Internet of Things (IoT) and The Role of IoT in Education

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Abstract: With the advancement in technology we are moving towards a society where everything and everyone will be connected. Internet of Things (IoT) is a rapidly growing network of a variety of different 'connected things'. Just like Internet has changed the way we work & communicate with each other, by connecting us through the World Wide Web , IoT also aims to take this connectivity to another level by connecting multiple devices to communicate electronically with the world around them thereby facilitating man to machine and machine to machine interactions. It has a wide number of applications in almost every field like healthcare, business, transportation, agriculture, management and education. Use of IoT in education is like a new wave of change that has brought new opportunities and possibilities for the improvement of both teaching learning process and educational institutions' infrastructure. This paper presents what IoT is and the role of IoT in the field of education.

***Index Terms* - Internet of Things(IoT), Characteristics, Architecture, IoT in Education, Challenges, Future impact.**

I. INTRODUCTION

For this The Internet and all its associated services and applications have strongly influenced communication, information and marketing across the world. The concept of connected devices or things has given a new rise of the Internet. Anything, anywhere can get connected with the Internet and becomes 'Smart. The interconnection of various things embedded with sensors, electronics, software, and so on, over the internet with the capability of sending and receiving information is named as Internet of Things (IoT).

The term internet of things was first used by Kevin Ashton in 1999.It refers to uniquely identifiable objects or things and their virtual representation in as internet like structure. People who came up with this idea, have also realized that this IoT ecosystem is not limited to a particular field but has business applications in areas of education, home automation, vehicle automation, factory line automation, medical, retail, healthcare and more. The IoT network connects different types of devices like personal computers, laptops, tablets, smart phones, PDAs and other hand-held embedded devices. Internet of things is an internet of three things: People to people, People to machine /things, Things /machine to things /machine, interacting through internet.

IoT technology has an important impact on education field. IoT has not only changed the traditional teaching practices but has also brought changes in the infrastructure of educational institutions. The IoT enabled transformation from teacher-centric education to student-centric education is reinventing education in our country. This paper presents what IoT is, its characteristics ,architecture, the role of IoT in the field of education, challenges and future impact of IoT in education..

II. CHARACTERISTICS OF IOT

Key characteristics of IoT are as follows:

2.1 Intelligence: IoT comes with the combination of algorithms and computation, software & hardware that makes it smart. Ambient intelligence in IoT enhances its capabilities which facilitate the things to respond in an intelligent way to a particular situation and supports them in carrying out specific tasks. In spite of all the popularity of smart technologies, intelligence in IoT is only concerned as means of interaction between devices, while user and device interaction is achieved by standard input methods and graphical user interface.

2.2 Connectivity: With regard to the IoT, anything can be interconnected with the global information and communication infrastructure. Connectivity enables network accessibility and compatibility. Accessibility is getting on a network while compatibility provides the common ability to consume and produce data.

2.3 Dynamic Nature: The primary activity of Internet of Things is to collect data from its environment , this is achieved with the dynamic changes that take place around the devices. The state of these devices the number of devices also changes dynamically with a person, place and time.

2.4 Things-related services: The IoT is capable of providing thing-related services within the constraints of things, such as privacy protection and semantic consistency between physical things and their associated virtual things. In order to provide thing-related services within the constraints of things, both the technologies in physical world and information world will change.

2.5 Heterogeneity: The devices in the IoT are heterogeneous as based on different hardware platforms and networks. They can interact with other devices or service platforms through different networks.

2.6 Security: As we gain benefits from the IoT, we must not forget about safety. As both the creators and recipients of the IoT, we must design for safety. This includes the safety of our personal data and the safety of our physical well-being. Securing the endpoints, the networks, and the data moving across all of it means creating a security paradigm that will scale.

III. ARCHITECTURE OF IOT

The architecture of IoT depends upon its functionality and implementation in different sectors. Still, there is a basic process flow based on which IoT is built.
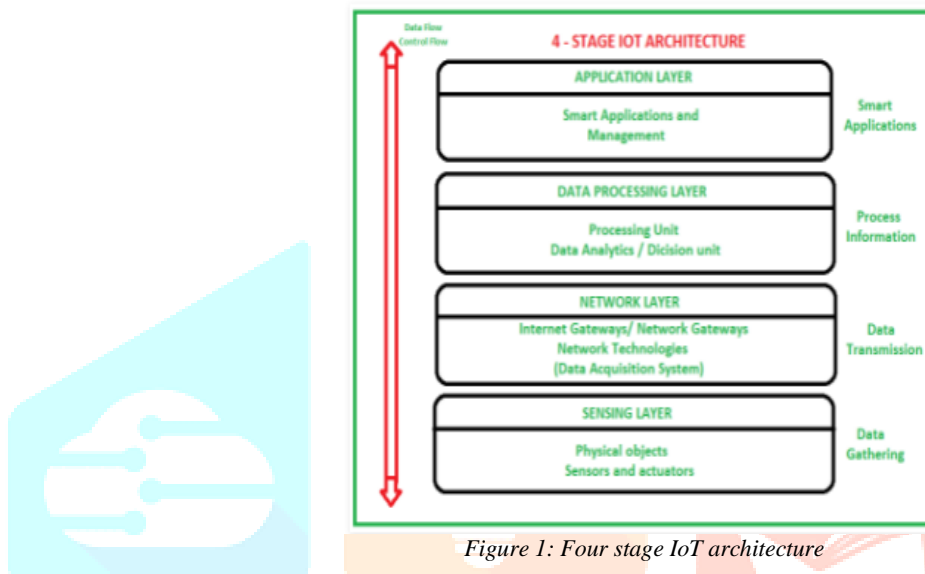

Figure 1: Four stage IoT architecture

So, from the above figure (Figure 1) it is clear that 4 layers are present that can be divided as follows: Sensing Layer, Network Layer, Data processing Layer, and Application Layer.

- **Sensing Layer** – Sensors, actuators, devices are present in this Sensing layer. These Sensors or Actuators accepts data (physical/environmental parameters), processes data and emits data over network.

- **Network Layer** – Internet/Network gateways, Data Acquisition System (DAS) are present in this layer. DAS performs data aggregation and conversion function (Collecting data and aggregating data then converting analog data of sensors to digital data etc). Advanced gateways which mainly opens up connection between Sensor networks and Internet also performs many basic gateway functionalities like malware protection, and filtering also sometimes decision making based on inputted data and data management services, etc.

- **Data processing Layer** – This is processing unit of IoT ecosystem. Here data is analyzed and pre-processed before sending it to data center from where data is accessed by software applications often termed as business applications where data is monitored and managed and further actions are also prepared. So here Edge IT or edge analytics comes into picture.

- **Application Layer** – This is last layer of 4 stages of IoT architecture. Data centers or cloud is management stage of data where data is managed and is used by end-user applications like agriculture, health care, education, aerospace, farming, defense, etc.

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IV. IOT IN EDUCATION

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After Technology in education has played a significant role in connecting and educating the students. IoT technology has an important impact on education field. Students are increasingly moving away from paper documentation toward smart phones, tablets and laptops that offer them the necessary information at their fingertips, and also the possibility to learn at their own pace. This trend provides convenience also for teachers, because the teaching activities become more efficient and student-centered. Professors can collaborate, using IoT connected devices, with each of the students, adapting their course and practical activities. Mobile Devices and Tablets Educational Apps changed the methods of teaching/learning and can be considered as powerful tools to create 3D graphics presentations and textbooks featuring videos. Also, mobile devices allow students the access to eBooks,

quizzes, projects and to watch the labs and courses in video format, which are very attractive learning methods for students and new teaching opportunities for teachers.

The term Internet of Things in Education is considered two faceted because of its use as a technological tool to enhance academic infrastructure and as a subject or course to teach fundamental concepts of computer science. IoT technology is playing a likely role for the improvement of education at all levels including school, college and university teaching. From student to teacher, classroom to campus, everything can get benefited with this technology. The Internet of Things (IoT), the connection of devices - other than standard products such as computers and smart phones - to the Internet, is in the process of transforming numerous areas of our everyday lives. As in many other sectors, the Internet of Things (IoT) has been a boon for education. From so-called "flipped classrooms" and online courses to integrated mobile technology and more efficient teaching methods IoT can help us make education more accessible in terms of geography, status, and ability. E-learning is revolutionizing our education system as it remains the only option during the ongoing crisis. According to recent report, IoT in Education Market was valued at USD 5.31 Billion in 2019 and is projected to reach USD 19.57 Billion by 2027, growing at a CAGR of 17.74% from 2020 to 2027
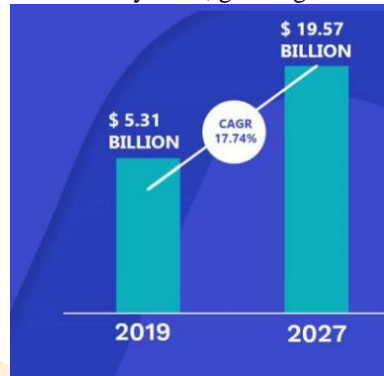

Figure 2: Global Iot in education Market 2020-2027

IoT provides a better-connected and more collaborative future for education. IoT devices give students better access to everything from learning materials to communication channels, and they give teachers the ability to measure student learning progress in real-time. IoT is not about the technology, it's about sharing knowledge and information, communicating efficiently, building learning communities and creating a culture of professionalism in schools. These are the key responsibilities of all educational leaders. A change in education requires reassessing our education strategy. It also requires educating and retraining teachers and students in the field of technology. The infusion of technology in education will be phenomenal we will not go back to the pre-COVID era of the education system. The IoT enabled transformation from teacher-centric education to student-centric education is reinventing education in our country.

V. RESULTS AND DISCUSSION

5.1 Smart Classrooms

The classrooms of the future will be truly tech-enabled. Augmented reality will make dissection day much more humane by obviating the need for actual animals. Virtual reality will replace history class with up-front seats to Charlemagne planning for war and science class with a true-to-size demonstration of the particles that make up life as we know it.
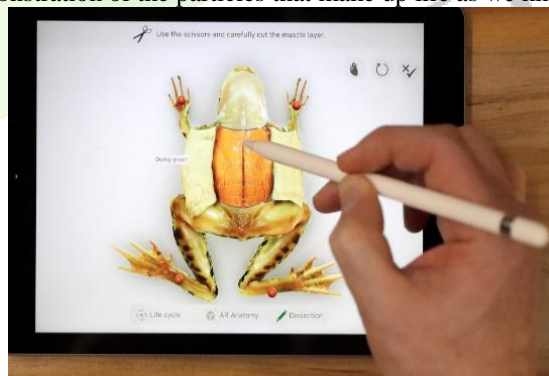

Figure 3: Smart Classroom

IoT applications in education will be the foundation on which these classrooms operate. Students will be automatically counted as present or tardy when the bell rings. Wearable devices will determine when the class is too tired or disengaged and may need a break, and whiteboards will record all notes taken in a class. Smart-microphones may even recognize when a teacher mentions there is a homework assignment due and update students' planners accordingly. Three primary objectives in the Smart classroom are learning, reasoning and predicting. In other words, creative environments must learn or understand how the environment works and thinks and must able to react according to the action or situation.

5.2 Enhancing online connectivity

Imagine a scenario when learners sitting at their desks at home or in a classroom can communicate with their classmates, educators, and mentors scattered all over the world. Or, let's say, the activity of the day is focused on sea life. To provide a highly educational and a really exciting experience to their students, teachers decide to access the information generated via live feeds and sensors monitoring water bodies.

5.3 Task-Based Learning

One of the structural shifts taking place in education is the move from a knowledge transfer model to a collaborative, information-sharing system. IoT will have a profound impact on the way we teach, because connected systems free-up teachers from recording and monitoring students, enabling them to facilitate learning rather than merely to regurgitate information. In task-based instruction, students learn-by-doing and teachers assist when needed. IoT systems provide feedback, assistance, and classroom-level monitoring automatically. By signaling teachers for help and by increasing difficulty when necessary, no student falls too far behind nor gets too far ahead—a problem that has always persisted in the classroom.

5.4 Attendance monitoring automation

Taking attendance of a class is a time-consuming task. Use of IoT can save time and effort both. A study proposed an efficient smart classroom roll caller system (SCRCS) using IoT architecture to collect or record student attendance after every period accurately and timely. RFID tags are attached to the Students' ID cards. The SCRCS can be installed in every classroom and read the students' identity card collectively. It shows not only the total attendance e on LED display at the beginning of any class but also shows the all identity card on multiple slots of SCRCS. The record of a student's attendance is also kept at the academic office. This could help the agency to reduce the time it takes to publish attendance facts and allows school officers to send a piece of email to mother and father.

5.5 Sensor gloves

Sensor gloves connected to an IoT system can be used for teaching sign language to children. When a learner wearing a sensor glove makes a sign, an IoT system fetches the signal and analyses it. Comparing a learner's sign with the correct sample, a control app can provide a learner with the feedback on his or her signing accuracy. Hearing-impaired students may utilize a system of connected gloves and a tablet to translate from sign language to verbal speech, converting sound into written language. Using IoT devices and systems is a constructive way to provide educational assistance to disabled learners.

5.6 Wearable IoT devices

Wearable IoT devices like virtual reality headsets, watches, and fitness bands may soon find their way into classrooms. The IoT enabled headbands report the activity of a student's brain to a mobile app. This could help teachers track students' learning styles and monitor student engagement.

5.7 Superior safety features

This Application of IoT in Education is important as enforcing the superior technology inside the school rooms and training area may be very useful. It includes emergency indicators, audio enhancement, Wi-Fi clocks and hearing impaired notifications that offer the scholars and body of workers with a feeling of security. The colleges and schooling centers are adopting specific security measures that assist to relax the campuses. The IoT enabled communications system also be utilized for various cases such as special emergency tones, live bulletins, a couple of bell schedules and pre-recorded instructional messages in order to direct the group of workers and students at some point of emergency.

5.8 Online laboratory classes

Data obtained from wearable sensors report the effect of specific stimuli. For instance measuring users' brain signals while studying Internet marketing traces the impact of various advertising tools (for example, advertising formats) on a company's web site. EEG devices are connected in IoT hub and their signals are analyzed by Stream Analytics in real-time or offline after additional processing with discretization methods

5.9 Real-Time Feedback on Lecture Quality

Students' understanding directly relates to the lecture quality. Students' feedback plays an essential role to improve lecture quality. A study proposes a creative environment that can monitor and observe students' reactions to a lecture using sensing and monitoring technology. This IoT-based smart classroom provides real-time feedback on lecture quality which will help to improve the lecture quality.

5.10 IoT for examinations

During an examination, data collected from IoT sensors are processed for detection of abnormalities in examined students' behavior. The lecturer receives messages indicating which the students with dishonest behavior are. The lecturer could warn and/or remove these cheating students from the examination.

VI. CHALLENGES WITH INTEGRATION OF IOT IN EDUCATION

For successful integration of IoT devices in a classroom environment, an education provider may have to face many difficulties like network bandwidth, reliable Wi-Fi Connection, web analytics, security, privacy, availability of devices for students, teacher training and cost of equipment, etc. Some of the challenges are discussed below.

6.1 Privacy and Security

In IoT-based environment, data is stored at an Internet-based network of connected devices, as devices start to measure and collect data from students, they put student's security and privacy at risk. Any security breach could disclose student's personal information related to an individual's medical record, family financial background or any other private information.

6.2 Reliable Wi-Fi Connection

There is a continuous need for new technologies for education, like high-speed wireless networks which provide the bandwidth for audio and video streaming of lessons
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6.3 Data Management

Data management is a crucial aspect in the Internet of Things. When considering a world of objects interconnected and constantly exchanging all types of information, the volume of the generated data and the processes involved in the handling of those data become critical.

6.4 Cost

IoT uses technology to connect physical objects to the Internet. The whole setup of an IoT-based educational institution can be expensive. Therefore the cost of devices and equipment is another challenge.

VII. IMPACT OF IOT IN FUTURE EDUCATION

For successful integration of IoT devices in a classroom environment, an education provider may have to face many difficulties like network bandwidth, reliable Wi-Fi Connection, web analytics, security, privacy, availability of devices for students, teacher training, IoT will improve teaching and learning process in future. IoT will bring ease for both students and teachers. A modern lecturer is much more than a good presenter of the training material. He or she is also involved with monitoring students' progress and encouraging their overall performance towards successful course completion. To cope with thesechallenges, along with the pedagogical training and experience, the lecturer could employ described IoT framework to communicate with the audience and to automate some educational activities.

Data collected from the IoT devices provide information about students' attitude to the training topics. The artificial intelligence methods useful in revealing some hidden dependencies in collected dataare as follows:

- face recognition for student identification;
- facial expressions recognition for determining student's emotional state;
- classification of the attendees according to their behavioral parameters.

Main learning activities and the corresponding IoT tools and Machine Learning (ML) algorithms for their monitoring and management are shown in Table 1.

Use cases	IoT devices	ML algorithms
Teaching (lectures and seminars)	Web camera EEG(electroencephalogram device)	Face Recognition Deep Learning
Laboratory Classes	Web camera EEG GPS tracker Smart watch	Face Recognition Classification algorithms
Examination	Web camera EEG Eye tracker	Face Recognition Deep Learning
Attendance	Web camera	Face Recognition

Table 1. Learning activities and corresponding IoT toolsand algorithms for their monitoring and management

It can be predicted that IoT tools will provide a more appealing, flexible, engaging and quantifiable system of education that fulfills the different needs of a vast number of students. A student spends one out of every five minutes in the classroom on jobs that can easily be removed by using a network of IoT. Teachers would be able to spend less time on simple procedures and more time working with students to monitor their progress. They can also help them grasp difficult concepts in short span of time, attendance could be recorded automatically, neuro sensors could be used to determine learners' cognitive brain activity, and haptic vibrations could be sent to a student's wearable to warn them back on task discreetly. While a majority of educational institutions have yet to adopt an IoT program, such a learning environment is not that far off.

VIII. CONCLUSION

Internet of Things is a new revolution of internet. Use of technology and especially IoT in the field of education has opened the doors for new and innovative ideas to bring ease and betterment in the lives of both students and teachers. The rapid influx of technology in the education system amidst the crisis might give rise to a new era wherein the students will have access to the best of faculty from across the globe. It is expected that IoT enabled technology will leave a lasting impact in the field of education. There will be an increased focus on the quality of faculty and IT infrastructure and the need for faculty to be familiar with digital teaching methodologies. Though there are various advantages of IoT in education but may have to compromise privacy and security. In the future new techniques may be introduced that can resolve all these issues.

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