

Survey on Internet of Things (IOT) in India

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Abstract

In the coming years, technology will impact the learning experience in many ways. Internet of Things (IoT) continues to confirm its important position in the context of Information and Communication Technologies and the development of society. With the support of IoT, institutions can enhance learning outcomes by providing more affluent learning experiences, improved operational efficiency, and by gaining real-time, actionable insight into student performance. Internet of Things is the connection of embedded technologies that contained physical objects and is used to communicate and interact with the inner states or the external surroundings. This paper familiarises the status of IoT growth in India. Nowadays, due to huge advancement in wireless sensor network and other computation technologies need to improve the technology in IoT that can be used in various fields. The major challenge is to spread the knowledge and awareness about such systems across the country. In this paper, we will be discussing on areas or fields that IoT can be implemented in Indian industry.

Keywords: Internet of things (IoT), IoT in Healthcare, IoT in Education, IoT in Agriculture.

1. INTRODUCTION

The Internet of Things (IoT) is lauded by most as the next great revolution in technology. A world where every object we use has a sensor, enabling it to connect to the internet so it can communicate with each other and the user is a world that seems like something out of science-fiction. With the Internet of Things fast approaching, that world could become a reality very soon. Experts estimate that the IoT market could be worth as much as \$1.7 trillion by 2020, with more than 50 billion devices connecting to the IoT by that time. But where will much of that growth come from? The U.S. is always near the forefront of technological developments, and China is in the middle of a massive economic expansion, but some are saying India will be the place to look for IoT growth, even becoming the largest consumer of IoT devices in five years. While some dispute the claims, it's clear the future is bright for the IoT in India.

Part of the push to maximize the potential of the Internet of Things in India is coming from the national government. Collaboration between the Department of Electronics and Information Technology and the Ministry of Urban Development has resulted in an emphasis in programs designed to expand the capabilities of the country in using the IoT. Some of these initiatives include the support of smart cities (or cities that use IoT devices to manage traffic, utilities, and other aspects), healthcare IoT sensors for monitoring health, and Indian Railways. In the Indian

Railways example, IoT devices on the trains communicate through the cloud to indicate fuel

consumption. This information can be used to increase efficiency on India's railroads. These projects are a good indication of how important India's government views the IoT, but a number of obstacles still exist that may prevent the country from becoming the biggest user of IoT devices as predicted. One of the most formidable challenges is internet accessibility among the general population.

Many people in India still cannot get the internet on a consistent basis, with reliability problems plaguing many areas. Even when internet performance is consistent, bandwidth becomes a serious issue, and since the IoT needs plenty of bandwidth to function properly, this may hinder widespread prevalence of the IoT. The cost of IoT devices is another major hurdle in mainstream acceptance. Some existing devices, such as wearable health bands, have failed to take off among Indian customers, mainly due to price. India also deals with plenty of challenges regarding its infrastructure. To make the IoT function well, more work first needs to be done to set up support for smart grids, traffic systems, and technologies that can handle increased data demands, like flash storage (SSD).

Despite these challenges in consumer acceptance of the IoT, the outlook is more optimistic within the commercial sphere. Businesses in India are more likely to take advantage of the benefits of the IoT, allowing

for more industrial automation and efficient operations. Logistics are expected to get a real boost from IoT devices, as seen in how some companies have already used it to maximize their transportation. And some businesses are developing platforms designed to make the IoT more accessible to other organizations and, eventually, the rest of the population.

That's not to say there still isn't promise for more consumer IoT devices. A number of start-ups have arisen in India seeking to harness the potential of the IoT. One company called CarIQ manufactures a device that turns normal cars into smart cars. This IoT device records and analyses data like mileage and speed while also taking into account driving patterns, all while communicating with other cars. The device made by Life Plot is similar to the Indian government's healthcare initiative, in which the connected device is able to record medical data about a patient, providing remote diagnosis with little training needed. These are just a few examples of companies fully utilizing the potential of the Internet of Things.

Though challenges still remain, the future of the IoT in India is a promising one. The government is fully backing the effort to develop better infrastructure, companies are coming out with innovative products, and industries understand the benefits the Internet of Things provides. With more time and resources, IoT progress could prove to be impressive on a large scale. If that progress continues, the prediction about IoT use in India may come true after all.

1.1 Survey onIoT in India

Everyone wants a world which is connected to the internet and everything in it – from your smartphone to computers to watches and refrigerators can communicate in real-time. Internet of Things certainly makes it possible. In India, the maximum push for IoT adoption is coming from the government, with initiatives like 'Digital India' and 'Make In India'. A special focus is on the development of Smart Cities – one that uses IoT devices to manage utilities, traffic, healthcare etc.

These projects are a good indication of the government's focus on IoT. But still, there are a number of obstacles that might stop the organizations from making maximum use of it. Lack of consistent internet connectivity, bandwidth issues, cost of IoT devices etc. are some of the prevalent challenges.

Despite consumer acceptance challenge in IoT, the potential is great on the commercial front. Businesses can be seen taking advantage of the IoT for enabling industrial automation and for efficient operations. As already stated, a good number of start-ups have emerged to harness the potential of technology.

Survey onIoT in India fig 1 is very promising with undying support from the government. If the current progress continues, the prediction about IoT potential in India might come true.



Fig 1: Survey onIoT in India

2. IOT in Healthcare

The reliance of healthcare on IoT is increasing by the day to improve access to care, increase the quality of care and most importantly reduce the cost of care. Based on an individual's unique biological, behavioral, social and cultural characteristics, the integrated practice of well-being, healthcare and patient support is termed as personalized healthcare. This empowers each and every individual by following the basic healthcare principle of "the right care for the right person at the right time", which leads to better outcomes and improvement in satisfaction thus making healthcare cost-effective. A sustainable service focuses on the prevention, early pathology detection, and homecare instead of the expensive clinical one, and checks the overall well-being to anticipate needs and ensure compliance to healthcare plans. Internet of Things promises to manage the personalization of care services and can maintain a digital identity for every person. Different equipment is used in healthcare, to communicate and to make the ubiquitous system-of-system. The classifications of IoT based personalized healthcare systems are Clinical care and remote monitoring. [1]

A. Clinical Care IoT-driven, noninvasive monitoring systems are used for hospitalized patients whose physiological status requires constant close attention. These monitoring systems employ sensors to collect physiological information which is analyzed and stored using gateways and the cloud. This information is then sent wirelessly to caregivers for further analysis and review hence, rendering a health professional having

to check the patients' vital signs after regular intervals unnecessary. Instead, it provides a continuous automated flow of information. Thus, the quality of care is improved through constant attention which in turn lowers the cost of care and eliminates the need for a caregiver to actively engage in data collection and analysis. [2]

B. Remote patient Monitoring shown in Fig 2 Lack of ready access to effective health monitoring systems may lead to many health risks go undetected, which is a problem being faced all over the world. But small, powerful wireless solutions connected via the IoT make it possible for monitoring to come to patients instead of vice-versa. Patient health data can be securely captured using these solutions. A variety of sensors and complex algorithms are used to analyze the data and then share it through wireless connectivity. The medical professionals can then make appropriate health recommendations remotely.



Fig 2: Remote patient monitoring.

A restructuring and reorientation of this kind would change the definition of healthcare and evolve new business models. The resultant scenario can be a win-win situation for everyone. The biggest challenge here would be to create IoT infrastructure that improves healthcare for ordinary citizens, and makes it more affordable and available even in remote areas. Affordability would be a key criterion because financial constraint is the biggest hurdle in seeking medical treatment, as stated by 55% and 60% of the urban and rural respondents, respectively, as per the latest National Sample Survey.

Currently, citizens consider private doctors as the most significant source of treatment in both rural and urban areas, according to the same survey. The affordability challenge can be tackled by increasing the uptake of health insurance in the country, which is

currently very low. Over 80% of Indians have no health insurance.

India is also now uniquely positioned among very few countries where the identity of the citizens is digitized. Through the globally acclaimed Aadhaar initiative of the UIDAI (Unique Identification Authority of India), a unique 12-digit number issued to each citizen in the country, every citizen can now be identified, verified and then linked with benefits that governments have for them.

In the healthcare sector as well, using Aadhaar infrastructure, where over 98% of population is now registered along with their basic demographic profile of age and gender, the benefits meant for cross section of society can now precipitate through the value chain without any pilferages. This will not only optimize the return on government spending in the social sector, but also enable health profiling of the country. A timeline can now be drawn for each citizen registering the story from birth to death.

Linking of Aadhaar with healthcare sector will enable creation of several IoT applications directly benefiting the government, healthcare sector and the citizens, especially in the critical areas where authenticating the identity of the end-beneficiary is critical for deriving the actual use of the technology platform; in this case an IoT application.

2.1 Benefits of IOT in Healthcare in India

1. Integration of IoT platform with various healthcare initiatives like 'Pulse Polio Immunization', 'Neonatal Healthcare', etc, can yield results for a wide base. The persistent monitoring of patients and the treatment timelines will throw up immense data which could be used by the government for defining KPIs (Key Performance Indicators) for a healthy nation. This big data will also take research to new heights and create more opportunities for defining proactive healthcare systems.
2. Citizens stand to gain the most because they're looking for quality as well as affordability in healthcare services. With IoT applications and sensory networks, physical interaction requirements between a doctor and a patient could be minimized. As a result, there would be real-time diagnosis and reduction in number of visits to a doctor.
3. Long queues of patients in clinics and OPDs of hospitals are unfortunately a sore sight in the country today. It puts doctors

undertremendous pressure because they have no options of prioritizing which patient to see first—those who’re coming back to show their diagnostic reports or the patients coming for the first time. With the help of wearable’s and sensors, several basic but important parameters like blood pressure, ECG, etc., can be shared with doctors any time over the internet.

3. IOT in Education

3.1 Concept of Digital Campus

Digital Campus System is an important platform for students to get all kinds of information [3]. New technologies are also affecting other areas of campus administration. There is an increasing demand for higher education institutions, especially, universities to digitize their content and activities, and adapt their methods to allow academic and researchers to work effectually in a digital environment [4]. A well designed physical campus, completely integrating technology, is fundamental for building the brand of digital university by enhancing the student experience, and providing the appropriate settings and facilities for teaching, learning and research. It promotes supports and encourages lifelong learning [5]. A digital university must have the technology that enabled teaching and learning, and empower collaborative research. All contemporary digital threats can be faced by universities if they compete, however few have the vision, flexibility, platforms, or appropriate leadership, to put in place the strategies to ensure that they can innovate, or react to marketplace conditions.

Within a digital campus, technology can reduce operational costs, improve security, and offer tools for researchers, academics, students and staff. These benefits provide real value to university operations and developments, the experience of students, and researchers. The digital campus comprises two main components. Firstly, it reuses the IT Service Delivery Platform – end-to-end infrastructure to provide network connectivity, mobility and security for all applications and services across the campus. Secondly, it includes a large number of Internet of Things (IoT) applications operating over the platform system to support the professional of the university, enable teaching and learning activities, and enhance student’s experience. According to Cisco -“Digitizing Higher Education To enhance experiences and improve outcomes”- IoT applications differ from conventional network applications as they support sensors and sensor data, rather than users and user data. IoT applications for the digital campus include

five main categories: Building Control and Management; Security and Access Control; Video and Information Systems; Location and Attendance Systems; Energy Monitoring and Control. as shown in Fig 3:

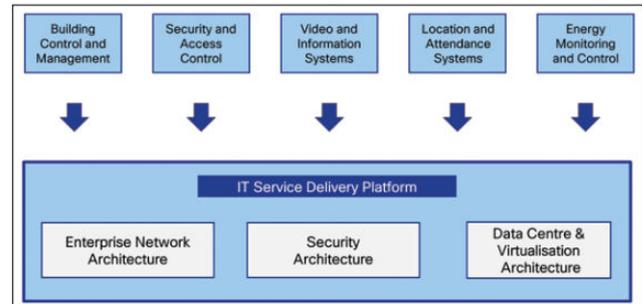


Fig3: IoT Applications for the Digital Campus

The wireless network has a main role to play within the digital campus, thus must be designed to meet the high demands of a modern university.

In addition, IoT reform and change the teaching and learning in the campus, for example, the IoT in the training of the same sight, making the teaching space, training venues, sports venues, learning dormitories, restaurants and students across the campus of IoT, making the campus to train students anytime and anywhere, can become a physical, mental, and skills place to acquire a full range of learning and training. This will lead colleges to become ubiquitous learning and training [6].

3.2 Impact of Internet of Things on Education

The IoT is going to affect every part of society at some point in the near future. Higher education institutions in general and universities in particular, can work across disciplines and lead the progress of the IoT technologies, business models, ethics, and leaders of the IoT enabled economy of the future.

For instance, university instructor of computer science and engineering are directing IoT labs for the development of IoT technologies. In addition, Informatics College can teach how to leverage the sizes of IoT data, with TIPSS. Also, they can work with business colleges to set and design IoT courses to create new business models. Medical colleges can empower the Internet of Medical Things as well as, Law colleges can teach IoT ethics, privacy, and policy. According to Zebra technologies, as higher education institutions commence to develop and leverage solutions such as radio frequency identification (RFID) and cloud computing through IoT technologies, they will be able to analyse and manage Big Data.

The IoT is not just a technology update and development within the industry, but can lead to expand the change to the whole society including

higher education institutions. IoT will lead the change and reform the higher education institutions. According to [6], IoT will lead to changes in educational technology; reform the education, change in teaching, change in learning, management of change, experimental and practical changes, changes in campus, teaching resources changes and others.

With the development of IoT, the prospective application in higher education lies in the three aspects: student's progressive evaluation, integration of current teaching platforms and development of educational middleware [7]. This change provides increased convenience for students, and makes the teaching process more effective for instructors and professors. The flow in connected devices and technology means that instructors and professors can focus on the actual learning that is more useful to the students rather than perform the routine task.

In addition, IoT has the ability to increase the learning experience by providing for real-time and actionable insights into student performance. Nowadays, students particularly in university are gradually moving away from textbooks to new technologies such as tablets and laptops. The advanced e-learning applications allow students to learn at their own pace and have an identical learning experience in classrooms and homes [8], which rises progression and satisfaction rates as well as instructors can deliver one-to-one instruction and persistent student assessments [9]. Moreover, through IoT technology, professors can collect data about student's performance and then determine which ones need more care and attention. This data analysis also helps instructors accurately change plans and methods for future classes. Additionally, connected devices can allow instructors to do dynamic classroom. Interventions as well as logging attendance will be simplified if students have a wearable device that tracks ECG patterns. Furthermore, these devices can redirect a student's attention by giving a warm up activity and exercise to do on their own devices. Also, EEG sensors can be used during courses to monitor students' cognitive activities.

This vision and understanding give stakeholders with a view of students, organization, and financial assets. This asset intelligence enables organization to make informed decisions in order to enhance student knowledge and learning experiences, operational proficiency, and the security of campus.

According to Zebra technologies (2015), by enhancing asset intelligence, educational institutions can enhance outcomes by adding values in some areas include: Enhanced Learning Experiences and Outcomes, Improved Operational Efficiency, Safer Campus Designs.

Moreover, outside of the classroom, universities can use connected devices to monitor their students, staff,

resources and equipment at a reduced operating cost [10]. Furthermore, the growth of mobile technology and the IoT enable universities to improve the security of campuses, enhance access to information and applications at anytime from anywhere, and keep track of main resources. IoT is changing the student learning experience besides facilities management by connecting individual, data and things.

3.3. IoT in Higher Education

Universities have long realized the ability of technology to disrupt teaching, learning, and assessment. Furthermore, technology disruption is fundamental if a modern university is to distinguish its student offer, so increasing admissions, improving retention, and delivering desired outcomes. But preparing students to be confident for the world of work is complex. It requires strong academic leadership, access to a high quality curriculum and content, and the exposure of students to the effective use of new technology. With the development of IoT, many institutions of higher education have started to focus on the related technology and application of the IoT [11]. This attempt is also used in university [12]. The Internet has deeply rooted itself into colleges and universities, and e-learning has become common practice in most universities systems. Although it is not an obvious application of the IoT, however, education is on that list and the applications of the IoT in universities are numerous, and the implications for this are massive. IoT will allow for better operational efficiency in all learning environments. IoT can support classroom instruction by improving learning setting, enhance learning resources, improve methods and techniques of learning, raise management efficiency, and save management costs. The resources available for learning on devices, like e-books, are more engaging and interactive. However, there is a constant need for new technologies for learning process, for instance, high-speed wireless networks with the bandwidth for streaming audio and video lessons.

According to the Citrix 2020 Technology Landscape Report (2015), in the next five years, IoT technology will enhance the learning experience in different ways. Learning experience will continue to become more virtual, students will consume knowledge and learning in new ways, and classrooms will be better equipped for learning. Eventually, learning will become an amazing experience for instructors and students with knowledge accelerating while bringing new ideas and solutions around the world. As well, students are prepared for the future of work and expectations at the workplace of the future.

Technology will always have a place in all educational discipline. IoT also has many opportunities for Science, Technology, Engineering, and

Mathematics (STEM) disciplines, such as computer programming and physical computing. It is easy to foresee how IoT capabilities can be used in STEM disciplines, robotics, and anything having to do with collecting specific data. It is all in the potential of the IoT. However, ultimately the educationists need to be able to identify the right technology and integrate it properly in the classroom for learning to evolve. Although main IoT technologies are so far unclear, the point certainly is that a lot of contents are the outcome of new development phase. Considering the demand of more professional research, setting the IoT major is relative easy and applicable for graduate students. However, for undergraduate students, they still need a wide range of basic courses, so it is not easy to set IoT major independently like other majors at present. New training methods shall be explored for undergraduate students. Different colleges have to explore the appropriate approach according to their own characteristics. The system approach and courses content need to be progressively established and improved. Since IoT is achieving the unity of the virtual world and the physical world, many new training methods and cross-cutting areas will be generated in the future.

4. IOT in Agriculture

IOT application areas are ubiquitous across the life cycle of agriculture sector, viz. cultivation, water management, harvest, storage, processing, transportation, and sales. Along with the common available sensors, a variety of specialized sensors are available for Agricultural applications, e.g. Soil moisture, Humidity, Leaf Wetness, Solar Radiations, Ultraviolet Radiations, Pluviometer (Rain Gauge), Wind Vanes, etc.

In a typical IOT scenario, sensors can be deployed in fields, green houses, seed storages, cold storages, agriculture machineries, transportation system, and livestock; and their data can be stored in cloud for monitoring and control (Fig. 4). The research and analysis of the data can guide the ways to improve production with optimized use of resources, and can bridge the demand and supply gap of the agricultural produce. Processing, correlating, analyzing and inferring correct information from the data, which is coming from a variety of sensors, is the most challenging task in any IOT system. M. Lee, et al. [13] presented an IoT-based agricultural production system, based on correlation analysis between the crop statistical information and agricultural environment information, to enhance the ability to analyse current conditions and predict future harvest. Further, Semantic heterogeneity of multiple information resources is a

challenge for integrating different agriculture IT system.

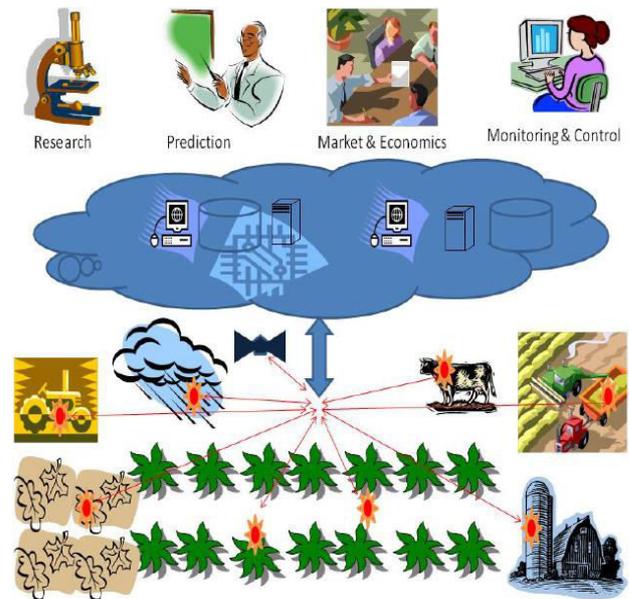


Fig. 4: IOT framework for agriculture applications

Many researchers are working in this direction, e.g. Siquan Hu, et al. [14] proposed an ontology-based approach (AgOnt) to solve the semantic interoperation problem for a seamless access of the distributed agriculture products information system. Phenonet, a large scale experimentation built on open semantic IOT platform, was developed by CSIRO Australia to study the impact of environmental variations (light, temperature and soil moisture) on plant growth [15].

4.1 IOT applications in Agriculture

As discussed in earlier sections, IOT can be helpful during all the phases of the Agricultural ecosystem (Fig. 4). It can be applied for real time monitoring and control of controlled environment in greenhouses, and can be used for real time monitoring and decision support systems for field parameters, e.g. soil parameters (moisture, conductivity, etc.), environmental parameters (temperature, humidity, light, wind, etc.). The data received from remote sensing satellites and aerial imageries (through satellite/drones) can further complement the decision making process. Some application areas are discussed in brief in subsequent section.

A. Monitoring and control systems

Various IOT based systems have been proposed for monitoring and control of environmental conditions in greenhouses [16]; and monitoring and decision support systems for agriculture field application [17]. WSN based precision agriculture architecture was proposed for sensing vital parameters of soil (the soil pH, the electrical conductivity, the soil temperature and

the soil moisture)[18]. WSN based solutions have also been proposed for environmental monitoring, precision agriculture, machines and process control, etc [19].

B. Smart Irrigation system

Water is a critical input for agriculture yield in nearly all its aspects. Without optimal water, even good seeds and fertilizer fail to achieve their full potential. India has about 4% of the world fresh water resources with about 17 % of the world's population. But in terms of water use efficiency, India uses 2-3 times the water used in countries like China, Brazil and USA to produce one tone of grain.

IOT based solution can be utilized to improve the water use efficiency, e.g. S. Li, et al. proposed an IOT based precision agriculture irrigation system for optimum water usage [20].

C. Agri- produce and Agri resource management

In a typical IOT scenario, RFID tags (electronics barcode) or sensor node can be attached to the agricultural produce (e.g. grain/seeds bags with RFID tags) and the agriculture resources (e.g. expensive machineries) for effective tracking and management. Uses of RFIDs have been proposed for identification and tracking of livestock, Agro-produce, farm machinery, etc. Similarly, real time monitoring of products stored or transported under controlled environment is also a possible scenario. Further IOT and cloud based platforms can be helpful in intelligent scheduling of expensive agricultural machinery.

D. Agri-Business management

IOT based integrated information environment, within information from farms, storage houses, transportation systems, processing units, markets and export houses available at single platform, can help in achieving resource optimization, quality improvement, cost reduction, improved profit, competitive sale prices, etc.

5. Conclusion

In this world of rapid rising of technology, IoT gives insights of how people can integrate technology in their lives. As IoT is valuable information that could be used in various ways, it's globally used, including India. IOT based system in education, healthcare and agriculture, although proven successful in developed countries, are in very primitive stage of implementation in India. The major challenge is to spread the knowledge and awareness about such systems across the country. Today, the mobile networks, internet and smartphones have already started their penetration towards villages, and building I-ways are considered as important as highways; this is a right time to seed the IOT knowledge and infrastructure in these entire

sectors for realizing a technology driven precision. The future of IoT becomes a worth but massive amounts of data increased its complexity in detection, communications, controller, and in producing awareness but its growth will be increased day by day. Although future of IoT will be predictable to be integrated, all-in-one, and ubiquitous. Service organization required to be enclosed in a set of standards. IoT have become an expected trend of development of information industry. This will outcome in quality of lifestyles.

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