

Comparative Analysis of IOT Based Smart Parking System

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Introduction

The Internet of Things (IoT) has a multidisciplinary vision to help many fields, including the environment, industry, public and private sector, healthcare, transportation, etc. Regarding

particular areas of interest and issues, different scholars have provided varying explanations of the IoT. IoT's potential and strength are seen in a number of application sectors.

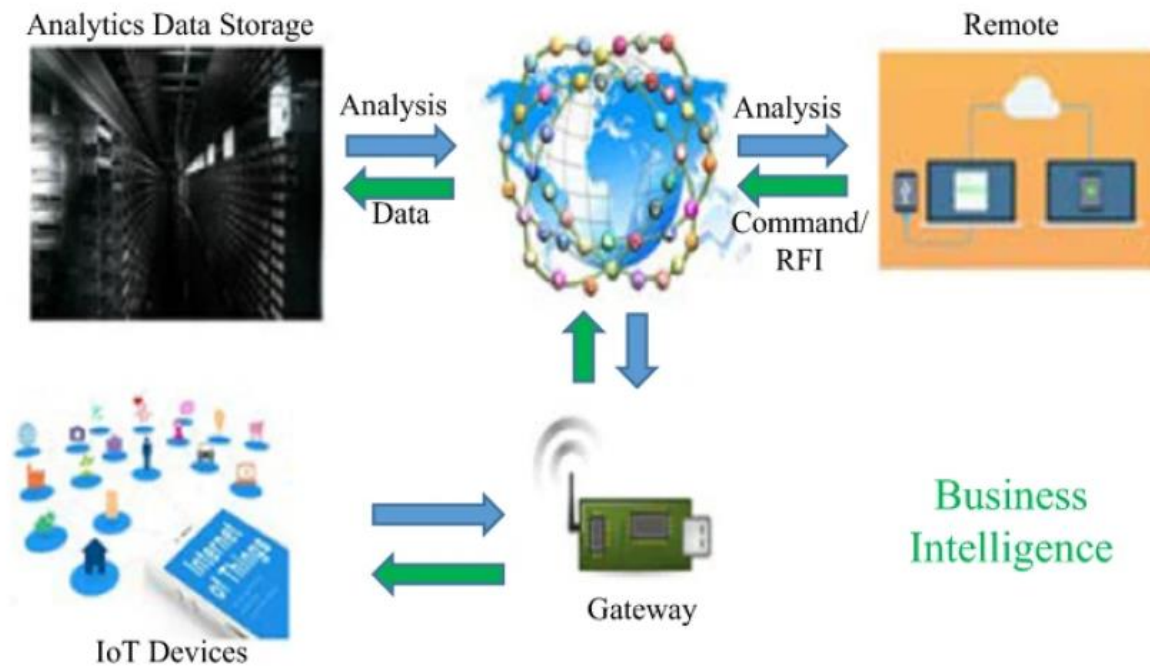


Figure: shows the overall IoT architecture.

Transportation is another significant component of our lives. IoT has led to some fresh developments that have improved its effectiveness, comfort, and dependability. At numerous signalized junctions across major cities, intelligent sensors and drone gadgets are now in charge of managing the flow of traffic. Additionally, new cars are coming off the assembly line with sensors pre-installed that can

detect impending large traffic jams on a map and offer an alternate route with little to no congestion [1]. IoT can therefore be very useful in many areas of life and technology. We can draw the conclusion that IoT has a lot of potential for improving technology and helping humanity.

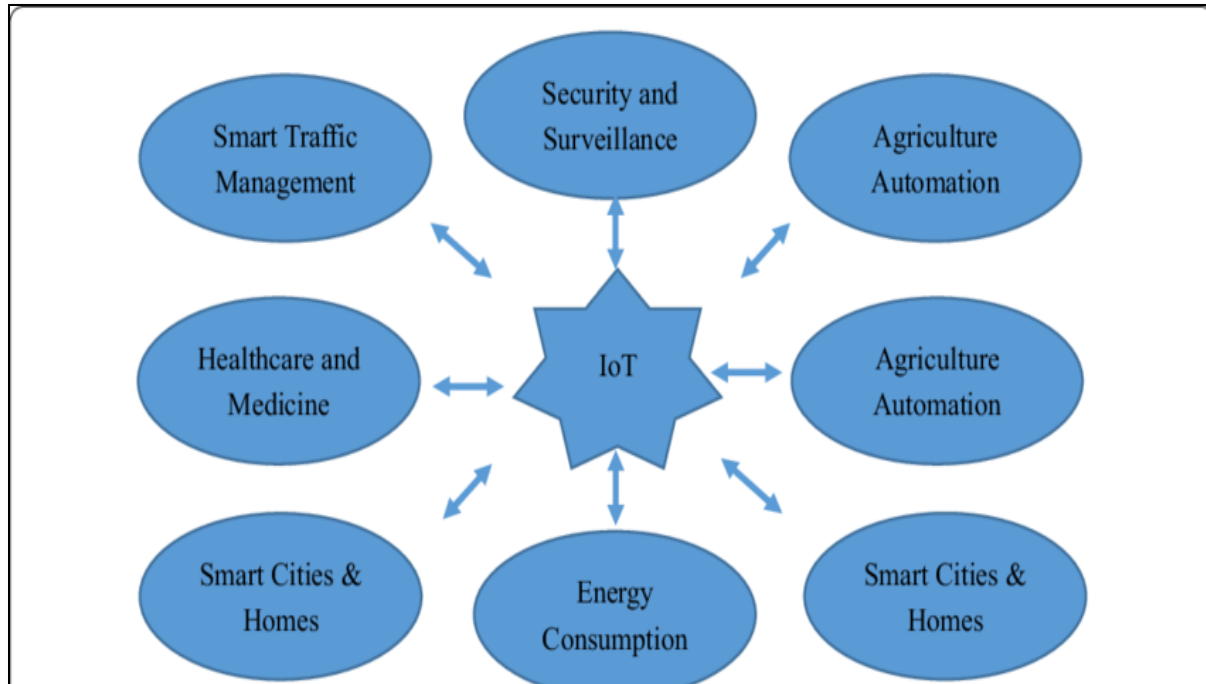


Figure: IoT's potential application areas

Security and privacy are a key IoT concern that necessitates attention and extensive research. A private corporation using IoT should incorporate data authentication, access control, attack resilience, and client privacy into their business activities, according to Weber [2], who focused on these concerns and stated that doing so would be advantageous. Weber argued that IoT developers need to consider the geographical constraints of the various nations in order to establish global security and privacy challenges. To accommodate the diverse needs for privacy and security around the world, a general framework must be created. Before creating a fully functional IoT framework, it is strongly advised to research and identify the problems and obstacles in privacy and security.

Later, a security flaw in IP-based IoT systems was discovered by Heer et al. [3]. They claimed that the internet serves as the foundation for all device connectivity in an IoT system. Security concerns in IP-based IoT systems are therefore a major issue. Additionally, the capabilities and life cycle of every IoT system object should be taken into account while designing the security architecture. It also incorporates the use of security standards and a trusted third party. It is also desired to have a security architecture that can grow to accommodate both small- and large-scale IoT objects. The study made the point that because the

Internet of Things (IoT) has given rise to a new method of communication among various devices throughout the network, traditional end-to-end internet protocols are unable to offer the necessary support for this communication. To achieve end-to-end security, new protocols must be established taking into account the translations at the gateways. Additionally, each layer involved in communication has its own security concerns and needs. Therefore, security needs to be assured for all layers because meeting the requirements for just one layer will leave the system susceptible.

In order to create an efficient environmental monitoring and control system, Fang et al. [4] introduced an integrated information system (IIS) that combines IoT, geo-informatics, cloud computing, global positioning system (GPS), geographical information system (GIS), and e-science. They claimed that better data collecting, analysis, and decision-making for climate control are provided by the suggested IIS. Another significant issue facing the world now is air pollution. There are numerous technologies and methods for controlling and measuring air quality.

One of the most significant issues with urban transportation, according to Ghulam Ali et al. (5) is traffic congestion, which results in significant energy consumption and air pollution. One of the main causes of traffic bottlenecks is the lack of open

parking spaces. Parking and congestion go hand in hand since looking for a location to park causes more delays and boosts local traffic. 10% of traffic circulation in the middle of big cities is caused by cruising, as vehicles spend almost 20 minutes looking for free parking.

Abrar Fahim et al. highlighted a significant issue in contemporary cities for which several smart parking systems (SPS) have been created in 2021 (6). In terms of technological approach, sensors used, networking technologies, user interface, computational techniques, and services offered, this study contributes to the provision of comprehensive knowledge, comparison, and in-depth analysis of SPSs. The report also closes a research vacuum by outlining the appropriateness of SPSs in diverse environmental contexts and highlighting their benefits and drawbacks. Researchers, designers, and policymakers would be able to choose the best SPS and comprehend the current developments in this industry thanks to the detailed comparison of many SPS features.

M. Whaiduzzaman. In order to assess the significance and requirements of specific IoT technology components for a smart city, et al.; 2022 (7) discussed the significance of IoT technologies on the technical roadmap of a smart city (TRM).

Feng Yuan Wang and Yi Liu 2017 (8) described a mechanical parking system that included a rotational mechanism that allowed all of the cars to move in a rotary motion. The rotational motion of all the cars was used to load and unload the cars. For 8–12 autos, this method was ideal. The fact that it was simple to use and made parking the car a breeze were advantages. Limitations included a complicated structure, a high initial cost, and the requirement to rotate all cars in order to reach one car.

Smart Parking Occupancy Monitoring and Visualization system for smart cities' is the title of a study written by Fernando Rios- Gutierrez, Danda B. Rawat, and Robin Grodi that was published in 2017[9]. Fernando Rios-Gutierrez, Danda B. Rawat, and Robin Grodi had completed.

Shimi, A., et al. 2022 (10) made the argument that the automobile industry has made great strides, that urban populations are expanding, that there are more cars on the road, and that this makes parking more difficult. Intelligent parking management systems provide the best way to locate vacant parking spots so that motorists may

easily locate their vehicle parking spaces. Designing an intelligent parking system is crucial to address these problems since it not only makes drivers more comfortable, but it is also commercially viable.

The emphasis of Pradhananga, P., et al.'s 2022 (11) study was Data Receiving, Monitoring, and Displaying (DMD). The data about the parking area is received with the aid of sensors or video cameras, and the information is displayed on the monitor screen or on mobile devices, such as smart phones. The detection system is based on RFID, and with the assistance of this system. Sharing and displaying information on the server allows for easy monitoring. The system has suggested outcomes for monitoring parking spaces using intelligent techniques, such as monitoring with the aid of intelligent sensors based on IoT.

A novel way for enhancing smart parking systems in 2020 that makes use of computer vision and electronic payment systems [12]. The system's goal is to give consumers more security and convenience. It is composed of a network of smart parking sensors linked to a Raspberry PI and accessed via cloud-based software. Although the system has made great progress, it is still not completely safe because hackers might still alter data. Despite this drawback, the suggested strategy offers hope for future advancements in smart parking technologies. In 2014, a smart parking system's security and transparency were increased through the usage of blockchain technology [13]. With the help of this decentralized strategy, which included anonymous credentials and an emphasis on protecting user privacy,

Sheng, N.W., et al. noted how finding available parking places has become a daily difficulty for most drivers in 2023 (14). When unauthorized cars (patients and students) take over spaces that were initially designated for their employees (doctors and lecturers), the issue is getting worse in open space parking areas in public venues like hospitals and universities. Because the doctors will be running behind schedule for their patient appointments and the lecturers will be running behind schedule for their lectures, this undesirable scenario could have an impact on production.

An essay was put up in 2018 that sought to develop smart parking systems by employing a novel computer vision technique to recognize the license

plate number and parking space [15]. In addition to accepting digital payments, the smart parking system's security was enhanced. A tool to assist users in finding their automobile if they lose track of where they parked it was also included in the suggested method. The architecture of the suggested method entailed using Raspberry Pis and smart parking sensors to collect data, which was then delivered to cloud computing applications to help the user.

Aditya, A., et al. 2023 (16) concentrated on the application of various types of regression to create a parking occupancy prediction system for better delivery bay management. This model's objective is to determine the current state of parking space availability and forecast its future availability. The stacking algorithm is the basis of this. Finally, it determines how many parking spaces are available in a specific location at a particular time of the day.

Table: Shows the methods used in smart parking system; advantages & disadvantages

S. No.	Authors	Methods	Advantages	Disadvantages	Gap
1	Evangelos A. et al; 2011 ¹⁷	RFID and smart object-based infrastructures	The proposed architecture is based on a layered lightweight and open middleware solution following the paradigm of Service Oriented Architecture and the Semantic Model Driven Approach,	Many challenges have been identified by the research community, including interoperability, security and privacy, reliability, energy constraints, scalability, and lack of common standards	1) evaluating the proposed infrastructure in terms of scalability, adaptability and performance maximization 2) extending the social scope of the proposed architecture by studying the human-object interaction, especially in social network environments.
2	Somayya Madakam, ¹⁸	IoT Literature Survey	Achieved Improved productivity. Improved job satisfaction. Improved performance and better serviced customers	The main cons include complexity, compatibility, privacy concerns, lesser employment, and technology addiction. There is no standard definition in worldwide Technologies are varying from vendor-vendor, so needs to be interoperable.	Universal standardizations are required in architectural level For better global governance, we need to build standard protocols. Let us hope future better IoT
3	Mario Weber, et al; 2017 ¹⁹		Minimizes the human work and effort	Increased privacy concerns Increased unemployment rates	Managing Trust and Coordinating Interactions in Smart Networks of People, Machines and Organizations

4	Can Biyik et al; 2021 ²⁰	Smart Parking Ideas	Parking operators need to expand their revenue outlets by capitalizing on the possibilities of adopting the consolidated services that smart parking systems are making possible	High Maintenance cost	smart parking systems will improve parking system efficiencies by solving the issues that occur as a result of urbanization.
5	Sachin Kumar et al 2019 ²¹	IoT Litreture Survey	It helps us to Know the precise quantity of supplies or the air quality in your home, it can also provide more data that could not have previously been possible to collect easily	The enormous growth in number of connected devices. Availability of networks coverage. Security. Power consumption.	The importance of big data analytics is also discussed which can provide accurate decisions that could be utilized to develop an improved IoT system.
6	Jhonattan J. Barriga et al 2019 ²²	Smart Parking Technological Perspective Review	Obtained Smart cities use IoT devices such as connected sensors, lights, and meters to collect and analyze data.	Failed to include Effective and Efficient Data Processing and Analytics. ...	Smart Parking to propose a formal method to select a sensorbased on its technical features and the aim pursued
7	Jorge Lanza et al 2016 ²³	Service management satisfaction	Better Traffic Management. IOT smart cities can easily reroute hectic traffic with the use of new technology.	Security issues in terms of public data.	encompasses the development of a service to allow users to make smarter travel choices to get to their destinations, reducing the time spent driving through the streets and avoiding, as much as possible, congestion and occasional incidents on the streets

8	Amira. A. Elsonbaty et al 2022 ²⁴	Application	The system benefits from avoiding wasting time and reducing pollution and fuel consumption	Failed to maintain the whole database. Users have to spend 12 minute for booking the slot.	Reduce the Time Span for booking, Check-in & Check-out.
9	Sheng, N.W et al 2023 ²⁵	Smart Parking Ideas	The system benefits from avoiding wasting time for the professional ones.	The unwanted scenario may affect productivity,	Searching for available parking spaces becomes a daily challenge

The three sub-fields of this topic's research and study are as follows:

Indian parking troubles

- More than 40 million automobiles are in India.
- Low parking fees due to public demand.
- Poor enforcement of parking laws.
- The number of automobiles is increasing daily.
- Pavements are not a good setting for walking.

In India, parking solutions are already widely used. MLCPS, or multi-level vehicle parking system

Advantages:

- Space Utilization
- Low cost of building
- Low operating and upkeep costs

Disadvantage:

- Safety of the automobile [2]

Different types of modern parking solutions

- Standard Multilevel Parking
- Parking Automated Multilevel
- Wireless sensor networks are used in the smart parking system.
- Applications for Smart Parking Using RFID Technology
- GSM and RFID Car Parking System
- Image Processing for Multi-Level Car Parking

The vehicle will occupy the specific space that has been assigned, according to the work of Robin Grodi et al. [26]. RFID sensors can identify whether a car or other things are nearby. The system needs a mechanism to alert drivers or parking spot occupants when a vehicle is detected. The drawback is that because there is no GPS sensor to look for parking spaces from a distance, the parking spot will only be identified in surrounding locations.

Through the study of embedded sensors in smartphones and Bluetooth connectivity, Rosario Salpietro et al. [27] achieved automatic detection of parking actions carried out by the users. An adaptive technique enables the dissemination of the information over the target scenario once the parking event has been identified, employing a combination of internet connectivity to a remote server and device-to-device connections using wifi direct links.

Conclusion

A system is required where you can reserve your parking space which can assist you in finding nearby parking lots in your region. You can pay for things online as well. We therefore draw the conclusion that by putting the suggested approach into place, we will be able to cut down on time and traffic.

The issues that could arise when using the smart parking system and their remedies have been discussed, providing a solid foundation for all users. Smart parking system adoption ensures the comfort of living for people who struggle with daily tasks in day-to-day life. The approach we suggest gives real-time information about the number of parking spaces that are available in a parking lot.

By using our smartphone application, users can reserve a parking space for themselves. so that users can avoid spending time looking for parking space and searching that space inside the parking area which will reduce the time and fuel.

Arrival of automated vehicles (AVs) is anticipated to have a significant impact on the future of smart parking systems. Self-parking automobiles, specialized AV parking lots, and robotic parking valets are already being tested in a number of places around the world. With the automatic parking fee system, travelers may travel without carrying cash. Additionally, it would improve the effectiveness of the parking system and reduce waiting times, lengthy lines, tension, and stress. The fleet, ship, and airplane management systems can all be used with the smart parking management system. For domestic and residential parking systems, the device can be connected to home automation systems that can manage different home appliances by detecting when a person is leaving or entering a parking place.

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