IoT in Building Smart Cities and Smart Environment: Your Way to Success

1Mukesh Kumar, 2Gaurav Mehta, 3Nandini Nayar, 4Manik Gupta

Department of Computer Science and Engineering, Chitkara University Institute of Engineering and Technology, Chitkara University, Himachal Pradesh, India
mukesh.kumar@chitkarauniversity.edu.in, nandini.nayar@chitkarauniversity.edu.in, gaurav.mehta@chitkarauniversity.edu.in, manik.gupta@chitkarauniversity.edu.in

Abstract: Internet of Things has given us a new epoch of computing technology. As we know that Internet, a rebellion innovation has transformed everything, Internet of Things has made a hope for excellent future of Internet with Machine-Machine type of communication in addition. Thoughts of creation that correlates a different means of considering the events with invented concepts that avail the possibilities proposed by new approaches in intelligent ways. Framing an intelligent environment depends on smart education system, smart traffic management system, smart vehicle management system, smart waste management system, industrial control, smart agriculture etc. Today, safety on roads, cleanliness in residential areas, security at home has become an essential component in our daily life. So there is a necessity to avail new approach of innovative technologies based on Internet of Things to solve the environmental problems. In this paper we surveyed some of these problems and suggested various executable plans also. The actualization of smart sensing and transferring of data has offered a significant assurance for building the blueprints. This review paper has also shown that it is possible and affordable to construct these smart systems based on Internet of Things (IoT). We have studied various blueprints which can sense unforeseen happenings such as landslides, traffic jam, accidents, etc. using different sensors and demonstrate the facts accumulated on LED display. Observational outcomes have shown good agreement with the hypothetical statements.

Keywords: Internet of Things, Sensors, Smart Hospitals, Smart Cities, Wireless Sensor Network

1. Introduction

IOT refers to the brilliantly linked devices and smart systems to scrape together facts, knowledge, details, documents, evidence, experiments, figures, inputs, reports, results, statistics, etc. from nested sensors and actuators and other real commodities. At the moment, every single person is associated with each other employing tons of conversation modes and we can say that Internet of Things is one of them.
It is eminently contributing for specimens with disabilities as it upholds individual’s liveliness at immense extent identical to community, as the devices can jointly coordinate to operate as a total system or structure [1]

The objectives of IoT are to frontierly governing the physical individuals’ liveliness with highly developed cloud-based processing and accomplish the actions beyond any interference. Extensive wireless automation such as Wi-Fi, Blue tooth, nested sensors and actuators have been empowered, thereby IOT seems to be more boundless and revolutionizing itself into an entirely integrated forthcoming Internet. This revolution is in concern with interconnection amongst individuals at a remarkable and extraordinary extent and rapidness, and the succeeding one will be in concern with interconnection amongst entities to discover an agile and smart environment. All that we can keep track of and administrate employing advanced automation is the so called IoT and if we want to frontierly access it, fast speed of Internet is must.

In addition, this more protected and potential proficient devices have been offered by IoT. Peculiar IoT devices including wearable fitness equipments, health-monitoring devices, and network-facilitated medical equipments are transfiguring the approach in which healthcare aids are implemented through it [2]

Assume that you are seeking for your valuable thing on internet that you have lost at your home. So, that’s the widespread sight of IoT, an environment wherein objects are expert to conversate and data can be transformed for accomplishing responsibilities through Machine Learning. It provides a wonderful thing in your home which is smart enough to learn and implement about your comings and goings, likes and dislikes, when you forget to change settings of your electronic devices or people leave their home without switching off the appliances.

This paper aims to contribute an encyclopedic sketch of IOT and surveying its enabling technologies and sensor networks. It gives an outline of highly tracked and administrated devices used in various applications like home and industrial automation, disaster management, medical aids, mobile applications, healthcare, smart grids, smart agriculture and city concepts and supply-chain management.

2. Brief Review on applications of IoT in Building Smart Cities and Smart Environment:

Several divisional governments are planning to equip an IoT- based smart city via elevating a test-bed for IoT verification and an interspersed framework. Smart city equipment models depend on IoT that may be actualized by divisional government has been elucidated using examples here. Here, we sketch little applicability that may facilitate by urban IOT standard that are of reasonable concern in the city context. This can visualize win-win situation of flourishing superiority and booming the applications bidded to civilians whilst fetching an efficient improvement for city administration to decrement in operative expense. Some areas that have been considered in this paper where IoT can be availed very often are Smart traffic management system [3-5], Smart hospitals [4-8], Smart environment [9, 10] and Smart education service[11,12]. [13] Highlighted the role of Data Analytics (DA) and IoT for enhancing productivity and operational efficacy in agriculture.
Figure 1: IoT’s and its different Application Environment/Areas

2.1 Exploitation of Internet of Thing (IoT) in Building Smart Cities

The author [14] accounted an extensive outline regarding facilitation of technologies, protocols and design for urban IoT. Moreover, they introduced and examined the high-tech results with best practice protocols affiliated in Padova smart city project. This project is accomplished by joint effort with city municipality, a proof of concept deployment of IOT in the city of “Padova” and “Italy”. The prime aim of smart city is to lift up the early affiliation of information and information and communication technology solutions in general administration. Its applications consist of technique for gathering environmental information and supervising street lighting with wireless nodes equipped with numerous types of sensors, implanted on street light poles which are further linked with the internet via an “access unit”. With such types of implementation, environmental specifications such as humidity, air temperature, etc. can be collected which helps in analyzing the proper functioning of street lighting system by determining the light potency of each post. These smart city projects are controlled by link layer technology, wireless sensor network gateway, database servers, mobile operator device and street light.

The author in [15] has outlined the smart traffic services and smart education services by enforcing IoT technology based models. Dominant Smart Traffic services comprises of smart parking to obstruct illicit parking and promoting suitable parking and smart secure crossing services. It also allows real time examining of free space and parking charges, simplifying reservation or payment via Internet and Smartphone network. This facility shows betterment in illicit parking quelling structure by authorizing civilians to easily address specific offense or trespassing using their smart phones. It helps in finding pedestrians in children safety region and also alarm pedestrians and coming conveyance using computerized exposition panel and confer towards avoiding the casualties. Moreover they introduced effective real-time, high definition lectures with F2F sensation at home via HD services and wide area Internet framework.
The literature in [16] introduced a smart highway scheme for tracking accidents over the roads. Here they have planned a scheme that is “An Intelligent Highway System with W.A.L.T. (Weather Accidents Landslides and Traffic)”, an advanced abstract to retain security on roads. The facts attained for such downfall by availing digital sensors will flash LED display on roads via XBee, Global System for Mobile communication (GSM) technologies. Another component of these schemes inheres accident detection design depending upon the sound sensor which maintains details of the sound of accident occurrence relying upon strength of sound and in case of detection, it will transmit message through GSM modem to nearby stations. The subsequent component is bridge overflow detection design that is beneficial for regions where water runoffs over bridges in monsoon evoke bulky halt. To prevent this situation, wireless sensors will be used to interpret water facts of River Bridge which will further transfer message to control station and further flash on LED. Likewise, landslide-prone areas are situated in outlying parts where hardly any intercommunication resources are accessible. So, here they have used ultrasonic sensor-based landslide detector sensors and transmit data for disaster management using XBee or GSM. All types of sensors used are linked to a microcontroller (Arduino ATMega 328) which is further based on AVR core-based microcontroller.

The literature [17] surveyed a matter that says conventionally our structures build upon an electronic recognition for automobiles. This discipline relies upon an image and automobile license plate which lapse in the trick because of its inferior recognition ratio and inclination by unfavorable atmospheric conditions. So, here they urge an appropriate design having worldwide exclusive EPC code as selfness recognition of conveyance rather than conventional automation and apply radio-frequency identification device (RFID) reader to interpret Electronic Product Code (EPC) by radio-frequency electromagnetic waves, resolving the question of no-all-weather activities. Adding to this, GPS tech provides the location data of automobiles. Research and Development exhibit that it is achievable and economical to engineer this Smart system owing to its benefits such as price, accuracy, never inclined by unfavorable atmospheric conditions, etc.

In [18] contrast and evaluation of many Smart Transportation System elementary constituents has been done. Some of these constituents have been enhanced and claimed for its actualization in Jakarta transportation. They pointed on smart highway car management architecture and the car end users are more pleased with a botheration-free gyropilot system on the automobiles. This system supplies traffic details acquisition and overlook data and can track convict or unlawful automobiles such as taken-away cars or vehicles which avoid toll- tax. The design architecture comprises of GPS navigation, RFID reader and ACC sensors. It gathers and computes standard acceleration and facts on every highway and subsequently, it distribute and integrate active traffic facts by upstream sending of reports concerning the instant traffic status and modify the acceleration of car. A flooding algorithm has been applied to interchange and renew data with all acquaintance servers. This actualization is very valuable in conserving driving period, reduction in contamination by lowering vehicle discharge and illuminant intake. It is profitable to government also as it helps in dropping traffic over-crowding on trunk roads and utilize driver’s data. This system is sectioned into 3 paradigms: Smart toll payment, Smart drive and Smart geo. Smart drive opted gyropilot system when the car go across trunk road entrance and conveyance acceleration is aided by ACC sensor. The smart toll payment system over through the disadvantage of traditional technique which induce hold and inaccessibility. Here they set RFID on car door which sensed the passing car automatically and repay the
toll tax. The Smart geo overcome the driver direction issue. It interlinks the GPS system concerning the globe via satellites so that driver’s terminal can be traced easily in case car is taken away.

[19] has demonstrated the groundwork for an intelligent roadside structure like infrastructure based sensors and On-Board Diagnostic (OBD II) - Based Vehicle Sensor system. Intelligent systems like intelligent transport systems (ITS), intelligent telematics system and real-time traffic support services to drivers are exhibit two application prototypes like red-light violation warning system design for signalized intersection and speedy recommended scheme for highway authority. Calculated outcome for the same has been viewed using a micro-simulation approach. As per history record a lot of blueprint has been in progress since 2006 operated by Europe, Korea focusing merely on user driving and dropping casualties’ ratio.

[20] Explored possible actualization of IoT application in bus transportation system (BTS) in Singapore city. The Mass Rapid Transit train system over there is very beneficial in terms of supervising crowd and schedule. There is an extreme requirement for the customer to analyze various bus choices in an effective manner. They have subsidiary analysis which helped in constructing a commercial framework in spite of an application where IoT can be availed to figure out schedule of buses, crowd within each bus, leftover sitting space using sensors in seats. The traveler can cooperate with the bus through the mode of smart phone. Japan and Korea are the leading ones in availing this approach. The details can be delivered via bus sensors, embedded devices, satellite, smart phone application and a cloud server cum database so that real time information will be given to travelers in Singapore using IOT and this has been booming steadily.

2.2 Exploitation of Internet of Thing (IoT) in Building a Smart Environment:

The Author in [21] urge a structure to upgrade the way of acknowledging the end users enquiry and crisis occurrence and computing solid waste quantity devoid of engagement of any driver. As driver can make an error of missing any useful data owing to a few factors such as his laziness or behavior, thus automation could be done to decrease driver’s labor and verify the position of vehicle also The combination of inter-communication technologies with an affordable camera in order to get images is framed for solid-waste observing system. The installed camera captures the images and sends these images to control server through wireless general packet radio service sensors. Dustbin status such as quantity of waste or physical analysis of dustbin comprising vehicle location, and timings can be attained using GUI (Graphical User Interface). Tracing devices that are further installed in the vehicles acquisize real time location information through GPS and further transmitted continuously via GPRS to vital database. Formal users are able to stare at efficient location of each vehicle in the acquisition phase through a internet based technology and thereby handle the vehicles. This information concerning solid waste/trucks and bin is able to be exposed on electronic map, which is accessible by map-server. The details of dustbin are listed by RFID tag, transmitted to RFID reader, enabling the system to analyze whether vehicles reached near the dustbin or not. In Malaysia, solid-waste issues are the severe environmental problems as database is finite to handle the facts by local authorities. For this, the innovative technologies results must be used, e.g. Alam Flora, a company in Malaysia has already started vehicles monitoring and tracing system (Alam Flora 2009).

[22] has designed a capacitive point-level sensor and project a sensor network planned for betterment of solid-waste collection in buildings. This helps in preventing needless rounds of people in terms of
discharging the waste baskets because of the undetermined loading rate of a number of waste baskets. So, it is in demand to architect an extremely cost-effective sensor which can be customized to present or upcoming waste-paper baskets. These sensors are comprised of coplanar and face-to-face electrodes framed from low priced adhesive metal tape acting as capacitor electrodes and can be utilized to sense when a basket that accumulates paper to be reused is full. Head-to-head electrodes are not much reactive to any interruption from strongly metallic things and to the status of waste paper. The capacitance threshold is specified which is equated to a loaded basket. The waste baskets rid of the use of RF radar and Ultrasound sensors affixed on top. Openly placed papers just fill the basket but do not load a lot. These capacitive sensor devices have high-impedance, which shows less electric power usage which is a required feature in these sensor networks. They analyze that electric capacitance between electrodes raised when basket is partially filled with paper and rest is occupied by air as the dielectric, also raised with surface of paper within the waste basket. An increase in evaluated capacitance does not essentially imply that large amount of waste paper has been disposed into the basket. From several evaluated conclusions such as determining capacitance for both electrode angularity, without hindrances, with hindrance of metallic ashtray 7cm away, capacitance for head-to-head electrodes when electrode interface is earthen and when interface is apart from power line ground, they resulted that when waste basket was loaded, Cm was 8.6 pF, means more than while filling the basket with rigid paper. This maximized capacitance outcomes that metallic objects have a powerful impact on co-planar electrodes but their impact on head-to-head electrodes is lesser as compared to paper loading into the basket.

The presented paper [23] sketches an innovative technology for use in the supervising of municipal solid waste, supported with geographical information systems as well as distributed-sensor technology. Major Chinese cities exhibit an appealing structure for waste management designs or methods due to the consequences of the speedy raising in industrialization and to the existence of mostly heavily-inhabited metropolitan regions and need for environmental shield. Clean Wings Project introduced a method providing a management mean having a web-access design for a network of sensorized waste dispenser connected to data management and an intelligence discipline. Three levels representing this network are: a backend set of applications comprising the geographical information storage, Data Application layers (DALs), and database management system, a front-end application for referred data retrieved to all the licensed users. Primary region testing and experimental results of the method provided were done in Pudong, Shanghai (PR China). The listed features were taken into consideration comprise supervising amount of waste produced, quantity of waste at every location and determining the category of containment present in the gathered waste. Dispensers utilized here were fitted with sensors affixed onto standard waste bins. The function in information computing is to gather real time facts from the network. Dispenser aggregated facts are brushed up every 5 seconds at DAL and DBMA levels, and transmit the facts every time lid is on or off again. Two subsets of sensors were tied external to dispenser for electric power and fact interchange. The device named Operating prototypes (OP) was used to measure dispenser quantity. Here dispenser doesn’t required mobile tracing or any connection. This Project has also provided a front-end interface for a number of management utilities can be approached through web and grants real-time visibility of trucks location as well as dispenser status too. The other need is to manage tuck routes to shorten the gathering cost and betterment of waste gathering economically.
3. IoT based Technological Framework in Building Smart Cities and Smart Environment:

**Radio Frequency Identification (RFID):** A network that transfers the recognition, location or any other parameters of a thing or any individual through telecommunication via radio waves with serial number pattern. It computes recognition issues of things close to us in a price efficient way. RFID is categorized into different type of tags shown in figure below. It can be combined into any object due to its decreased length and effective price. The signals are sent to receiver through radio frequencies which further delivered to the processors to examine the data. It has a large range of wireless technologies such as military field, tracking, etc.

![Radio Frequency Identification categorized into different type of tags](image)

**Wireless Sensor Network (WSN):** One of the most valuable pillars for numerous IoT applications are the WSN’s. Capella, [24]Wireless Sensor Network is a two-fold directional linked network of sensors which gathers information such as velocity, temperature, noise, motions, space, and pressure etc. The fields which it holds in IoT devices are home security, healthcare, agriculture, industrial control, disaster management and many more. [25]

Sensors can be affixed on individual’s body to gather the data so that doctors can prescribe the patients wisely and timely. WSN can be linked to the Internet through many ways as shown in figure given below.
Figure 3: WSN can be linked to the Internet through many ways

Electronic Product Code (EPC): It is a 64 or 98 bit code stored electronically on an RFID tag for the purpose of betterment in EPC barcode design. It records the information about the EPC type, specific serial number of goods, its distributions, constructor details etc. It has four constituents named as ONS, EPCDS, EPCIS and EPCSS. Below is the figure which explains the working of Electronic Code machine.

Figure 4: Explains the working of Electronic Code machine.

On-Board Diagnostic (OBD II) - Based Vehicle Sensor system: On-Board Diagnostic (OBD II) is a device which further affix inside a conveyance that observes the complete information within it every second. All the gathered information’s which are provided by controller area network from conveyance sensor which comprises of velocity, RPM, temperature, voltage, fuel used, etc. parameters. These facts are
arranged as examined data and further refined and transferred to an intelligent road computing device for advance preparation to yield crystal knowledge of upcoming environment. In figure, it is shown that sensor is joined with the conveyance region through any gateway which behaves like mobile access between outside devices and vehicle’s engine control unit.

![Vehicle Mobile Gateway](image)

**Figure 5: On-Board Diagnostic (OBD II) - Based Vehicle Sensor system**

From an IT point of view, the enforcement of a central supervising technology and the formulated systems participate towards offering chronicle facts, adding to it also offered enriched performance on the current status of dispenser system, smart parking, smart education, smart highways and many more functions.

**Discussion and Conclusion:**

In this paper, modern outcomes that combine passive WSN, Sensors, Actuators, GPS tracing, and inexpensive camera to heighten solid-waste collection, landslides, traffic management, and weather occurrences effectiveness is reviewed. From the above-mentioned frameworks and study, we extract the various applications of IoT build a smart society and thereby provide numerous benefits such as low price, good reliability etc. The illustrations shown in this paper clarify that the chronic pretended IoT evolution in traffic, waste collection, highways, landslide, is currently in progress. With the new appearing facts day by day, they sustain noticing the demand for affordable management. We are moving closer to the end point of the partition between realistic, practical, digital worlds. IoT step by step serving a sea of modification applications in our everyday existences, which make our life easier. Fieldworks, case studies are conducted for acceptance of IoT to a broad extent, without disclosing its formulation challenges and provide secrecy and safety to the end-users. The implementation of IoT necessitates energetic as well as hard attempts. With a broadly shared, localized sophisticated scheme of intelligent devices, IoT has enabled improvements to significant facilities in utilities, education and other areas, which gives a modern scheme to technology advancement.
References

[1] Fernández Caramés et al 2017 Reverse engineering and security evaluation of commercial tags for RFID-based IoT applications Sensors 17.1: 28.
[2] Stergiou et al 2018 Secure integration of IoT and cloud computing. Future Generation Computer Systems 78: 964-975.
[3] Sharif et al 2017 Internet of things—smart traffic management system for smart cities using big data analytics. 14th International Computer Conference on Wavelet Active Media Technology and Information Processing (ICCWAMTIP). IEEE, 2017.
[4] Rizwan et al 2016 Real-time smart traffic management system for smart cities by using Internet of Things and big data. 2016 international conference on emerging technological trends (ICETT). IEEE.
[5] Javaid et al 2018 "Smart traffic management system using Internet of Things." 2018 20th International Conference on Advanced Communication Technology (ICACT). IEEE.
[6] Rizwan et al 2017 Design and development of low investment smart hospital using internet of things through innovative approaches. Biomedical Research 28.11.
[7] Ashish Mehta et al 2017 Architecture and plan of smart hospital based on Internet of Things (IOT) Int. Res. J. Eng. Technol 4.4: 1976-1980.
[8] Seth et al 2017 Hidden Markov model and Internet of Things hybrid driven smart hospital. 2017 8th International Conference on Computing, Communication and Networking Technologies (ICCCNT). IEEE.
[9] Chin and Jeannette et al 2019 The Internet-of-Things: Reflections on the past, present and future from a user-centered and smart environment perspective Journal of Ambient Intelligence and Smart Environments 11.1: 45-69.
[10] Ahmed et al 2016 Internet-of-things-based smart environments: state of the art, taxonomy, and open research challenges IEEE Wireless Communications 23.5: 10-16.
[11] Abdel-Basset et al. 2019 Internet of things in smart education environment: Supportive framework in the decision-making process. Concurrency and Computation: Practice and Experience 31.10: e4515.
[12] Widya Sari et al 2017 Study of smart campus development using internet of things technology MS&E 190.1: 012032.
[13] Elijah and Olakunle et al An overview of Internet of Things (IoT) and data analytics in agriculture: Benefits and challenges. IEEE Internet of Things Journal 5.5 (2018): 3758-3773.
[14] Z. Andrea et al 2017 Internet of Things for Smart Cities”, IEEE IOT JOURNAL, Vol.1, no. 1.
[15] Jaehak Byun and Sooyeop Kim et al 2016 Smart City Implementation Models Based on IoT Technology Advanced Science and Technology Letters Vol.129 (Mechanical Engineering), pp.209-212 http://dx.doi.org/10.14257/astl.2016.129.41
[16] K. Kumar, Gaurav et. al, 2017 Smart Highways Systems for Future Cities International Conference on Emerging Trends in Engineering Technology and Management, IIIMT College of Engineering, Greater Noida, India, ISBN: 978-93-86171-38-2.
[17] L.Xiao and Z.Wang 2011 Internet of Things: A New Application for Intelligent Traffic Monitoring System in JOURNAL OF NETWORKS
[18] Atut Pindarwati 2013 Smart Highway: Near Future System in Jakarta”, The Third Asia Future Conference, At Kitakyushu International Conference Center and the University of Kitakyushu, Kitakyushu, Japan. Hello
[19] Jeong Ah Jang et al 2011 Smart Roadside System for Driver Assistance and Safety Warnings: Framework and Applications", ISSN 1424-8220 www.mdpi.com/journal/sensors, Sensors, 11, 7420-7436; doi:10.3390/s110807420.
[20] Maher Arebey et al 2010 Integrated technologies for solid waste bin monitoring system, © Springer Science Business Media B.V.
[21] Hassan Basri et al 2011 Integrated technologies for solid waste bin monitoring system", Environ Monit Assess, 177:399–408 DOI 10.1007/s10661-010-1642-x.
[22] Ferran Reverter et al 2012 Capacitive Level Sensing for Solid-Waste Collection Department of Electronic Engineering, Technical School of Castelldefels (EPSC), Technical University of Catalonia (UPC), Castelldefels. Barcelona, Spain, reverter@eel.upc.es
[23] W Alberto Rovett et al 2009 Early detection and evaluation of waste through sensorized containers for a collection monitoring application 0956-053X/$ - see front matter, Elsevier Ltd. All rights reserved. doi:10.1016/j.wasman.08.016.
[24] Juan Vicente et al. 2016 A reference model for monitoring IoT WSN-based applications Sensors 16.11: 1816.
[25] Bera, Samaresh, et al 2016 Soft-WSN: Software-defined WSN management system for IoT applications IEEE Systems Journal 12.3: 2074-2081.