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The Challenges of Smart Environments and Future Trends Supported by the Internet of Things

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Abstract
The internet of things (IoT) has become a popular technology for creating smart environments that offer convenient and efficient services to benefit society. These environments are available online but are vulnerable to attacks. The main aim of IoT is to create a virtual system allowing communication between people and devices, and among the devices themselves. However, many smart devices face problems such as limited memory, storage capabilities, battery capacity, and hardware resources. This study discusses applications of smart environments such as smart homes, parking, and traffic. Also, this paper offers several contributions. The first contribution, its highlights the challenges that need to be addressed when applications design and implemented. The second contribution is to identify ongoing problems in IoT and suggest future trends for researchers in the development these techniques that can positively benefit the community.

Keywords: IoT, Challenges, IoT Applications, Future Trends, Smart Environment

1. Introduction

The internet of things (IoT) refers to a network of devices that are connected to the internet and use sensors and software intelligence to exchange data. This connectivity allows for greater integration between the physical world and computer systems, resulting in increased efficiency, accuracy, and economic benefits. With the implementation of IoT technology, objects can be remotely sensed and controlled via the internet, with embedded computing systems that identify and interconnect with the current internet infrastructure (Tiwary, 2018; Alcácer, 2019) [26, 1]. Such as the use of a variety of communication technologie RFID, sensors, mobile phones, NFC, and other which enable multiple devices to connect and interact with each other. thus, This allows for the tracking of various IoT devices, and making our world increasingly smarter with the advent of new technologies (Tiwary, 2018; Malche, 2017) [26, 17]. The four components of the Internet of Things can be summarized in:

- IoT devices and sensors: A sensor is an Internet of Things (IoT) device that can recognize, quantify, and gather information from the real world, including things like light, movement, temperature, pressure, or other similar factors.
- IoT gateways: An IoT gateway functions as a link that connects sensor networks to cloud services. Its main role is to process the data collected by the sensors before transmitting it to cloud computing platforms.
- Cloud function: Cloud functions streamline the analysis and monitoring of IoT devices, which helps to minimize the time it takes to complete operations, curtail expenses, and decrease energy usage.
- User interfaces: The user interfaces in an IoT system are the physical components that users interact with. These interfaces allow users to access and manage the services they have subscribed to within the IoT system.as shown in Fig 1 (Bali, 2020) [4] presents a basic summary of the components of the Internet of Things:

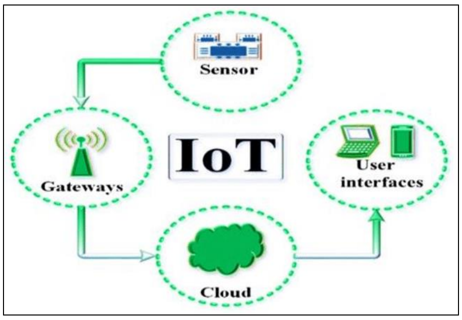

Fig 1: Elements of IOT (Bali, 2020) [4]

The technology known as the Internet of Things (IoT) is constantly evolving and has become increasingly popular for scientific and engineering applications. It allows for problem-solving without requiring actual physical interaction between human beings and machines. Thanks to advancements in internet technology, it is now possible to establish a more comprehensive network connection between different devices. Each device that is added to the network is referred to as a node within the IoT, and enables the sharing of various types of information in both directions. However, one potential problem that could jeopardize network security is tampering that occurs during transmission. For example, an attacker could add false information to a message during data transmission, and this could be a significant threat (Kadhim, 2019) [13].

Real-time systems require objects to have sensors, microcontrollers, communication components, and storage capacities with appropriate protocols. The Internet of Things (IoT) connects these objects, which we use daily, to enable new services for customers. Despite academic efforts in this field, this paper outlines research areas that require further exploration (Shouran, 2019) [22].

2. Application Areas

The vast potential of the Internet of Things is being explored in diverse fields. New applications are being developed which are making a difference to people's everyday lives and impacting the environments in which we live, work, travel, exercise and more. In each of these settings, there are various smart objects that are able to communicate with one another. The possibilities for future applications of IoT are numerous, such as in smart farming and animal management, energy monitoring, healthcare and transportation and so on as shown in Fig 2 (Talal, 2019; Risteska, 2017; Hassija, 2019) [27, 20,10]. However, in this paper, we selected several applications such as Traffic Smart, Smart Parking, and Smart Parking to discuss them in the next section.

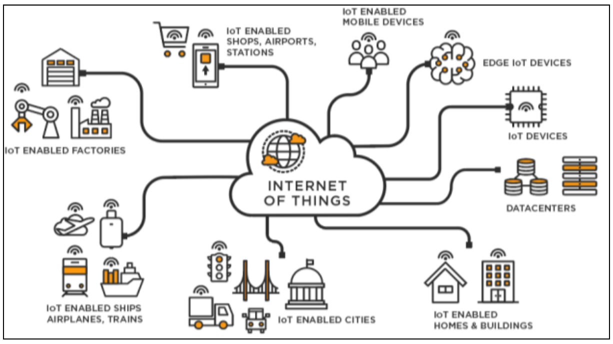

Fig 2: shows the application ares of IoT (Business, 2023) [5]

3. Smart Environments

This section presents a set of key features and services in smart environments. Although there are several types of smart environments, the focus on these environments includes smart homes, smart health, smart cities, and smart factories in this part, Most of the time, all individuals are able to share the data obtained by the internally connected devices with the cloud applications and other devices. These devices use every bit of data in our daily lives. The primary goal is to use different technologies to connect physical elements to the Internet. We can connect temperature, rain, humidity, and soil sensors to the internet. As a result, it is possible to memorize various types of information (such as temperature and humidity) and evaluate it later, and then make the necessary decisions and perform the necessary actions (Sharma, 2020; Anthi, 2019) [23, 3].

In this section, three types of smart environments are summarized: smart home, smart parking, and smart traffic.

3.1 Smart Home

The typical smart home system is made up of a number of apps that are built on top of a robust IoT infrastructure, it is also known as a connected house or smart home (Risteska, 2017; Mohammed, 2020) [20, 18]. A smart home consists of advanced automation systems that handle various tasks such as overseeing and managing household appliances, multimedia equipment, security systems, as well as controlling lighting and temperature settings from a remote location, the aim of this system is to raise living standards, security and safety while conserving resources and energy (Malche, 2017; Sobin, 2020) [17, 24]. however, the challenges of implementing smart homes can be simplified into designing practical solutions that prioritize efficient processing of data (Risteska, 2017) [20]. Although researchers have made significant effort to develop this area, they have not yet achieved an optimal system. Security experts are concerned about the potential risks posed by numerous connected devices that are not secure, as these devices can report whether data has changed. This presents yet another challenge that must be considered (Shouran, 2019; Kadhim, 2019) [22, 13]. This section presents some of the studies that contributed to solving one or more problems:

Anthi *et al* in 2019 (Anthi, 2019) [3] A supervised technique-based intrusion detection system consisting of three layers was developed to identify various cyber-attacks present in IoT networks. The first layer employs tools to scan the network and recognizes connected IoT devices based on their MAC addresses. The second layer categorizes packets from these devices as benign or malicious while the final layer classifies these malicious packets as one of the four types of attacks. The study demonstrated that the proposed system could detect network attacks accurately and achieve intrusion detection (IDS). However, IoT networks, being the most vulnerable and prime target for cyber-attacks, require more security protection due to their increasing usage in daily tasks and smart gadgets.

Jan *et al* in 2019 (Jan, 2019) [11] A supervised machine learning-based support vector device (SVM), SVM is utilized to detect an attempt by an adversary to insert redundant data into the Internet of Things (IoT) via a two-tier IDS (Intrusion Detection System) design. This system comprises two layers, the first being the training stage that utilizes a set of training data containing sample pieces. From this data, features are extracted to create a feature pool. In the second stage of this layer, the feature set is combined with the label vector to train the classifier. After the training, the unobserved test samples are run through the trained classifier to get classified. The same attributes employed in the training stage are applied to the test samples, and the classifier produces the expected outcomes. The performance of this classifier is evaluated in the evaluation stage using detection time and classification accuracy. The authors suggest a lightweight attack detection approach with an SVM-based classifier utilizing two or three straightforward features. The system used three features to obtain advantages in processing time. However, due to limited resources such as protocol, hardware, and battery capacity, traditional IDS methods for IoT may require modifications and optimizations. The proposed algorithm was trained and tested using online datasets.

Elsayed *et al* in 2021 (Elsayed, 2021) [7] The proposed model consisted of eleven layers, which were used to detect anomalies in smart home networks utilizing a bi-directional LSTM-based architecture. The data was not scaled or preprocessed before being fitted into the model, and for this reason, the batch normalization layer was used as the first layer in order to normalize each batch. To reduce computational costs and prevent overtraining of the model, the middle 1D aggregation layer was added as a second layer. Next, the model consisted of bilstm components with 1D convolutional layers, which were important in comprehending the temporal relationship between network flows and changing temporal dynamics. Finally, the softmax layer determined whether the input class was a typical network flow or an anomaly, triggering an action to prevent a flow attack within the network traffic.

The model was tested using the IoT intrusion dataset, which included 42 raw network packet files captured at various times. The results showed how accurately the model was developed and used to identify anomalies, determining the critical data features that primarily affect the anomaly-type detection extract from the model. This includes the originating IP address, the destination IP address, the destination port number, the time of the captured packets, and the normal and anomaly packets. The model also defined the categories of attackers into types such as mirai, dos, mitm arp, normal, and scan. It can be implemented and applied in the smart home network gateway to the decision-making alarm system that either automatically controls the smart home. Nevertheless, due to the rise in security concerns, IoT devices can create backdoors into network data that hackers can exploit.

3.2 Smart Parking

The number of customers' vehicles has increased and with the growth of the Internet of Things, smart cities have gained popularity. IoT is addressing traffic congestion, limited parking, and street security. To mitigate these issues, various parking management systems have been established to reduce traffic problems and enhance car usage convenience. A smart parking system is created by combining smart phones, wireless algorithms, and mobile applications.

The Internet of Things began with personal communication devices that could be monitored and operated from remote personal computers linked to the Internet. However, these conveniences come with significant security concerns that are growing rapidly. Thus, sensors are being installed in the parking lot, available via the mobile application to help users locate vacant parking spaces (Elsonbaty, 2020; Chettri, 2020) [8, 6]. This section presents some of the studies that contributed to solving one or more problems.

Ghulam *et al* in 2020 (Ghulam, 2020) The available parking prediction system was developed using the architecture of the parking system. This system collects parking data from various sensors across different locations, these sensors are spread across the parking location to collect data on available spaces. The collected data is then stored in the cloud and deep learning techniques are used to analyze this data and determine the free parking spaces available. The proposed system has four layers, which include the sensor layer, communication layer, processing layer, and services layer. The sensor layer is responsible for collecting information about the movement of cars from different locations. The information is then transmitted to the gateway using the LoRaWan protocol which is known for its energy efficiency and long-range capabilities. The Message Queuing Telemetry Transport (MQTT) protocol is then used to transmit the information from the gateway to the cloud. The final layer uses a deep learning approach to make decisions about available parking spaces at different locations. This information is then sent to end-user devices which helps to reduce traffic congestion and fuel consumption while searching for available parking area. The researchers used the proposed algorithm using Birmingham parking dataset, which was collected from 30 car parks in Birmingham.

Gopal *et al* in 2019 (Gopal, 2019) [9] Intelligent parking system has been constructed thats consists of three different layers. The first layer operates with the physical equipment, including an arduino microcontroller and ultrasonic sensors installed in each parking space. The main job of this layer is to use sensors to identify parking spaces and determine if they are assigned, reserved, or available. The second layer is the communication layer, which includes a central server that interacts with the sensors of the first layer. The task of this layer is to receive the data collected by the sensors and send it to the cloud software for processing. The processed data is made available to the user through a web application, which is the third layer and is referred to as the presentation layer. The aim of the parking system is to reduce the amount of time drivers spend searching for parking spaces, checking availability, and reserving spaces. The system can, however, have a delay in providing the acquired data to the central server due to the sensors. The parking system can be further developed and improved by incorporating more payment services, security services, etc. For the system to be more efficient, the integrated sensors need to be pre-set according to the parking area infrastructure.

Mufaqih *et al* in 2020 (Mufaqih, 2020) [19] The smart parking system is built on a three-layer architecture. The first layer uses infrared parking sensors to detect the availability of parking spaces. When a space becomes available, the system indicates the same by turning on a green light, and a reserved space displays a red light. The second layer includes mobile and web applications used by customers to reserve parking spots, check availability, and pay fees. The third layer is hosted on the cloud and monitors all system activities. The system hardware includes gateway devices like raspberry pi, sensors, desktops, and laptops. The raspberry pi connects to the cloud server to transmit information between users and systems. The proposed system offers an automated reservation system with cashless payment options for customers. It simplifies the reservation experience, optimizes the parking strategy, and reduces waiting times compared to valet parking. The proposed solution is applicable not only in malls but also in restaurants, tourist destinations, theme parks, and local markets. This study provides valuable insights for future research on parking issues in various other locations.

3.3 Smart Traffic

Traffic congestion in cities is becoming more problematic, which is causing concern. The Internet of Things (IoT) is a technology that utilizes sensors and cloud-based algorithms to monitor and manage traffic. In this process, traffic cameras play an essential role, along with other technologies, such as using Wi-Fi, Bluetooth, and Zigbee signals from smart devices in cars to analyze traffic patterns. By gathering data on the number of vehicles on the road, we can use sensor-based technology to divert or reroute vehicles to reduce congestion on the highway (Ramesh, 2020) [21]. In this section, we examine some studies that have helped solve one or more transportation problems.

Javaid *et al* in 2018 (Javaid, 2018) [12] To improve traffic flow, a combined decentralized and centralized approach can be used. A hardware system including cameras, sensors, RFIDs, and smoke sensors, as well as an AI-based algorithm, is proposed to predict and manage traffic congestion while prioritizing emergency situations. The system also utilizes the blob detection algorithm on local servers to optimize traffic flow. Ultrasonic sensors are used to enhance accuracy in measuring traffic density by emitting a sound wave of a specific frequency and listening for its return. The aim of the system is to calculate traffic density levels and adjust traffic signal timing accordingly. In emergency situations, such as when an emergency vehicle is detected, normal traffic operation is suspended, and the signal turns green for that vehicle to pass through. This system is also capable of managing emergency situations like fires or smoke detected on the road.

Khan *et al* in 2020 (Khan, 2020) [15] A traffic control system that utilizes an unmanned aerial vehicle (UAV) and 5G technology has been created. This system consists of three layers and a base station, each with unique properties and contributions to the overall system. The first layer involves the use of a surveillance drone to scan highway traffic for speeding and other traffic violations. The drone's high-tech camera detects speed and other violations in real-time. The second layer serves as the connection between the initial layer and the base station, which contains telemetry equipment and communication technology such as radiocommunication or 5G. By using UAVs, this system provides a wide range of access areas for data collection, real-time monitoring of traffic accidents, and the monitoring of all vehicles and pedestrians in a specific section of road for speeds and accelerations. Despite some limitations and small-scale tests worldwide, the proposed algorithm utilizing the general authority of statistics dataset showed a reduction in the number of road accidents, resulting in fewer casualties and deaths.

Sarrab *et al* in 2020 (Sarrab, 2020) [25]. The proposed system uses an IoT-based architecture to collect, process, and store real-time traffic data. The communication system comprises roadside components and a central server based on cloud computing. The components include a geographical map, various sensors, a microcontroller, an IoT platform, a database, and electronic display units. The central server provides data storage, cloud services, and interfaces. Communication between components is established through WiFi. An IoT-based architecture typically consists of a sensing layer, network layer, service layer, and application layer. The sensing layer gathers information from things or devices, the network layer transfers that information to the service layer, the service layer manages the devices and analyses the data, and finally, the application layer displays the user interface. In this system, the magnetic sensors capture real-time vehicle data to estimate vehicle length and detect vehicles. The predicted vehicle speed is used to calculate the vehicle's length by measuring the vehicle's magnetic length as a disturbance in the earth's magnetic field. This length (VML) is then used to calculate the vehicle's physical length.

There are a few shortcomings in the system that require more attention. One of them is that the proposed system relies on Wi-Fi to connect devices, but this study does not take into account the energy costs or methods to recharge the devices. Future research could explore alternatives such as solar charging or charging from lamps. Additionally, the system was only tested on a single-lane road, and to improve the accuracy of the detections, it would be beneficial to test in a multi-lane environment. The focus going forward will be on improving the system by providing drivers with recommendations for the best route based on real-time data. There will also be an emphasis on real-time implementation of IoT security measures in the communication layer. The integration of IoT security, inter-display communication, and traffic signaling will be examined in future studies.

All the work done by the researchers is summarized in Table 1.

Table 1: Description of related work

Research	Years	Research Direction	Dataset Used	Model Proposed
Anthi	2019	Smart Home	Collection and classification	A three-layer intrusion detection system (IDS)
Jan	2019	Smart Home	Online dataset	Supervised Machine learning- based Support Vector Device (SVM)
Elsayed	2021	Smart Home	The dataset available on the IEEData port	Eleven-layer detection using BiLSTM- based model
Ghulam	2020	Smart Parking	Birmingham parking data	Four-layer architecture system
Gopal	2019	Smart Parking	Collect and analyze	A three-layer SPS framework
Mufagih	2020	Smart Parking	Collect and analyze	Three-level smart parking architecture system
Javaid	2018	Smart traffic	On real traffic data	Hybrid approach (centralized and decentralized)
Khan	2020	Smart traffic	General Authority of Statistics	Unmanned Aerial Vehicle
Sarrab	2020	Smart traffic	Collect and analyze	Real-time traffic monitoring system

4. Discussion

In the field of smart homes (Anthi, 2019) [3] a three-layer method has employed a for intrusion detection and developed an online model of data. They evaluated the system using the nsl-kdd dataset. The decision tree algorithm successfully classified devices, but the confusion matrix revealed that the classifier made errors in classifying devices. This suggests that the proposed system needs further development to improve the classification results

In (Jan, 2019) [11] The system has developed a SVM-based classifier that uses only three features instead of 40 from the Cicids 2017 dataset. This has several advantages, including reducing processing time, lowering detection display time, and simplifying the SVM's complexity by using fewer input features. However, one drawback is that the algorithm may not be able to detect overlaps, which could affect a node's traffic density. The algorithm using 40 complex features may be better suited to detecting complex overlaps.

In (Elsayed, 2021) [7]. The researchers utilized the bilstm-cnn hybrid model to identify attacks within IEEEDataPort dataset. The model has been demonstrated to be highly effective in detecting attacks accurately. However, there are growing concerns that may require the development of multiple models in the future to safeguard data against infiltration or sabotage.

In the field of Smart parking (li, 2020) [16] The researchers utilized algorithms that were based on the Keras deep learning framework to make predictions about the availability of parking spaces. They conducted three experiments to forecast parking space availability for a particular location, time and day. These experiments provided an overall perspective of parking availability across the whole city using a dataset of parking sensors in Birmingham. The main aim in the future is to develop actual prediction techniques to forecast parking spaces in real-time by employing sensors. However, there are limitations to the algorithm such as it only indicates the occupied parking spaces and does not indicate availability at a later time or consider weather conditions that may impact the performance of the sensors

In (Gopal, 2019) [9] The researchers used a smart parking that built on an architecture called Smart Parking System Framework (SPSF). With this system, users can check for available parking spaces and reserve them in advance. This reduces the time it takes to find a spot. However, there are limitations to the system's performance that should be considered, such as the sensors used to detect available spaces. These sensors may have delays in providing accurate information, which is one of the key drawbacks that the authors highlighted in their study.

In (Mufaqih, 2020) [19] the researchers used the smart parking system, which consists of sensors and a cloud, and this program allows solving many problems of losing paper tickets, facilitating non-cash payment, and reserving parking spaces before arrival, and this solves a group of problems that are represented by delays in finding an available parking space, loss of coins or loss of paper tickets, and this It leads to a loss of time.

In the field of Smart traffic (Javaid, 2018) [12] The researchers utilized an advanced system to monitor heavy traffic by implementing intelligent methods that forecast the level of congestion on actual roads to stipulate the movement of cars, and to enable emergency vehicles like fire trucks or ambulances to move smoothly. They counted on several modern technologies such as cloud computing, RFIDs, GPS, wireless sensor networks (WSN), proxy servers, and other technologies to gather, regulate, preserve and supervise transportation. Additionally, it provides a comprehensive perspective of the data, which could offer valuable insights for local officials for future roadway planning to prepare for the growth in population and urban development.

In (Khan, 2020) [15] The researchers have presented Al-Saher system, which is primarily composed of cameras and is assisted by License Plate Recognition (LPR), is a vehicle movement control system that has been successful in reducing the number of daily road accidents that result in injuries and damages - but not to a significant degree. Drivers have discovered ways to exploit the system's static nature, as the camera distribution is not comprehensive. As a result, researchers have explored alternate methods of monitoring and mitigate traffic violations. This new system uses drones to overcome the gaps and prevent injuries and fatalities from traffic accidents. Overcoming these gaps is expected to result in a reduction in the number of accidents.

In (Sarrab, 2020) [25] a system was developed using sensors, processing devices, and application services to estimate the speed of vehicles on single-lane streets. The system was tested and proved effective, but it still has some areas for improvement such as the energy consumption for sensors and finding alternate ways to recharge them for multi-path usage.

Table 2 lists the advantages and disadvantages of this smart environment. Further development is needed to address these issues and optimize the system for real road usage.

Table 2: Comparative Analysis

S. No	Years	Methods	Advantages	Disadvantages
1	2019	Correlation Attribute Evaluation Filter and Gain Ratio Attribute Evaluation Filter provided in Weka.	Can distinguish between IoT devices and detect the attack	It is difficult to access many attacks
2	2019	machine learning-based support vector machine (SVM)	Less processing time classification accuracy	- Limited battery capacity - Hardware with limited resources - Protocol-specific memory
3	2021	BiLSTM-CNN based Model	- Determine the type of attackers - Can use in a decision-making alarm system	Security concerns
4	2020	Deep Long Short Memory Network	- Introduce details information about vehicles in the parking IoT - Reduce traffic congestion and fuel consumption	- Hard to monitor in the parking lots of critical nature, work places, and residence - Safety issues
5	2019	- Wifi- direct technology	- Less time for a driver	- Delay sending data to the server

		- Long ranvailge using the internet	- Check availability - Making parking reservation	
6	2020	AWS IoT platform	- Making parking reservations without using people - Reduce waiting time - Less expensive alternative to valet parking - Solve lost tickets - easier for customers	- Applied this system in a shopping mall and not applied in other locations
7	2018	Regression Tree algorithm	- Calculate the level of density according to the traffic congestion	- Reading may change with the change in temperature and humidity
8	2020	SAHER system	- Real-time monitoring of all vehicles	- Very small test - Limitations to the use of drones
9	2020	WiFi technology	- Real-time vehicle data captured - Estimate vehicle lenght	- Do not perform for vehicles of length - Energy consumption

5. Future Trends

This section presents several significant findings opportunities for future researchers, various problems, challenges, and gaps that could not be solved and that were discovered by analyzing the systems studied by the researchers in this paper. Some potential areas for future research include:

1. Employing smart parking applications that incorporate weather conditions and parking occupancy data.
2. Creating a recommending system for reducing traffic congestion by considering uncertainty estimates when searching for available roadside parking spots.
3. Finding alternative solutions to street lighting charging by incorporating sensor devices or solar charging to decrease energy consumption.
4. Developing IoT security features between display units and traffic lights, as some studies showed little interest in this area.
5. Improving smart home systems by creating a decision-making alarm system that can automatically control home.

6. Conclusion

The internet of things (IoT) refers to physical objects that are equipped with sensors, software, processing ability, and other advanced technologies, allowing them to communicate and exchange data with other systems and devices via the internet or other communication networks. This research focuses on the most important technologies within this field, such as smart homes, smart parking, and smart traffic, and highlights efforts made by researchers in this area. The review discusses important inferences drawn from this research, which may help future researchers to develop smarter systems to support IoT applications. Furthermore, this study identifies and reviews current problems and challenges that still exist in the field despite significant research efforts. It provides insights and indicates new directions that may lead to optimal solutions to these problems or development of IoT technologies.

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