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ABSTRACT

The Internet has transformed its original form into connecting objects from a medium of connecting networks, people, institutions, and countries. The new Internet of Things technology allowed the physical objects to interact, exchange information, and even monitor each other through sensors, code, and networking protocols, what we see around us, and what we are around. Such technological advancement brought about a sudden paradigm shift, just like other industries, even in the education system in the form of e-learning, m-learning, i-learning, m-learning, u-learning, o-learning, etc. The word education is slowly transforming as 'smart education', ‘intelligent-education’, ‘online education’, ‘smart education’, ‘ubiquitous education’, etc. By delivering enhanced teaching-learning experience, streamlining operative effectiveness, and providing real-time, cognizance into the performance of students’, educational institutions are capable of enhancing teaching-learning experience through IoT. A theoretical model is presented in this paper aimed at automating every entity of the education system and the elements involved in it to enrich and improve, as well as change, the knowledge ecosystem's end-to-end learning lifecycle. The proposed model ‘autonomous intelligent smart ubiquitous campus’ for IoT based education environment discusses various functional entities of the central digital nerve system of the HE campus with their perspectives and challenges in a real-world scenario. Also, it provides a conceptual framework designed to encapsulate the modules of the system within an already existing or new campus environment.

Keywords: Education, IoT, Smart Education, E-Learning, Higher Education, Campus, Senor.

1. INTRODUCTION :

In the field of information technology, the buzzword Internet of Things (IoT) is not recent. It has been in use for a while now. Off late, due to technological advances in wireless technology, the word is attracting more attention and attraction. IoT will expand the scope of the Internet from a mere link provider to various computers and computer equipment to allow the interconnection of different things, physical objects, we see around us and we are around such things as lamps, fans, air conditioners, toothbrush, microwave oven, pens, televisions, washing machines and so on in our residence, internet-working of different machines or equipment in the business, and so on. To be precise, the IoT interconnect smart physical objects that can collect data, communicate data, exchange data, and send/receive messages over the Internet [1]. That means IoT technology empowers these ‘things’ to talk to each other, share information, and synchronizes activities to see, hear, think, speak, and perform jobs assigned to them[2]. By providing the technologies they needed, including ubiquitous and omnipresent computation, embedded devices, communications networks, sensor technology, protocols, and a variety of technologies, the very technology allowed them to switch from passive to active and intelligent. Original IoT was strongly based on Radio Frequency Identification (RFID) for Interconnection; today there are several similar technologies, they are Near Field Communication (NFC), Machine-to-Machine (M2M),

and Vehicle-to-Vehicle Communication (V2V) all may be may be used for the realization of modern IoT solutions. The IoT technology promised a revolution in the way we work, we live, we play, we analyze and we think makes life easy [3]. IoT's influence is seen everywhere today, from consumer products to military equipment, from motorcycles to aircraft, from manufacturing units to industries, from everyday use items to utility components, from data gathering to education and from home to smart cities. The everyday use objects which are being combined with Internet connection and data analytics capabilities guarantee ease of doing work, ease of living, ease of analyzing, ease of thinking, and ease of playing. In essence, IoT provides a flat-form to interconnect various electronic devices through the Internet and open up a new world of possibilities [4]. It was anticipated that every different thing we see around us and we have around us will all be internet-worked or interconnected very soon. Such technological advancement brought about a sudden paradigm shift, just like other industries, even in the education system. In the form of electronic-learning, mobile-learning, internet-learning, ubiquitous-learning, online-earning, machine-learning, etc. The word education is slowly transforming into 'intelligent education'. Through IoT, with the help of IoT, educational establishments can enhance teaching-learning experience by facilitating enhanced teaching-learning experience, streamlining operational competence, and providing meaningful, pervasive perspective into student performance [5].
This paper provides a plan aimed at automating every element of the system of education andthe elements involved in it. The paper suggests a model for IoT based education environment in the form of an ‘intelligent campus’ and discusses its perspectives and challenges in a real-world scenario. The paper throws light on the subject matter using fourteen sections – i) Objectives, ii) Methodology, iii) Related Study, iv) Elements of IoT Ecosystem, v) Required IoT Infrastructure, vi) Shift in Education Paradigm, vii) Pillars of IoT in Education, viii) Integrated Intelligent Education System, ix) Architecture of the proposed model, x) Functioning of the Proposed System, xi) Benefits &Challenges xii) Discussion & Future work andxiii) Conclusion.

2. OBJECTIVES OF THE STUDY :

- To provide a clear picture of the IoT architecture
- To study IoT's impact on higher education
- To analyze the use of IoT in 'intelligent campus' formation
- To present a conceptual model for the solution 'intelligent campus’

3. METHODOLOGY :

The authors are making an effort in this paper to answer the question "How IoT can turn the model of higher education from teacher-student, one-to-one environment into an omnipresent-autonomous-smart-intelligent ecosystem." The study is carried out by using educational services and interconnected campus components to explore the possibilities of IoT's impact on the educational environment, making it more and more application-centered. This Conceptual research paper is developed by observing and analyzing existing information on the topic 'smart campus’ published in Journal Articles, Conference Proceedings, and Online Papers. An *'i-campus'* model is designed by evaluating and updating the refereed materials. The model is only theoretical; require further unlocking efforts and different techniques to exploit its potential

4. RELATED STUDY :

In the rapidly evolving world of technology that develops the IoT, a global network infrastructure in which trillions of linked devices permeate the environment we live in. In the context of supply chain management, Kevin Ashton was the first one to coin the term IoT in 1999[6]. It is a technological innovation that allows objects, individuals, and environments to communicate all over the world. The data will be collected by implanted sensing devices and actuators, and then will be fed to specialized applications to deliver actionable knowledge. IoT was known as one of the foundation stones of Industry 4.0' because of its ability to transform the conventional industrial and business procedures[7]. Physical systems are becoming smarter and more interactive than ever with the growth and development proliferation of the IoT. This has changed the way we live in almost every aspect of our lives by enhancing sustainability, productivity, accuracy, and economy. In many sectors such as “health systems”, “traffic management”, “energy management”, “education”, “environmental monitoring”, “smart homes”

and “smart cities”, IoT has been leveraged [8].In [9] IoT is defined as *“The worldwide network of interconnected objects uniquely addressable based on standard communication protocols”.* The European Projects Cluster for IoT [10] defines IoT as *“Things are active participants in business, information and social processes where they are enabled to interact and communicate among themselves and with the environment by exchanging data and information sensed about the environment while reacting autonomously to the real/physical world events and influencing it by running processes that trigger actions and create services with or without direct human intervention”.* Gubbi, *et al.* [11] defines IoT as *“an Interconnection of sensing and actuating devices providing the ability to share information across platforms through a unified framework, developing a common operating picture for enabling innovative applications. This is achieved by seamless ubiquitous sensing, data analytics and information representation with Cloud computing as the unifying framework.”*
Learning has evolved from the passive conventional information transfer infrastructure to a dynamic interactive self-governing framework through the technology's transformative impact in the educational institutions of today. This prompted many institutions to reconsider learning and teaching. Increasing student engagement in learning and curriculum development, the impact of technology can be seen in many areas of learning environment to help educators deliver customized content and enhance student outcomes. Currently, there are 7 types of technologies, instruments, and approaches that drive innovation in education [8]:

1. Consumer Technology.
2. Digital Strategy.
3. Enabling Technology.
4. Internet Technology.
5. Learning Technology.
6. Social Media Technology.
7. Visualization Technology.

IoT is an Internet technology sub-category that promotes learning in many respects. IoT systems allow educational institutions to collect vast quantities of data from sensors and wearable devices and introduce meaningful technology-based decisions. Such systems enable students to explore a field through the use of prevalent technologies. Learners can use the learning material and other information anytime from anywhere [12]. In classrooms teachers can also use wearable devices and smart phones to enhance teaching and learning. An intelligent classroom can be defined as a smart atmosphere, with different types of software and hardware modules. Video projectors, sensors, cameras and face recognition algorithms are modules that track particular physical environment parameters or the behaviors of students such as focus, attention and responsiveness [13].

5. ELEMENTS OF IoT ECOSYSTEM :

The IoT Environment is a mixture of various layers of IoT from the application layer to the communication level. It consists of various architectural elements, such as hardware modules, applications, and analytical device networking layers, etc. An IoT ecosystem's generic architecture is not easy to describe in practice, because it differs from business to business. Here an attempt is made to generalize components of the IoT network based on which an ecosystem is based [13].

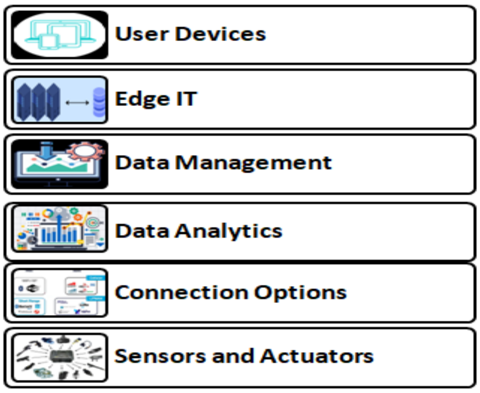

Fig.1: Elements of IoT Ecosystem.

1. Sensors and Actuators: User add temperature, gyroscope, pressure, light sensors, GPS, electrochemical, RFID, and so on to gather information based on the specific use. Light sensors are required for automotive use, for example, along with sensors for heat, velocity, and imaging. A key move is to select the right sensing components in a good use case [13].
2. Connection Options: Connectivity is an important part of the IoT process. We cannot execute a use case without flawless communication between IoT devices, end-users, and analytics or components. The different connectivity layer modules are :
Protocols: IoT implementations can be Internet-based and intranet-based. TCP / IP derived architecture is generally followed for web applications. Devices are connected to intranet IoT using RF, Wi-Fi, etc [13].
Gateway: The IoT gateway connects the Internet and IoT devices. Sensor devices use an IoT gateway to push data into the cloud. The gateway aggregates sensor data converts sensor data between different sensor protocols, processes, and sends it to storage and analytics cloud servers and applications. IoT gateways abstract the communication medium conceptually and also provide a secure channel that is necessary for the transmission of this information [13]. It performs several critical functions such as synchronization of devices, translation of protocols, sorting and processing of information, protection, updating, and more. New generation IoT gateways can also run software code for processing incoming statistics and providing intelligence. The gateways are usually installed within the organization or entity and are situated at the edge boundary of systems such as computers, controls, sensors on one side, and the internet on the other [14].
3. Data Analytics: The data are used in virtually every case of IoT usage to extract useful business knowledge and to guide business decisions. To gain knowledge the system uses machine learning / deep learning algorithms based on data. Raw analog impulses are processed in advance and transformed format. Depending on the use situation, the program selects a big data infrastructure [13].
4. Data Management: Industry-standard IoT applications require raw and processed data to be collected, handled, and controlled on a large scale. Cloud-based systems are commonly used to meet the business needs-based purpose. Large-scale companies that can handle large-scale data also maintain their data-centers to accommodate this [13].
5. Edge IT: Edge is the architectural synthesis of raw-data pre-processing software and hardware gateways. Edge devices are used for gathering and processing raw data from sensors, RFID, and electromechanical components before it is sent to cloud servers. They also provide a local storage, which is used as a buffer for data streams before conversion[13].
6. User Devices: The end components of an IoT ecosystem are smart devices such as smart-phones, tablets, PDAs, etc. Such devices are linked via cloud frameworks to the IoT software infrastructure and remote access is provided on request. I n some instances the computing engine is included in modules, utilities or servers as a parent ecosystem feature of third-party user interfaces [13].

6. REQUIRED IoT INFRASTRUCTURE :

Three parts of the IoT infrastructure can be realized:

1. Things-oriented (perception layer).
2. Internet-oriented (network layer).
3. Semantic-oriented (application layer).

We may describe the first layer as "hardware". This layer includes sensors, actuators, and embedded hardware communication systems. “Middle-ware”, the second tier, consists of data processing software for on-demand storage and cloud computing. And the third layer is known as "Presentation", which offers tools for visualization and analysis that can be accessed widely for different applications on various platforms [6].

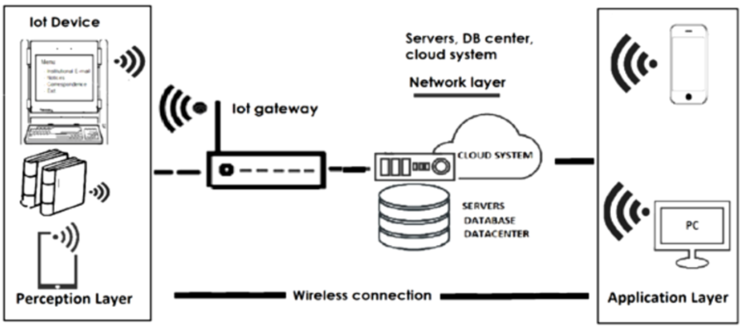

Fig. 2: Required Architecture of IoT in Education. Source: Internet of learning-things, 2013[4]

The application layer is known to be a user-to-network interface. The network layer links nodes to the gateway level. The gateway point is an intermediate node between layers of application and perception, charging the collection of sensed data from the nodes in the layer of perception, and then sending the sensory data to a private cloud system area. The layer of perception may include the physical devices or sensor nodes that can sense an event or action [4]. IoT sensors detect events or any information in the layer of perception in aarchetypal IoT education system as made known in Figure-2. The information collected will be sent to the gateway stored for further analysis and user decision making in a private cloud that can be educators, learners, or even developers [4].

7. SHIFT IN EDUCATION PARADIGM :

Since the emergence of IoT, it is important to consider their potential proliferation and, while analyzing their attractiveness from various viewpoints, to adopt suitable strategies. Such viewpoints include, the student involved in further implementation of information technology; the teaching faculty interested in the learning efficiency and administrative endeavors ; and the manager concerned with administrative duties, and certainly from the learning process. Considering the presence of the IoT on campus, that means exploring the different perceptions of requirements, preparation, or risk posing [15].

a. Learner Perspective: The student is an entity of first-class focus for learner-centered education. His interests, comfort, and motivation are critical for engagement with learning. With the increasing use of technology, the interest of younger generations is not just in the clever use of technology but also in its application. From the student point of view, successful implementations of IoT will open doors to the accessibility of the higher education system to improve the learning outcomes. This helps students, especially digital natives, to view the world as a vast, manageable digital world, where they can tailor their special routes to fulfill their academic goals [16].

b. Educator Perspective: What are the implications on the instructor and how can he/she appreciate the abundance of knowledge in the student community? Educators are interested in greater student involvement, better learning performance that the environment enables. The teacher may be supported by several new automated features. Examples are the automatic recording and documenting the completion of the learning mission. Educators are likely to be able to deal with changes like learning programs and correct instructional advice. The instructor's role in achieving higher usability is to ensure consistency of the educational experience but as flexibility and power to keep the learner active. Concerning the aspect of cyber-physical systems, some lessons from the nature of the learning activities in e-learning systems will be learned [16].

c. Administration Perspective: Given the challenges, the impacts of such transition on education governance are anticipated - creating educational opportunities, concentrating on Student training, enabling creativity situations, user privacy management, enabling extended campus time, ensuring equity participation, managing training situations, and enabling and planning for for Bring Your Device management (BYOD)[16].

8. PILLARS OF IoT IN EDUCATION :

IoT is in the nascent phases of education. Some establishments already attempted to show how IoT can be used effectually to educate the young and the general public. The impact of IoT on each educational pillar is addressed with the support needed and the tasks presently being designed or executed [4].

i. People

Many individuals today, use multiple devices and social networks to connect to the Internet. It's too early to predict the tools that people will use in the future to Internet-connected is likely people are going to be hyper-connected through such platforms. To improve their learning and thus apply their skills, the education sector needs to recognize how people connect themselves with the Internet. The capacity to learn is going to be used tomorrow as key skills learned today. Such flourishing learners should stay up-to-date and ahead of the pack [17]. It will be important to find the right people to learn; as each person becomes a "node" on the network, people need to know how to communicate, not only with the work of experts but with peers with similar interests and goals. In this way, people can share ideas, discuss work / the latest developments in their area of study and build ever more connected networks of study. Specialists in a given field will be taught lessons anywhere in the world, and exchanging knowledge will become the norm via streaming or live video [4].

ii. Process

Process plays a significant role in how individuals, data, and objects work with each other to contribute positively to the IoT's connected world. Communications are vital to the correct process and add value as the correct information is provided to the right person at the right time [18]. Making sure that youth have access to learning chances that suit their needs will increase learning efficiency, maximize mastering time and inspire learners. These platforms will also encourage the engagement of students and the use of new knowledge, which is essential to future progress in both work and community. Much of the benefit can be extracted from feedback on the progress of a student. The process could remove the tests used to evaluate and compare the learner's performance and accomplishment. The evaluation model can be beneficial at any stage to provide ongoing, focused, to customized suggestions on what a learner needs to do to develop their comprehension and performance[4].

iii. Data

As issues about the Internet grow, they will also become smarter, offering more valuable knowledge. Connected devices will eventually return greater-level information to machines, computers, and people instead of simply capturing raw data for further review and quicker decision-making. The educational consequences of that are enormous [19].Learners may also access data from research projects, track meteorology or climate change strategies, or watch wildlife in their natural habitats through live webcams and gather data about their movements via sensors attached to animal bodies. The quality of these data would have a significant effect on learner interests. Remote processing of data would also help people raise their carbon emissions by making fewer field trips [4].

iv. Things

Things are objects that can be linked to the Internet as well as to people using sensors. Sensors offer items like a 'voice;' sensors allow things to become context-aware by collecting data, providing more conceptual knowledge to help humans and machines make accurate and useful decisions. Smart sensors, for example, are extensively used in bridges for real-time tracking of temperature, structural stability and traffic density. Using their handheld tools to capture and monitor the bridge at peak traffic times. Such abilities have major implications on teaching-learning practices. When 'things' communicate with each other to exchange information the performance of the system would increase. Sensing devices can be installed in everyday products for the purpose of uploading the information to the Internet[4].

9. INTEGRATED INTELLIGENT EDUCATION SYSTEM :

IoT enables the globally accessible and feasible interaction between the physical world and the Internet. IoT makes the interconnection with physical things at different points, colleges, centers, universities, institutes, laboratories, libraries, and organizations all over the world. It can also bind internal educational institutions, as well as global systems, with online learners and lecturers, ensuring that teachers and students have access to the vast educational resources. To take benefit from IoT technologies, the educational institute's entities are integrated into the proposed model with sensors that have capabilities for "sensing, computing, and wireless communication". Figure-3 displays the essentials of the intelligent education plan proposed.

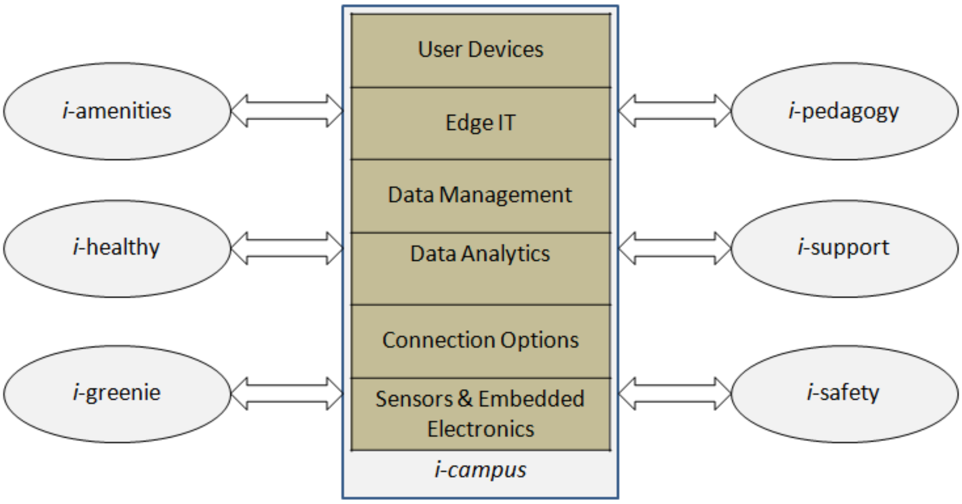

Fig. 3: Components of proposed i-campus System

i-pedagogy

This component includes *i-classroom*, *i-laboratories*, *i-evaluation*, *i-learning*, *i-devices*, and *i-feedback systems*. Integrating IoT in the intelligent teaching-learning process will promote interaction in the classroom environment between actors (teachers and students) and objects [14]. The pressure is on to prepare students in a hyper-connected world for a more dynamic workplace. By providing enjoyable learning opportunities and gaining continuous, actionable insight into academic performance, institutions can improve educational outcomes with the IoT. Whether it is a home tablet or a school laptop, students are progressively going to learn[4].

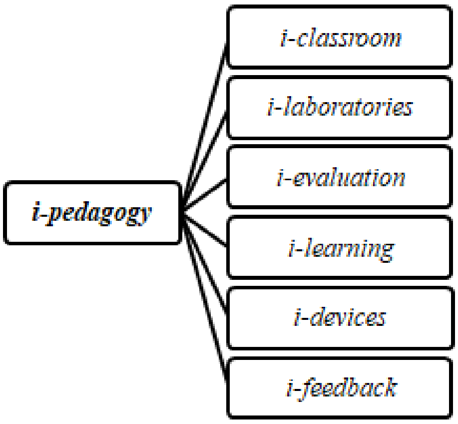

Fig. 4: Elements of the i-pedagogy system

- Students may work at their speed with *i-learning* apps, allowing the instructor to provide one-to-one guidance to those most in need of it.*i-learning* technologies can pool data on the performance of the student when connected to the cloud, which can be used in future years to improve lesson plans.
- Tests and assessments can become more automated, less manual and time consuming. Educators are no longer expected to mark or feed any of the exam sheets into a printer. Instead, they will concentrate on learning opportunities that have the greatest effect on the students [20].
- The *i-classrooms* have digital screens, microphones, air purifiers, HVAC systems, and smartboards. Videos, audios, texts, and pictures are the different forms in which the class lectures are recorded. These lectures will be stored simultaneously for future references on the cloud [1]. IoT encourages and assists students in communicating with and engaging with educators in a variety of ways and helps create a fruitful teaching-learning environment.
- Learners are supplied with a smart tab *(i-devices)* for conducting examinations. The devices can be used to compose text or draw diagrams. Such content is automatically sent to the teachers'

accounts in the cloud for evaluations. After the evaluation, the teacher will communicate the feedback directly to the respective participants [1].

- This platform ensures timely assessment and complete recommendations *(i-feedback)*method that helps students identify areas that need improvements and take appropriate action.
- The laboratories *(i-laboratories)*contain virtual set-ups powered by open-source software suites, accessed from personal computing devices using basic Internet connectivity. These laboratories are fitted on related topics with numerous simulations. Students can use their respective tools to gain hands-on experience with the laboratory setup. The student's experimental work is also processed on the cloud for analysis and reference purposes in real-time[1].

i-security

This component includes *i-gate, i-surveillance, i-roads, i-parking, i-identity, i-doors, i-safety,*and*i-attendance systems*. To ensure that their campuses are safe school officials are under increased pressure. An increase in school emergencies along with increasing concerns about bullying and abuse, suggests that keeping students safe is more critical than ever. The IoT's ability to track objects, learners, and workforce and to connect devices around the campus offers institutions a greater level of protection [4].

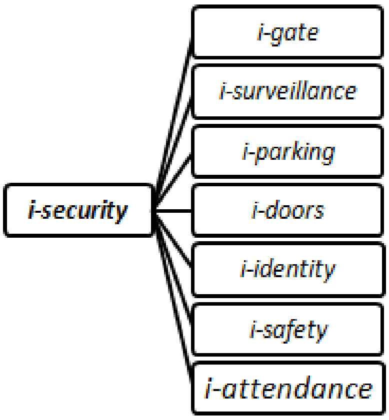

Fig. 5: Elements of the i-security system

- · Campus security measures such as door security monitoring systems (*i-doors*) where computer-enabled building exit and entrance doors, classrooms, restrooms, libraries, administrators, laboratories and canteens. Locks which can only be opened / closed by approved staff using smart identity cards or remote phones, preventing any breach of security or illegal trespassing [1].
- Through smart id cards, students, and staff attendance *(i-attendance)*is automatically tracked.
- The roads*(i-roads)*within Inside the premises, speed sensors are mounted which constantly monitor vehicle speed inside the campus. If any vehicle's speed reaches the predefined speed limit, the driver may receive a notification in real-time, which is also expressed in the individual driver's electronic logbook (student or staff). It helps the admin to monitor the vehicle speed limits on the campus [1].
- The campus has smart security detectors and smart cameras *(i-surveillance)*that monitor the environment, allowing for real-time detection and recording of any suspicious activity [1]. Furthermore, because each item is integrated with IoT devices, all of these can be tracked and monitored continuously, thus avoiding the possible chances of theft [21].
- Live alerts, intelligent water-sprinklers, smart fire-alerts, unique warning sounds, computerized disaster management alert systems, pre-recorded instructional messages *(i-safety)* are used for any emergencies on campus premises [1].
- GPS-enabled automobile system ensures that vehicle routes are monitored so that interested parties can know the location of a specific vehicle. Besides making the school trip easier for students as students got alerted when the specific vehicle approaches their pickup location; no longer need to wait outside their home[4].
- Students can be automatically checked in with RFID-equipped backpacks when they get-into the vehicle [4].

- The prevalence of 'intelligent' ID*(i-identity)* cards and wearable equipments mean that students can be instantly labeled "current" while walking through the door of the classroom[4]. These devices enable educational institutions to store students' or visitors last identified location to help ensure that the right people access the right campus areas. These also allow cashless transactions at the school cafeteria/shop, providing a more seamless process with the potential to deter fraud and bullying [4].
- Eventually, automated campus management helps staff to respond more rapidly in an emergency. By connecting laptops, smartphones, and two-way radios, employees can instantly talk, write, or email any other device in the network [4].
- Smart parking areas *(i-parking)*; fitted with sensors to monitor parking space occupancy and show the areas available capacity, saving time, and energy [15].
- *i-Gates* allow *i-identity* holder students to quickly clear security checks at entrance gates and improve the security of students through electronic identity checks. It uses facial recognition technology to verify the identity of the holders against the data stored in their biometric ID in the chip and to check against the database of the students [22].

i-greenie

This component includes *i-HAVC, i-water supply, i-environment, i-energy, i-lighting, i-garden systems*.

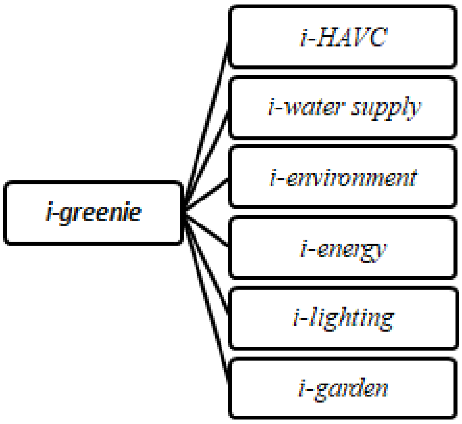

Fig. 6: Elements of the i-greenie system

- Smart Heating, ventilation, and air conditioning *(i-HVAC)* and electrical units based on IoT are responsible for the automated modification of atmospheric conditions within the Institution premises. The environment of the classrooms, laboratories, and other facilities can be automatically monitored and modified to provide a comfortable teaching-learning environment according to the preferences of the users [1].
- The electrical systems are fitted with sensors (*i-environment)*that detect the presence of a human object in a classroom or in other places, and they may make smart judgments about when to turn on / off or alter systems and equipment. Such a system maintains a favorable environment and therefore helps to improve students' and staff efficiency as they do not feel exhausted due to regulated temperature and increased air quality [1].
- However, because systems and equipment are operated automatically it helps to reduce electricity bills and conserve the environment to some degree by reducing carbon emissions from systems and equipment [20].
- Conserve more energy *(i-energy)* consumption while the equipment is in perfect condition. Energy monitoring systems improve the energy efficiency of the units [4].

i-healthy

This component includes *i-health, i-canteen, i-gym, i-track, i-sports, i-hygiene, and i-fitness systems.*

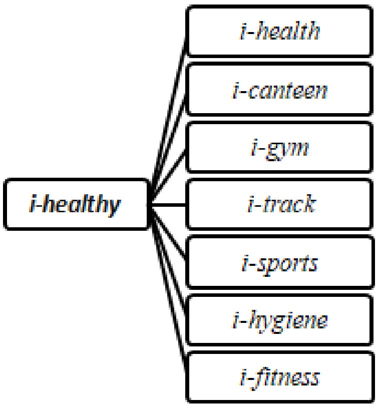

Fig. 7: Elements of the i-healthy system

- The canteens *(i-canteen)*were fitted with IoT-based sensors. Barcoded food items show the calorie count and date of expiry [1].
- The student/staff watch *(i-fitness)*keeps track of the maximum number of calories in a day. If the number of calories reaches the predefined limit, they will receive an immediate warning. In this way, they can track calorie intake and stay healthy by the staff and the students.
- Through monitoring the expiry dates (*i-hygiene)*, the wearable ensures hygienic food is received by the consumer and notifies the user when the item expired is chosen.
- The device can also monitor the users' vitalities*(i-health)* automatically and notify the departments concerned instantly in the event of any abnormal deviations [1]. As an essential factor in determining the academic performance of the student is the student's health status, improved health care access is very important in every educational institution.
- A wearable device monitors non-invasive and non-obtrusive physiological signals over long periods. Example: wearable devices such are smartwatches and fitness bands
- RFID technology is used to incorporate the internet to track *(i-track)* students at high blood pressure risk. The program takes into account the health information of multiple students, such as medical history, medications, tests of electrocardiography and blood pressure, etc[12].

i-support

This component includes *i-transport, i-messaging, i-feedback, i-hostels, i-notice boards, and i-announcement systems.*

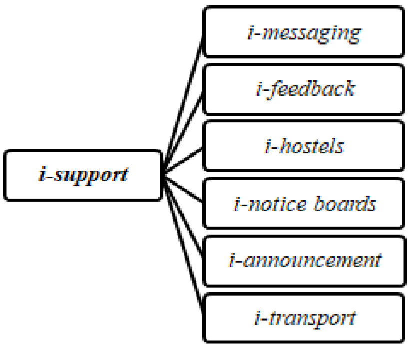

Fig. 8: Elements of the i-support system

- The smart notice boards (*i-notice boards)* are can send the messages shown on them to every linked display unit in real-time so that users are attentive of any significant notifications.
- Using smart devices, the instructor can relay some information directly to students in real-time. Monitoring application software can also be used on any hand-held device to keep track of academics and other works sent to the administrator.
- As all information is stored in the cloud and accessed securely by interested institutions, manual reporting will be avoided, improved tracking, monitoring and management will be ensured and time and energy savings will be achieved.

On the other hand, administrators can efficiently handle all tasks such as tracking published library books, costs, employees' and students' education and personal information using sophisticated software and apps.

i-amenities

This component includes *i-library, i-office, i-shop, i-halls, i-auditorium, and i-kiosk systems.*

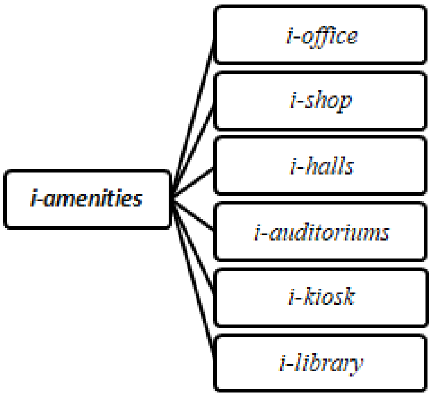

Fig. 9: Elements of i-amenities system

- Digital library (*i-library*) allowed by RFID is necessary as our requirements to obtain the necessary books. The machine communicates with the RF-supported Personal Digital Assistant computing platform via an intranet, internet, and extranet via the central database of inventory and library [23]. By uploading circulation, scanning RF, reviewing book records, updating transaction data in the library database, we can use this tool. Digital library inventories are managed by a smartphone with a CompactFlash (CF) card device that automates check-in, processes, and records data integrity testing properties [11].

Empowering the proposed system would mean a better teaching-learning environment, increased learner and staff participation and attentiveness, improved accountability and efficiency, better monitoring of student progress and development, the omnipresent availability of resources (laboratories and lectures) and, more than anything, the proposed system would tend to save environment [24].

10. ARCHITECTURE OF THE PROPOSED SYSTEM :

The framework of the future i-campus System consists of sensing devices & actuators, embedded devices, network & data security mechanisms, build platforms to be used, network standards & protocols to be adapted, network architecture, IoT and network gateways, Edge IT, cloud services & storages, user devices with appropriate interfaces, software & applications, mashup tools, data analytics tools, machine learning tools and integration of independent autonomous solutions.

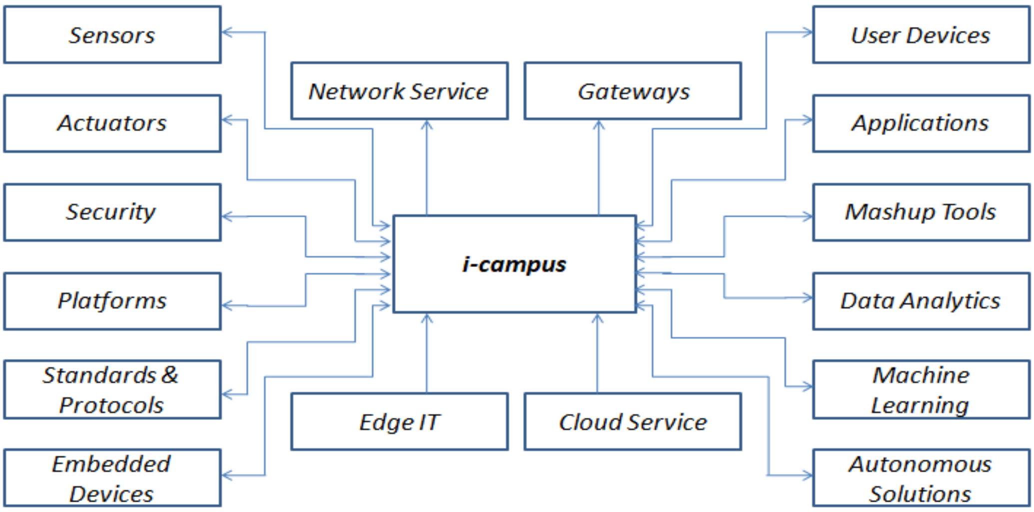

Fig.10: Architecture of the proposed Intelligent Campus System

11. FUNCTIONING OF THE PROPOSED SYSTEM :

The diverse participating entities are embedded in an educational system with IoT-based microchips (sensors) that store information about the entity and its environment. The IoT system controller which uses various pre-processing techniques such as data cleaning, pruning, stemming is also responsible for mining the relevant information. These entities are linked to an IoT control system that directs them regarding the correct actions in the event of any user request. Besides, the computer controller has the potential to adjust and improvise according to the situation by using extremely powerful artificial intelligence algorithms. Figure 3 offers a description of technical work on the proposed model. In the proposed solution, the idea of software-defined networking (SDN) is implemented to dynamically manage the network and create an agile, adaptable, and scalable networking environment. Using SDN, the IoT application controller can dynamically track and control network traffic, path algorithms, packet forwarding protocols, and congestion management using simple programming frameworks. It uses the OpenFlow protocol concepts to interact with the IoT devices that underpin it. The different sensors and actuators transform energy into electrical data in coordination with each other, and vice versa. All data from the participating computers and sensors is stored in the cloud [25].

12. BENEFITS&CHALLENGES :

Benefits

- It enables institutes to improve their campus security, to track resources, and to improve access to information.
- This offers a flat-form to build a smart lesson plan that can be accessed anytime, anywhere.
- This optimizes the heating, ventilation, and air conditioning (HVAC) scheme charges.
- Maintains optimal temperature without wasting energy.
- By automatically managing the lights, the lighting costs are adjusted based on the occupancy of the space and the natural lighting of the windows and doors.
- This enables educators by eliminating repetitive works such as automatically turning projectors on, dimming the lights when slide shows are on, etc.
- It helps to enhance each student's achievement.
- All the information from each sensing device is gathered and preserved in the cloud or database throughout the time, which can be investigated to find more effective ways.
- It offers customized and adaptive education that is an instructional innovation that makes what the student needs.
- It makes an omnipresent learning environment that is context-aware. This strengthens communication between educators and learners.

Challenges

- Because different hardware units used in the 'i-campus' such as sensors, actuators, handheld devices use incompatible and heterogeneous technologies such as Wi-Fi, BLE, Zigbee, USB, Bluetooth, etc., it is a difficult task to adapt and configure existing solutions to boost reusability and scalability[26].
- A new framework for central control must be created. All independent solutions such as detection of smoke, recognition of movement, identification of fire, distribution of information, warning systems, etc. must be included within this central control structure[27].
- Problem-specific custom implementations are not adaptable or versatile to the overall criteria for integration and growing needs.
- Educators need to rethink existing theories of pedagogy such as cognitive theory, constructivism, etc. [28].
- Educators may be hesitant to embrace new technologies. Institute can find it hard to preserve IoT devices' confidentiality and privacy.
- It may be costly to implement IoT. Most IoT tools and software are not compliant, which makes implementation difficult [29].
- It requires medium to large scale investment to automate independent components and to integrate them into a central control system [30].

13. DISCUSSION &FUTURE WORK :

The eventual fate of the IoT in education looks encouraging due to the huge potential it has. In any case, making IoT a piece of standard education will require some time. The most essential factor, in this case, is developing the fundamental technologies both open and simple to utilize. There should be an adjustment in the outlook of the instructors, guardians, and students, upheld by the change in the policies related to education.

IoT technology removes the constraint of physical presence and extends access to the redress of any education such as instructors, software, and wherever E-learning is effectively facilitated. IoT aims to have a huge effect on the higher education learning process by giving students and teachers access to international tools and opportunities. Hence one of the main impacts of the IoT-based learning environments is that the roles of traditional students and teachers can be dramatically modified. Students and teachers can practically maintain teaching material and/or laboratory at any time, from wherever they can interact [16]. The Internet of Things is supposed to promote the vast array of research opportunities for educators, students, and researchers around the world. Although it cannot contribute to the success of the great teacher & students, it can be encouraged by the student judge to include them in the learning process by connecting the real objects in their assignments, homework, and scientific study [31].

The IoT can be used effectively in high school and college environments, where students are as of now moving ceaselessly from printed course books to digital books on PCs and tablets. By utilizing cloud linked gadgets, teachers can track the progress of the students as well as they can monitor the students who require special attention. This flow in connected technology implies that the resource and time of the teacher can be utilized by the teacher on more initialed guidance, as the IoT would robotize forms that were recently directed manually[32].

"Technology allows teachers to design their lesson plans in a way that combines more than one teaching method. Incorporating a variety of technological enhancements enables a teacher to program each and then put learning into the hands of the students"[33]. This indicates that each learner can learn in their specific manner thinking about their own exceptional needs, boosting certainty, and making an elevating procedure of learning. Moreover, adapting the advance technology of IoT at the bigger scope inside the setting of higher education denotes that the possibility to associate with pioneers and experts, elevating an interdisciplinary way to deal with training which is becoming more applicable in these days' world [34].

IoT technology has applications not only inside the classroom but also outside the classroom. Such as it helps to track equipment and resources for quick access to schedules, teachers and students can be able to save their precious time and money. Concerning this approach, IoT can be best used to expand vitality effectiveness and decrease working expenses. Another application is inside transport plans; students can be able to track the route of the bus so that they do not need to wait in an unsafe zone [35].

Six major processes form the model presented in this work. Also, every major process describes its elements in sub-processes. Only theoretical constructs of potential utility and validity are highlighted. Every sub-process itself is a research agenda. Therefore we will pursue our future papers individually with appropriate implementation models.

14. CONCLUSION :

This paper explores the potential impact of IoT technology may have on the field of education. Though this idea is in its early stage of development, there are indications of development in the underlying technologies and protocols. In reality, the cost of putting the model into operation will be inversely related to technological advancement in the future, according to the 'Moore Principle.' Today the 'Internet of Things' opens the educational field to pedagogical innovations and fosters a cooperative, interactive, smoother, faster, and more sustained educational environment. Also, it attempts to encourage a higher degree of customized and collaborative learning experience by incorporating real-life issues into teaching in the classroom and allowing students to acquire greater knowledge of the dynamics of society as a whole. The potential of this evolving revolution indicates its rapid development as in the modern educational system, IoT has a pre-eminent capacity to eliminate barriers such as demographics, gender distinction, languages, and socioeconomic. Therefore, IoT-enabled education will successfully meet the expectations and requirements of the student and teacher family in a much broader scenario.

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