Cloud-Based Smart Environment Using Internet of Things (IoT)

E. Laxmi Lydia, Jose Moses Gummadi, Sharmili Nukapeyi, Sumalatha Lingamgunta, A. Krishna Mohan, and Ravuri Daniel

Abstract Internet of things (IoT) is a primary computational paradigm to develop a smart environment in every area of health, city, factory, and home in our daily lives. It incorporates wireless transmissions to all sensor devices through the internet. Equipping a smart environment to the society, IoT as the primary source provides alternative diversified communicating characteristics. Its ecosystem is the solution to all communication technologies as well as designed architectures. This paper deals with distinct core requirements to generate reusable features and technologies to develop a smart environment. Technological architectures like Radio Frequency Identification (RFID) and Constrained Node Network (CNN) are identified to enhance the Internet of things. This paper also describes the necessity of having smart environment sensors with the Internet of Things (IoT). This shows the involvement of a smart environment crossing all communicative disputes from the technical and informative perspective that desires to fulfill the efforts of the people in the coming years.

Keywords IoT · Smart environment · Cloud computing · RFID · CNN

E. Laxmi Lydia (✉)
Department of Computer Science and Engineering, Vignan's Institute of Information Technology (A), Visakhapatnam, Andhra Pradesh, India

J. M. Gummadi
Department of CSE, VFSTR (Deemed to be University), Guntur, India

S. Nukapeyi
Department of Computer Science Engineering, Gayatri Vidya Parishad College of Engineering for Women, Visakhapatnam, Andhra Pradesh, India

S. Lingamgunta · A. Krishna Mohan
Department of Computer Science & Engineering, UCEK (A), JNTUK-Kakinada, Kakinada, India

Department of Computer Science and Engineering, JNTUK, Kakinada, Andhra Pradesh, India

S. Lingamgunta
e-mail: sumalatha@jntucek.ac.in

R. Daniel
Department of Computer Science and Engineering, Bapatla Engineering College (Autonomous), Bapatla, India

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1 Introduction

The measures of IoT computations and prototypes for communication transmission on connecting frequent objects to the internet are sustained by the establishment of resource-constrain tools. These incorporate and facilitate intelligent systems using sensors and actuators. Intelligent systems gather physical world information to perform actions subsequently. Most of the efficient advantages of IoT have resource management, upgraded productivity, and elevated quality of life for the smart environment of the large human population. The beginning of a smart environment starts with enhancing smart homes, cities, factories, and surrounding areas that relate to our daily activities. IoT tools make possible multiple transmissions of data through Radio Frequency Identification and Constrained node network technologies. These technologies have various features and plenty of heterogeneous solutions for IoT communications. Smart environments gather information from different sources based on different scales with disparate prerequisites. Therefore, information is retrieved depending upon unique domain connectives.

IoT appliances demand maintenance and assist the sensors to handle data for storing, managing, and processing. The various data flow through consistent approaches like cloud computing and Fog computing exist.

The influence of the internet on remote areas comprises scalable solutions with low latency for more number of devices are connected uses fog computing. Real-time interactions for smart monitoring intend to have smart homes through cloud computing. This allows us to control complementary data processing and storage operations but not absolute to the latency such as operating television, turning on the bulb, AC so on through remote control. For explicit interaction of devices, it is mandatory to have either cloud computing or fog computing. Smart cities were operated through cloud and fog techniques. Low latency helps us to have more number of IoT tools with potential information within the city. Production of smart factories invokes advanced sensors and actuators for the internet connectivity among large administration systems and companies through gateway using stream of data. Smart factory applications like Enterprise Resource planning, manufacturing execution systems develop smart products by monitoring machine-health parameters.

To aid all smart applicational manufacturing products, computing analytics help to process data in real-time with capability apprehension. The waiting time of the data processing is the primary concept to progress manufacturing applications as it ranges within milliseconds. Instead of continuous execution of all jobs in cloud computing, smart technologies make use of fog computing to offload some of the data processing jobs. This results in introducing low latency and low operational investment i.e., a smart manufacturing company. Industry 4.0 realize to have cloud computing to share the data from the internet to all enterprise and suppliers which hold manufacturing process using cloud services. The major intention of the expanded transparency through the supply chain and procedural networks lead to the automated production environment.

2 Literature Survey

The dominance to empower users in smart cities reduces the deployment rate and enhances the development of the capillary sensory apparatus. Nevertheless, the beginning of the smart cities uses these mechanisms uniformly to progress and test at many distinct exploratory platforms. Along with the frequent mechanisms the emerging edge computing allows different forms of network organization to sense the environment [2].

Some of the political issues in the cities obstruct the formation of the smart city due to an assortment of technical problems and lack of technologies [1]. The interoperability of high-tech solutions in the area of the Internet of Things extensively identifies the basic technological promoter of smart cities. The modernized progression of evolution uses mobile applications to sense models associate with valuable functionality to sense information from the cities for intimate smartphones [3].

Smart homes provide smart services that vary extensively. Assistive services and management services are the services that help to meet the needs of user mostly elderly people, disabled. These satisfy to furnish the e-health services [4]. The frequent explosion of technological modifications has led to the evolution of smart sensors, advanced computing approaches (cloud computing, big data analytics), internet of things possibly correlated to smart home healthcare projects. These smart home-based projects were carried out in research and commercial systems using two primary real-time telemonitoring methods like video examinations/consultations and also diverse bio-signals [7].

Collection of information from many systems as input, for example, computer vision frame smart environments. The obligation of the entire process acknowledges the smart environment from a human perspective directly or indirectly [5]. According to ICT, mostly contradict to all fields and challenges, and point schemes of smart cities, some precisely extend to smart energy [12], e-government [11], e-health [6],e-culture, smart mobility, e-tourism [16].

Electro-Mechanical Systems (MEMS) use inertial sensors as the most unique measures for better human observations. Depth cameras give more intelligence and evaluate more efficiently [7].

The moderate potential wireless networking is to describe instability as a concern of hasty improvement of ingenious IoT resolutions that unfold the restricted modern technologies. The eventual consideration and the work across the major improvement in limited issues. IoT technologies and systems acknowledge the exchange of data to initiate a smart environment astounded by artificial and enveloping intelligence [8].

For the entire population, quality-of-life is increased through the assistance of adequate resource management, complemented productivity IoT [9]. Later on, the applications are encouraged to enterprise the precision of endemic diseases and deterioration [10]. This can enhance the living standard of smart cities and their reparations.

Intelligent systems [13] for the smart environment include smart remote driving technologies for the benefit of the materialized business standard of Industry 4.0.

Smart homes, manufactured systems, working offices acquire the assistance of common application with the process of acquiring data and dealing with disparate compatible context information.

One of the most complex scheme to develop smart cities and smart environment come across many dominions [14, 15] that incorporate the economy, energy, mobility, governance of a huge number of correlated disputes and implicate collective actors such as city service providers, administrators, operators, citizens with conceivable challenging objectives.

3 Methodology

3.1 RFID Technology

Radio Frequency Identification is a noticeable technology that implements a selection of the immense range of frequencies, merge with multiple device types and communication protocols. It is a standardized model to large international organizations like ISO (International Organization for Standardization), ITU (International Telecommunication Union), IEC (International Electrotechnical Commission), and also national wide organizations like DIN (Deutsches Institut for Normung), JIS (Japanese Industrial Standards) and SINIAV (National Vehicle Identification System). A trivial method is been accepted by all technologies that are equivalent to the Frequency band.

RFID technologies have a low-frequency band with 125–134.5 kHz, a high-frequency band with 13.553–13.567 MHz, and Ultra-high frequency band with 433 MHz and 858–960 MHz, Microwave with 2.4–2.454 GHz 5.725–50,875 GHz. RFID technologies have Passive, semi-Passive, Active, Sensor Tag chip type for transmission, signal modulations, and Chipless time-domain frequency. RFID technologies that are used by the IoT are ISO 14443 (13.56 MHz), ISO 18000-63 (858–960 MHz), ISO 18000-7 (433 MHz), EN 300 220-2007 for different applications such as personal identification, Online Payments, ticket booking, Access control, and security, tracking logistics, retail/consumer applications, real-time location tracking.

Most of the IoT applications utilize any three of the shared types of RFID technologies that match the number of collaborating devices at the same location with supported speed by preventing collisions.

- **Radio Frequency Identification (Identifier schemes)**

The expansion of the open IoT systems consolidate any number of stakeholders with the scalable operation. These RFID identifiers retrieve tags by interpreting them in a general way. Use of widespread standard identifier schemes requests to have RFID among the mixture of material objects, digital artifacts, and their locations with a feasible point of view. SG-1 has matured Electronic Product codes globally through object identifiers at ISO/ITU Organizations. Identifiers from Japan use Ubiquitous

IDs to employ RFID technology. Industries classify tagged billions of objects using barcode encodings. Patterns and codes of the individual scheme may not have the same for all identifiers. EPC system follows a specified prefix code for all its users i.e., 00110000. The remainder of the code generates 96 bit length as Serialized Global Trade Item Number which is always ordered in a stratified process that enables the code within the organizations with allotted authorization.

- **Radio Frequency Identification (Identifier resolution systems)**

Internet of Things (IoT) system integrates with RFID. It tags the existence of individual entities to analyze the information related to the identifier, privacy protection, and secured operations provided by the control access. This capacity and the effectiveness of the system is indicated as Identifier Resolution Service. The ongoing scheme specifications for services use Identifier Resolution Service. Contradiction to the IoT applications, they need to be open and comprehensive.

3.2 Constrained Node Network (CNN) Technology

Technologies like RFID refer to communicate with other objects, but CNN is preferably used to communicate with the physical world. These are the sensing computer tiny devices with a max 16-bit processor and ~10 KB RAM with some computational constraints, energy constraints (for example batteries with limited energy source). The communication transmission can be done through wired or wireless technologies. CNN technology mostly works under MAC and physical layer functionalities. Every innovation may have explicit qualities and might be more qualified for a restricted arrangement of situations. The arrangement of technological advancement consists of

- ***IEEE 802.15.4*** is a wireless technology meant to allow tracking and manipulating various applications for WPAN. Its first publication point to standardized low-rate transmissions and low energy consumption. It was not produced to work for only a particular domain, rather preferred as universal technology with significant protocol architectures by upholding Ipv6 and protocol architecture with non-IP-based protocol architectures. Smart environments with optimized technology like IEEE 802.15.4 were designed to neglect destructions in Industrial environments. This mode of implementation is referred to as Time slotted channel hopping a specified protocol.
- ***BLE*** was launched in 2010 with a very low-electricity variant of conventional Bluetooth. About the partial use of hardware, a tool that is supported by the conventional Bluetooth also supports the low additional price of BLE. Consequently, this will leverage its large existence in smartphones, possibly accumulated information can be sent to nearby sensing devices and actuators. Smartphones that interact using tools, actuators over the Internet have a gateway. This can be further designed for most of electronic devices, wearable.

- ***ITU-T G.9959*** is a wireless Z-wave technology that clarifies the stack protocol mostly innovated to model smart homes i.e., home automation.
- ***DECT-ULE*** is a technology meant for voice and data transmissions through the gateway. It generates low-energy and enables communications for indoor cordless telephony connected to all sensors, actuators by manipulating the robust latency of DECT appliances in the home.
- ***NFC*** is a wireless technology that implements reader mode, peer to peer communications and satisfies multiple communication modes of data communication within a short range of ~10 cm. The intrinsic security properties of NFC provide maximum rejection of unauthorized devices that intend to grab transmitted data.
- ***IEEE 802.11*** is referred to as WLAN wireless communication, designed to have various power-saving techniques with low power consumption, energy-constrained tools. It also enables multiple compilations of sensor devices for data collection namely smart grid.
- ***LoRaWAN*** is a wireless technology referred to LPWAN. Its communication through the physical layer transmits data within 10s of km. It follows star topology as it transfers data between hundreds of communicating devices with low-cost infrastructure, low bit rate limitations through gateway implementing LoRa technology at the layer.
- ***Sigfox*** is similar to LoRaWAN, the wireless technology with reduced bitrate and low-cost infrastructure reflects LPWAN technology. It connects devices of large distances by using star topology. This technology functions under unlicensed frequency bands, managed by the organization.
- ***Narrowband IoT (NB-IoT)*** is one of the advancing wireless technology, categorized as LPWAN. It offers many numbers of systems with a licensed spectrum with a low bit rate of specified 3GPP under the single base station.
- ***Power Line Communication (PLC)*** represents a smart grid framework. It is a wired technology that tampered with the impairments related to the wireless media. Its applications are applied to have an innovative smart home living with a low bit rate. IEEE 1901.2 or ITC-TG.9903 are the variants of PLC.
- ***Master-Slave/Token Passing (MS/TP)*** determines the wired technology usually related to the BAC net. This technology is mostly designed based on grid-powered to develop automated features in the physical layer. These are constrained to RS-485 requirements at low bit rates.

Protocol Architecture for Constrained Node Network (CNN)
Constrained node network architectures were classified into IP-based architectures and non-IP-based architectures. The main protocol and connections were generated and based on the physical layer.

IP-based architectures are interoperable and flexible to communicate remotely with many devices, sensors, internet connectivities, and actuators. The data that has been shared between devices are secure by providing address names. Any connections to the constrained devices use running IP to obtained efficient internet connectivity. It is an open protocol modeled to have underlying technologies and stack protocols like HTTP, TCP, IP as frequent network interfaces. This can be mostly observed with grid-powered devices. Some devices with insufficient computational power cannot afford to use traditional protocol stack as it is energy-constrained. To advance more in technology IP based architectures added Ipv4 and then later Ipv6 for system self-configuration. IoT stack-based protocol composes of adaption layer down to IPv6, Low powered routing protocol, Constrained Application protocol, and RPL. This also supports IEEE 802.15.4 networks.

Network Topology of CNN

Cities that are developed as smart environment cities adopt mesh network topology. Network with mesh topology is a sophisticated network similar to star topology connections. CNN implements dynamic routing protocol which enables the paths of the network through routers for real-time logical networks. The foremost prominent preferences of the mesh topology of CNN has two advantages. It overcomes the limitations of star topology by reducing the link range. It provides path diversity and avoids star topology single-point failure issues. Due to multiple network connections and path propagation, this will improve the wireless network functionality. This can be applied to develop both smart homes and smart factories with advanced sensors and also with low infrastructure costs. In some cases, LPWAN technologies were also implemented for innovative smart cities.

3.3 Smart Environment Sensors with the Internet of Things (IoT)

The following are the different categories of sensors, technologies that are used to invoke a smart environment using IoT-based Systems. Specialized sensors for smart environments adapt to physical parameters. These sensors are placed for the automatic generation of the information ordered at locations such as homes, body, factory, city, etc. Despite the exploitation of the user information through a smartphone, sensors provide information even though the sensors have not been intended for an unambiguous use case that implicates many disputes.

Specified systems for developing authentic, robustness, and analyzed management of smart factory always encourage to have more sensing effectiveness of the environment, mostly smartphones.

The development of smart homes influences the existence of smartphones. Smart manufacturing devices offer both analog and digital sensors to have quick look over work status. Some of the most implemented manufacturing applications are Industry 4.0 automation. Anticipates the operations that supply information from the device or production of the analyzing process generates a high quality of sensors. Which allows us to have smart homes. Some of the privacy preservations for sensors are considered to come against environmental disputes and performance such as a change in the moisture, the existence of chemicals, vibrations, changes in temperature, dust.

Smart environments mostly reflect the design of smart homes and also overcome the changes affected by nature, i.e., high temperatures, and shocks using a large number of available technologies. Smart homes use ITUTG.9959, infrastructure uses PLC and DECT-ULE. Commonly used technologies are IEEEc802.15.4, BLE. Smart factories use IEEE 802.15.4e TSCH technologies leads to having primary settings. Emerging technologies of LPWAN uses LoRaWaN, NB-IoT, Sigfox. Eventually, the physical environment carries e-health smart applications as home-centric connected to smartphones.

4 Conclusion

Remote operations using IoT-enabled keen cloud computing frameworks provide smart homes, advanced healthcare, smart manufacturing factories, and cities. However, selecting the correct innovative technology reaches the best prerequisites of a particular framework with a challenging errand and produces the best framework modeler due to the huge differing qualities of preferences. The trade of information permitted by IoT innovations and frameworks could be the beginning state for enhancing smart environments encouraged by manufactured and encompassing insights. This paper concludes to design the core requirements that generate reusable features and technologies to develop a smart environment. Two technological architectures like Radio Frequency Identification (RFID) and Constrained Node Network (CNN) are described to enhance the Internet of things. Thus the process of inventing a smart environment for the social changes the style of living to advanced good health and safe life.

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