a liquid manufacturing facility. The student will use an Internet of Things (IoT) device to achieve his/her objective during. While the student is working towards achieving his/her objective, he/she will be using an IoT module (such as Arduino or Raspberry Pi) to collect data that will be able to be connected to a mobile device connected to the student's Learning Management System account while the student is completing his/her assignment. The students are able to read data from the external source through the IoT module and filter it (if the IoT module has an advanced data filtering system built into it) before uploading it to their LMS account. In the course of performing the experiment or working on the project, the student's data will be stored in the experiment/project profile as they work through the experiment/project. It is possible to automate and make more efficient the process of collecting data for scientific purposes with the help of LMSs based on the IoT. As part of the LMS account, the student has the option of reviewing the data collected by the student before it is entered into the experiment.

A general rule of thumb is that IoT devices can be used in labs to conduct simulations and interactive experiments remotely. IoT devices can be connected to various lab machines (chemical reactor, microscope, Bunsen burner, oscilloscope, etc.) so students can access them from a distance using their Learning Management System. The machines can be controlled by a control program running on an IoT device that is connected to the Internet of Things. As a result of this program, robotic machines will be controlled to interact with lab apparatus in a controlled way. A wide range of IoT devices are being used in this project, such as sensors, audio recorders, Google Glass, etc. The results of the experiment will also be recorded using these IoT devices, and will be uploaded to the LMS so that they can be used in future experiments. In addition to tracking their usage and calculating various statistics for them, IoT devices will respond to the actions of a wide range of users as well. When the intelligent agent receives feedback from the user following completion of an experiment, it will change the IoT device's operation in accordance with the feedback given by the user. The robot arm shown in Figure 1 can be dynamically controlled with the help of a laboratory controller module that contains IoT devices, as well as a variety of other lab equipment types.

The experimentation section of this LMS will consist of three main components: the Robotic Arm package, the Arduino Lab Controller package, and the Remote Service package. It is important to note that the Robotic Arm package runs on the Arduino microcontroller in order to be able to define the physical components of a robotic arm, such as how many motors, arms, weights, and sensors there will be. To send commands to the Robotic Arm and to have them executed, we use the Lab Controller package to do this. Aside from running on the Arduino microcontroller, the Arduino Lab Controller package also defines the interface between the Arduino's inputs and outputs and the commands that are sent to the robotic arm, as well as defining what specific tasks the arm is supposed to perform when it is instructed by the Arduino. It's also important to note that the Remote Service package is actually an

embedded plugin within Moodle and consists of a server-side code which accepts information from the user and generates commands that are then sent to the Arduino Lab Controller via the internet.

The students must log in to their LMS accounts and initiate the Remote Service in order to conduct remote experiments. Each remote lab has its own set of experiments, equipment, and regulations, all of which are contained in this service. The first step a student takes is to select a laboratory, specify the experiment that is going to be performed, and reserve the equipment for the experiment. IoT modules can be used for experiments that require external data to be collected and saved into the experiment profile in cases where they require external data to be collected and saved. When a student receives the data from the LMS, they execute the experiment after importing the data from the experiment profile into the experiment program that is executed by the Remote Service package after receiving the data from the LMS. Lab Controller is a package that translates the experiment data into commands or data that can be used to control the lab machines and perform the experiments.

As shown in Figure 1, students have the opportunity to view the results of the experiment running on their mobile devices via a livestream on their Learning Management System (LMS), as shown in Figure 1. In order to setup and control various lab machines within our system, the Remote Service package will be able to make use of different libraries. PyVISA (PyVISA, 2016) is used in the experiment to control the measurement devices that are being used. In addition to installing the Remote Service package, other types of devices will also need to be imported before being able to use the Remote Service package. As soon as the experiment concludes, the memory of the Internet of Things module will be filled with the results of the experiment as well as data from various sensors that will be monitoring the conditions of the experiment. It is then expected that Lab Controllers will be used for sending data to Remote Service packages, which will display the data to students and store it in their experiment profiles after they have completed the experiment. It is possible for the LMS database to store the experiment profiles of the different laboratories on the server of the university or in the cloud on the university's server.

The IoT-enhanced learning management system will provide the students with a wealth of advantages when it comes to conducting remote experiments: First, they will be able to conduct lab experiments at any time and from anywhere without worrying about missing out on the benefits of being physically present at the site of the experiment. The students will be able to gain all of the experiences that the experiment provides by viewing the webcam video stream, viewing the sensor readings, and controlling the robotic arm with the webcam video stream. A student-centered approach will play a vital role in enhancing personalized learning by giving him the option to conduct the experiment in a manner of his own choice. As soon as a student has completed an experiment, a lab instructor will review the student's experiment profile; analyse the student's performance based on the execution steps, the sensor readings, and the experiment results; and offer guidance and advice for improvements to the student. Last but not least, the use of an LMS will encourage cooperative learning through the facilitation of groups of students collaborating on a single experiment via a distributed Remote Service environment, each using their own LMS account, by sharing a distributed Remote Service Environment.

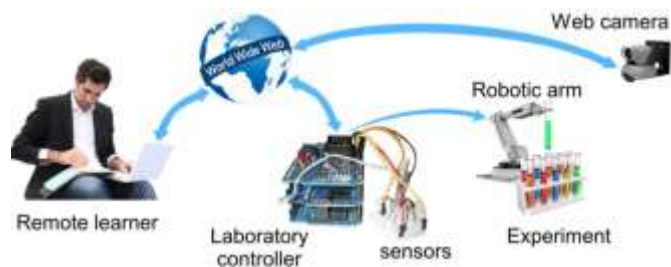


Figure 1: Components of remote experimentation system controlled from the IoT-enhanced LMS

4. IoT with Virtual reality:

Virtual reality (VR) is a computer-generated scenario that simulates experience through senses and perception. The immersive environment can be similar to the real world or it can be fantastical, creating an experience not possible in ordinary physical reality. Augmented reality systems may also be considered a form of VR that layers virtual information over a live camera feed into a headset or through a smartphone or tablet device giving the user the ability to view three-dimensional images.

Current VR technology most commonly uses virtual reality headsets or multi-projected environments, sometimes in combination with physical environments or props, to generate realistic images, sounds and other sensations that simulate a user's physical presence in a virtual or imaginary environment. A person using virtual reality equipment is able to "look around" the artificial world, move around in it, and interact with virtual features or items. The effect is commonly created by VR headsets consisting of a head-mounted display with a small screen in front of the eyes, but can also be created through specially designed rooms with multiple large screens.

VR systems that include transmission of vibrations and other sensations to the user through a game controller or other devices are known as haptic systems. This tactile information is generally known as force feedback in medical, video gaming and military training applications[9].

VR has many applications in a variety of fields. It is most commonly used in entertainment applications such as gaming and 3D cinema. Consumer virtual reality headsets were first released by video game companies in the early-mid 1990's. Beginning in the 2010's, next-generation commercial tethered headsets were released by Oculus, the HTC Vive and PlayStation VR, setting off a new wave of application development.

3D cinema has been used for sporting events, pornography, fine art, music videos and short films. Since 2015, virtual reality has been installed onto a number of roller coasters and theme parks.

In robotics, virtual reality has been used to control robots in telepresence and tele-robotic systems.

In social sciences and psychology, virtual reality offers a cost-effective tool to study and replicate interactions in a controlled environment.

Surgery training can be done through virtual reality. Other medical uses include virtual reality exposure therapy (VRET), a form of exposure therapy for treating anxiety disorders such as post-traumatic stress disorder (PTSD) and phobias. In some cases, patients no longer meet the DSM-V criteria for PTSD after a series of treatments with VRET.

VR can simulate real spaces for workplace occupational safety and health purposes, educational purposes, and training purposes. It can be used to provide learners with a virtual environment where they can develop their skills without the real-world consequences of failing. VR has been used and studied in primary education, military, astronaut training, flight simulators, and driver training.

The first fine art virtual world was created in the 1970s. As the technology developed, more artistic programs were produced throughout the 1990s, including feature films. When commercially available technology became more widespread, VR festivals began to emerge in the mid-2010s. The first uses of VR in museum settings began in the 1990s, seeing significant increase in the mid-2010s. Additionally museums have begun making some of their content virtual reality accessible. Immersive VR engineering systems enable engineers to see virtual prototypes prior to the availability of any physical prototypes.

Virtual Reality is becoming an important part of modern learning. Students can learn various concepts and material by means of a 3D explanation much better than text, photos, or videos. Virtual reality education lessons are being developed for various majors and courses.

5. Scenario and Proposed solution:

The proposed IoT-enhanced LMS will enable students to learn Virtual Reality lessons, by integrating the VR software within the LMS, and by connecting the IoT modules to the system to enable students to interact with the VR lesson by exploiting data that is obtained by the IoT module into the VR lesson. In other words, virtual reality could be transformed by exploiting IoT capabilities from its current static form into what we call Dynamic Virtual Reality (DVR), in which the 3D environment modelled by the VR software is dynamically changed according to the input

data from the IoT sensors. In a recent article, SMACAR anticipated that mixed reality (MR) will be replacing VR gradually in the next few years. The main reason that MR is gaining popularity is that it takes the capabilities of illustrating and modifying a certain environment that are provided by VR, and adds these capabilities into the real environment. Mainly, MR allows the user to experiment and explore inside the real surroundings, while performing the corresponding VR functionalities by interacting with the real world via the virtual (synthetic) world. In many educational applications, it is impossible to learn using MR, due to the unavailability of the real world that is to be learned, or due to the inadequacy of students to use the real world. For example, medical students can perform a surgery within a simulated virtual reality program, but will not be allowed to perform that surgery on a real patient using MR.

Another example is that history students can perform a tour of a historical location using a virtual reality program that simulates the complete 3D details of the historical location. However, they cannot do the same tour using mixed reality due to the physical distance that separates them from that location. In order to enhance VR and make the experience that it provides similar to that provided by MR, IoT could be used to transform VR into dynamic VR. This is done by exploiting the readings of sensors that are attached to the real world that is simulated by VR. The readings of these sensors will be fed by the VR program to the software modules that generate the VR environment, which will be created and continuously modified based on these readings. For example, sensors that are scattered across the historical location that is simulated in the VR program send frequent readings that depict the location environment to the cloud. The VR program will download these readings and create the simulated VR environment based on them. For example, the weather, temperature, visibility, etc. are modified based on their current situation that is deduced from the sensor's readings. Students using the VR program will know that they are exploring and interacting with a simulation that is identical to the current real status of the location they are exploring. With respect to the second example, instead of working on a simulated (virtual) patient that will react based on a static saved program, students will wait for a real surgery to be happening at a hospital and will start their simulated VR surgery at the same time. Furthermore, sensors and IoT equipment used by surgeons that are doing the real surgery will save frequent readings of the patient reactions, blood pressure, heart rate, etc. to the cloud. The VR program will download these readings and adjust the status of the patient in the VR simulation according to them. The students working with the simulated VR surgery will be performing the surgery on a patient that resembles a real patient with real reactions and medical conditions, not just a simulated one that is restricted to the limits of the VR program. In addition, the students will be comparing their work with that of a real medical team at the end of the surgery.[6]

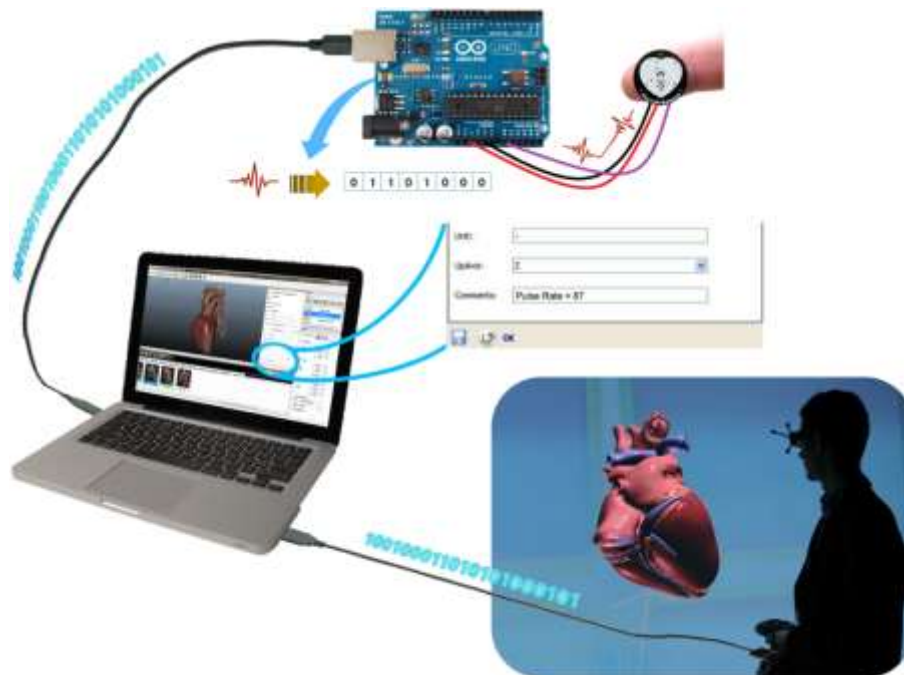


Figure 2: Dynamic Virtual Reality: changing the VR simulation based on real time readings from IoT sensors

Using dynamic VR, the students will be able to learn within a realistically changing environment that is depicted in the VR simulation. In our proposed LMS, we will build a VR prototype using the NeuroVR virtual reality platform. From the LMS, we make software calls to the NeuroVR editor and player that will enable the LMS user to set up a VR environment and view it within the LMS Interface. A 3D model of a human heart will be used to create a VR simulation. At the same time, a pulse rate sensor, similar to those provided by SparkFun or Arbor Scientific, will be attached to an IoT kit to save the pulse rate data that is read by the pulse sensor to the IoT kit memory. Next, the pulse rate data is transferred from the IoT kit memory to the LMS and translated into a numeric value that is used as input to the VR thread that is being executed.

Based on the value of the pulse rate, the VR simulation will be interrupted to setup a new value of the heart beat rate parameter and apply it dynamically while the simulation is running. Figure 2 illustrates the components and execution of a dynamic VR scenario.

In addition to dynamic VR integration with the LMS, Augmented Reality modules can also be incorporated into the LMS to help students in performing simulations and experiments by providing them with directions and corrections. An example is a student performing a lab experiment by capturing a video of the experiment into the LMS that will execute an augmented reality module using the video as input. At the same time, the IoT devices will send real time readings from the experiment to the LMS, which will use the readings to modify the AR display or environment.

When IoT data is transferred from the sensors to the IoT module and then to the LMS, the latter needs to perform a process of data analysis to extract the specific data and calculate the needed parameters that will be used by the VR simulations. A suitable machine learning algorithm would be executed by the LMS in order to mine the IoT obtained data in order to calculate these parameters. The machine learning algorithm should be tuned such that the resulting data are suitable to be used efficiently by the virtual reality simulation.

5.1 IoT for examinations

During the study, data collected from IoT sensors is processed to detect deviations in the behaviour of the students being studied. Faculty receive messages that reveal who the students are who are behaving dishonestly [10]. The faculty may warn and/or remove these cheaters from the exam. The main learning functions and the corresponding IoT tools and algorithms to control and manage them are shown in Table 1.

Table 1: Learning activities and corresponding IoT tools and algorithms for their monitoring and management

Use cases	IoT devices	ML algorithms
Teaching (lectures and seminars)	Web camera	Face Recognition
	EEG	Deep Learning
Laboratory classes	Web camera	Face Recognition
	EEG	Classification algorithms
	GPS tracker Smartwatch	
Examination	Web camera	Face Recognition
	EEG	Deep Learning
	Eye tracker	
Attendance	Web camera	Face Recognition

Our goal is to reduce the cost, time and storage space by analysing distance first on the raspberry pi before transmitting it to the Moodle database [11][12]. Then, to compare the results of the analysis before and after

analysing distance in order to reduce the cost, time and storage space even further. The data analysis was concluded to have reduced the enormous amount of data storage and, as a consequence, to have also reduced the time and cost associated with data analysis. Further, the results of the analysis of the temperature of the experiment circuit board, which has been shown through an HTML page, also allow us to keep the same goals of reducing the time cost involved in the experiment. As part of this analysis, it is also done on the Raspberry Pi database before it is being accessed by Moodle. As a result of this research, LMS users are able to connect wirelessly to the IoT and reach their specific needs directly by using a raspberry pi in conjunction with the appropriate analysis to help them reach their goals without having to waste their time on unnecessary analysis.

5.2 Analysis of the temperature Experiment before sending it to LMS

To analyse temperature using the dht11 sensor, [13] [14] we make simple flashing red lights using transistors on a breadboard. Our analysis of temperature is based on 3 cases that we are choosing corresponding to a circuit board of a student to check the status of the student during experiment.

CIRCUIT DIAGRAM

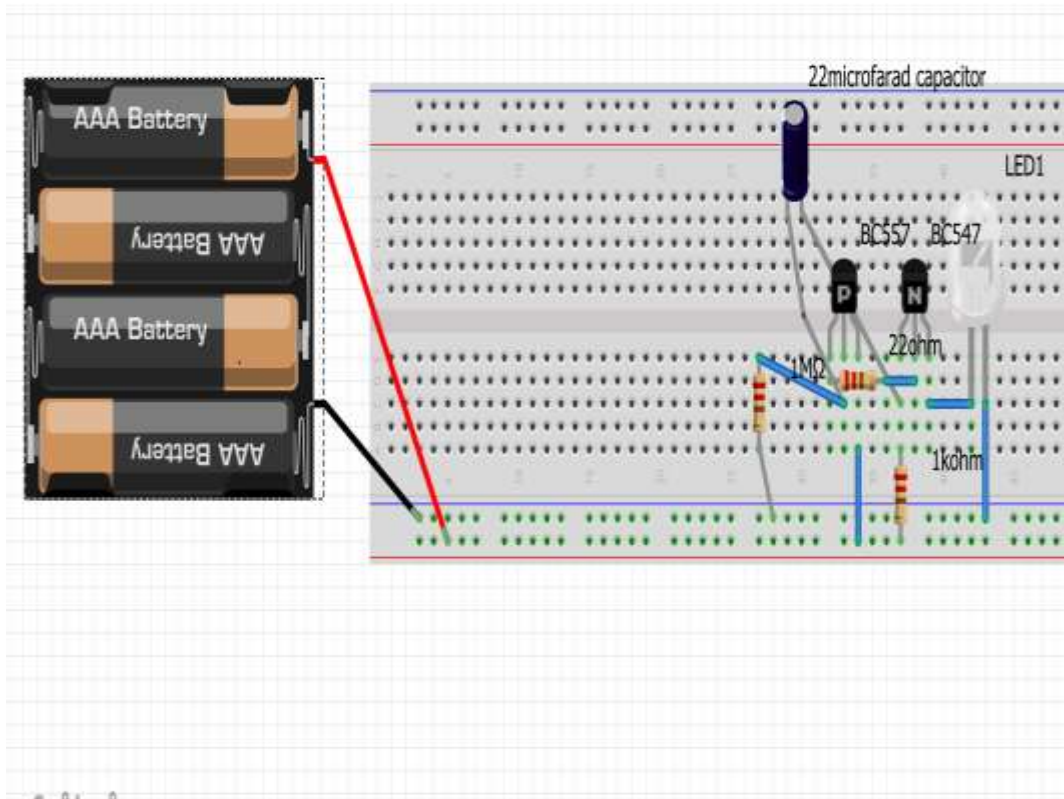


Figure 3: circuit board experiment (circuit diagram)

The components required to build a circuit using a Raspberry Pi and a DHT11 sensor. Our first step is to run a python code, which intends to measure the temperature using the DHT-11 sensor and ignore the value of humidity after the DHT11 sensor has been connected to the circuit board in order to measure temperature. Using the Raspberry Pi database, we run a python code to check if the circuit is working or not, by using the database of the Raspberry Pi.

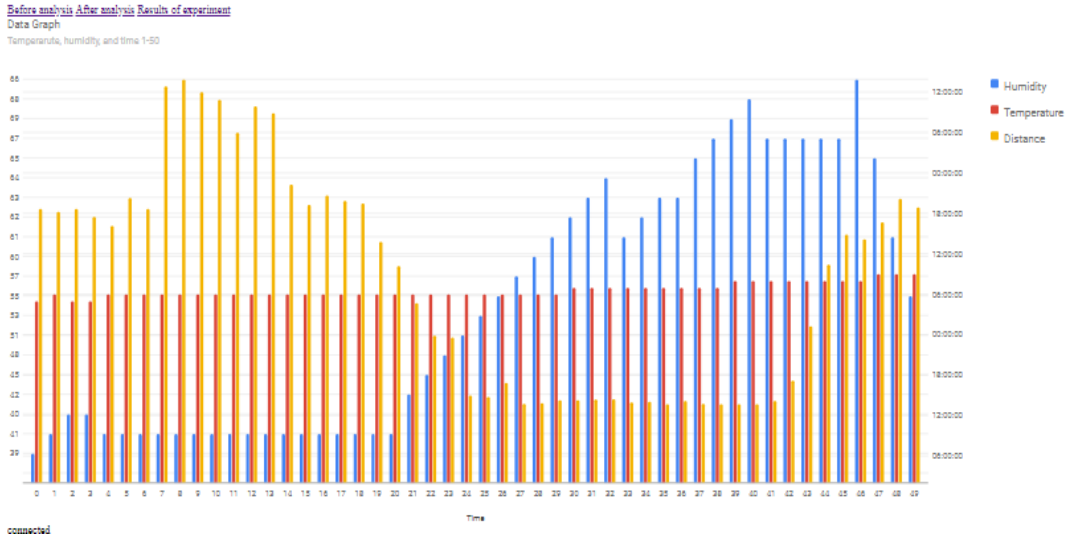


Figure 4: Data graph showing Temperature, humidity, time and distance from initial data

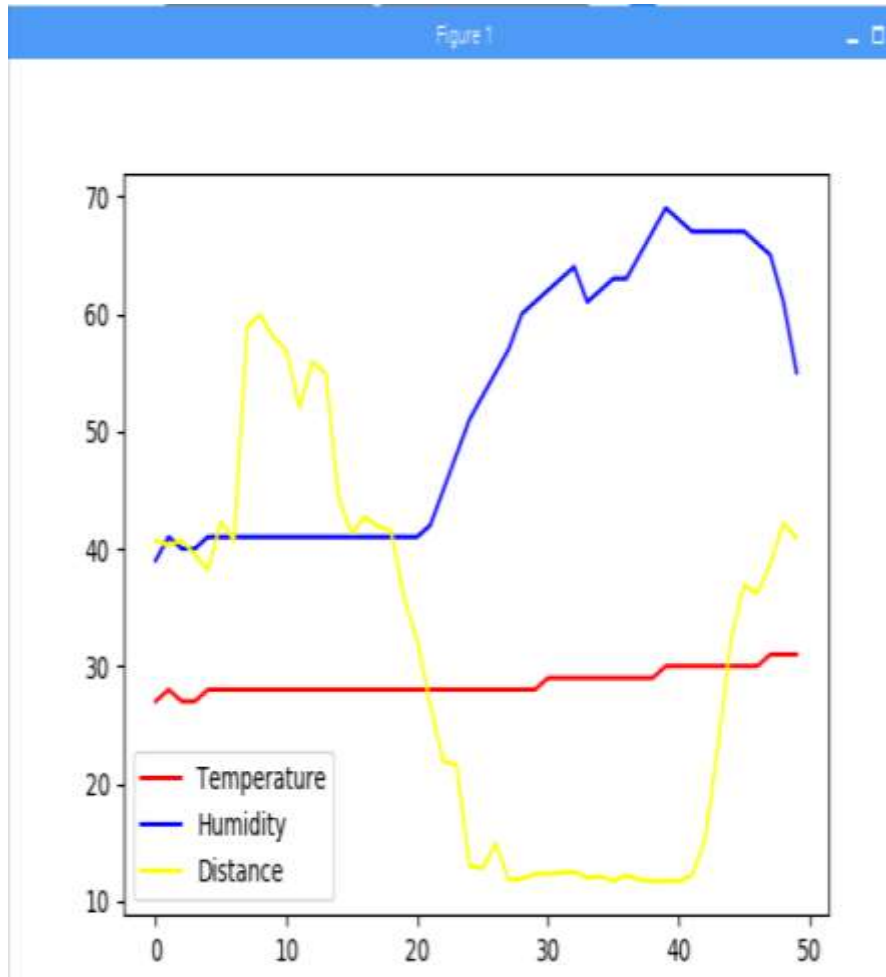


Figure 5: Data analysis by using temperature, humidity and Distance sensors

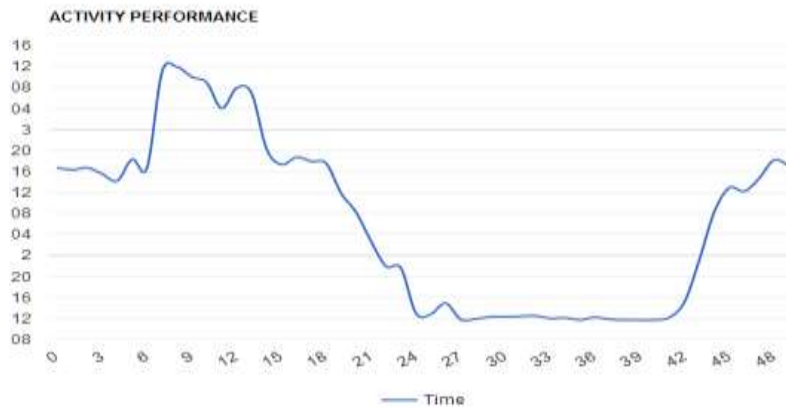


Figure 6: before analysis

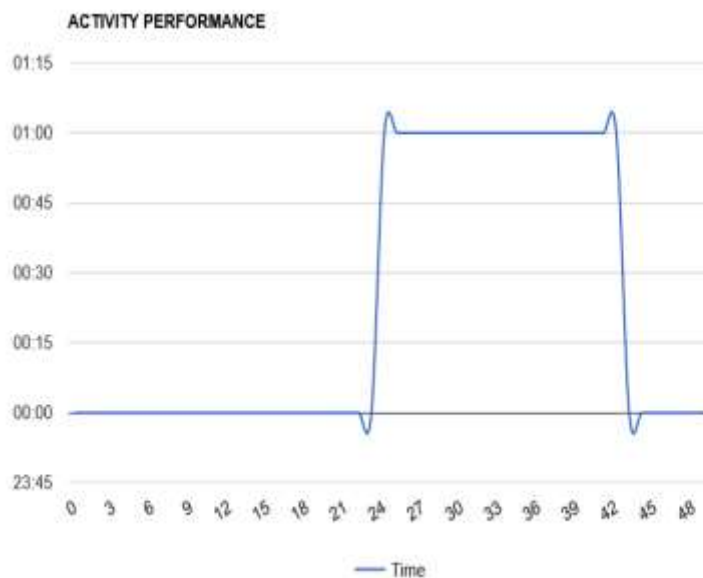


Figure 7: After analysis

6. Results and Discussion

By comparing the two graphs before and after graphs, the gap analysis can conclude that it has reduced the huge amount of storage space required as well as the latency between data transmission and analysis on another device after IoT. By comparing the two graphs before and after graphs, the gap analysis can conclude that it has reduced the huge amount of storage space required as well as the latency between data transmission and analysis on another device after IoT. These results allow teachers to benefit from detecting the distance of students doing experiments in the laboratory, thus reducing time wastage, verifying the students' participation in their work. by comparing the distance value that the ultrasonic sensor took when collecting data with a specific value that we have chosen as a reference to achieve our goal.

7. Conclusion and Future Work

The design of a prototype data set is important in order to reduce the time that is spent on data analysis and this is especially true when there are small natural errors resulting from spikes coming from sensors or indirect interference errors. The advantage of analysing the graphs before and after the analysis is that we are able to estimate the results in total without having to take into account small errors that may occur during the analysis. On raspberry pi we will be collecting and analysing humidity, temperature, and distance data before sending it wirelessly to the Moodle database, and this is our responsibility. An analysis was conducted on a student circuit board based on two parameters, namely distance and time, in order to obtain the results. The area of estimation shrinks with the increase in accuracy of the analysis.

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