The Impact of Big Data and IoT for Computational Smarter Education System

Asma Jahangeer, Ahthasham Sajid, and Afia Zafar

Abstract In modern era of cyber net and latest smart technology i.e., Internet of things (IOT) has played an essential role in every field of life. IOT is known as one of the pillars of 4th industrial revolution (4th IR). Connectivity using different sensor and objects used in daily mankind life are connected to internet that makes communication easy for human to human, human to machine and machine to machine now a day. Many applications of Big data and IOT including smart home, smart hospitals, smart shopping mall, and smart education system have been introduced in past few years. With the passage of time education system and learning methods are massively transformed due to latest technology specifically by use of IOT in education. Using IOT in education is an enhance level of learning opportunity for students. Use of Big data and IOT helps teachers to ass's students in a better way and can take better decisions to fulfill students learning, from data collected by IOT devices to store large amount of data using Big data tools. Administrative staff of educational institutes can take benefit from IOT devices to manage their task more efficiently. Along with advantages there are some challenges to fully apply IOT in field of education but no doubt that the adoption of IOT has completely changed the model of education system in all over the world.

Keywords Smart education · IOT · Big data · Cyber

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1 Introduction

In the era of twenty first century everyone is part of fast-moving technology over the cyber net. People are surrounded by IOT everyday even if they do not notice it. What comes to mind first when they think of IOT? Possibly wearables or smart home devices like smart refrigerators, But IOT is not only limited to these devices. People are likely to not even notice the presence of Internet of Things solutions in their life, but they are nearly everywhere. The Internet of Things provides connectivity for people at any place. With the progress in technology, people are moving towards a society, where everything will be connected through internet. The Big Data and IOT is considered as the future evaluation of the Internet. The question is that what is M2M learning? The answer to this question is that M2M learning stands for machine-to-machine learning. Machine to machine defines to direct communication between devices using any communications channel, like wired and wireless [1].

The basic idea of IOT is to permit autonomous and secure connectivity and exchange of data and applications. The IOT links with real life works and physical devices with the computer-generated world. There are many viruses, hackers, malicious programs which effected the IOT devices so security of IOT is very important. Without security IOT is not powerful. Because all malicious programs, viruses, hackers attack on devices which are connected through internet. In past, no one was paying attention on security issue. Day by day everybody knew and notice that security of IOT devices is very important. Fourth industrial revolution has digitalized the technology. Along with artificial intelligence, block chain, IOT has an important role in this digitalization [2].

Like the other fields of life IOT is an emerging technology in the field of education. With the help of IOT devices in education system, students can participate and interact with other people like teachers, others students and with admin staff in their institutes. IOT brings a lot of possibilities, it helps to develop better Infrastructure of educational institutes as well as improve learning process of students. By using IOT based smart devices higher education institutes can be smarter. Today IOT is a ubiquitous technology, as per estimation by the end of 2020 more than 26.66 billion IOT devices have been active and this number is not stopped here. By the end of 2025 almost 152,200 IOT devices will be able to connect to internet every single minute. Figure 1 has given a representation that how in terms of devices vs. people over the internet has changed drastically after the innovation of internet of things. In 2003 there were allot of human beings' user of the internet whereas there are only few numbers of devices connected to internet; after 2008 with the introduction of IOT this ratio started to changed and we have a good number of devices connected to the internet as human started to carry smart handled devices with them. Right now, in 2020 scenario of connectivity is totally changes; as we now have over 50 billion devices connected to internet which is a huge number if we compare it with the people who are using internet now a days [11].

Basic purpose of IOT is to bring automation in every task in major industries such as IOT is enabled in home automation, in clothing industry, in health care, in

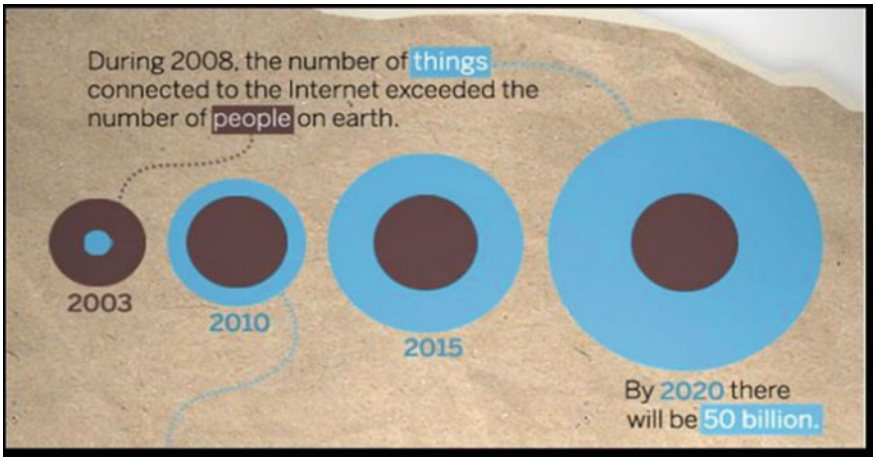

Fig. 1 IOT growth over time [20]

agriculture and in education. IOT devices communicate with each other with the help of sensors which is heart of these all devices. Number of small sensors are embedded in single device. All the data from these devices is gathered and collected on cloud. After analytics these devices become actionable. So far there are many IOT devices are introduced such as smart glasses, smart watches, smart door lock, smart fire alarm system, medical sensors and smart security systems. Scanmarker, LOCOROBO, KALTURA, Blackboard are IOT based devices which are specifically used in Education sector. Use of IOT in education brings a valuable change [14].

2 Architecture of Smart Learning Environment

Twenty first century is known as an era of technology, where technology providers have ambition to provide cheap affordable technology to every individual. Now a day's smart devices are becoming smaller and smarter, easy to use and have seamless network. Its living example is our smart phones which are smaller in size but greater in work. Architecture of smart computing is rapidly changed. It has 3-tier architecture, by name cloud computing, fog computing, and swarm computing. The 3-tiers work as companions. Learning applications may have different components that run in 3-tier (Cloud, fog and swarm). All 3 tiers depend on each other to manage and control the resources and to analyze learning content [12].

2.1 3-Tier Architecture

The three-tier architecture is presented below.

2.1.1 Cloud Computing

The 1st layer or inner most layer is known as cloud computing. It provides software as a service (SaaS). It has centralized data storage system along with many remote servers and software networks. Its centralized server makes accessibility of resources and computer services possible. In smart learning environment cloud computing provide centralized data storage, platform visualization, and software services such as smart content, smart pull and push and smart prospect.

2.1.2 Fog Computing

Fog computing have very important role in IOT. Diverse type of services can be produced by it. It has virtualized platform that provide storage, networking services and compute services to data centers in traditional cloud computing and to end devices. Its platform is highly virtualized. In smart learning environment fog computing facilitates with real time interaction, provide support for mobility, location awareness, large scale sensors networks and so on.

2.1.3 Swarm Computing

In 3 tier architecture outer most layer is known as swarm computing. It is also now as environment a wear computing. It executes on swarm of smart devices. As the technology is becoming ubiquities and pervasive, swarm computing envisions to develop an environment that can sense activities on learning devices. Collect data from devices and transfer the data for analysis to data management system.

3 Key Functions of Smart Computing 5 A's

There are five intelligent functions that make computing technology smarter. These smart functions include 5 A's which are actions, audibility, Alternativeness, analysis and awareness. Actions and audibility are functions of cloud computing, Alternativeness and analysis are functions of fog computing and awareness is key function of swarm computing. The all functions are discussed as below:

3.1 Action

Actions can be taken by executing process. These actions can be used by the learners such as to locate places for example campus direction.

3.2 Auditability

Audit report is generated to determine that either learning actions are correct or not. In smart education there is need to make learning more efficient which is possible by analyzing data of learning activities, monitoring, capturing and tracking it at each stage and evaluate. The purpose of audit is to bring improvement in actions.

3.3 Alternativeness

Alternatives can be made to identify that learning flow either through human review or by automatic tasks. Learning pattern depends on alternative course of action.

3.4 Analysis

Different data mining, learning analysis and big data tools are used to analyze real time data received from learner's device. After analysis resources and learning patterns are recommended to learner.

3.5 Awareness

We should be aware of this thing that learning process can be taken place anywhere and anytime. Students' identity, location, condition, status can be captured by swarm computing. For example, by learning analytics, data mining, pattern recognition. This data then can be transfer to central server from learner's device.

4 Smart Environment

The computing paradigm earlier was not that much effective in terms of computational and connectivity prospective (Wireless Communication) capabilities, but

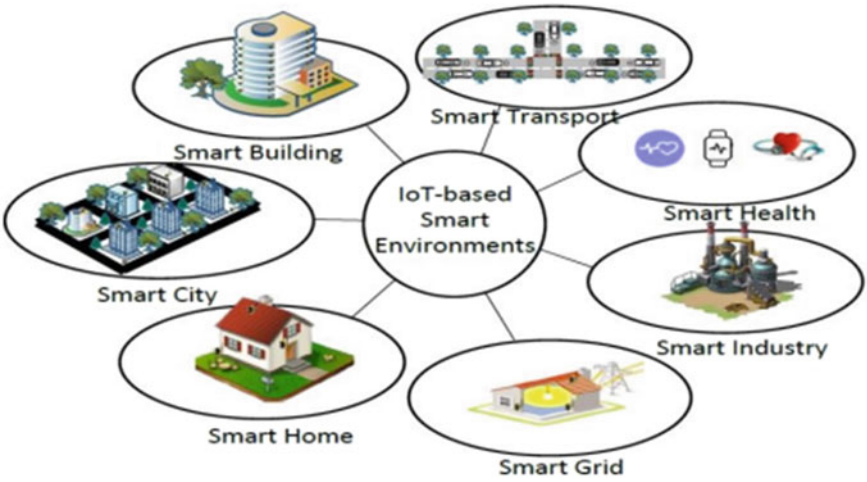

Fig. 2 IOT based smart environments [21]

with the introduction of new paradigm "Connected" everywhere, everyone at any time with objects carried out by the human being with built-in sensing capabilities has tremendously increases an environment to become smarter indeed. IOT systems currently providing such smarter environment with various effective performance characteristics on the other hand also facing some key challenges.

Wireless connectivity is one of the major ingredients in almost every IOT-enables connectivity providing smart features. Challenge is in the selection of right wireless technology for the system so that smart features can be delivered 24/7 (everywhere, everyone at any time) in true spirit [15].

Figure 2 illustrate that with the use of sensor technology and handheld smart devices usage among human being; now a-days almost every environment connected with society (Cities, Offices, Internet of Things Transportation Social Life & Environment Home Automation Cities Office Automation Energy Conservation Health Education Home, Buildings, Transportation, Education) etc. are possibly connected in smart environment. Smart environment could be controlled remotely with smart handheld devices [16].

5 IOT Applications

After the invention of sensing technology with various sensors available now a days in market for almost every field, applications of IOT has also attracted almost every industry belonging to society and human being. Figure 3 bellow has given an insight to this in detail.

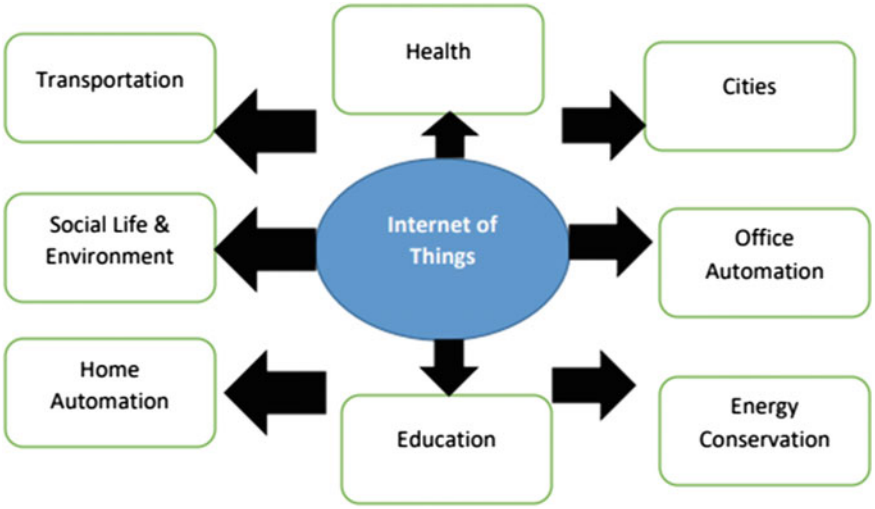

Fig. 3 IOT applications

5.1 Significance of IOT in Education

Use of IOT in education means creating smarter education system which provide structured and an advance value to the system. People get familiar with use of IOT at smart home by using same technology we can get better infrastructure of school buildings. IOT base devices help to reduce men power and save cost. For example, by using smart lightening system in campuses, HR do not need to hire a person for this job instead lights can be turn on and off automatically by sensing a human body in surroundings by this way less electricity will be used. similarly, during the lectures instructor can set the light system to be bright or dim by change of light in classroom students will be more attentive [8]. There are many institutes that have already implemented smart light system and they got better results and found students more productive. IOT devices can be used for security purpose such as smart alarm system that can alert everyone in the building about misfortune or gun shooting can be sense by special purpose sensors. Significance of IOT based devices in education provide secure learning environment. Student performance can be better by use of IOT objects inside the classes especially in circumstances like COVID-19 when learning take place remotely. According to student needs smart devices in the class can be personalized and facilitate students. This application recommends helping material to students so an improve learning environment is able to develop [9].

5.2 Smart Education

Smart education is a term that is being used for the process of applying modern technology in the field of education such as converting teaching into smart teaching, managing educational process with the help of smart devices and use of technology in research area. By implementation of smart education can be a way to improve quality of education, bringing new ideas and innovations in the field and a chance to change traditional way of education. Smart education can change historical process. Like there are eight planets there are eight parts of smart education system has been proposed which are personalized and diverse learning path, culture, skills, resources, global integration of knowledge, economy, technical immersion and system [7]. Online intelligent tutor system, learning analytics, e-learning, knowledge graphs and big data are few directions in smart education. There are many universities which already have developed IOT based smart education system, few of the universities are as following: University of North Carolina, Stanford University, University of Southern California and they have implemented smart INSTRUCT system, MMAP collaborative teaching model teaching system and RIDES Intelligent Tutoring System respectively. Educational Robot, smart campus along with virtual teachers and parallel education are also few examples of already system [17].

5.3 Challenges of Smarter Education

There are few challenges in smart education system such as security, Data visualization, connectivity and prediction system, these are discussed below in detail.

5.3.1 Security

IOT applications in smart education collect data from teaching staff, students and other faculty members, this data is vulnerable to attacks and cause serious security and privacy issue for individuals. Therefore, more research is needed in this aspect [18].

5.3.2 Data Visualization

Data generated from the smart device is very big in size it is very important to take insight from the data collected from smart educational devices, although there are many research papers that have presented data visualization techniques but their need to be correlate already manually collected data and huge amount of data collected from the smart devices. The purpose of smart devices is to provide ease and comfort to users not to create hap hazard with big size of data [18].

5.3.3 Connectivity

Speed of internet depends on the traffic, as there are number of students connected to internet in smart campuses at the same time, so it is discovered that the speed of communication is slow. There is need of a quick protocol such as combination of AR or VR with RFID or any other sensor. These types of protocols introduced more elements and able to respond more quickly as compare to traditional protocols [18].

5.3.4 Prediction Systems

Purpose of smart system is to provide automation, analysis and collect better results, for this purpose there is need to build better prediction modeling algorithm, by this way better results can be collected. For example, by seeing students fee submission it can be predicted that number of student's width drawl or by analyzing student's performance their grades can be predicted. By this analysis correct measures can be taken and resources can be provided for student's improvement [18].

5.4 Effect of Smart Classroom on Student Achievement at Higher Education

A classroom can be an ideal classroom if educators can deliver an engaging session. Students' capabilities can be improved by tech-based learning which is only possible by providing infrastructure of smart classroom. A smart classroom provides better learning environment because this novel atmosphere is more attractive and interactive for the learners [4].

A smart classroom impact student learning but how can we actually define a smart classroom? A smart classroom is defined as room having sensors that can collect data on real time, a computer and an audiovisual system that gives response to instructions. With the help of audio-visual equipment, variety of media can be used by the teachers. By use of internet in the classroom students can get vast knowledge about subject. It increases student interest and bring dynamic perspective to the education. Online learning makes students independent as they can explore about their topics. They can find answers without help of instructors. It makes them more confident and enhance their curiosity for learning. By use of smart devices for learning students can think out of the box. They can analyze, develop better understanding and collect results about tools used in the class [5].

Every student sitting in the classroom have different IQ. They have different way of learning and understanding things. With the help of different sources and media they are not bound to one book. Student's academic performance can be improved by use of technology as it is challenging for students to visualize the

concept without technology. A better learning environment that can develop interest and engage students can be achieved by smart classrooms in higher education [19].

5.5 Existing Applications of IOT in Education

There are some of the existing applications of IOT based technology that has implemented and running successfully across the globe.

5.5.1 Smart Lightening System in the Campus

This smart lightening system in the campus help to reduce energy consumption and by saving this energy campus can easily implement the ideal environment of green campus [3]. Smart wearables can help to collect data. Most of these wearables such as hand band or foot wear are connected to web apps and after processing of data feedback is provided to students [8].

5.5.2 Smart Entrance System

The IOT based smart education system have upgraded the learning environment. Manual system of student entrance in campus gates take a lot of time due to security purpose but IOT based RFID ((Radio-frequency Identification) tags can be applied on student's ID cards by that they can enter the campus with ease, these RFID's help to mark an automated attendance. Universities administration can also manage access control of different entrance gates and doors. IT can increase security and enable a comfortable environment for students. Students can use smart devices to reserve their seats in campus library, gymnasium and at auditorium [6].

5.5.3 Student's Healthcare

Fitness band are used to monitor the temperature of students during the school time. It also gathers data for e healthcare and monitor students blood pressure and rate of heart beat. Students having high or low blood pressure or any other illness can be treated in the campus immediately [10].

5.5.4 Smart and an Enhanced Learning Process

Sony smartwatches and google glasses are used to monitor understanding level of students during classes. By collecting data from these smart device's instructor can

facilitate students with personalized explanation about any topic. Student behavior can be measured by smart camera.

Let's discuss some of smart devices which are already applied in classrooms.

5.5.5 Scanmarker

Scanmarker is amazing invention of IOT; Its name presents it scan text on the documents, book, magazine and scan it on word or excel document. It works as highlighter all you have to do is scan the text on the book. It has features of text to speech, image reader, and multiple language translation. While you scan you can listen and read the text at same time that prepares students to read fast and absorb quickly. Just imagine transfer of text from physical book to your computer system by just one scan [14].

5.5.6 LOCOROBO MY Loopy

My loopy is first programmable robot for students of early years established by LOCOROBO company. It is designed for learning purpose. My loopy is an interactive way to teach STEM courses to young learners. It develops code writing skills in children because loopy love to response when it is touched by human. Similarly, it response to light, temperature and sound [14].

5.5.7 Kaltura

KALTURA is a video editing tool for kids. If any child wants to edit video KALTURA helps to edit and produce line and on demand video. By this way student can learn tool of video editing and image processing that develops a skill which can be very beneficial for them in future. Integrating IOT in education makes system much easier than ever before, institutes that have established digitized technology have higher value proposition such personalized learning, collaboration, safety and lower cost as compare to traditional systems [14].

5.6 General Challenges of IOT in Education

Along with many benefits there are some challenges that are faced while implementing IOT based infrastructure at educational environment.

IOT based education system have challenges as well some are discussed below:

- Converting traditional system to an IOT based smart system required support from teachers, students and other staff members for that they need to be little tech savvy and should know how to use these smart device and applications. Utilization and

managing these resources in the classroom is very important otherwise all effort is useless.
- Making an ordinary system a smart IOT based infrastructure is very costly especially for institutes that have low revenue. In this regard government support is required.
- Security of IOT devices is vulnerable from the beginning although a lot of work has been done for achieving high security but there is still security issue with IOT devices.
- Always required fast and reliable internet connection.
- IOT based data has issue of scalability as data collected from all the devices used in school is so big in volume.
- IOT devices increasing health issue in students and making them less social with in their community. That impact on student's social well-being [13].

6 Conclusion

The role of information technology to improved educational academics activities in society internationally or nationally could not be ignored now days, especially from last 10 years. Internet has shifted from IOP (Internet of People) to IOT (Internet of Things) nowadays. Education could be provided with ease and accessibility on timely and efficient manner with use of smart handheld devices connected over Internet of Things in twenty-first century. Recently an epidemic of COVID 19 has given rise to online education activities in the world; unfortunately, those countries which did not have good internet connectivity and infrastructure suffers allot in delivery of quality education to (School, Colleges and Universities even). A smart educational environment is therefore encouraged with the use of various information technology devices and infrastructure for the quality of education in twenty-first century and in future.

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